

## HYPERKALEMIA AS A MEDICAL EMERGENCY IN PATIENTS WITH ESRD ON HEMODIALYSIS

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### ABSTRACT

**Objectives:** To see the incidence and clinical presentation of hyperkalemia as a medical emergency in patients with ESRD on hemodialysis and to determine the safety and efficacy of two hours hemodialysis session as an emergency measure for the treatment of this emergency.

**Methodology:** This observational study was conducted in emergency department [ED] and hemodialysis unit [HDU] of Qilwah General Hospital Albaha, Saudi Arabia from Feb.2001 till Jan.2009 [8years]. Twenty two patients with ESRD on hemodialysis presenting to ED as a medical emergency due to hyperkalemia were studied to know the clinical presentation of hyperkalemia and ECG changes. Salbutamol nebulisation along with DW 50% 50 ml with regular insulin was used to buy time for dialysis. Calcium gluconate 10% 10ml was given for cardioprotection if indicated. All patients were monitored closely. Serum potassium levels were measured at arrival, after one hour, at completion of two hours of hemodialysis and at 12 hours later.

**Results:** Total 20848 dialysis sessions were done in HDU and 192[0.92%] were as emergency dialysis sessions. Twenty two dialysis were done for hyperkalemia. Shortness of breath was the most common symptom and mean time since last dialysis session was 65.91±16.08 hours. Mean serum potassium at arrival to ED, one hour later, after 2 hours of dialysis and 12 hours later was 7.10±0.39 mmol/L, 6.41 ± 0.38 mmol/L, 3.48 ± 0.37 mmol/L and 4.53 ± 0.47 mmol/L respectively. The mean decrease in serum potassium after medical treatment in ED and after two hours of dialysis was 0.69±0.13 [p value<0.0001] and 2.93±0.12 mmol/L [p value <0.0001] respectively. Two patients died in ED before dialysis could be started.

**Conclusion:** ESRD patients may come to ED with hyperkalemia. If serum potassium is more than 6.0 mmol/L or ECG findings of hyperkalemia are there in these patients, ventolin nebulisation and dextrose-insulin infusion should be given in ED to buy time for an emergency session of dialysis. Calcium gluconate has cardioprotective effect. A two hour dialysis session as an emergency measure is effective and safe in such situations provided it is followed by a scheduled session of dialysis next day. Any delay may prove fatal.

**KEY WORDS:** End Stage Renal Disease, Hemodialysis, Hyperkalemia

**Abbreviations:** End stage renal disease [ESRD], Hemodialysis [HD], Emergency department [ED], Dextrose water [DW], Hemodialysis unit [HDU]

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### INTRODUCTION

Chronic renal failure (CRF) requiring dialysis or transplantation is known as end-stage renal disease (ESRD). Patients with end-stage renal disease (ESRD) are commonly

encountered in the emergency department with problems related to the metabolic complications of their renal disease or dialysis related complications.<sup>1,2</sup> The most common cause of sudden death in patients with end-stage renal disease [ESRD] is hyperkalemia, which is often encountered in patients after missed dialysis or dietary indiscretion. Serum potassium also rises when the serum is acidemic, even though total body potassium is unchanged. Cardiac arrest in a patient with CRF or ESRD may be due to hyperkalemia.<sup>1,3</sup> The risk of cardiac arrhythmias is higher when the potassium is above 6.5 mmol/L or below 3.0 mmol/L. Patients who are especially at risk of cardiac arrhythmias are those with ischaemic heart disease, previous arrhythmias, or low serum calcium.<sup>4</sup>

Hyperkalemia is defined as a potassium level greater than 5.5 mmol/L which is further divided as; mild[5.5-6.0 mmol/L], moderate [6.1-7.0 mmol/L] and severe[7.0 mmol/L and greater]. Patients may be asymptomatic or report vague symptoms like Weakness, Paresthesias, Paralysis, Palpitations and Generalized fatigue. Emergency dialysis is a final recourse for patients who are experiencing potentially lethal hyperkalemia that is unresponsive to more conservative measures or for patients who have complete renal failure. Initiation of dialysis often can take some time, therefore, even if dialysis is contemplated, it is recommended to initiate first the other modalities of therapy in emergency department to buy time.<sup>4,5</sup>

This study was conducted to see the incidence, causes, clinical features and ECG changes related to hyperkalemia in population of ESRD patients attending emergency department of our Hospital as emergency cases. We also studied the efficacy and safety of two hours emergency hemodialysis session as an emergency measure in these hyperkalemic patients.

## METHODOLOGY

This prospective observational hospital based study was conducted in Emergency Department [ED] and Hemodialysis Unit [HDU] of Qilwah

General Hospital Albaha, Kingdom of Saudi Arabia from Feb. 2001 till Jan. 2009 [8years]. Those patients who had ESRD and attended ED for dialysis and ESRD related medical emergencies and needed emergency dialysis session were included in this study irrespective of their age, sex and nationality. Patients who had acute renal failure and those not on dialysis already were excluded.

A complete history, physical examination, 12 lead ECG, complete blood counts, ABG and serum biochemistry [Blood sugar, BUN, S.creatinine, uric acid, sodium, potassium, chloride, calcium and phosphate] was done on arrival in ED. Care was taken to avoid sampling associated pseudohyperkalemia. All patient with high serum potassium [more than 5.5mmol/L] received salbutamol nebulisation 5mg [one ml] in 3ml normal saline, DW50% 50ml with 4 unit regular insulin. Calcium gluconate 10% 10 ml was given if serum potassium was more than 7.0 mmol/L or there were ECG changes of hyperkalemia. Sodium Bicarbonate infusion was given only if there was severe metabolic acidosis [pH<7.0].

An emergency dialysis session was arranged within 90 minutes of arrival of patients to ED as per hospital policy. Serum electrolytes were repeated before starting dialysis and at the end of two hours session and 12 hours later. Dialysis was done with bicarbonate as buffer and FF1 as acid concentrate with dialysate potassium of 2 mmol/L. Dialysate flow rate was 500ml/min. Polysulfone hollow fibre dialysis filters were used. Surface area of dialyser and Heparin bolus and hourly infusion rate was according to previously determined prescription. Blood pump was between 200–300ml/min. During dialysis all patients were closely monitored for vital signs, spO<sub>2</sub> and ECG. After dialysis all were admitted for further observation till the next scheduled session of dialysis. After scheduled session of dialysis in next 18 hours they were discharged if there was no further indication for staying as in-patients. Data was analysed on Graphpad statmate Prism-5.

## RESULTS

During study period from Feb. 2001 till Jan. 2009 [8years] a total of 20,848 dialysis sessions were done in hemodialysis unit of Qilwah General Hospital Albaha, Saudi Arabia for patients with ESRD. Out of these, 192[0.92%] sessions were done as an emergency for those ESRD patients who presented to ED with various ESRD related medical emergencies. These emergencies included; pulmonary edema in 162[84.37%], hyperkalemia in 22[11.45%], severe metabolic acidosis & tetany in two[1.04%] each and for the purpose of blood transfusion during dialysis for profuse GI bleeding in four[2.08%] sessions.

Twenty two patients had emergency dialysis for hyperkalemia and their age ranged from 35 to 90 years [mean age  $55.18 \pm 14.32$  years]. Male and female patient were equal in number. The duration since starting on hemodialysis ranged from six months to seven years.[mean  $2.95 \pm 2.05$  years]. The time since last hemodialysis session done was from 48 hours to 96 hours.[mean  $65.91 \pm 16.08$  hours].Five [22.73%]patients had hypertensive nephropathy,four [18.18%] had diabetic nephropathy & lupus nephritis each, three[13.63%] had chronic glomerulonephritis, two[9.09%] had nephrolithiasis, one[4.54%] had reflux with recurrent urinary tract infections as a cause for ESRD. The cause of ESRD was unknown in three[13.33%] cases. Shortness of breath was the most common symptom noted in 18[81.81%], fatigue in 17[77.27%], generalized weakness in 16[72.72%] and palpitations in nine[40.90%].There was an associated pulmonary edema in 13[59.09%] cases of hyperkale-

mia. Regarding the cause of hyperkalemia in these patients nine[40.90%] had a delayed session of dialysis or missed the previous dialysis session due to social reasons, seven[31.81%] had history of intake of high potassium diet and no apparent cause was found in six[27.27%] cases. ECG showed a peaked T-wave in seven[31.81%] and widened QRS complex in three [13.63%]. There was associated left ventricular hypertrophy in five[22.72%] and old anterior wall myocardial infarction with frequent PVC's in two[9.09%] cases.

Serum potassium on arrival to ED, one hour after conservative treatment in ED, two hours and 12 hours after dialysis is shown in Table-I & Fig.No.1. Two [9.09%] patient died before dialysis could be started. During dialysis patients improved regarding symptoms and no complication happened during dialysis. Further observation as in-patients did not show symptom of fluid overload or hyperkalemia. All patients were discharged 18 hours later after routine scheduled hemodialysis and an advice for prevention of this problem in future.

## DISCUSSION

Patients with ESRD may visit ED from time to time with minor to major and life threatening problems.<sup>1-3</sup> It is important to decide if they have any dialysis or ESRD related medical emergency. Their symptoms may be vague like generalized weakness, malaise or more specific and severe like shortness of breath and palpitations. It is important to know since how long they have had ESRD and been on dialysis, the cause of renal failure, schedule of dialysis and time since last dialysis session. Emergency dialysis

Table-I: Serum Potassium at 0, 1, 2 and 12 hours (mmol/L)

	<i>at 0 hour</i>	<i>at 1 hour</i>	<i>at 2 hour</i>	<i>at 12 hour</i>
Minimum	6.50	5.90	3.00	3.90
Median	7.05	7.27	3.48	4.53
Maximum	7.90	7.00	4.20	5.20
Mean	7.10	6.41	3.48	4.53
Std. Deviation	0.3934	0.3885	0.3750	0.4752
Std. Error	0.08387	0.08284	0.08385	0.1090

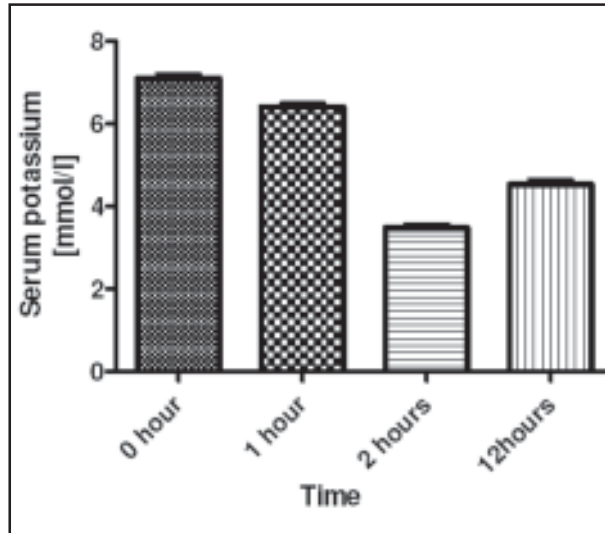


Figure-1: Serum potassium at 0,1,2,12 hours

sessions for known ESRD patients make a minor fraction of total workload at a satellite hemodialysis unit [HDU] like ours. We did only 192[0.92%] emergency dialysis sessions out of 20,848 total sessions in 8 years. Bigger centres offering services for acute renal failure and with more number of patients may have a greater workload of emergency dialysis sessions.

Out of the 192 emergency dialysis sessions, hyperkalemia was in 22[11.45%] cases. Shortness of breath was the major complaint in 18[81.81%] most probably due to associated pulmonary edema in 13[59.09%] hyperkalemic patients. Delayed or missed dialysis session [40.90%] and dietary indiscretion [31.81%] were the known causes for hyperkalemia whereas no apparent cause was found in 27.27% cases. The possibility of hyperkalemia must be ruled out in ESRD patients coming to ED with any complaint especially if the previous scheduled dialysis session has been delayed or missed. Plasma potassium and total body potassium rise between dialysis sessions due to dietary intake and inability of the kidney to excrete excess potassium.<sup>4,6,7</sup>

Hyperkalemia related classical ECG findings were present in only 45.45% cases and majority did not have ECG findings suggestive of hyperkalemia. Similar findings have been reported by many other researchers from across the world.<sup>8-11</sup> ECG alone should not be used to rule

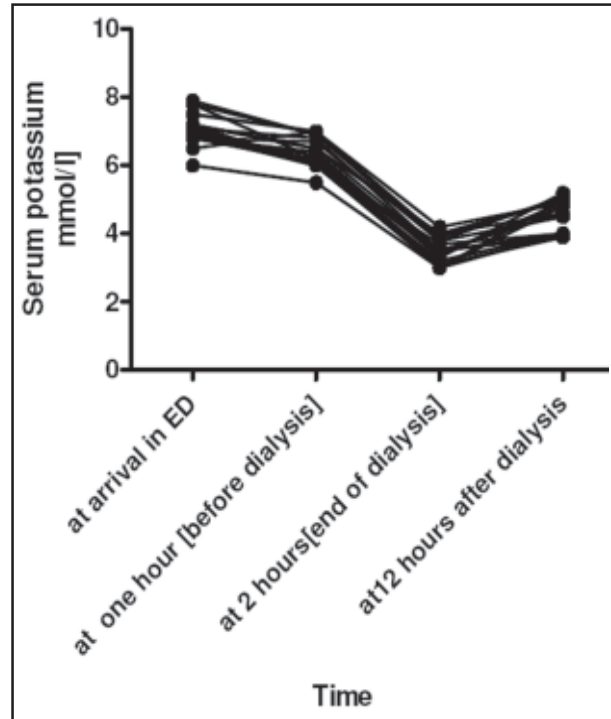


Figure-2: Effect of 2 hours of dialysis on serum potassium.

out the possibility of hyperkalemia and a laboratory confirmation of serum potassium in must.<sup>12,13</sup> However if ECG shows classical findings of hyperkalemia in ESRD patient then it must be respected and treated promptly pending the laboratory reports.<sup>5,12</sup> Proper sampling technique and laboratory calibration is must to avoid pseudo hyperkalemia.

There is always some delay in starting dialysis at a satellite dialysis centre due to logistic and technical reasons but this is the definite treatment in patients with ESRD to remove excess potassium on an emergency basis. Moreover such patients present to ED at odd hours and any delay in performing dialysis may prove fatal. Treatment like Calcium gluconate or Calcium chloride, dextrose water with insulin and salbutamol are only time buying temporary measures.<sup>14-17</sup> We used salbutamol nebulisation instead of intravenous infusion because it is safer and quicker to administer nebulisation contrary to intravenous regimen used by Mushtaq & Masood.<sup>18</sup>

There is no consensus on the length of emergency dialysis session for hyperkalemia and



other ESRD related medical emergencies like pulmonary edema. We have found that a 2 hours dialysis session as an emergency measure is enough to remove excess potassium from body and bring it down to safer levels in known ESRD patients presenting to ED with hyperkalemia. Our study showed that serum potassium lowered from  $6.41 \pm 0.38$  mmol/L [predialysis] to  $3.48 \pm 0.37$  mmol/L [post dialysis] with difference between means of  $2.93 \pm 0.12$  mmol/L [p value 0.0001] [Fig.No.2]. Blumberg et al<sup>19</sup> have noted that maximum decrease in serum potassium takes place in first hour of dialysis and at three hours maximum decline in serum potassium level is achieved. They also noted a rebound in serum potassium level at 16 hours postdialysis that reached maximum level at 38 hours after dialysis, just before next session of dialysis. They studied 14 stable hemodialysis patients whereas in our study we have included only those patients who had emergency dialysis sessions. Variability in potassium removal during the whole length of dialysis session has been noted by other researchers as well.<sup>20,21</sup> We further observed in our study that a dialysate potassium of 2 mmol/L is safe and effective in such situations. Hous et al<sup>22</sup> did dialysis with potassium free [zero], 1 and 2 mmol/L potassium dialysate. Although there was maximum decrease in potassium with potassium free dialysate in their study but it was associated with treatment resistant arrhythmia during dialysis if potassium free dialysate was used. It is the speed of decline or rise in serum potassium that makes membrane unstable besides absolute potassium level.<sup>13,21</sup> We also noted an increase in serum potassium [mean value= $1.05 \pm 0.13$  mmol/L] at 12 hours post dialysis. Other researchers have also noted similar findings.<sup>19,22</sup> Those patients who come to dialysis unit for routine dialysis and have a higher predialysis serum potassium [ $>6.0$ ] must be educated again on diet. Those having predialysis potassium more than 7.0mmol/L should be on potassium binding resin<sup>4,23,24</sup> and frequency of dialysis be increased as a preventive measure.

## CONCLUSION

Hyperkalemia is a potentially life-threatening illness, sometimes difficult to diagnose due to paucity of distinctive signs and symptoms. Emergency room physician should consider this possibility in patients who are at risk for this disease process like the patients with ESRD. If serum potassium is more than 6.0 mmol/L or ECG findings of hyperkalemia are there, ventolin nebulisation with dextrose-insulin infusion should be given in ED. Calcium gluconate has cardioprotective effect and should be given if there are ECG findings of hyperkalemia or serum potassium is more than 7.0mmol/L. An emergency session of dialysis should be arranged as early as possible to remove excess potassium. A two hour emergency dialysis session as an emergency measure is effective and safe in such situations. Routine session should be given the next day.

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