

A SIMPLE PROTOCOL TO IMPROVE SAFETY AND REDUCE COST IN HEMODIALYSIS PATIENTS UNDERGOING ELECTIVE SURGERY

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Abstract

Background: When patients with end-stage renal disease (ESRD) miss their routine intermittent hemodialysis (IHD), electrolyte abnormalities and volume overload often occur. An institutional protocol to ensure that patients receiving IHD have elective surgeries scheduled within 24 hours after their dialysis may reduce procedural delays or cancellations caused by hyperkalemia and hypervolemia after a missed IHD session. The effect of this protocol was evaluated.

Methods: A retrospective chart review was performed for ESRD patients receiving IHD who underwent surgery from 6 months before to 6 months after the institutional protocol was implemented. Preoperative potassium values, timing of IHD relative to surgery, and the nature of surgery (elective or emergent) were documented. The percentage of patients having IHD more than 24 hours before their elective surgery was compared before and after protocol implementation. Average potassium values were compared when IHD occurred within 24 hours vs. more than 24 hours, using *t* test analysis. Cost associated with delay and cancellation for IHD was also explored.

Results: Of the 15,799 cases performed, 190 involved ESRD patients receiving IHD. Before the protocol, 32.1% of elective cases (n=17) involved patients scheduled for surgery more than 24 hours after IHD vs. 12.0% (n=6) after the protocol. Preoperative potassium values were less when patients underwent IHD within 24 hours than at more than 24 hours (mean [SD], 4.32 [0.6] mEq/L vs 4.63 [0.8] mEq/L; *P*=.03).

Conclusions: The simple scheduling policy is effective at reducing both cost and unnecessary perioperative risks for patients.

Keywords: Cost effectiveness, Elective surgeries, End-stage renal disease, Hemodialysis, Hyperkalemia, Hypervolemia, Patient safety.

Abbreviations: ESRD, end-stage renal disease; IHD, intermittent hemodialysis.

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Introduction

Since the beginning of 2012, prevalent population included more than 395,000 ESRD patients in the United States requiring intermittent hemodialysis (IHD)¹. This patient population presents distinct preoperative considerations. Most of these patients have multiple comorbidities, including anemia, cardiovascular disease, and diabetes mellitus. Independent of the stress of surgery, this patient population has an adjusted all-cause mortality rate that is 6.5- to 7.9-fold higher than the general population². Merely 52% of hemodialysis patients are still alive three years after the start of ESRD therapy in 2006².

Investigators have found that the overall mortality rate for ESRD patients undergoing general surgery is approximately 4%³. ESRD patients receiving IHD have a 10-fold increase of in-hospital death following spinal surgery⁴. The need for IHD has been found to be an independent risk factor for postoperative stroke in patients undergoing noncarotid major vascular surgery⁵. When these patients undergo cardiac surgery, they have higher morbidity rates⁶, an increased operative mortality rate of 4.8%⁷, a 30-day mortality rate as high as 18.3%⁸, and a long-term mortality rate of 29%⁹. Because of these risks, ESRD patients require effective cooperation and communication between nephrology, anesthesia, and surgical staff.

The role of anesthesiologists expands into perioperative care with the advent of the “surgical home” concept. Thus, it is important to gain adequate understanding of medical optimization of patients with ESRD who receive IHD. One particular concern is the management of electrolyte levels, volume status, and the logistical issues relating to perioperative provision of hemodialysis. Given their renal dysfunction, patients receiving IHD are at increased risk for preoperative hyperkalemia (serum potassium, >5.5 mEq/L), with an incidence as high as 19% to 38%¹⁰. Volume status is an important issue because patients may require intraoperative transfusion of blood products, necessitating that they be as close to their dry weight as possible to reduce the risk of volume overload.

Because of these issues, the timing of IHD needs to be considered. Although no practice guidelines or recommendations exist for scheduling elective

surgery with respect to IHD, the suggestion has been that IHD should be performed within 24 hours of the operation^{3,11-13}.

At our institution, we have observed instances involving ESRD patients not having IHD within 24 hours of their elective surgeries. Subsequently, the surgical procedures were cancelled or delayed for emergent hemodialysis to correct electrolyte abnormalities and volume overload. To avoid unnecessary cancellation and delays, we implemented an institutional protocol stating that patients receiving IHD would have their elective surgery scheduled within the 24 hours after dialysis. This protocol was shared with medical personnel involved in preoperative care and scheduling (eg, surgeons, physician extenders, preoperative clinic staff).

The purpose of the present study was to establish the efficacy of such a scheduling protocol, to evaluate the preoperative potassium trends of ESRD patients undergoing surgery, and to explore the cost of cancellation and delays due to not scheduling surgery within 24 hours of a patient undergoing IHD.

Methods

After approved by the Mayo Clinic Institutional Review Board, a retrospective chart review was performed for ESRD patients receiving IHD who had surgery from 6 months before to 6 months after the following protocol was implemented and conveyed to personnel involved in preoperative patient care:

1. Patients with ESRD who received IHD were identified through the preoperative interviewing process and medical record.
2. Patients receiving IHD were scheduled to have their elective surgeries less than 24 hours following IHD.
3. Preoperative laboratory tests were performed to check serum potassium level on the day of surgery, to ensure proper management of potassium if the reading was greater than 5.0 mEq/L.

This scheduling protocol was implemented on November 15, 2011, with data collection ranging from May 15, 2011, to May 15, 2012. Patients included were those undergoing surgery both in the main

operating rooms and the outpatient surgery center at our institution. Patients undergoing procedures in our interventional radiology, cardiology, and gastroenterology suites were excluded as these patients were not routinely evaluated by the preoperative clinic at our institution. Two patients were excluded because it was unclear from the chart review when they last underwent IHD. We documented preoperative potassium values, emergent or elective surgery, and whether the patient received hemodialysis within 24 hours of surgery. Furthermore, we investigated the cost of delaying or cancelling elective surgery when a patient did not have IHD within 24 hours of surgery.

To examine the effectiveness of this protocol, we calculated the percentage of elective cases involving ESRD patients undergoing IHD more than 24 hours before surgery both before and after the policy was implemented. In addition, we calculated the percentage of elective cases that had preoperative potassium values checked before and after policy implementation. Potassium values were averaged among two subsets of patients—those who had IHD within 24 hours of surgery and those who did not—regardless of whether the case was elective or emergent.

Statistical Analysis

A *t* test was performed on these potassium averages to determine whether having IHD within 24 hours of surgery produced a statistical difference.

Results

During the study period, a total of 15,799 surgical cases were performed in our operating rooms. Of these cases, 190 involved patients with ESRD who were receiving IHD at the time of surgery. These patients comprised the following cases: kidney and liver transplant (n=72), vascular (n=49), orthopedic (n=18), cardiac (n=11), urology and gynecology (n=19), general (n=18), ear, nose, and throat (n=2), and neurosurgery (n=1) procedures. Before the implementation of this protocol, 32.1% of the elective cases (n=17) involved patients being scheduled for surgery more than 24 hours after undergoing IHD, with this figure decreasing to 12.0% (n=6) after the

protocol (Table 1).

Table 1
Effect of Policy on Elective Surgery Scheduling

Case	Prepolicy	Postpolicy
Elective cases of patients receiving IHD, No.	53	50
Elective cases of patients with IHD >24 h of surgery, No. (%)	17 (32.1)	6 (12.0)

Abbreviation: IHD, intermittent hemodialysis.

One ESRD patient had an elective parathyroidectomy delayed before the protocol was implemented because the patient had a potassium value of 7.3 mEq/L. This patient was receiving IHD on a Monday-Wednesday-Friday schedule and presented for surgery as the first case on a Monday morning, having gone nearly 72 hours without IHD.

Another ESRD patient had an elective arteriovenous fistula formation cancelled because of hyperkalemia after the policy was implemented, with a potassium value of 5.7 mEq/L despite having IHD the day before surgery. In reviewing this patient’s chart, we learned that the patient consumed a meal high in potassium the night before surgery after undergoing IHD earlier that day.

Potassium values drawn the day of either elective or emergent surgery were analyzed. For patients who had IHD within 24 hours, the mean (SD) potassium value was 4.32 (0.6) mEq/L. Of patients undergoing surgery more than 24 hours after IHD, the mean (SD) potassium value was 4.63 (0.8) mEq/L. After *t* test analysis, these two average potassium values were found to be statistically different (*P*=.03). In addition to requiring that ESRD patients have their elective surgery scheduled within 24 hours of IHD, the protocol also conveyed the need to check potassium values on the day of surgery. The effect of policy on preoperative laboratory tests was evaluated (Table 2).

Additional expenses associated with delaying elective cases for emergent preoperative hemodialysis included the costs of dialysis, extra perioperative personnel staffing time from the delay, reesterilization of the instruments from the surgery suite, stat laboratory tests after dialysis, and lost income from having an unused operating room.

Table 2
Effect of Policy on Checking Preoperative Potassium Values

Case Characteristics	Prepolicy	Postpolicy
Cases with patients receiving IHD, No.	95	95
Patients with potassium values checked preop, No. (%)	81 (85.3)	70 (73.7)
Emergent cases with patients receiving IHD, No.	42	45
Emergent cases with patient potassium values checked preop, No. (%)	41 (97.6)	44 (97.8)
Elective cases with patients receiving IHD, No.	53	50
Elective cases with patient potassium values checked preop, No. (%)	40 (75.5)	26 (52.0)

Abbreviations: IHD, intermittent hemodialysis; preop, preoperation.

Discussion

This retrospective study examined the implementation of a protocol requiring patients with ESRD to have IHD within 24 hours of elective surgery and to have their preoperative potassium values obtained before surgery. This policy was conveyed through e-mail correspondence and educational conferences to personnel involved in preoperative care of surgical patients. Indeed, this protocol was effective at decreasing the percentage of ESRD patients having elective surgery more than 24 hours after IHD. Although no universal practice guidelines specify the timing of elective surgery for patients receiving IHD, several studies have recommended that IHD be done within 24 hours of surgery^{3,11-13}. These strategies are targeted toward avoiding unnecessary perioperative risks, such as hyperkalemia and hypervolemia.

Hyperkalemia can induce deadly cardiac arrhythmias and alter the anesthetic plan. For instance, succinylcholine therapy may have to be avoided for a patient with a difficult airway if the patient has preoperative hyperkalemia. Thus, it has been recommended that the serum potassium concentration be less than 5.5 mEq/L for elective surgery¹⁴. Fortunately, the use of succinylcholine in normokalemic patients with ESRD has been shown to be safe because it increases serum potassium values to the same degree as in patients without ESRD¹⁵.

The protocol failed at encouraging perioperative staff to check potassium values on the day of surgery. Of patients with ESRD undergoing either elective or emergent surgery, 85.3% had preoperative potassium

values checked before the protocol's implementation vs 73.7% after it. Interestingly, in two instances-1 preprotocol and 1 postprotocol-patients with ESRD underwent emergent surgery without first checking serum potassium values. From reviewing the charts, we presumed that these patients had IHD within 24 hours of the emergent case and the anesthesiologist felt comfortable proceeding without this information. We caution against such practices and suggest the routine checking of preoperative potassium level, regardless of when IHD was last performed. Eight patients in this study had IHD within 24 hours yet still had potassium values of 5.5 mEq/L or greater. Requiring that patients have IHD within 24 hours will not eliminate the incidence of preoperative hyperkalemia; average potassium values were statistically lower when patients had IHD within 24 hours than when patients did not.

Investigators have recommended that hemodialysis patients be as close to dry weight as possible preoperatively¹⁶. Hypervolemia is a particular concern in this population because patients often have anemia from ESRD. Because of lower hemoglobin content, they may require intraoperative blood products more often than patients without ESRD who have hemoglobin levels within the normal limits. Transfusion of blood products has its own risk factors, including an increased potassium burden. In addition, when patients not at dry weight preoperatively receive a transfusion, they may be at risk for acute congestive heart failure. Furthermore, when these patients have an unanticipated surgical bleeding that necessitates massive volume replacement, the use of intraoperative dialysis may be warranted-an expensive endeavor that

may have been avoided if volume status was optimized before surgery. The potential for these risks can be reduced by ensuring that patients have IHD within 24 hours of an elective surgical procedure.

In addition to improving patient safety, our scheduling protocol can have a marked cost-saving benefit. Although the savings is difficult to quantify, there is undeniable increased expense when surgical procedures are delayed or canceled.

A question remains about whether IHD on the day before surgery is safer for patients than IHD on the same day of and immediately preceding surgery. Heparin use during IHD suggests that IHD should be done 12 hours before surgery. However, to reduce the effects on coagulation, most centers now can perform heparin-free IHD¹⁰.

Having IHD on the same day of surgery may place the patient at risk for dialysis disequilibrium syndrome. The rate of urea removal during IHD is a crucial factor in the development of this syndrome, and patients may undergo dialysis at increased blood flow rates the day of surgery, in an effort not to delay their upcoming procedure.¹⁷ This practice may be avoided by having IHD on the day before elective surgery.

Yukioka et al¹⁸ investigated the effects of IHD administered at 24 hours vs 3 hours before surgery. Serum potassium values were similar for the 2 groups preoperatively; however, the patients with IHD at 3 hours before surgery were more likely to have intraoperative hyperkalemia. The investigators attributed this outcome to the removal of less fluid during the IHD of these patients.

A potential criticism of the present study is the

small sample size when looking at scheduling trends involving 6 months before and 6 months after the protocol implementation. Expanding the study period may show that more providers are not adhering to the recommendations, necessitating the need for repeat educational efforts to ensure the hemodialysis patients have their elective surgeries scheduled according to the protocol. Noting the volume status of these patients while potassium values were recorded would have been interesting. Unfortunately, dry weight was rarely noted and was not easily accessible during the present chart review. In addition, a connection was not made between having surgery more than 24 hours after IHD and clinical outcomes such as death and major morbidity.

Heldt et al¹⁹ described ESRD patients who had similar clinical outcomes (eg, blood loss, complication rate, postoperative stay, and positive margins) as patients not on dialysis when IHD was performed the day before radical prostatectomy. Likewise, Gulati et al²⁰ reported that patients with ESRD receiving IHD had similar blood loss and median time to discharge as patients who had normal renal function while undergoing laparoscopic radical nephrectomy when the patients were kept on their normal IHD routine, including IHD on the day before surgery. Future efforts warrant further exploration to see whether such a scheduling protocol has impact on patient outcomes.

In conclusion, the implementation of a scheduling policy for ESRD that states that IHD should be done within 24 hours before elective surgery is simple to conduct, may reduce cost, and does reduce potential unnecessary risks for patients.

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