

# A quality improvement project to enhance the management of hyperkalemia in hospitalized patients

Providing residents with a user-friendly pocket-sized guideline increased the proportion of hyperkalemia cases managed according to best available evidence and reduced the cost of treatment.

## ABSTRACT:

**Background:** Hyperkalemia is a common condition, occurring in up to 10% of hospitalized patients. Although severe hyperkalemia is a life-threatening condition, there is little consistency in the management of high serum potassium. We conducted a quality improvement project aimed at increasing the proportion of hyperkalemia cases managed according to the best available evidence and reducing the cost of treatment.

**Methods:** A pocket-sized guideline outlining the management of hyperkalemia according to the best available evidence was distributed to internal medicine residents. Cases of hyperkalemia occurring in a 2-week period before the guideline was distributed (observational phase) were reviewed retrospectively and com-

pared with cases occurring in two 2-week periods after the guideline was distributed (intervention phase).

**Results:** A review of paper charts and electronic health records indicated that before the intervention, hyperkalemia was managed according to the best available evidence in 63% of cases. After the intervention, cases were managed according to the best available evidence in 94% of cases. In addition, the overall cost incurred per case declined from \$16.74 to \$7.51.

**Conclusions:** Providing residents with a user-friendly guideline for hyperkalemia increased the proportion of cases managed according to best available evidence and significantly reduced the cost associated with treatment.

## Background

The reported incidence of hyperkalemia in hospitalized patients is between 1% and 10%.<sup>1-3</sup> The majority of cases are due to medications, including angiotensin-converting enzyme inhibitors (ACEIs), angiotensin II receptor blockers (ARBs), and diuretics such as spironolactone, which reduce the loss of potassium.<sup>4,5</sup> Severe hyperkalemia is a life-threatening condition that can result in muscle paralysis or fatal arrhythmias, and requires prompt reduction of serum potassium levels.<sup>5</sup> However, there is little consistency in the management of hyperkalemia among clinicians at various levels of training.<sup>6</sup>

A review by the Cochrane Collaboration concludes that the current body of evidence for the emergency

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management of hyperkalemia lacks a sufficient number of large randomized controlled trials.<sup>6</sup> Based on a small number of studies, the use of a beta-agonist as well as intravenous insulin and glucose appears to be effective in rapid reduction of hyperkalemia. Furthermore, the use of nebulized beta-agonists combined with IV insulin and glucose appears to be more effective than either therapy used alone. Results for bicarbonate therapy were found to be equivocal, and monotherapy with bicarbonate is not recommended. In the absence of gastrointestinal pathology, potassium-exchange resins were not found to be effective within 4 hours and should not be relied upon for rapid effects. If medical therapy fails or is only temporarily successful, as in the case of renal failure, dialysis

should be considered. Anecdotal and animal data suggest that IV calcium is effective in treating arrhythmias.<sup>6</sup>

In 1998, Acker and colleagues designed a quality improvement (QI) study on the treatment of hyperkalemia in hospitalized patients.<sup>7</sup> They found that during the observational phase of the study only 39% of cases were managed according to the hospital standard for treatment. Even after the intervention phase, when laboratory personnel faxed a copy of the hospital management guideline to the ward for each case of hyperkalemia, there was little improvement. Postintervention data showed that only 42% of cases were managed according to the standard, up slightly from 39% during the observational phase. The effect of intervention may

have been limited by the small number of faxed guidelines (38%) actually transmitted.

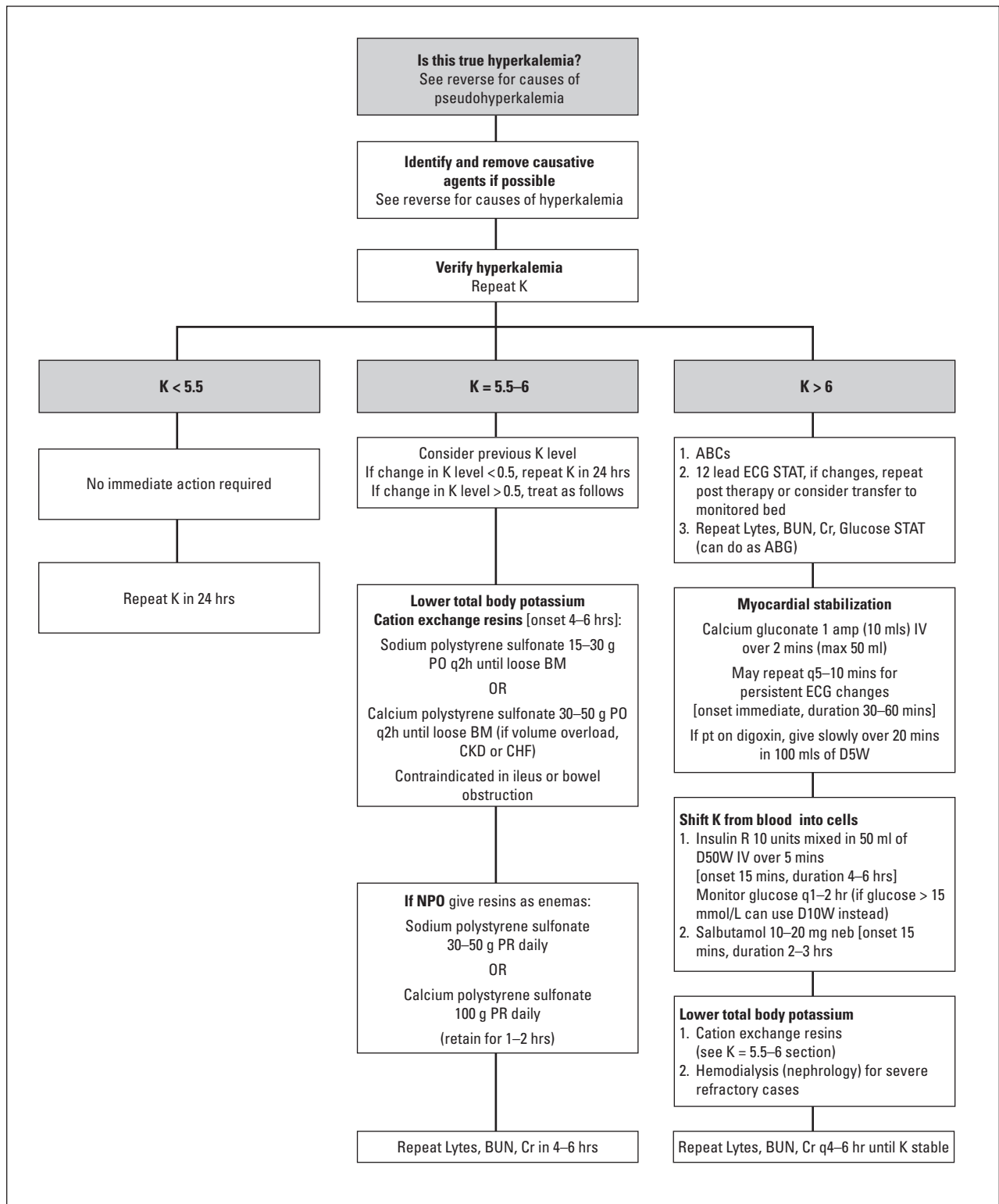
We designed a QI project targeting the management of acute hyperkalemia on the general medicine wards at St. Paul's Hospital, a tertiary care and teaching centre in Vancouver, British Columbia, Canada. Our goal was to increase the proportion of hyperkalemia cases managed according to the best available evidence by 10%, and to reduce the cost incurred per case by 10%.

During the observational phase, we collected data on how hyperkalemia was being managed on all hospital wards. In the intervention phase, we distributed a guideline based on an evidence-based treatment algorithm to house staff (**Figure**). We then

<p><b>MANAGEMENT OF ACUTE HYPERKALEMIA IN HOSPITALIZED PATIENTS</b></p> <p><b>THIS GUIDELINE IS PART OF A QI PROJECT WITH THE UBC INTERNAL MEDICINE PROGRAM 2010</b></p> <p>THIS GUIDELINE IS STRICTLY FOR THE <b>MANAGEMENT OF ACUTE HYPERKALEMIA</b> AND IS NOT INTENDED TO REPLACE INDIVIDUAL CLINICAL JUDGEMENT. PLEASE CONSIDER THE CLINICAL CONTEXT IN WHICH THE HYPERKALEMIA HAS OCCURRED.</p>	<p><b>CAUSES OF HYPERKALEMIA</b></p> <p><b>EXCESS INTAKE</b></p> <ul style="list-style-type: none"> <li>• K containing IVF</li> <li>• K supplements</li> <li>• Enteral feeds</li> </ul> <p><b>IMPAIRED SECRETION</b></p> <ul style="list-style-type: none"> <li>• Renal impairment</li> <li>• Decreased ECV</li> </ul> <p><b>DRUGS</b></p> <ul style="list-style-type: none"> <li>• ACEI/ARB/Renin inhibitors</li> <li>• K sparing diuretics</li> <li>• Beta blockers</li> <li>• Digoxin</li> <li>• NSAIDs, COX 2 inhibitors</li> <li>• Antibiotics (trimethoprim and sulfamethoxazole, pentamidine)</li> <li>• Heparin</li> <li>• Cyclosporine, Tacrolimus</li> </ul> <p><b>EXCESS POTASSIUM RELEASE</b></p> <ul style="list-style-type: none"> <li>• Tissue necrosis (burns, trauma, rhabdo)</li> <li>• Tumor lysis syndrome</li> <li>• Increased catabolism (sepsis, exercise)</li> <li>• Large volume PRBC transfusions</li> </ul> <p><b>METABOLIC DISTURBANCES</b></p> <ul style="list-style-type: none"> <li>• Hyperglycemia, DKA</li> <li>• Acidosis</li> <li>• Hypoaldosteronism</li> <li>• Urinary diversion</li> </ul>	<p><b>PSEUDOHYPERKALEMIA</b></p> <ul style="list-style-type: none"> <li>• Prolonged tourniquet time</li> <li>• Hemolysed sample</li> <li>• Marked leukocytosis or thrombocytosis</li> <li>• Sample taken from limb infused with K containing IVF</li> </ul> <p><b>SYMPTOMS ASSOCIATED WITH HYPERKALEMIA</b></p> <ul style="list-style-type: none"> <li>• Often none</li> <li>• Twitching</li> <li>• Fatigue</li> <li>• Parasthesias</li> <li>• Nausea</li> <li>• Paralysis</li> <li>• Muscle weakness</li> <li>• Palpitations</li> <li>• Cramping</li> </ul> <p><b>ECG CHANGES ASSOCIATED WITH HYPERKALEMIA</b></p> <ul style="list-style-type: none"> <li>• Peaked T waves (&gt; 50% QRS)</li> <li>• Prolonged PR interval</li> <li>• Flat/absent P waves</li> <li>• Wide QRS</li> <li>• Sine wave</li> <li>• Ventricular fibrillation</li> </ul> <p>* Any arrhythmia is possible, especially with history of ischemic heart disease</p>
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**Figure, part 1. Evidence-based guideline distributed to internal medicine residents in 2010 (side 1 of pocket-sized guideline).**

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**Figure, part 2. Evidence-based guideline distributed to internal medicine residents in 2010 (side 2 of pocket-sized guideline).**

determined whether the intervention resulted in an improved adherence to evidence-based protocols and a reduction in cost incurred per case of hyperkalemia.

## **Providing internal medicine residents with a user-friendly guideline for the management of acute hyperkalemia resulted in a significant increase in the proportion of cases that were managed according to best available evidence.**

### **Methods**

#### **Study population**

During the observational phase of the study, 23 March to 6 April 2010, 54% of hyperkalemia cases occurred on the general medicine wards. The intervention was thus focused on cases of acute hyperkalemia occurring in patients admitted to general medicine wards. Patients in the intensive care unit and those undergoing renal replacement therapy were excluded, as these patients are managed according to their own hyperkalemia protocols. For study purposes, a case of hyperkalemia was defined as serum potassium greater than 4.7 mmol/L.

#### **Data collection**

All cases of hyperkalemia that occurred between 23 March and 17 October 2010 were identified by the Department of Pathology and Laboratory Medicine at St. Paul's Hospital. Data pertaining to the management of hyperkalemia were obtained retro-

spectively through paper charts and electronic health records. Two independent members of the QI team determined whether each case of hyperkalemia was managed accord-

ing to evidence-based protocols. Cost of care was calculated for each case of hyperkalemia, and included costs of medications, laboratory tests, and electrocardiograms.

#### **Plan-do-study-act cycles**

Two plan-do-study-act (PDSA) cycles were implemented during the data-collection period. The first PDSA cycle ran from 22 July to 8 August 2010. Prior to this, a pocket-sized guideline for the management of acute hyperkalemia incorporating best available evidence was created and distributed to the house staff on the general medicine wards, including the members of each clinical teaching unit—an attending physician, a senior resident in the second or third year of the internal medicine program, two junior residents in the first year of residency, and two third-year medical students. Prior to the second PDSA cycle, which ran from 22 September to 17 October 2010, the guideline was distributed to

all internal medicine residents in order to reach house staff providing overnight coverage. In addition, posters describing the protocols were placed in the emergency department and general medicine wards. During the entire study period, house staff were unaware of the data collection and analysis.

### **Statistical analysis**

We used run charts, a common method of plotting data over time to evaluate the success of improvement efforts in an objective way. Run charts are appropriate for quality improvement projects and have been shown to be effective in detecting signals in a wide range of health care applications.<sup>8</sup>

### **Results**

During the observational phase (23 March to 6 April 2010), 114 cases of hyperkalemia occurred. Only 63% of cases were managed according to the best available evidence. The overall cost incurred per hyperkalemia case was \$16.74.

During the first PDSA cycle (22 July to 8 August 2010), 76 cases of hyperkalemia occurred. The average percentage of cases managed according to the best available evidence increased from 63% in the observational phase to 79%, achieving the absolute target increase of 10%. In addition, the overall cost incurred per hyperkalemia case decreased to \$7.80, also achieving the absolute target reduction of 10%. However, there was still significant inconsistency in the management of hyperkalemia.

During the second PDSA cycle (22 September to 17 October 2010), 98 cases of hyperkalemia occurred. The average percentage of cases managed according to the best available evidence increased substantially to 94%. In addition, the overall cost incurred per hyperkalemia case decreased to \$7.51.

## Conclusions

Providing internal medicine residents with a user-friendly guideline for the management of acute hyperkalemia resulted in a significant increase in the proportion of cases that were managed according to best available evidence. The use of evidence-based management also resulted in a reduction of treatment cost.

These results came at a minimal cost to our program. The only financial costs incurred involved printing the protocols and posters, further demonstrating that successful quality improvement projects can be implemented effectively with little to no cost.

The study had important limitations. First, the incidence of severe hyperkalemia (defined as a serum potassium level greater than 6.0 mmol/L) was low throughout the study, limiting our ability to assess the effect of the intervention for patients with hyperkalemia in this range. Second, since the house staff were unaware of our data collection and analysis, the recognition of hyperkalemia and the clinical reasoning process guiding

intervention or nonintervention were poorly documented in patient charts.

Further quality improvement studies are needed to assess safety and sustainability outcomes of our intervention.

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### Competing interests

None declared.

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**The use of evidence-based management resulted in a reduction of treatment cost.**