

Research Article

DOI: 10.29011/2574-7568.001081

Fixed Rate Insulin Infusion (FRII) vs Variable Rate Insulin Infusion (VRII) in Management of Patients with Diabetic Ketoacidosis (DKA)

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Citation: Paranthaman KS and Srinivasan B (2020) Fixed Rate Insulin Infusion (FRII) vs Variable Rate Insulin Infusion (VRII) in Management of Patients with Diabetic Ketoacidosis (DKA). J Diabetes Treat 5: 1081. DOI: 10.29011/2574-7568.001081

Received Date: 29 July, 2020; **Accepted Date:** 12 August, 2020; **Published Date:** 15 August, 2020

Abstract

Background: DKA is a serious acute metabolic complication among patients with diabetes, with mortality rates as high as 6-10 percent if not managed effectively. The current UK management guidelines for patients admitted with DKA is the FRII modality as compared to the VRII used previously.

Aim: This audit provides a head to head comparison between FRII and VRII in management of DKA and the impact on patient outcome.

Methods: Retrospective paired t-test comparison of patients on long acting insulin diagnosed with DKA before May 2014 (VRII protocol) with those after May 2014 (FRII protocol) was carried out. 11 patients were compared, with a total data set of 19 amongst them.

Results: When the FRII protocol was introduced, the performance on regular long acting insulin administration, regular CBG with ketone checks and door to insulin time was better as compared to the old protocol. The average length of stay in hospital was also lower in the FRII group as compared to the VRII group, with infusion rate per kg statistically significant ($p < 0.03$) for those above 75 kg.

Conclusion: FRII has played a key role in improving recovery time of patients admitted with DKA, especially in heavier patients (>75 kg).

Introduction

DKA is the most serious acute metabolic complication of diabetic decompensation among patients with diabetes, especially

those with Type 1 Diabetes Mellitus. The rate is estimated to be 13.4 episodes per 1000 patients-years in young persons with diabetes. Figure 1 denotes the general worldwide incidence of DKA [1].

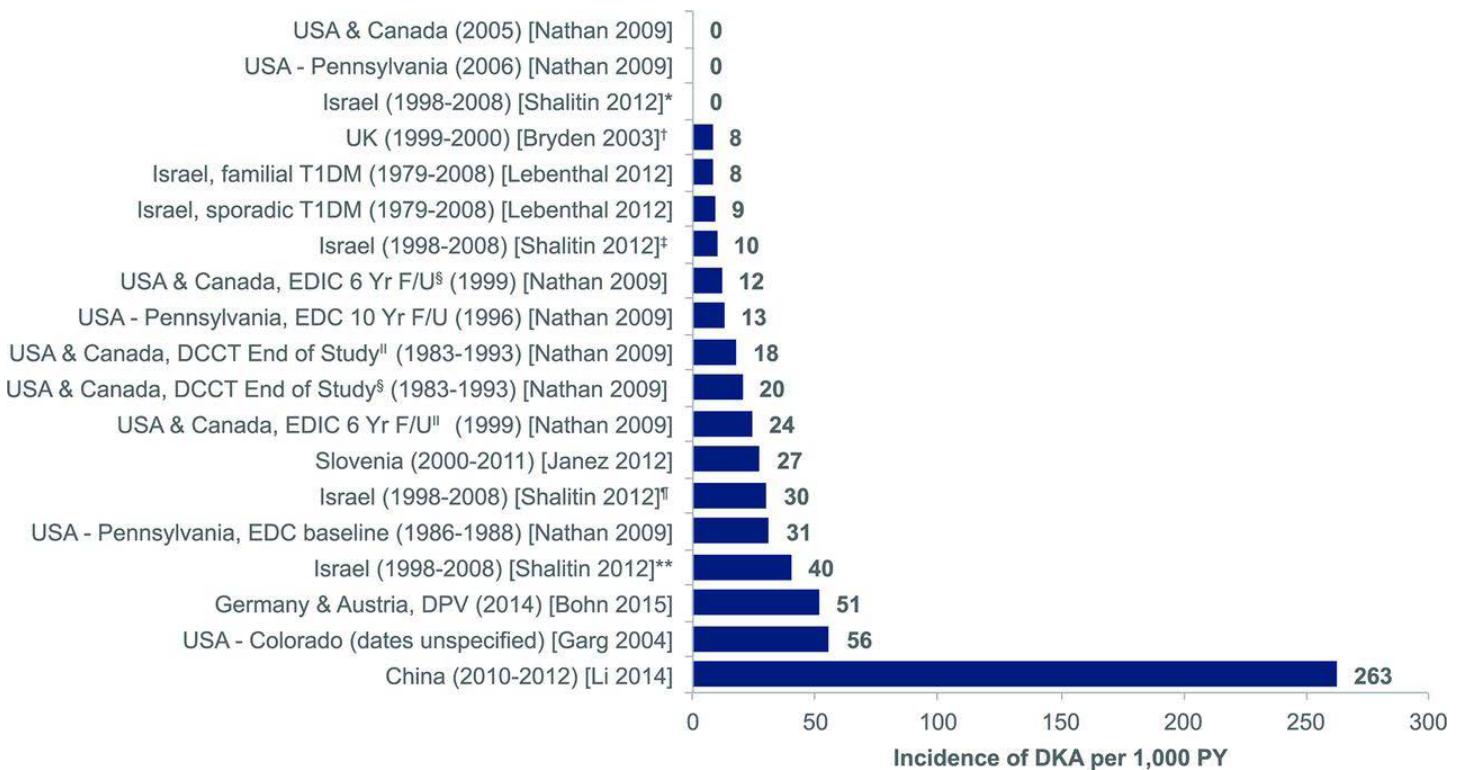


Figure 1: Worldwide Incidence of DKA [1].

It remains a serious medical emergency, with mortality rates as high as 6 to 10 percent if not managed effectively. For example, in children under 10 years of age, DKA accounts for 70% of diabetes-related deaths [2,3]. DKA is associated with insulin deficiency which can trigger hepatic glucose production and reduced glucose uptake, resulting in hyperglycemia, and can also stimulate lipolysis and ketogenesis, resulting in ketoacidosis. Both hyperglycemia and hyperketonemia will induce osmotic diuresis, which leads to dehydration [4].

One of the major risk factors involved is the poor adherence to insulin therapy, especially among young patients with Insulin Dependent Diabetes Mellitus (IDDM) [3]. In addition to that, infection is a well known precipitating factor in the development of DKA. In 20%–25% of cases, infections are the first manifestations of previously undiagnosed diabetes mellitus. In 2 to 10 percent of cases of DKA, no obvious precipitating factor can be identified [4].

There is general consensus that in the management of DKA, regular insulin should be administered by means of continuous intravenous infusion in small doses through an infusion pump which is now part of the current UK management guidelines as per NICE. Such low-dose insulin therapy provides insulin concentrations that are more physiologic and produce a more

gradual and steady fall in plasma glucose levels, and it decreases the risk of hypoglycemia and hypokalemia. As soon as hypokalemia (potassium concentration < 3.3 mmol/L) has been excluded, continuous infusion of regular insulin can be started at a dose of 0.1 U/kg per hour, which should produce a gradual decrease in the plasma glucose level of 3 to 4 mmol/L per hour, otherwise known as the FRII regime [4].

Overall, major emphasis is placed on the use of low-dose insulin regimens for the treatment of DKA. Low doses of insulin are as simple and effective as high doses and have fewer associated complications of hypoglycemia and hypokalemia [5,6].

Aim

This retrospective clinical audit looks at a head to head comparison of FRII against VRII in effectively managing patients with DKA, and if the effectiveness of either management protocol is dependent on patient weight, administration of regular long acting insulin and Capillary Blood Glucose (CBG) as well as ketone checks during treatment and time taken from patient admission and diagnosis of DKA to administration of fluids and intravenous insulin, and how it will impact patients outcome in terms of duration between stopping treatment and discharge, as well as overall total duration of stay in hospital.

Methodology

Retrospective paired t-test comparison of patients on long acting insulin admitted to LCH diagnosed with DKA before May 2014 who were treated with the VRII protocol with those after May 2014 who were treated with the FRII protocol when LCH adopted the new protocol as per national guidance. Retrospective data was collected between June 2009 and December 2015. During that period, 11 patients were compared, with a total data set of 19 amongst them (4 patients had 2 sets of admissions, 1 patient had 5 sets of admission and 6 patients had 1 set of admissions). The patients included 8 females and 3 males, ages ranging between 22 to 84 years. The assumption made is that patient weight does not differ between admissions before and after May 2014.

Results

The majority of 10 admissions noted that the patients weighed between 71-80 kg's, with mean weight about 74 kg's. When the new protocol was introduced, regular long acting insulin administration was done on 13 occasions, as compared to during the previous protocol in which it was only done on 6 occasions. Similar findings for regular CBG and ketone check during treatment, in which patients were tested on 15 different occasions after the new protocol was introduced, as compared to it only being done 4 times on the old protocol. Figure 2 provides a comparative bar chart representation of it.

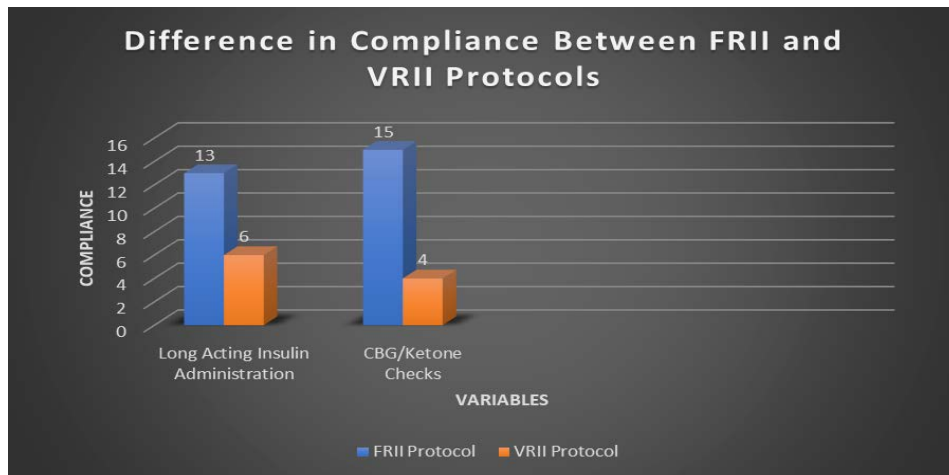


Figure 2: Compliance between FRII and VRII protocols.

In regards to the management of DKA, patients on the new protocol had an average door to insulin time of 101 minutes, as compared to 145 minutes on the old protocol. However, it was noted that the door to fluid time was on average better on the old protocol, as compared to the new protocol, 126 minutes to 195 minutes. Figures 3 and 4 denote this in line chart progression.

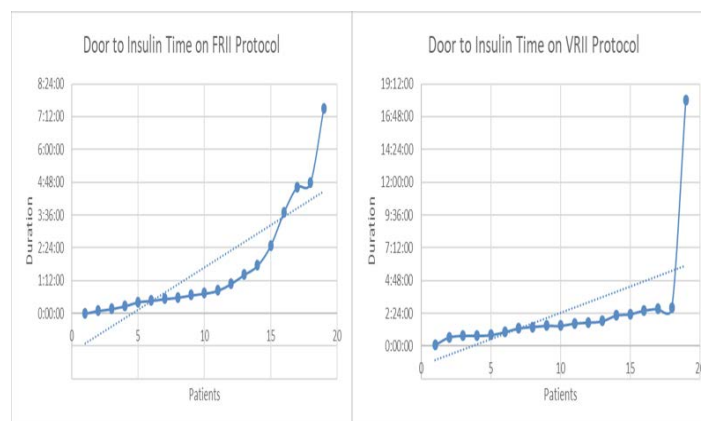


Figure 3: Door to Insulin Time Comparison between FRII and VRII Protocols.

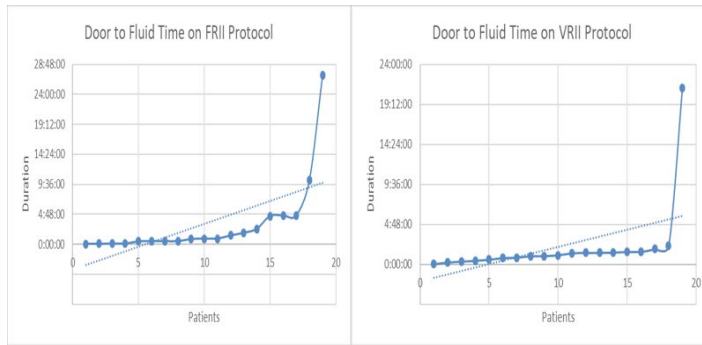


Figure 4: Door to Fluid Time Comparison between FRII and VRII Protocols.

The mean insulin duration for patients on the FRII was about 12 hours shorter compared to those on the VRII. This corresponds to the total insulin administered on patients on the FRII as compared to those on the VRII, 72 units to 112 units.

Nonetheless, the outcome noted that the average length of stay in hospital for patients on the FRII protocol was roughly 108 hours, as compared to those on the VRII protocol, which was roughly 130 hours, as depicted in Figure 5. This also corresponds to the duration of time between stopping the intravenous insulin infusion with date of discharge, which was about 79 hours for those on the new protocol and 84 hours for those on the old protocol.

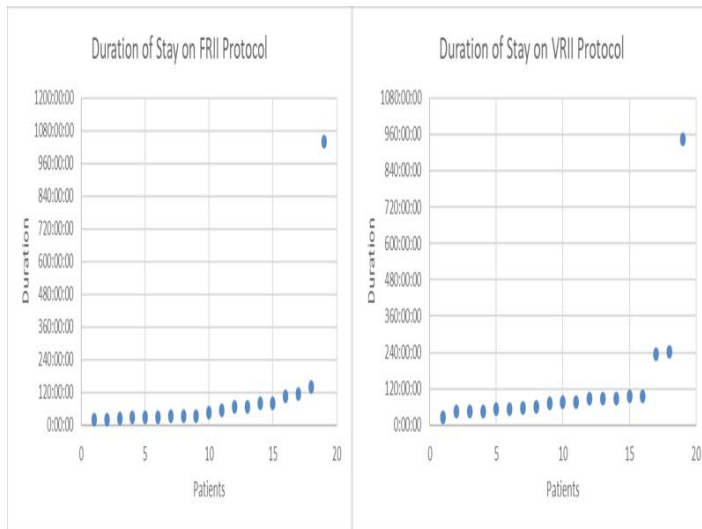


Figure 5: Duration of Stay Comparison between FRII and VRII Protocols.

Discussion

Despite the majority of admissions being on the higher weight range (71 to 80 kgs), it was noted that the mean insulin duration, corresponding total insulin administered, average length of stay in hospital and duration of time between stopping the

intravenous insulin infusion with date of discharge were lower in the FRII group as compared to the VRII group. Based on the analysis done on this study, it was noted that the infusion rate per kg was statistically significant ($p < 0.03$) for those above 75 kg. This likely indicates that a fixed continuous insulin infusion based on heavier patients improves their level of glucose and ketones, and thus recovery time, as compared to a variable continuous insulin infusion, where the infusion depends on the patients CBG levels and the protocol dictating that infusions be stopped if the patient developed hypoglycaemia, instead of treating the hypoglycaemia and adjusting the rate of infusion. However, the same cannot be said of lighter patients on the FRII as they are likely to be getting lower amounts of fixed continuous insulin based on their lighter weight. This is clearly shown in Figure 6.

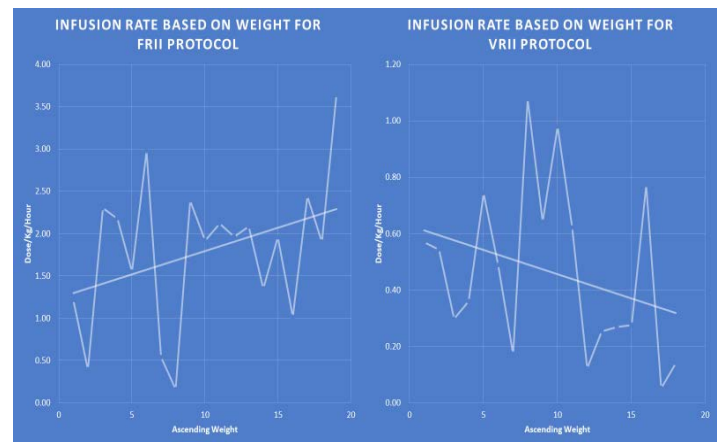


Figure 6: Infusion Rate based on Weight Comparison between FRII and VRII Protocols.

It was also noted that on the new protocol, the performance on regular long acting insulin administration, regular CBG/ketone check and door to insulin time was better as compared to the old protocol. However, the door to fluid time was better in the VRII group as compared to the FRII group. This could be attributed to the fact that on the old protocol, hydrating the patient took priority to insulin infusion as the school of thought at that time is that prioritising saline infusion at the initial stage of DKA treatment.

Limitations

Some of the limitations in this clinical audit includes those who have capacity and decided to stop their management of DKA prematurely and also in contrast, elderly patients who stay in hospital after completing the DKA management protocol due to social issues. Another limitation of this study is the small sample size, thus reducing the power of the study.

Conclusion

FRII has played a key role in improving recovery time of patients admitted with DKA in view of steady improvement in CBG and

ketone levels, especially those in the heavier weight range (>75 kg). However, more study needs to be done in the lighter weight range patients, with a possibility of cut off weight for patients to be treated on the new protocol vs the old one. Furthermore, a checklist on need for quick and rapid administration of insulin infusion, fluids, regular CBG and ketone checks as well as regular long acting insulin administration would greatly improve patient outcome in terms of morbidity and mortality.

Acknowledgement

We would like to thank the Clinical Audit team at Lincoln County Hospital for their help in obtaining patient clinical records in order to identify patients who have been admitted with DKA before May 2014 who were treated with the VRII protocol with those after May 2014 who were treated with the FRII protocol. We would also like to take this opportunity to thank the Diabetes & Endocrinology team for their support in this venture and help with the data analysis using paired t-test comparison.

Conflict of Interest: No conflict of interest has been declared by authors.

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