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Original Articles

Lapses in safety in end-stage renal disease patients admitted to surgical services

Ziv HAREL,[1,2,3] Ron WALD,[1,3] Jessica J. LIU,[3] Chaim M. BELL[2,3]

[1]Division of Nephrology, University of Toronto, Toronto, Ontario, Canada; [2]Department of Health Policy Management and Evaluation, University of Toronto, Toronto, Ontario, Canada; [3]Department of Medicine and Keenan Research Centre, Li Ka Shing Knowledge Institute of St Michael's Hospital, Toronto, Ontario, Canada

Abstract

Chronic dialysis patients are a vulnerable population that may be highly susceptible to medical errors, particularly when they are hospitalized. We performed a chart review of chronic hemodialysis patients admitted to surgical services at a tertiary care center in order to characterize lapses in patient safety. We conducted a retrospective chart review of admissions of patients receiving chronic hemodialysis to various surgical services at St. Michael's Hospital from January 1, 2009 to December 31, 2010. For each hospitalization, we collected data on four process of care indicators of potential safety lapses. When these lapses were identified, we sought to determine whether: (i) the lapse was detected and remedied; and (ii) the lapse resulted in an adverse event. Among the 41 patients, 96 process of care lapses were identified. Multiple lapses were detected in 83% of the cohort. Failure to order a renal diet (72%) occurred most often. There was one adverse event. Process of care lapses were detected 39% of the time, usually within 1.5 days of their occurrence. Patients receiving chronic hemodialysis admitted to surgical services experience multiple lapses in patient safety, which often remain undetected. As such, it is imperative that these patients be closely monitored in order to mitigate against potential adverse events.

Key words: Hemodialysis, patient safety, process of care

INTRODUCTION

Patient safety has garnered substantial attention in health care since the Institute of Medicine's groundbreaking 1999 study "To Err is Human" reported that medical errors account for 98,000 deaths in hospitalized patients per year.[1] These errors are detected in all stages of the process of care, from diagnosis to treatment. Aside from death, they are associated with disability or physical harm, psychological harm, additional or prolonged treatment, and increased costs.[2–4]

Correspondence to: Z. Harel, MD, FRCPC, St Michael's Hospital, 30 Bond Street, Toronto, ON M5B 1W8, Canada. E-mail Address: harelz@smh.ca

As a result, many medical disciplines have begun to assess the nature of patient safety lapses in their specialized health care settings with the ultimate goal of creating a "culture of patient safety."[5–8] While several groups have reported on patient safety in the setting of predialysis chronic kidney disease (CKD), there is limited data on safety in individuals with end-stage renal disease requiring dialysis.[9–16]

There are several factors that heighten the susceptibility of chronic dialysis recipients to medical errors and adverse events. They possess a high comorbidity burden along with associated polypharmacy and are often subject to fragmented medical care.[17] Chronic dialysis recipients have high rates of hospitalization, which increases their exposure to iatrogenic injury.[17] Finally, they may be admit-

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ted to hospitals that are not linked to their base dialysis units thereby creating difficulties in inter-facility communication of important medical information.

In order to better characterize the frequency, nature, and implications of medical errors in hospitalized patients who receive chronic dialysis, we conducted a retrospective chart review of patients receiving chronic in-center hemodialysis admitted to a surgical service in order to: (i) characterize lapses inpatient safety using four predetermined process of care indicators; and (ii) report on the detection, remediation, and resultant adverse events of such lapses inpatient safety.

METHODS

Study design and time period

We conducted a retrospective chart review of consecutive recipients of chronic hemodialysis who were admitted to all surgical services at St. Michael's Hospital from January 1, 2009 to December 31, 2010.

Study setting

We identified patients who were admitted to the General Surgery, Orthopaedics, Vascular Surgery, Urology, Neurosurgery, Otolaryngology and Ophthalmology inpatient services at St. Michael's Hospital, a 511 bed teaching hospital in Toronto, Canada. These wards comprise 172 beds and were functioning at 95%–100% capacity during the study period. At the time of the study, computerized order entry (CPOE) was not utilized at St. Michael's Hospital; therefore, orders were initiated by physicians writing in the patient chart.

Patient population

Consecutive patients receiving chronic in-center hemodialysis at St. Michael's Hospital who were admitted to a surgical service either electively or emergently were included in the study. As per usual hospital policy, primary responsibility for the care of these patients fell to the admitting surgical service with parallel follow-up by the inpatient nephrology consultation service. If a patient was readmitted to hospital, only the first admission was included in our study.

Process of care indicators

As there are no published process of care indicators for hemodialysis inpatients, we a *priori* developed 4 indicators that represent lapses in care based on a modification of Krumholz et al.'s criteria for an "ideal" process of care indicator.[18] An ideal process of care indicator consists of three components: (i) a well-documented process-outcome link; (ii) is broadly applicable to patients with a particular disease state and is readily defined through chart abstraction; and (iii) is readily measurable through chart abstraction, based on documentation standards that are either presently accepted or may be readily developed.[18] Using these criteria, we considered the following process of care indicators: (i) ordering a diet not tailored to chronic dialysis recipients ("nonrenal" diet); (ii) antibiotic ordering that failed to account for impairment in kidney function based upon a criterion standard;[19] (iii) inappropriate use of intravenous fluid that could have led to volume overload; and (iv) ordering analgesia that failed to account for impaired kidney function based upon a criterion standard[19] (Appendix I). Similar to a prior study, we then tested these indicators for face validity through informal consultation with local content experts.[20]

Outcomes of care

An adverse event was defined as an unintended injury or complication that resulted in disability, death or prolonged hospital stay and that is caused by health care management rather than by the patient's underlying disease process.[2] Disability referred to a temporary impairment of function, permanent impairment of function or death.[21] Health care management included the actions of individual hospital staff as well as broader care processes and included both acts of omission (failure to diagnose or treat) and acts of commission (incorrect diagnosis or treatment, or poor performance).[22]

Data collection and measurement

One of two investigators (ZH and JL) independently reviewed the inpatient records for the occurrence of any of the four process of care indicators. Each occurrence of a process of care indicator represented a lapse inpatient care and was independently counted. Records that were positive for at least one lapse were further scrutinized in order to: (i) determine whether the lapse was detected and remedied; and (ii) identify any resulting adverse events.

Data collection ceased at time of death, discharge from hospital, or transfer of care to a medical service. In order to assess for agreement, 13 randomly chosen charts (32%) were reviewed by both investigators. Kappa statistics were calculated to determine inter-rater reliability.[23] The kappa statistic for inter-rater reliability was 0.96 for the presence

of process of care indicators. This represents excellent agreement.

RESULTS

Participants

Forty-one patients receiving chronic in-center hemodialysis were admitted 42 times to a surgical service at St. Michael's Hospital in 2009–10 (Table 1). No patient died in hospital and one patient was re-admitted to the same surgical service. Mean age was 60.1 years (standard deviation ± 15.8) and 54% of patients were men. The median modified Charlson Index was 2 (interquartile range [IQR] 0–3).[24] Previous myocardial infarction was the most common comorbid illness among the cohort (44%), followed by diabetes (41%). The median duration of stay was 8 days (IQR 4–23). Most patients were admitted to the Orthopaedic service (29%) with fracture being the most common admitting diagnosis (22%).

Table 1 Baseline characteristics of patients

Patient characteristic	
Age (mean, in years) (SD)	60.1 (±15.8)
Male, n (%)	22 (54)
Previous myocardial infarction, n (%)	18 (44)
Diabetes, n (%)	17 (41)
Peptic ulcer disease, n (%)	7 (17)
Modified Charlson Index for ESRD, n (%)	
0–1	16
2–3	17
4–6	5
7–8	3
Median (IQR)	2 (0–3)
Length of stay (days) median (IQR)	8 (4–23)
Admitting service, n (%)	
Orthopedics	12 (29)
General surgery	9 (22)
Vascular surgery	8 (20)
Otolaryngology	7 (17)
Urology	2 (5)
Ophthalmology	2 (5)
Neurosurgery	1 (2)
Most common admitting diagnosis by admitting service, n (% of total admissions)	
Orthopedics: fracture	9 (22)
General Surgery: sepsis	4 (10)
Vascular Surgery: access repair	4 (10)
Otolaryngology: parathyroidectomy	6 (15)
Urology: nephrectomy	2 (5)
Ophthalmology: cataract surgery	2 (5)
Neurosurgery: spinal abscess	1 (2)

ESRD = end-stage renal disease; IQR = interquartile range; SD = standard deviation.

Table 2 Frequency of lapses in processes of care

Indicator	Count, n (%)
Failure to order a "renal diet"	28 (72)[a]
Inappropriate analgesic order	26 (63)[b]
Morphine	24 prescriptions
Nonsteroidal anti-inflammatory drugs	2 prescriptions
Inappropriate intravenous fluid use	21 (51)[c]
Incorrect antibiotic dosing	21 prescriptions (42)[d]
Inappropriate dose	14 prescriptions
Inappropriate frequency	6 prescriptions
Contraindicated antibiotic	1 prescription

[a]39 patients eligible to eat at any point.
[b]41 eligible patients.
[c]41 eligible patients.
[d]50 total antibiotic prescriptions written.

Process of care lapses

In total, 96 process of care lapses were detected among 38 patients (Table 2). There were three patients whose admissions were free of lapses in care. Multiple process of care lapses were found in 78% of the cohort, with two being most common (Figure 1). Failure to order the appropriate diet was the most common process of care lapse detected, occurring in 28 patients (72%). This was followed by inappropriate ordering of analgesia in 26 patients (63%)

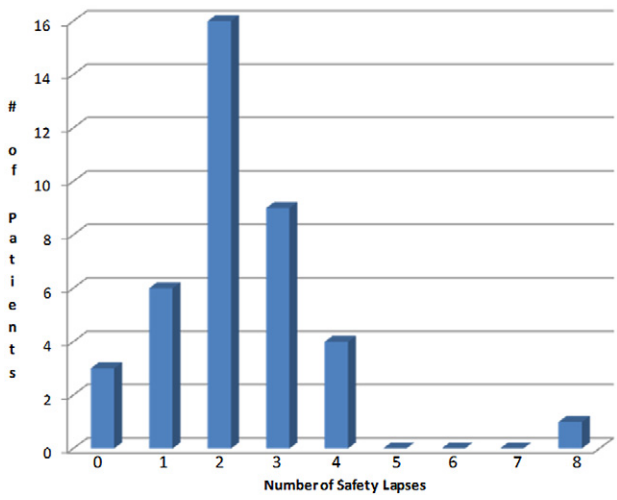

Figure 1 Number of lapses in care.

Table 3 Detection of lapses in processes of care

Safety indicator	Number of times safety indicator detected, n (%)	Time to detection (mean, in days[SD])	Service provider detecting lapse (n)
Failure to order a renal diet	15 (54)	2.5 (±2.5)	Nutrition (7) Nephrology (2) Orthopedics (2) Other (4)
Inappropriate antibiotic order	10 (50)	1.1 (±1.0)	Pharmacy (5) Nephrology (4) General Surgery (1)
Inappropriate intravenous fluids	9 (43)	0.9 (±0.64)	Nephrology (9)
Inappropriate analgesia order	7 (27)	1.4 (±1.3)	Nephrology (3) Anesthesia (2) Pharmacy (2)

SD = standard deviation.

and inappropriate intravenous fluid administration in 21 patients (52%). Antibiotics were prescribed on 50 separate occasions. Of these 50 prescriptions, 21 (38%) demonstrated errors in dosage and/or frequency.

One adverse event (volume overload) attributable to the lapse was detected in a patient receiving intravenous saline postoperatively without any documented indication. The patient was administered a continuous infusion of normal saline leading to a 4-kg weight gain and the development of clinical signs and symptoms of volume overload. Supplemental dialysis was required to correct the hypervolemia.

Discovery and remediation of lapses in processes of care

Detection and remediation of the various lapses in processes of care varied from 7% for inappropriate ordering of analgesia to 54% for detection of a nonrenal diet (Table 3). For the lapses that were detected and subsequently remediated, most were done within 1.2 days of the initial inappropriate order being recorded in the chart. The consulting nephrology service was responsible for detecting and correcting most of the lapses (Table 3).

DISCUSSION

The majority of patients on chronic in-center hemodialysis admitted to surgical services experience at least one safety lapse during their hospitalization. Despite this, only one adverse event directly attributable to lapses in safety was recorded. Most lapses were detected and remedied within 24 hours.

To our knowledge, this is the first study to describe patient safety lapses in chronic hemodialysis recipients. Prior studies used different process of care indicators and focused on patients with CKD not on dialysis. They demonstrated an increased number of safety lapses as glomerular filtration rate (GFR) declined.[10,13,25] Our data suggest that these findings extend and are magnified in patients with more advanced CKD who require hemodialysis.

In keeping with other studies across various medical disciplines, errors in medication ordering were common.[21,26,27] Given the proliferation of new therapeutic agents, health care professionals may not be able to adequately familiarize themselves with all the appropriate indications, contraindications, and adverse effects of drugs.[28] In the absence of appropriate oversight, such as CPOE or pharmacy databases, this may lead to medication errors and possibly adverse events. CPOE programs often incorporate dosing algorithms and decision support mechanisms that prompt the user in real-time when an inappropriate medication is ordered. Chertow et al. demonstrated that medication errors in hospitalized patients with CKD can be substantially mitigated through the use of computerized physician order entry programs.[14] Moreover, CPOE is also associated with decreased costs, shorter length of stay, and improved compliance with several types of guidelines.[29–32] At the time of our study, CPOE was not being utilized at St. Michael's Hospital, which may have contributed the high rate of medication errors that we observed.

Some of the lapses in processes of care in our cohort may be explained by our focus on patients on chronic hemodialysis admitted to a surgical service. Studies have

demonstrated that outcomes and quality of care are improved when patients with specialized needs are admitted to specialized wards. An example of this would be patients who suffer a stroke admitted to dedicated stroke wards.[33,34] These benefits may be derived from increased familiarity and adherence to processes of care specific to the admitted population by the health care staff.[20,35] We chose to study patients on chronic hemodialysis admitted to surgical services as we felt the unique medical issues inherent in this population may be beyond the scope of surgical health care professionals' training and experience. This would place hemodialysis patients at greater risk for lapses inpatient safety while on surgical units as compared with traditional internal medicine units.

In contrast to previous work in the field of patient safety in hospitalized patients, our study was unable to detect a substantial number of adverse events stemming from lapses in processes of care. This is surprisingly fortunate as it has been demonstrated that the risk of adverse events increases with progressive decline in GFR.[10,13] There are multiple reasons that may have resulted in our inability to detect many adverse events. Firstly, our small sample size may have limited our ability to demonstrate any adverse events resulting from lapses in processes of care. For example, medication error has been described as the most common type of medical error in hospitalized patients. According to a large meta-analysis, the incidence of adverse events related to medication errors in hospitalized patients is 2.29%.[36] Extrapolating this rate to our study would preclude us from detecting any medication-related adverse event in our cohort. Secondly, adverse events related to lapses in care may have been subtle, or possibly masked by an underlying condition thereby also limiting their detection. Similarly, some of the lapses in care may have been associated with "near-misses" or potential adverse events. That is, they had the potential to cause injury, but did not. These potential adverse events have been found to have a much higher incidence than actual adverse events, particularly for medication-related errors.[16]

Despite this, the potential impact of the lapses in our process of care indicators should not be overlooked. Patients on chronic dialysis possess many attributes that may heighten their risk of harm even for what may be considered relatively "benign" errors. For example, during hospitalization, patients often lose muscle mass for various reasons. In dialysis patients, this issue is of particular concern as the decrease in muscle mass leads to a decrease in total body water as well as impairment in the ability to effectively buffer a potassium load. In this regard, prescribing a diet that fails to account for renal impairment may provide such patients, who are often anuric, with a large potassium load, which may lead to hyperkalemia and its associated deleterious effects. This may occur despite a patient not tolerating much oral intake. Similarly, inappropriate use of intravenous fluids, particularly maintenance intravenous fluids with isotonic saline, in anuric patients may lead to pulmonary edema, which may require intubation in addition to the initiation of urgent dialysis. As such, even lapses in processes of care that may seem trivial have the potential for morbidity and mortality but may also unnecessarily increase the cost and length of hospitalization.

For all these reasons, the detection of such lapses in care is paramount. However, there was marked variability in the detection and remediation of various lapses among our cohort. This may be related to a number of reasons including a lack of prespecified expectations for the consulting service providers, a lack of coordination among the different members of the multidisciplinary team or other consulting services, as well as a lack of availability of tools known to detect and remediate specific medical errors such as CPOE. It has been reported that the reason for medical consultation is unspecified or unclear in approximately 15–25% of medical consultations.[37,38] As such, consulting services may often provide incomplete and potentially ineffective consultative service. This may have occurred in our study where the nephrology service may not have been provided with a clear expectation of their role, aside from the obvious provision for dialysis, which may have contributed to a lack of oversight concerning other important issues including appropriate medication and analgesic prescribing. Along similar lines, there may have been a lack of coordination among the multidisciplinary team members involved in the care of the admitted dialysis patients. Again, this may have resulted from the unclear communication of role expectations by the referring surgical service, which may have fostered a "pass the buck" mentality among the various service providers. In this regard, some services may have inadvertently assumed that certain issues were being dealt with by other services when in fact this was not the case. For example, the nephrology service may have overlooked doing a dietary review as they may have assumed that the dietician would be reviewing the admitted patient's diet and making changes as appropriate. Finally, the lack of tools known to mitigate medical errors such as CPOE and dedicated pharmacists may also have limited detection of inappropriate medication ordering.

Our study has several important implications for the management of chronic dialysis patients admitted to surgical services. First, as reported by Salerno and col-

leagues,[39] the effective communication of expectations of the nephrology and other consulting services should be indicated by the referring surgical service at the time of consultation. This should help to not only improve detection of lapses in care but also to abrogate such lapses in the first place. The use of a multidisciplinary team may also improve error detection; proviso that the health care team leader (the referring surgical service provider) is aware of members of the multidisciplinary team and appropriately delegates roles to each team member. This should ensure appropriate care, minimize redundancy, and avoid one team member overstepping their boundary and usurping the autonomy of the admitting service and other members of the multidisciplinary team. Second, where possible, the implementation of novel information technology tools such as CPOE may help in mitigating lapses in care. However, because of the high cost associated with the introduction of this tool it may not be feasible for smaller nonteaching hospitals to implement. Instead, the use of a simple checklist of important processes of care specific to chronic dialysis patients, by the nephrology service, may improve detection of errors and mitigate adverse events. Checklists have been extensively used in hospital settings, and have demonstrated benefit in the quality of care provided to patients.[40–43] As the use of a checklist involves little cost, it can be universally implemented in both teaching and nonteaching hospitals.

Our study has several limitations. First, our small sample size may have limited our statistical power to demonstrate associations between lapses in care and subsequent adverse events. However, they represent consecutive admissions over a 2-year period. Second, the process of care indicators used in our study may be considered arbitrary as they have not been formally validated. However, we feel that the indicators we chose to study are clinically relevant as they were developed based on criteria used in previous studies and were reviewed by clinical experts.[18,20] Moreover, for our medication-related indicators, we chose to focus solely on analgesics and antibiotics as studies have indicated that these types of medications most frequently yield adverse events.[16,21] However, inappropriate dosing of medications from other classes may also be placing hospitalized dialysis patients at risk. Third, it has been well established that chart reviews are highly sensitive to reviewer interpretation and therefore, the assessment for the presence of our process of care indicators and subsequent adverse events the reviewers may have been influenced by personal interpretation leading to bias.[44,45] However, the use of objective criteria to designate the presence of the various safety lapses and the high interrater variability for review of the charts by two independent readers are reassuring. Our data was also dependent upon the quality of the abstracted charts, such that missing, incomplete, or undocumented information may have limited our ability to discern whether a lapse in care and/or an adverse event occurred. Finally, this was a single-site study thereby limiting the generalizability of the results.

Patients receiving chronic hemodialysis who are admitted to a surgical service experience multiple lapses in patient safety, many of which remain undetected. Our findings suggest an urgent need to improve the surveillance of these vulnerable patients in order to reduce the risk of ostensibly preventable complications. Efforts to identify and implement practices that address the safety pitfalls observed in chronic dialysis recipients may prevent safety lapses when such patients are admitted to surgical services.

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APPENDIX I: PROCESS OF CARE INDICATORS FOR CHRONIC HEMODIALYSIS PATIENTS

Indicator	Definition
Ordering a nonrenal diet	Failure to write "renal diet" in the diet orders e.g., ordering DAT, cardiac diet, and diabetic diet.
Incorrect antibiotic dosing	(i) Ordering antibiotics that are contraindicated in ESRD†; and (ii) ordering antibiotics in excess of the recommended dosage or dosing interval.†
Inappropriate analgesic use	Ordering analgesics that are relatively contraindicated in ESRD† e.g., meperidine, morphine, and NSAIDs.
Inappropriate intravenous fluid (applies only to normal saline or 2/31/3)	Continuous infusion of intravenous fluid in the absence of objective evidence of hypotension/hypovolemia e.g., low jugular venous/central venous pressure, postural hypotension, and postural tachycardia.

DAT = diet as tolerated; ESRD = end-stage renal disease; NSAID = nonsteroidal anti-inflammatory drug.
†According to the criterion standard reference: *Drug Prescribing in Renal Failure: Dosing Guidelines for Adults*.[19]