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Pediatric Diabetic Ketoacidosis Fluid Composition and Rate in Care of Type 1 Diabetic Patients

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DOCTOR OF NURSING PRACTICE (DNP)

FINAL DNP PROJECT MANUSCRIPT FOR

PEDIATRIC DIABETES

Pediatric Diabetic Ketoacidosis Fluid Composition and Rate in Care of Type 1 Diabetic Patients

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Abstract

Objective

Complications of diabetic ketoacidosis (DKA) include iatrogenic hyperchloremia and acute kidney injury (AKI). The objective of this study was to evaluate the association of decreasing sodium chloride (NaCl) composition in standard DKA fluid resuscitation and the rates/severity of hyperchloremia and AKI in pediatric patients.

Methods

In December 2020, Children's Hospital and Medical Center (CH&MC) changed the standard base composition of DKA fluids from 0.9% to 0.675% sodium chloride (NaCl) and increased the fluid resuscitation rate for patients over 30kg as a quality improvement project. A retrospective chart review analyzed patients admitted with DKA from January 2019-December 2021, excluding patients <30kg. The primary outcome was the rate and severity of hyperchloremia. Secondary outcomes included frequency of AKI, as defined by KDIGO AKI guidelines, hospital length of stay (LOS), and duration of intravenous insulin drip. Outcomes were compared between study periods using chi-squared tests (categorical) and Wilcoxson rank-sum tests. To account for existing time trends, outcomes were also analyzed using interrupted time series models comparing each outcome by study period with quarterly intervals using R version 4.2.2.

Results

There were 345 patients included in the study, 183 in the baseline group (0.9% NaCl) and 162 in the intervention group (0.675% NaCl). No differences in severity of acidosis based on pH, bicarbonate, or GCS scores were noted between groups. No difference in rates of hyperchloremia between the intervention and baseline groups were observed (144 [79%] vs. 122 [75%], p=0.52).

Rates of AKI (28 [16%] vs. 18 [11%], p=0.34), hospital LOS (hours) (51.2 vs. 55.0, p=0.35), and insulin drip duration (minutes) (825.0 vs. 852.0, p=0.67) were reported.

Conclusion

In pediatric patients with DKA, decreasing NaCl concentrations to 0.675% does not appear to play a significant role in the reduction of hyperchloremia and AKI when compared to 0.9% NaCl concentrations. Increased fluid resuscitation rates may have impacted the total chloride delivered to the patient despite decreasing the NaCl composition.

Introduction

Type one diabetes is a lifelong disease and can cause many complications if left unmanaged. There are 1.6 million Americans that live with type 1 diabetes (T1D), with more than 200,000 pediatric patients under the age of 20 years old. The United States health care expenditures and loss of income annually to T1D is $16 billion [1]. Diabetic ketoacidosis (DKA) is a common complication of type 1 diabetes especially in newly diagnosed patients or uncontrolled blood sugars in known diabetics. Younger type 1 diabetics have a much higher rate of DKA admissions [2]. The increased admissions to the hospital for DKA equates to higher medical costs for both the country and the families of the patients. DKA admissions have greatly increased from 2006-2016, however this also coincides with rising prevalence and incidence of type 1 diabetes. The estimated number of young people from 0-19 years of age with type 1 diabetes increased from 148/100,000 in 2001 to 215/100,000 in 2017 [3]. The peak of admissions for DKA seems to be in adolescents, which is consistent with previous findings and can be somewhat explained by the worsened glycemic control due to transitions in their body and mind. The cost for admissions and care of patients with DKA is rising in the United States and there are

increased cost for patients and families out of pocket expenses. On the other hand, insulin cost has been on the rise in the last few years and can correlate to poorly controlled glycemic control which in turn can lead to DKA admission. This is a vicious cycle that needs to be addressed and there are programs out there that have been attempting to make caring for diabetes more manageable [2]. However, we looked at the areas of complications and examined ways of preventing extra complications that can accompany DKA and prevent longer hospitalizations along with fewer medical needs later. If a patient has a complication from DKA such as acute kidney injury (AKI), their hospital stay could in turn be longer resulting in higher costs and more health issues for the patient. Huang [4] found that of their studied participants of pediatric DKA patients 56.5% of patients suffered from some form of AKI.

When examining fluid composition and rates there is a lot to consider. Upon examining the research, it was recommended that normal saline 0.9% should be given as a 10-20mL/kg bolus over 1-2 hours and could be repeated if necessary to restore hydration and circulation. It was then recommended to use 0.45% or 0.9% saline with glucose, and electrolytes in the fluid to replace what was lost over 24-48 hours [5]. Children's Hospital and Medical Center (CH&MC) in Omaha Nebraska has adapted some of these guidelines in caring for DKA patients in the hopes of preventing complications such as AKI that can accompany DKA. At CH&MC, a 10mL/kg 0.9% saline bolus is given over an hour and then two times (2x) maintenance rate is utilized to resuscitate with a 2-bag system. The 2-bag system consists of a dextrose bag (D bag) with 10% dextrose (D10), 0.675% saline, 20 milliequivalents (mEq) potassium phosphate (Kphos) and 20 mEq potassium acetate (K acetate) along with the saline bag (S bag) which is the same composition minus the D10. The CH&MC pathway switched from using 0.9% saline to 0.675% saline on December 14, 2020.

The problem statement for this proposal was: In pediatric type 1 diabetic patients admitted with DKA >30kg, what is the effect of sodium composition and rate of fluid resuscitation when utilizing the International Society for Pediatric and Adolescent Diabetes (ISPAD) DKA guidelines on patient outcomes (i.e., hyperchloremia, kidney injury, etc.) compared to standard fluid resuscitation (i.e., isotonic/hypertonic crystalloids) during hospitalization? The purpose of this study was to compare labs such as chloride, creatinine, glomerular filtration rate, and others between the 0.9% saline pathway to the 0.675% pathway to identify the change in results related to decreasing the sodium chloride in the fluid composition.

A common theme in the literature was related to the crucial impact of fluid composition for patients hospitalized for DKA on electrolyte levels. According to Wolfsdorf [5], hyperchloremia is associated with the use of highly chloride-rich fluids along with the preferential renal excretion of ketones in the diabetic population. Increased chloride levels have been associated with increased risk of AKI when patients are resuscitated with 0.9% normal saline [6]. Hyperchloremia induces an acidifying effect that can mask the resolution of the patient's ketoacidosis. For this reason, b-hydroxybutyrate (BOHB) levels should be monitored to determine the success of treatment [5].

Potassium and phosphate can be added to fluids to prevent major complications such as metabolic encephalopathy, respiratory failure, and impaired myocardial contractility. Potassium is replenished with additives in the fluids as well as insulin administration to encourage the cellular shift to return to normal. However, insulin administration may exacerbate depleted phosphate levels and lead to serious complications if not replenished adequately. Calcium levels need to be monitored closely with the administration of potassium and phosphate additives [5].

Rewers [7] discussed findings from a randomized control trial where children were assigned groups where the authors compared 0.90% and 0.45% saline as well as rates of administration. The findings confirmed that chloride levels increased more rapidly with the 0.90% saline while the potassium levels decreased. An additional finding was hyperchloremic acidosis occurred more frequently in patients in the "fast" administration groups when compared to the "slow" administration groups. Although the faster fluid administration resulted in a more rapid anion gap and PCO2 normalization, hyperchloremic acidosis occurrence was increased [7].

Guidelines published by El Hussein & Kilfoil [8], address the shortened time to metabolic normalization in pediatric DKA patients in the USA. The guidelines are aimed at correcting dehydration, anion gap, electrolytes, and hyperglycemia using a two-bag system. The authors suggest a 20 ml/kg NS bolus to be given over the first 30 minutes and then recommend starting a 0.675% saline with potassium to run at 1.5 times maintenance. According to the authors the use of a two-bag system is a more efficient way to gain blood glucose control in pediatric patients [8].

As a result of a cohort study used as a secondary analysis of a multicenter prospective study, Myers [9], found that AKI may occur at a higher rate in children with more severe acidosis and circulatory volume depletion. The authors concluded that AKI may play a part in the multiple organ injury pattern involving the brain and kidneys during DKA [9]. According to Jayashree [6], the risk of AKI in patients presenting with DKA is likely increased with the administration of 0.9% saline due to the chloride content. According to the results of a respective chart review [10], findings showed that 64% of patients met the criteria set for AKI during their hospitalization. An even more concerning finding was that 65% of those patients met the criteria of severe AKI. The authors agreed with Myers [9], that the severity of dehydration and volume

depletion, along with severe acidosis was associated with severe AKI in pediatric patients with DKA [10].

We found an abundance of information related to cerebral edema throughout our literature search. We chose not to include these articles in our search due to the extreme rarity of the complication and the abundance of data already published. Our plan was to study all the factors including the different fluid composition and electrolyte additives as well as the rate of administration.

Methods

CH&MC was the setting utilized for this study. It was estimated that there are approximately 120-130 pediatric patients admitted per year for the treatment of DKA at this institution. We performed a retrospective chart review of patients admitted for the treatment of DKA after the implementation of the DKA pathway on January 1, 2019, and after changes to the pathway were made on December 14, 2020. Changes to the pathway included an adjustment to rate of fluid administration from 1.5 x maintenance to 2 x maintenance for patients >30 kg and a change in fluid composition from 0.9% saline to 0.675% saline. CH&MC and the 2018 ISPAD DKA Guidelines [5] both utilize the Holliday-Segar formula to determine maintenance fluid rates.

Since the December 2020 DKA pathway update involved a weight-based rate change, we focused on patients >30 kg as these patients receive fluid resuscitation at a faster rate. The inclusion criteria was patients weighing >30 kg admitted to CH&MC for the treatment of DKA after January 1, 2019. Exclusion criteria included patients who did not have a diagnosis of DKA, patients admitted for the treatment of DKA with a weight <30 kg, and patients admitted to CH&MC for the treatment of DKA prior to the initial DKA pathway implementation in January

1, 2019. This allowed us to focus on patient outcomes after the implementation of the pathway and compare them to patient outcomes after the DKA pathway update.

Subjects were enrolled on a waiver of consent as our research could not be practicably carried out without the waiver. We only reviewed retrospective data and did not enroll prospective subjects. Data was collected from EPIC data pulls and subject identifiers were removed. The only subject identifier collected was elements of dates (e.g., date of hospital admission/discharge). Our study was considered minimal risk as it was a retrospective data collection study. The only risk associated with our study was potential loss of confidentiality. While subject information was de-identified, there was still a potential for an unintentional release of patient information.

Interrupted time series (ITS) have been shown to be useful in assessing healthcare interventions at a specific time point [11]. The timepoints for our analysis began at the introduction of the DKA pathway, January 1, 2019, and after the pathway was updated, December 14, 2020. The intervention utilized for the ITS was the change in weight-based rate and fluid composition from 0.9% saline to 0.675% saline. We hypothesized that the change would follow the intervention immediately, however there would be a gradual slope change as opposed to a level change after the implementation of the intervention since the reduction in saline content was only by a quarter.

Lab Measures

The primary outcome for our study was, does the DKA pathway change in fluids reduce hyperchloremia? We hypothesized that the changes to the DKA pathway would decrease the incidence of hyperchloremia in this patient population. Secondary outcomes for our study consisted of a rate of improvement of acute kidney injury (AKI), reduction in hospital length of

stay (LOS), and reduction in duration of intravenous insulin drip. To determine if there were any differences in case mix/severity between the time periods, we reviewed lab values, including venous pH, Bicarb, Beta-Hydroxybutyrate (BOHB), chloride, and creatinine. We compared them between patients that were treated on the original DKA pathway and the patients treated on the updated DKA pathway. Lab values upon were collected at the time of hospital presentation and the maximum values in 24 hours. We compared the lowest GCS scores documented in the first 24 hours.

We utilized the definition of AKI and staging of AKI from the Kidney Disease: Improving Global Outcomes (KDIGO) AKI Guidelines [12]. The KDIGO Acute Kidney Injury Work Group [12] defines AKI as an "increase in serum creatinine ≥0.3 mg/dl (≥26.5 μmol/I) within 48 hours; or increase in serum creatinine to ≥1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or urine volume <0.5 ml/kg/h for 6 hours." The staging of AKI is divided into three stages. Stage 1 is defined as a serum creatinine 1.5-1.9 times baseline or ≥0.3 mg/dl (≥26.5 μmol/I) increase. Stage 2 is defined as a serum creatinine 2.0-2.9 times baseline. Stage 3 is defined as a serum creatinine 3.0 times baseline or increase in serum creatinine to ≥4.0 mg/dl (≥353.6 μmol/I). The KDIGO AKI Guidelines [12] also take urine output into consideration when defining and staging AKI, however for our study we did not focus on urine output as urine output may not be documented accurately for these patients as most did not have a catheter in place. We also used median normal value for the baseline as we were unlikely to have patient-specific baseline values.

Statistical Analysis

Bernal [11] stated that in order to analyze an ITS, three variables are needed. These were; time that has passed since the start of the study (T), the pre-intervention period (X_t), and the

outcome at time t (Y_t). To measure the time that has passed since the implementation of the DKA pathway, we utilized one month as the frequency for the data points are taken (T). Our pre-intervention period was defined as January 1, 2019 to December 13, 2020 (X_t). The outcomes we were interested in (e.g., incidence of hyperchloremia, rate of improvement of acute kidney injury, reduction in hospital length of stay, and reduction in duration of intravenous insulin drip) at time points were considered Y_t. We utilized the following segmented regression model for our analysis:

$$Y_t = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 + \boldsymbol{\beta}_2 X_t + \boldsymbol{\beta}_3 T X_t$$

The above regression model is explained by Bernal [11] as, "$\boldsymbol{\beta}_0$ represents the baseline level at T = 0, $\boldsymbol{\beta}_1$ is interpreted as the change in outcome associated with a time unit increase (representing the underlying pre-intervention trend), $\boldsymbol{\beta}_2$ is the level change following the intervention and $\boldsymbol{\beta}_3$ indicates the slope change following the intervention (using the interaction between time and intervention: TX_t)." (pg. 351-352). This model helped us determine the baseline values prior to the changes in the DKA pathway, changes after implementation of the intervention, and the level of change. Since we hypothesized that there would be a gradual slope change and not a level change, $\boldsymbol{\beta}_3 TX_t$ was excluded from the above formula as these values refer specifically to the level change. We felt that with a segmented regression model, we were able to find patterns and trends in patient outcomes prior to and after the changes in the DKA pathway. Minimum lab values and minimum GCS scores in the first 24 hours found to be associated with the outcomes of interest were adjusted to account for changes in mix between the study periods.

Results

A total of 345 patients were included in this study. The baseline group (0.9% NaCl) consisted of 183 patients, while the intervention group (0.675% NaCl) consisted of 162 patients. Two hundred twenty (63.8%) were non-Hispanic white, 57 (16.5%) were non-Hispanic black, 26 (7.5%) were Hispanic, 14 (4.1%) identified as other, and 28 (8.1%) were two or more races. One hundred sixty-three (47.2%) were female and 182 (52.8%) were male. The median age (IQR) of the patients was 14 (13.0 – 17.0) years. Patient weight ranged from 46.5 kg to 69.0 kg, with a median of 58.2 kg. The characteristics of patients treated for DKA during the study timeframes are listed in Table 1.

Clinical variables at patient presentation and during hospitalization, such as creatinine levels, eGFR, pH, bicarb, and GSC scores were also assessed and can be found in Table 2. There was no variability in the maximum (0.8 mg/dL, p = 0.84) and minimum creatinine (0.4 mg/dL, p = 0.26) between the groups. The eGFR at peak creatinine was slightly higher in the intervention group (122.6 ml/min/1.73m^2) versus the baseline group (117.9 ml/min/1.73m^2), while the eGFR at peak creatinine <75 ml/ ml/min/1.73m^2 was higher in the baseline group (11.7%) versus the intervention group (9.9%).

There were no differences observed between the first pH between the groups at 7.2 (p = 0.70), however the first bicarb result was slightly lower in the baseline group at 8.0 mmol/L and higher in the intervention group at 9.0 (p = 0.72). No differences in the minimum GCS in the first 24 hours were observed between the baseline and intervention groups (p = 1.00). There were slightly more patients in the intervention group (20.4%) with a GCS <15 during hospitalization, when compared to the baseline group (19.7%), however this did not reach statistical significance (p = 0.83).

Laboratory and outcome data for the study groups can be found in Table 3. There were no changes in the peak chloride between the baseline and intervention group and the median peak chloride level was 114 mmol/L across both groups (p = 0.38). Of the 345 patients in the study, 266 (77.1%) had iatrogenic hyperchloremia, 144 in the baseline group and 122 in the intervention group. While the rate of iatrogenic hyperchloremia was slightly reduced from 78.7% in the baseline group to 75.3% in the intervention group, there was no true significant change.

The ITS for the proportion of patients with iatrogenic hyperchloremia showed that there was a reversal of the upward trend, however the sample size was not large enough to state statistical significance (intercept difference: 49% 95% CI: -13 to 112%). The ITS for peak chloride levels were also not statistically significant. There was a significant upward trend in the baseline period flattened out in the intervention period (intercept change: 2.29 95%CI: -6.5 to 11.08). The ITS for iatrogenic hyperchloremia and peak chloride levels can be found in figures 1 and 2 respectively.

The presence of AKI was found in 46 (13.5%) patients in both groups. There were 28 in the baseline group and 18 in the intervention group. The rate of AKI was reduced from 15.5% in the baseline group to 11.3% in the intervention group. While there was a reduction in AKI, it did not reach statistical significance (p = 0.34). The ITS also showed that the rate of AKI was not reduced upon intervention (intercept difference: 0% 95%CI: -29% to 29%). Rates of AKI increased across both study periods with no difference in the rate of this increase (slope change: -2.7%, 05% CI: -6.7% to 1.2%). The AKI outcome data can be found in Table 3 and the ITS for AKI can be found in figure 3.

Hospital length of stay, treatment in the PICU, and insulin drip duration can be found in Table 3. The average hospital length of stay for both groups was 53.5 hours. Length of stay was

slightly shorter in the baseline group at 51.2 hours and longer in the intervention group at 55.0 hours. A total of 177 patients (51.3%) required treatment in the PICU. The rate of treatment in the PICU was slightly reduced from 51.9% in the baseline group to 50.6% in the intervention group. The average insulin drip duration for both groups was 829 minutes. The duration of insulin drips in the baseline group was 825 minutes, while the insulin drip duration in the intervention group was slightly higher at 852 minutes.

Adherence to the DKA pathway order set was also assessed. It was noted that adherence between both groups was high at 87.8%, however, it was slightly lower in the baseline group at 83.8% and increased to 92.6% in the intervention group. This was found to be statistically significant with a p-value of 0.013 (Table 3).

Discussion

While the power of our study was limited, it does not appear that decreasing to 0.675% NaCl in standard DKA fluid resuscitation played a significant role in decreasing hyperchloremia, and AKI rates as compared to 0.9% NaCl concentrations. Increased fluid resuscitation rates may have impacted the total chloride delivered to the patient despite decreasing the chloride composition. Looking at the results at face value there seems to be a positive change with decreased AKI and hyperchloremia rates in DKA patients receiving 0.675% NaCl compared to 0.9%, however when broken down and examined further there is no statistical significance in the rates. Due to limitations of the study, continued research is needed to decrease rates of hypochloremia and AKI while providing fluid resuscitation in patients with DKA.

The significance of the DKA fluid pathway study was to provide data to support the implemented pathway. Although the pathway is consistently used, no data collection or project

has been created to provide evidence on the success of the pathway. The chart review allowed for a thorough investigation on the impact the pathway has made on DKA treatment. Our data collection and project will provide confidence for staff members as they care for children by utilizing the steps in the pathway. The statistically significant change in the use of the pathway was a positive one, there may have been more education in place and exposure to the pathway in the intervention group which could contribute to the increased use.

The sustainability of the project has already been achieved due to the highly consistent use of the pathway. The DKA pathway currently has nearly 100% compliance at the CH&MC so data is widely available to be studied retrospectively. The use of our data may bring forward changes in the future to the pathway in order to have the best outcomes for patients.

The limitations of our study include limited sample size and time frame due to the single institution setting. Our data was also limited to patients >30 kg and we were unable to account for urine output. Future studies should be done to look at a larger population. In addition, research done at a facility utilizing the recommended 0.45% NaCl as compared to 0.675% may also be helpful to determine if there is a more significant role in decreasing hyperchloremia.

Future studies need to consider utilizing comparison of the recommended 0.45% NaCl to 0.9% NaCl as compared to the compromised 0.675% NaCl that this institute utilized. Increasing sample size through expanding this research into other institutions would also contribute to better results. Examining patients in the >30kg and <30kg would be recommended to get a more wholistic picture, along with limiting the change to just the fluid concentration and not the increased rate that was present in this study as well. Overall, there was no statistical change between the control and intervention group in hyperchloremia and AKI rates in patients >30kg.

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TABLE 1 Characteristics of patients treated for diabetic ketoacidosis during the study timeframes

Variables	Total (n = 345)	Baseline (n = 183)	Intervention (n = 162)	p-value
Race/Ethnicity				0.23
Non-Hispanic White, n (%)	220 (63.8%)	116 (63.4%)	104 (64.2%)	
Non-Hispanic Black, n (%)	57 (16.5%)	27 (14.8%)	30 (18.5%)	
Hispanic, n (%)	26 (7.5%)	16 (8.7%)	10 (6.2%)	
Other, n (%)	14 (4.1%)	11 (6.0%)	3 (1.9%)	
Two or More Races, n (%)	28 (8.1%)	13 (7.1%)	15 (9.3%)	
Gender				0.24
Female, n (%)	163 47.2%)	92 (50.3%)	71 (43.8%)	
Male, n (%)	182 (52.8%)	91 (48.7%)	91 (56.2%)	
Age (years), median (IQR)	14.0 (13.0 – 17.0)	14.0 (13.0 – 17.0)	14.0 (12.2 – 17.0)	0.88
Weight (kg), median (IQR)	58.2 (46.5 – 69.0)	58.8 (47.4 – 68.4)	57.5 (45.0 – 69.1)	0.49

Abbreviations: IQR, interquartile range

TABLE 2 Clinical variables at patient presentation and during hospitalization

Variables	Total (n = 345)	Baseline (n = 183)	Intervention (n = 162)	p-value
Max Creatinine in the First 24 hours	0.8 (0.6 – 1.0)	0.8 (0.6 – 1.1)	0.8 (0.6 – 1.0)	0.84
Minimum Creatinine in the First 24 hours	0.4 (0.3 – 0.5)	0.4 (0.3 – 0.5)	0.4 (0.3 – 0.6)	0.26
eGFR at Peak Creatinine (ml/min/1.73m^2)	120.9 (94 – 155.4)	117.9 (89.3 – 155.4)	122.6 (98.1 – 155.3)	0.63
eGFR at Peak Creatinine <75 ml/min/1.73m^2)	40 (11.7%)	24 (13.3%)	16 (9.9%)	0.40
First pH Result median (IQR)	7.2 (7.1 – 7.3)	7.2 (7.1 – 7.3)	7.2 (7.1 – 7.3)	0.70
First Bicarb Result	9.0 (6.0 – 13.0)	8.0 (6.0 – 13.0)	9.0 (6.0 – 13.0)	0.72
Minimum GCS in First 24 hours	15.0 (15.0 – 15.0)	15.0 (15.0 – 15.0)	15.0 (15.0 – 15.0)	1.00
Patients with GSC <15 during hospitalization	69 (20%)	36 (19.7%)	33 (20.4%)	0.89

TABLE 3 Study Outcomes

Variables	Total (n = 345)	Baseline (n = 183)	Intervention (n = 162)	p-value
Iatrogenic Hyperchloremia, n (%)	266 (77.1%)	144 (78.7%)	122 (75.3%)	0.52
Peak Chloride Level (mmol/L)	114.0 (110.0 – 118.0)	114.0 (110.0 – 118.0)	114.0 (110.0 – 117.0)	0.38

Acute Kidney Injury	46 (13.5%)	28 (15.5%)	18 (11.3%)	0.34
Inpatient LOS (hours)	53.5 (41.7 – 83.0)	51.2 (41.0 – 84.4)	55.0 (42.2 – 82.8)	0.35
Required Treatment in PICU	177 (51.3%)	95 (51.9%)	82 (50.6%)	0.83
Insulin Drip Duration (minutes)	829.0 (538.0 – 1,168.0)	825 (556.5 – 1,125.0)	852.0 (532.0 – 1,191.2)	0.67
DKA Pathway Order Set Used	303 (87.8%)	153 (83.6%)	150 (92.6%)	0.013
Abbreviations: LOS, Length of stay				

Figure 1

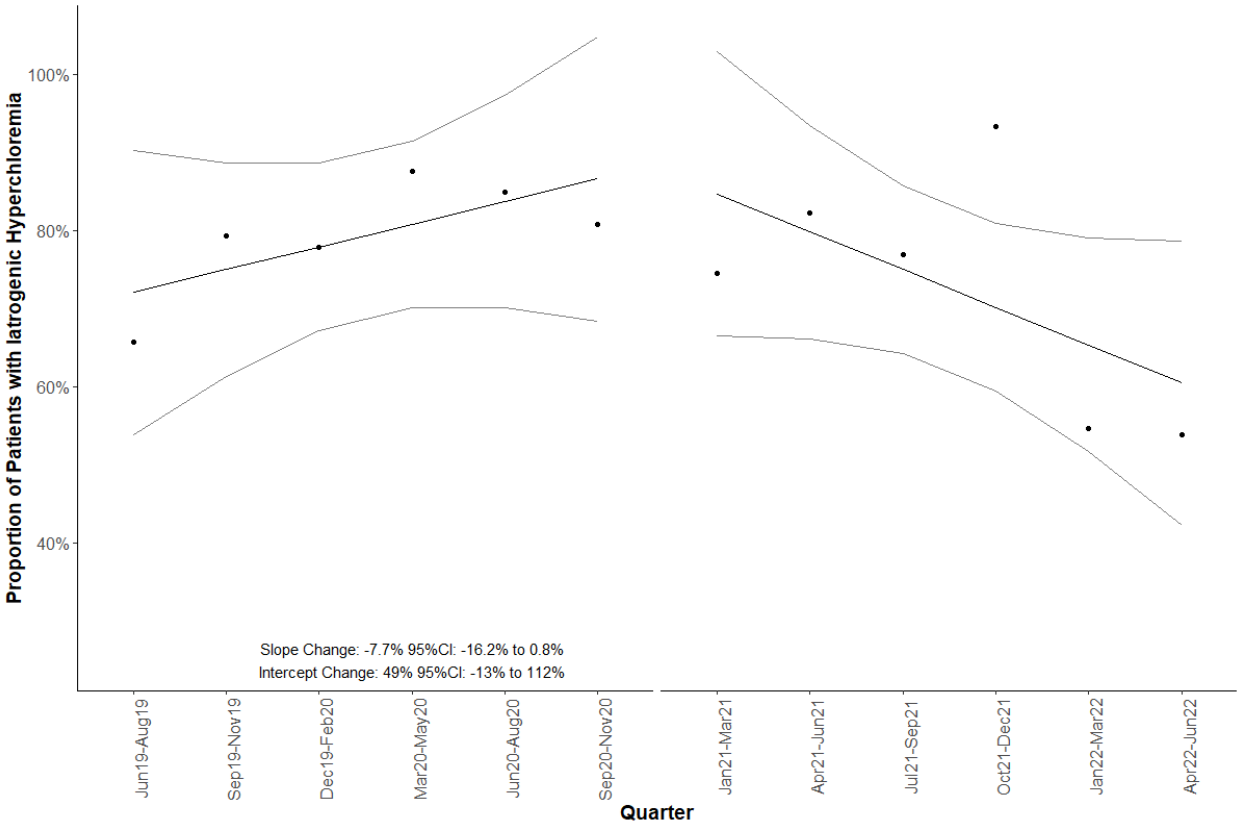


Figure 2

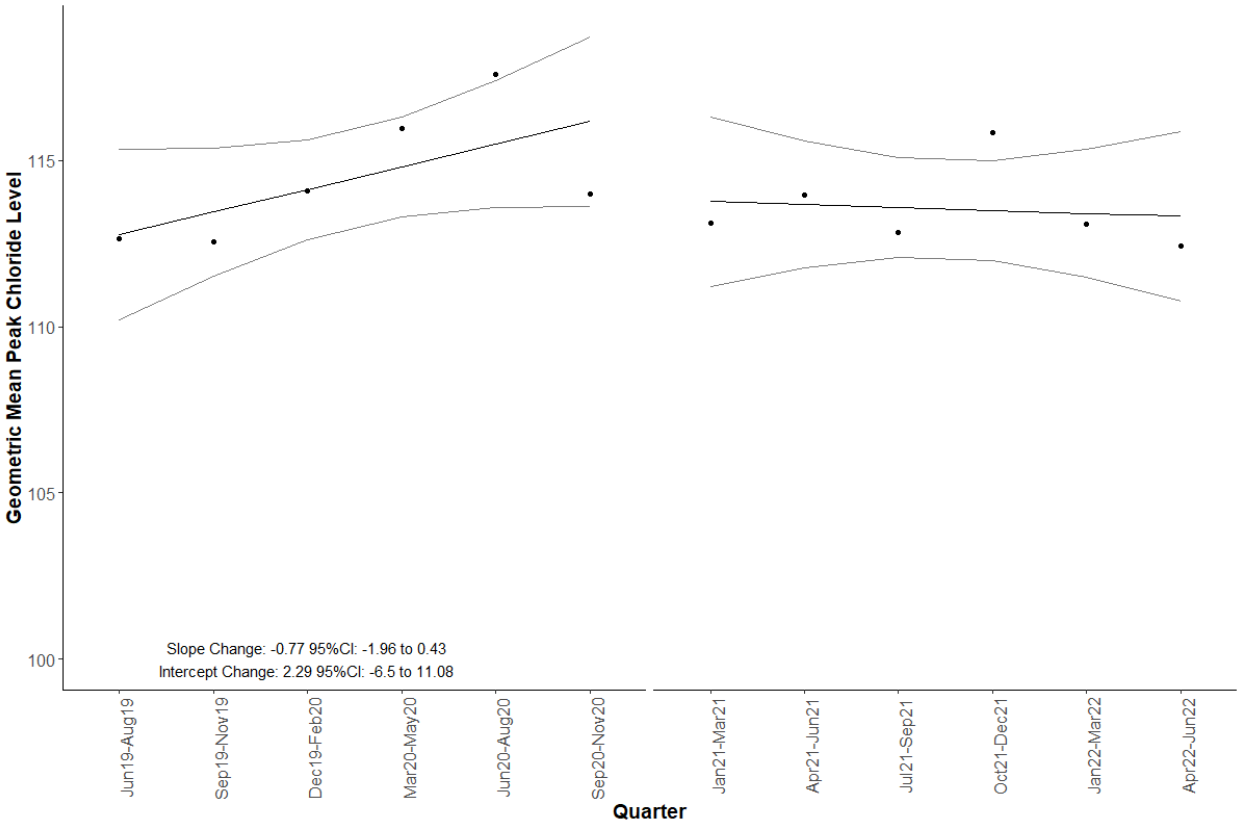
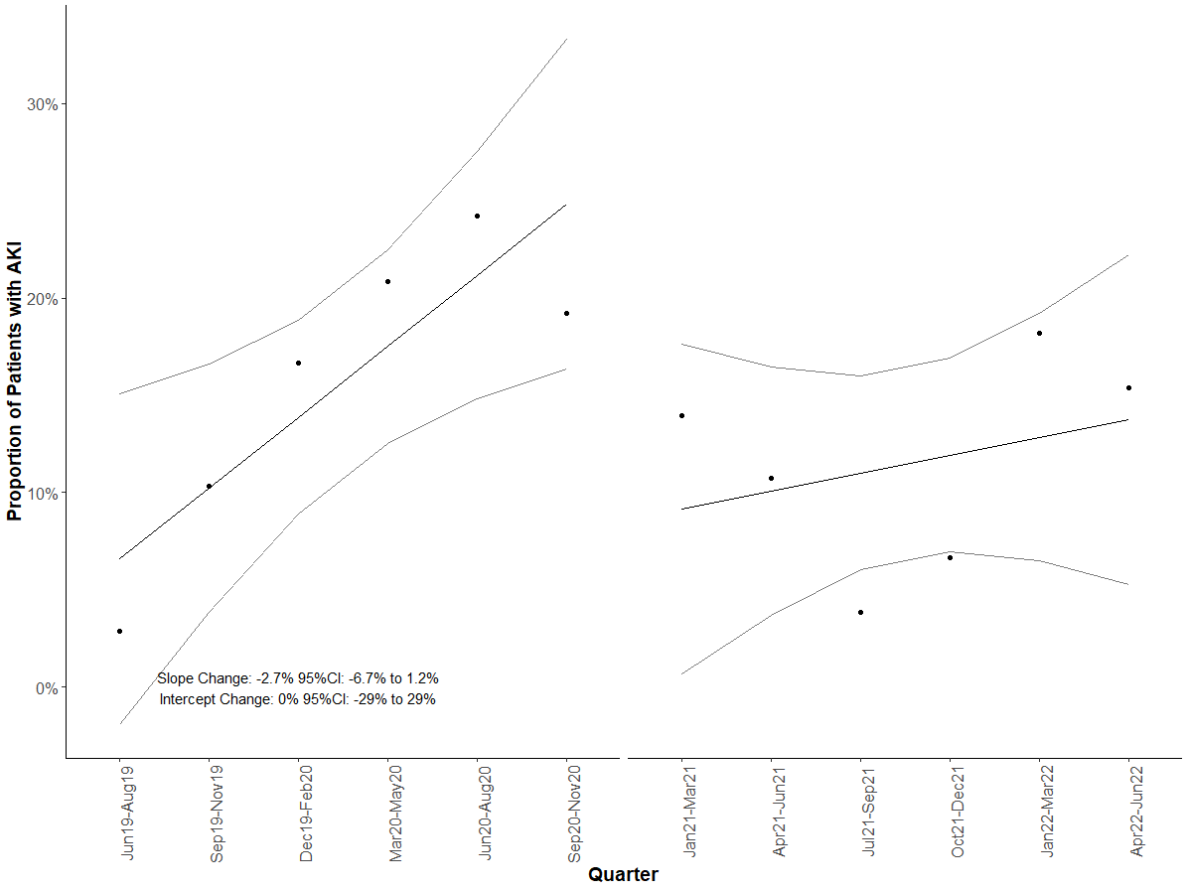

Geometric Mean Peak Chloride Level
115
110
105
100
Slope Change: -0.77 95%CI: -1.96 to 0.43
Intercept Change: 2.29 95%CI: -6.5 to 11.08
Jun19-Aug19
Sep19-Nov19
Dec19-Feb20
Mar20-May20
Jun20-Aug20
Sep20-Nov20
Jan21-Mar21
Apr21-Jun21
Jul21-Sep21
Oct21-Dec21
Jan22-Mar22
Apr22-Jun22
Quarter

Figure 3


Proportion of Patients with AKI
30%
20%
10%
0%
Slope Change: -2.7% 95%CI: -6.7% to 1.2%
Intercept Change: 0% 95%CI: -29% to 29%
Jun19-Aug19
Sep19-Nov19
Dec19-Feb20
Mar20-May20
Jun20-Aug20
Sep20-Nov20
Jan21-Mar21
Apr21-Jun21
Jul21-Sep21
Oct21-Dec21
Jan22-Mar22
Apr22-Jun22
Quarter