‘Effect of glycaemic and electrolyte variation on cardiac electrical activity during haemodialysis in people with insulin treated diabetes’

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INTRODUCTION

- Annual survival rate for diabetic patients on dialysis is 84.7% (UK Renal Registry Report 2010)
- Cardiovascular deaths account for 22% of deaths (UK Renal Registry Report 2012)
- Rapid electrolyte shifts, QT dispersion, Left ventricular hypertrophy, myocardial structural and functional abnormalities and sympathetic system over-activity are potential causative factors
- Arrhythmias account for more than half of cardiovascular deaths (USRDS report)
- Hypoglycaemia is linked to sudden death in insulin treated diabetes

Aims:

- To explore the relationships between glycaemic variation, serum electrolyte changes and heart rate, rhythm and QTc interval 4hrs before, during (3 to 4hrs) and 4hrs after haemodialysis (HD).
- To assess the time spent in hyperglycaemia (BG>13mmol/L) and hypoglycaemia (BG<3.5mmol/L) during these times.

Methods:

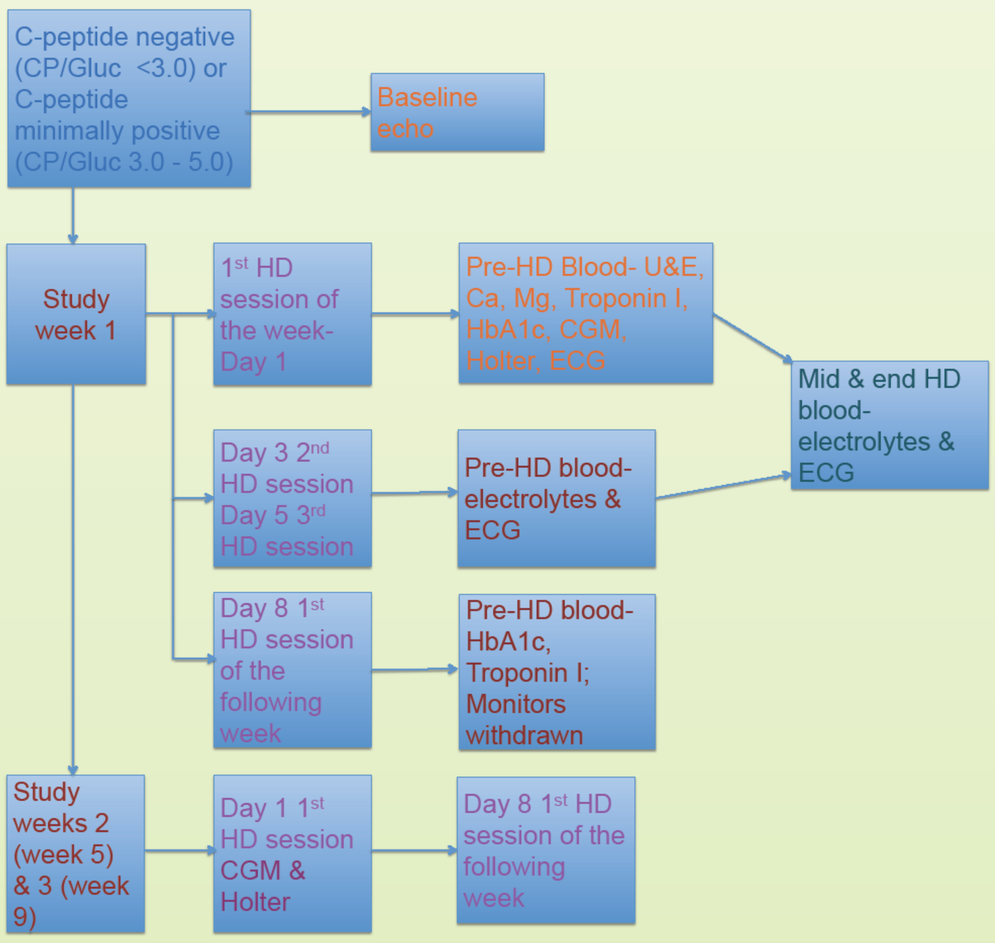
- Purely insulin treated diabetic patients with ESRD on maintenance haemodialysis at one of the four dialysis units under South Tees Hospitals NHS Foundation Trust were approached and consented.
- Patients were screened with Pre-HD blood sample for fasting or random blood glucose and C-peptide levels.
- C-peptide/Glucose ratio was calculated according to formula (Faradji et al):

  ‘C-peptide (ng/ml)/ Glucose (mg/dl) x 100’

  [C-peptide (ng/ml)= C-peptide (nmol/L) /0.333; Glucose (mg/dl) = Glucose (mmol/L) x 18]

Study design is as shown in diagram 1.

Diagram 1: Study design



- All patients are dialysed using a standard dialysate with; (Glucose 1g/L, Potassium 2.0mmol/L, Calcium 1.25mmol/L, Bicarbonate 32mmol/L)
- Data was analysed using SPSS 21

Demographics

- N= 11; Sex: M=4, F=7
- Age: Mean 52 yrs (40 – 72)
- Duration of study: 1 to 3 weeks/subject.
- Total= 85 HD sessions/ 28 weeks

Type of Diabetes:

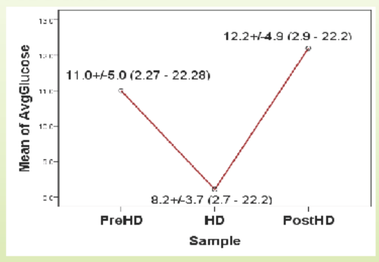
Type 1= 6 (C-pep/Gluc: 0 to 0.01)
Type 2= 4 (C-pep/Gluc: 0.89 to 2.63)
MODY 3 = 1 (C-pep/Gluc: 1.63 ng/L /mg/dl
Duration of diabetes: Mean 26.9 yrs (10 – 48)

Summary and Conclusion:

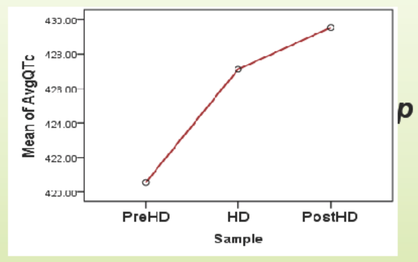
- Significant drop in serum electrolyte levels during HD with major proportion occurring in first half, on standard dialysate.
- Significant lengthening of QTc interval occurs by the end of the HD which could be related to drop in serum electrolyte levels
- Blood glucose levels are significantly lower during HD compared to pre-HD and Post-HD, along with significant period of hyperglycaemia during these periods. This needs Insulin dose/regime adjustment.
- Frequent episodes of arrhythmia occur in these patients with no clear relation to blood glucose levels or dialysis per se. Some of these could be life threatening.
- Larger study is required to understand the pathophysiological basis of these arrhythmias and their relation to glycaemia and electrolyte changes

Results

Fig 2: Change in average glucose levels and average QTc between pre-HD, HD and post-HD periods.

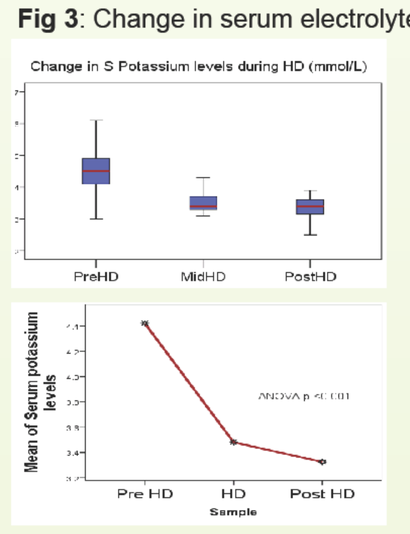


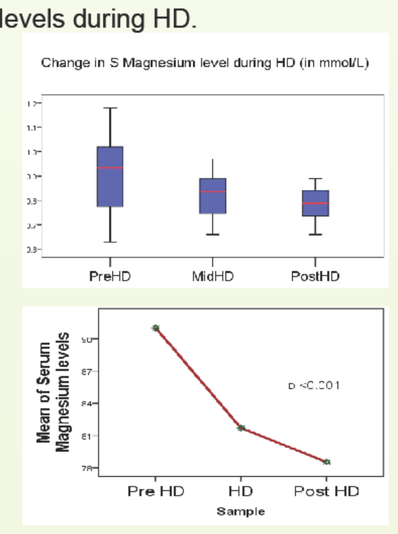
P <0.001



p <0.05

Fig 3: Change in serum electrolyte levels during HD.





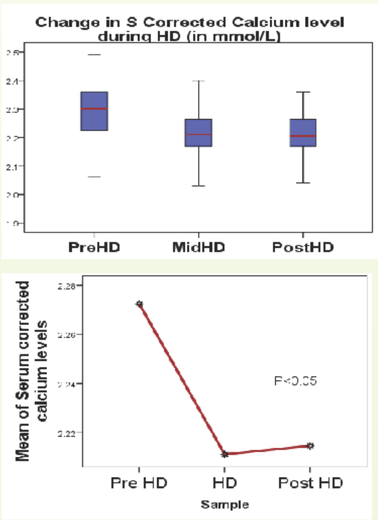


Table 1: Paired samples test for change in serum electrolyte levels during Pre-HD, HD & Post-HD period

Period	N=	Potassium Mean (SD;95%CI)	P=	Magnesium Mean (SD;95%CI)	P=	Cor. Calcium Mean (SD; 95%CI)	P=
Pre HD - HD	32	0.94 (0.54; 0.75-1.13)	<0.005	0.09 (0.09; 0.06-0.12)	<0.005	0.06 (0.09; 0.03-0.09)	<0.005
HD – Post HD	32	0.16 (0.25; 0.07-0.2)	<0.001	0.03 (0.05; 0.01-0.05)	<0.005	-0.03 (0.06; -0.02-0.02)	0.737
Pre HD – Post HD	32	1.1 (0.61; 0.88-1.32)	<0.001	0.12(0.11; 0.08-0.17)	<0.001	0.06 (0.12; 0.02-0.1)	<0.05

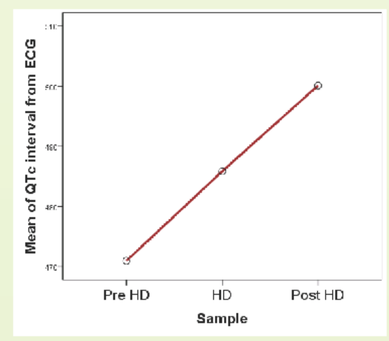
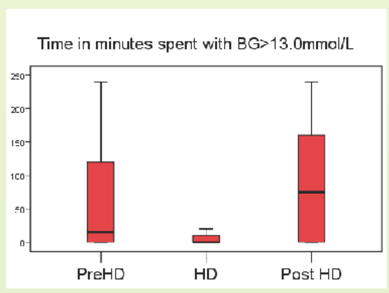


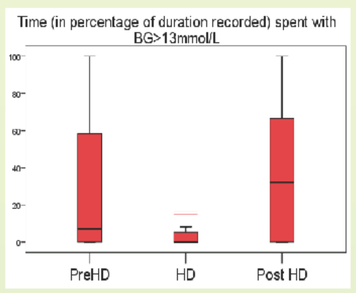
Fig 4: Change in QTc interval during HD (12 lead ECG)
P<0.05 between groups

Table 2: Paired samples test for difference in QTc interval during HD

Period	QTc interval Mean (SD; 95% CI)	P=
PreHD - MidHD	-15 (45; -33 to 3)	0.098
MidHD – Post HD	-14 (33; -27 to -1)	<0.05
PreHD – Post HD	-29 (45; -47 to -11)	<0.005

Fig 5: Glycaemic Variation- Duration of Hyperglycaemia in relation to HD

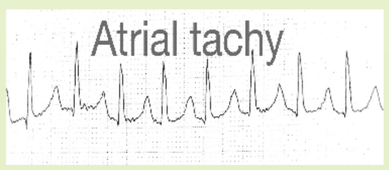


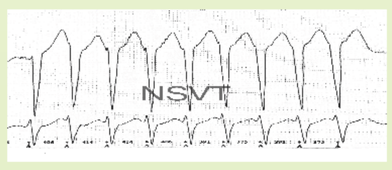


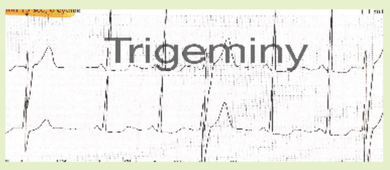
Significant duration of hyperglycaemia before and after HD

Duration of Hypoglycaemia in relation to HD: [% of time recorded (SD; Min – Max)]
PreHD- 3.7 (15; 0 – 93);
HD- 6.4 (19; 0 – 90);
PostHD- 3.2 (13; 0 – 87)

Arrhythmia in relation to HD







- Multiple short episodes of arrhythmia occurred in 7 out of 8 monitored patients.
- Arrhythmia was seen with or without presence of cardiac abnormality

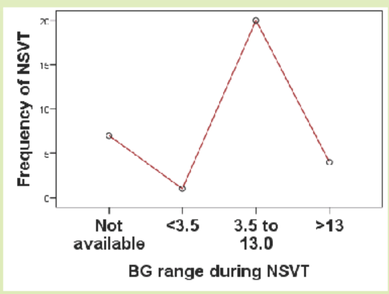
Table 3: Occurrence of arrhythmia during monitoring.

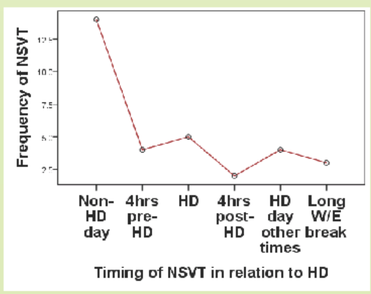
Type	N=	% of total episodes	Type	N=	% of total episodes
Bi/ Trigeminy	14	13.9%	Sinus Brady	1	0.99%
Atrial tachy	8	7.9%	Triplets	40	39.6%
NSVT/BCT	32	31.7%	Idioventricular rhythm	3	2.97%
Junctional	3	2.97%			

Table 4: Blood glucose levels & arrhythmia

B. Glucose level (mmol/L)	Arrhythmic episodes
< 3.5	8.9%
3.5 to 13.0	53.5%
>13.0	15.8%
Not available	21.8%

Fig 6: Relation of NSVT to Blood Glucose levels & Haemodialysis





Echocardiogram

(6 of 7 patients monitored with Holter)
Normal – 1 LVH with LVSD - 1
LVH only – 2 LVH, LVSD & valve dysfunction - 1
LVSD only - 1

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