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ORIGINAL RESEARCH

Optimizing MObility for critically ill patiEnts undergoing Continuous Renal Replacement Therapy (MOvE CRRT): An audit of mobility interventions in the intensive care unit

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ABSTRACT

BACKGROUND: CRRT is common in the ICU. This intervention has been shown to contribute to reduced mobilization due to fear of adverse events. This study sought to evaluate the degree of mobilization in patients receiving CRRT and to develop a procedure checklist to enhance mobilization in these patients.

METHODS: A retrospective observational matched cohort audit of adult patients admitted to the General Systems ICU at the University of Alberta Hospital from April 1, 2015, and April 1, 2017 was conducted. A total of 50 CRRT patients were matched to 37 critically ill patients and their mobilization events compared. Data was analyzed descriptively. A protocolized mobilization procedure checklist was subsequently developed.

RESULTS: Higher levels of mobility were achieved in patients not receiving CRRT. The highest level of mobility in CRRT patients was ambulation in 1 (2%), active mobilization in 17 (34%), passive mobilization in 13 (26%) and none in 19 (38%); whereas, in controls, the highest level of mobility was ambulatory in 22 (59%), active in 10 (27%), passive in 2 (5%) and none in 3 (8%). Four (8%) of the CRRT patients had a PT program delay attributed to CRRT. Adverse events were uncommon and unrelated to CRRT, occurring in 1 (2%) of CRRT patients and in 3 (8%) control patients. No critical adverse events occurred, and no CRRT was delayed or paused. Alarms limited or postponed treatment in 7 (14%) patients.

CONCLUSIONS: Mobilization while on CRRT is feasible and safe. It is conducted less frequently and to a lesser degree when compared to similarly acute patients not receiving CRRT. A procedure checklist has been developed to improve mobilization while on CRRT that can be safely implemented in critically ill patients.

RÉSUMÉ

CONTEXTE: La thérapie de remplacement rénale continue (TRRC) est courante dans l'unité de soins intensifs (USI). Il a été démontré que cette intervention contribuait à réduire la mobilisation en raison de la peur des événements indésirables. Nous avons cherché à évaluer le degré de mobilisation chez les patients recevant une TRRC et à élaborer une liste de vérification des procédures pour améliorer la mobilisation chez ces patients.

MÉTHODES: Nous avons mené une vérification rétrospective observationnelle de cohorte appariée de patients adultes admis aux systèmes généraux de l'USI de l'hôpital de l'Université de l'Alberta entre le 1er avril 2015 et le 1er avril 2017. Cinquante patients TRRC ont été appariés à 37 patients gravement malades et leurs événements de mobilisation comparés. Les données ont été analysées de manière descriptive. Une liste de vérification de la procédure de mobilisation protocolisée a par la suite été élaborée.

RÉSULTATS: Des niveaux de mobilité plus élevés ont été atteints chez les patients ne recevant pas de TRRC. Le niveau de mobilité le plus élevé chez les patients TRRC était la marche dans un cas (2 %), la mobilisation active dans 17 cas (34 %), la mobilisation passive dans 13 cas (26 %) et aucune mobilité dans 19 cas (38 %) tandis que chez les témoins, le niveau le plus élevé de la mobilité était ambulatoire dans 22 cas (59 %), active dans 10 cas (27 %), passive dans deux cas (5 %), tandis qu'aucune mobilité n'était notée dans trois cas (8 %). Quatre (8 %) des patients TRRC avaient un retard dans leur programme de physiothérapie attribué à la TRRC. Les événements indésirables étaient peu fréquents et sans rapport avec la TRRC, et sont survenus chez un patient (2 %) atteint de TRRC et chez trois patients témoins (8 %). Aucun événement indésirable critique n'est survenu et aucun TRRC n'a été retardé ou interrompu. Des alarmes concernant un traitement limitée ou reportée ont été rapportées chez 7 patients (14 %).

KEYWORDS
Continuous renal replacement therapy; intensive care unit; mobilization

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CONCLUSIONS: La mobilisation pendant le TRRC est faisable et sécuritaire. Elle est menée moins fréquemment et dans une moindre mesure par rapport à des patients présentant une gravité similaire ne recevant pas de TRRC. Nous avons élaboré une liste de vérification des procédures, dans l'optique d'améliorer la mobilisation sécuritaire des patients gravement malades pendant une TRRC.

List of Abbreviations: AKI: Acute kidney injury; APACHE II: Acute physiology, age, chronic health evaluation score.; CRRT: Continuous renal replacement therapy; GCS: Glasgow coma scale; ICU: Intensive care unit; LOS: Length of stay; PT: Physiotherapy; RRT: Renal replacement therapy

Introduction

Critically ill patients admitted to ICU often experience multi-system organ failure requiring invasive treatment measures.[1,2] This may include AKI. When AKI progresses to failure, RRT is necessary with CRRT being most common form of acute RRT.[3] Patients undergoing CRRT are often the sickest patients, have the highest severity of illness and suffer from prolonged ICU and hospital stays.[4]

In these sick patients, mobilization has repeatedly been associated with improved ICU outcomes, hospital outcomes, long term recovery and health related quality of life.[5–9] Early mobilization has also been demonstrated to be safe, with a low incidence of adverse events.[8,10,11] Practice patterns in the ICU are changing in response to these findings, with early mobilization and rehabilitation becoming the standard of care.[12–14] These practice changes are particularly important to consider in patients presenting with high severity of illness, such as those requiring renal replacement therapy who are most at high risk of deconditioning.[5]

Mobility protocols and initiatives are in place at various tertiary care center ICUs to facilitate concepts of early mobilization.[14] Any degree of mobilization has been shown to be of benefit and is especially true in patient populations that are frail at the onset of their critical illness. Prolonged stays, combined with decreased mobilization, greatly impair and delay recovery and discharge from the ICU and the hospital.[5,15]

Despite this widely accepted and otherwise growing practice of early mobilization and rehabilitation, therapies such as CRRT are associated with decreased mobility interventions.[5,16] This is largely due to the fear of adverse events, as well as the historic practice of maintaining these patients on strict bed rest for fear of disrupting their extracorporeal circuits.[15] While some patients may be suitable for treatment options more amenable to mobilization, such as intermittent hemodialysis (IHD), others may not. Previous focused interventional studies have shown that physiotherapy (PT) mobilization interventions in patients receiving CRRT can be safe and feasible.[15,17]

While evidence exists to support mobilization, published recommendations or protocols to support changes in practice are less robust and available. Despite any availability, reinforcing the safety of mobilization in this population is judicious whenever a center seeks to change practice standards. In light of this, the researchers sought to solidify recent data on safety and advance understanding of mobilization in this population and to develop a literature supported and stakeholder influenced procedure checklist for patients undergoing CRRT in the ICU. The study was conducted as a retrospective observational cohort audit of adult patients admitted to a single academic quaternary ICU in Canada. We hypothesized that mobilization would be less common in CRRT patients and that adverse events would be rare. Additionally, identifiable patient-level and ICU organizational level barriers could exist that may be amenable to intervention.

Methods

Ethics

After consultation with the local Research Ethics Board, it was determined that the project was within the scope of the quality assurance/quality improvement initiative. As per policy for these types of initiatives, "Ethical Conduct for Research involving Humans, program evaluation/quality assurance or quality improvement studies are not subject to Research Ethics Board review and approval." Formal Research Ethics Board approval was not required and the need for consent was waived.

Design and setting

The study utilized a retrospective observational cohort audit conducted at the General Systems ICU (GSICU) at the University of Alberta Hospital (UAH) between April 1, 2015, and April 1, 2017. The GSICU is an academic quaternary ICU that has a total of 32 beds capable of providing full organ support (mechanical ventilation, vasoactive agents and RRT [including both intermittent and continuous forms]) caring for general medical, surgical, transplant, burn and trauma patients. The nurse-to-patient ratio is generally 1:1 or 1:2. There are 2 full time equivalent (8-hour shift) physiotherapists available on weekdays and one on weekends and holidays.

Patient population: Inclusion criteria

All adult patients in initial admissions or readmissions during the audit period were considered eligible. CRRT patients were required to have an admission LOS greater than 7 days and have received CRRT for greater than 72 hours. There were no exclusion criteria for the CRRT group. For the non-CRRT cohort, patients were matched using criterion age +/-3 years and APACHE II score +/-2

with an initial target of matching controls to CRRT patients in a 5:1 ratio. If patients remained unmatched, rematching was performed with a broader criterion of age +/-7 years and APACHE II score +/-4. Patients were removed from controls if they had received CRRT during their admission or if their LOS was less than 7 days.

Operational definitions

Our operational definitions were structured on a discrete spectrum of mobilization in consultation with unit physiotherapists and clinical nurse educators. We defined patient mobilization on a spectrum of ambulatory, active, passive and none (see Appendix 1). Ambulatory mobilization was defined as any activity, with or without assistance, that involved a patient actively being involved in ambulating out of the bed to a chair, to and from bed with several steps in between or similar sequences. This excluded passive patient transfers that solely utilized power lifts or other similar devices. Active mobilization was defined as patient-initiated movement of extremities or trunk, up to and including standing but not ambulation. Passive mobilization was defined as provider-facilitated movement of extremities or trunk, but an inability to initiate or sustain the activity without facilitation. No mobilization was defined as either no physiotherapist assessment or a patient visit by a physiotherapist that included an assessment but no mobilization intervention. An adverse event was any patient mention of concern by physiotherapy, nursing or other medical staff about a patient's clinical status in the time surrounding mobilization. A critical event was defined as any event that required prompt intervention by medical staff on the basis of declining clinical status.

Outcomes

The primary outcome was to (1) describe mobilization in ICU patients receiving CRRT; (2) identify mobilization related adverse or critical events; and (3) identify strategies to facilitate mobilization. The secondary outcome was to create a procedure checklist to facilitate mobilization. Tertiary outcomes included any discontinuation of mobilization during stay, as well as patient ICU and hospital survival.

Data sources

Data collection was conducted via a focused audit of eCritical/TRACER, the bedside clinical information system, charting platform and data repository for critical care in Alberta, Canada. Data were extracted on socio-demographics, diagnoses, illness severity and treatment intensity. All mobilization data was collected from the repository's physiotherapy charting. This generally consisted of 3 to 4 sentences of free text that outlined the patient's physical status at initial assessment, consent and treatment provided (eg, passive manipulation of lower extremities or ambulation of 80 meters with a 4-wheeled walker). This charting also included notes on how well the patient tolerated treatment, any treatment delays, adverse events and the highest level of mobilization achieved. Data was collected from any PT sessions between initiation and discontinuation of CRRT, regardless of whether CRRT was running during the specific PT intervention. Nurse charting was reviewed before, during and after mobilization events to capture and any adverse events.

Data analysis

Our data analysis was primarily descriptive, with counts and proportions for binary or categorical variables, and mean and standard errors (SE) for continuous variables. The degree of mobilization was assigned for each patient according to the operating definitions after reviewing their entire physiotherapy chart on the clinical information system. We assessed the distribution of demographic and clinical variables. Differences between proportions of patients with baseline demographics were assessed with the chi-square, Student *t* and non-parametric Kruskal-Wallis tests, as appropriate. Statistical analysis was performed using STATA 15 (StataCorp LLC, Texas, U.S.A.).

CRRT mobilization procedure checklist development

To develop the mobilization procedure checklist, the researchers conducted a review of current mobilization practices in the ICU and audited the medical records. Multiple small group meetings were held with CRRT and mobilization stakeholders. These included representatives from the intensivist, physiotherapist, clinical nurse educator and administrator groups. Four meetings at 2- to 3-week intervals were held where the procedure checklist was refined and developed. In the first meeting, the data from the audit was presented to the group and specific barriers and facilitators to mobilization while on CRRT were discussed. In the second meeting, the evidence supporting safe mobilization while on CRRT was discussed. The third meeting involved drafting an outline for the mobilization procedure checklist that was further developed and refined in the fourth meeting. Once developed, the procedure checklist was circulated to the regional RRT committee where it was presented and ultimately approved for incorporation into clinical practice.

Results

Cohort audit

Our initial search for CRRT cases yielded 92 patients who fit our criteria, of which 50 were randomly selected as cases (see Table 1). A total of 46 CRRT patients using the initial criteria were matched; 4 CRRT patients required matching with our broader criteria. Using a total patient population of 3,173 patients, a matched non-CRRT patient cohort of 37 patients was generated. (Figure 1). There was no difference in mean age (54.5 +/- 2.2 vs 53.6 +/- 2.2 years, $p = 0.77$ respectively), sex (27 [54%] vs 17 [46%] male, $p = 0.46$, respectively)

Table 1. Baseline demographics.

Characteristic	CRRT Patients (n = 50)	Non-CRRT Patients (n = 37)	*p*-value
Age (years)	54.5 (2.2)	53.6 (2.2)	0.77
Male sex, n (%)	27 (54.0)	17 (45.9)	0.46
Admission Class, n (%)			
Medical	35 (70.0)	27 (73.0)	0.76
Surgical	12 (24.0)	6 (16.2)	0.38
Other	3 (6.0)	4 (10.8)	0.42
Severity of Illness			
APACHE II	29.1 (1.0)	28.7 (1.1)	0.76
GCS	11.7 (0.5)	10.0 (0.8)	0.08
MV, n (%)	32 (64.0)	25 (67.6)	0.66
Vasopressor, n (%)	31 (62.0)	21 (36.8)	0.63
CRRT Parameters			
CRRT duration (hours)	175.8 (17.8)	–	–
Femoral Catheters (%)	24 (48.0)	–	–
IJ Catheters (%)	26 (52.0)		–
Outcomes			
ICU LOS (days)	25.9 (2.6)	12.9 (1.1)	<0.001
ICU Mortality (%)	0 (0.0)	5 (13.5)	0.001
Hospital Mortality (%)	10 (20)	8 (21.6)	0.82

Abbreviations: CRRT, continuous renal replacement therapy; APACHE II, acute physiology, age, chronic health evaluation score; GCS, Glasgow Coma Scale; MV, mechanical ventilation; IJ, internal jugular venous catheter; ICU LOS, intensive care unit length of stay.

or admission class (35 [70%] vs 23 [73%] medical, p = 0.76; 12 [24%] vs 6 [16%] surgical, p = 0.38; and 3 [6%] vs 4 [11%] other, p = 0.42, respectively). The severity of illness was similar between groups (APACHE II 29.1 +/- 1.0 vs 28.7 +/- 1.1, p = 0.76, respectively; admission GCS 11.7 +/- 0.5 vs 10.0 +/- 0.8, p = 0.08, respectively; mechanical ventilation 32 (64%) vs 25 (68%), p = 0.66 respectively; vasopressor use 31 (62%) vs 21 (37%), p = 0.63 respectively). Hospital mortality was similar between the 2 groups (10 [20%] vs 8 [22%], p = 0.82 respectively). However, the ICU mortality was greater in the control group (14% vs 0%, p = 0.001) and the ICU length of stay was longer in the CRRT patient group (25.9 +/- 2.6 days vs 12.9 +/- 1.1 days, p < 0.001).

Vascular catheter location was nearly evenly distributed between femoral veins (n = 24, 48%) and internal jugular veins (n = 26, 52%) in the CRRT group. No CRRT mobilization critical events were recorded and only one adverse event was recorded, which was described as patient agitation during a mobilization attempt. CRRT was not paused or suspended for any patients undergoing mobilization. CRRT pressure or flow alarms during physiotherapy were rare; however, they contributed to limiting or postponing treatment in 7 (14%) patients. The median total CRRT time was 175.8 +/- 17.8 hours. Thirteen (26%) CRRT patients had an interruption of their PT program of at least 1 day for medical reasons. This included any patient condition concern such as hemodynamic instability or prolonged patient unavailability due to procedure or diagnostic exam but did not include delays due to PT caseload. Four (8%) of these CRRT patients' PT program delay for medical reasons was explicitly charted as "unable to mobilize as the patient was running CRRT."

The ICU length of stay at the time of mobilization assessment and initiation was not significantly different between the two groups (5.3 +/- 0.6 days vs 5.1 +/- 0.6 days, and 7.5 +/- 0.7 days vs 6.1 +/- 0.7 days, respectively). However, there were differences in mobilization between patients receiving CRRT and those not receiving CRRT. For CRRT patients, the highest level of mobility achieved was ambulation in 1 (2%), active in 17 (34%), passive in 13 (26%) and none in 19 (38%). In the non-CRRT patients, the highest level of mobility achieved during their entire ICU admission was ambulatory in 22 (59%), active in 10 (27%), passive in 2 (5%) and none in 3 (8%). This is summarized in Table 2.

CRRT mobilization procedure checklist

A CRRT mobilization procedure checklist was developed following the audit of the current mobilization protocol (Figure 2). This protocol was developed with input from all CRRT and mobilization stakeholders. The protocol involves 4 discrete sections: (1) checks to ensure before initiating mobilization, (2) steps preparing for mobilization, (3) actions to troubleshoot common alarms, and (4) a reminder to ensure proper documentation. Multidisciplinary input was also sought regarding perceived barriers and facilitators specific to mobilization during CRRT. Extracorporeal circuit disruptions, potential for hemodynamic instability and fluctuating level of consciousness were raised as concerns specific to CRRT. Femoral central catheters and a unit-adopted mobilization procedure checklist were seen as facilitators for CRRT mobilization.

Discussion

A retrospective, observational, cohort audit of mobilization in ICU patients receiving CRRT were performed at a large quaternary academic ICU. We identified 50 critically ill patients receiving CRRT and these were matched to 37 patients with similar baseline demographics and severity of illness. We described the incidence and degree of mobilization interventions and reported any adverse events. Finally, we have created a mobilization procedure checklist with input from all CRRT and mobilization stakeholders to enhance the mobility of patients undergoing CRRT.

Summary of key findings

Our efforts have reproducibly shown that mobilization interventions in ICU patients undergoing CRRT continues to appear feasible and safe. With all baseline characteristics similar in composition, the non-CRRT patients had higher mortality. This is likely attributable to equivalent APACHE II scores accounted for by non-renal (ie, AKI requiring RRT) comorbidities that contributed to morbidity and mortality. CRRT patients also had longer ICU LOS. This is likely secondary to CRRT requirements and transitions to intermittent RRT, which can frequently be barriers to discharge for otherwise ward-ready patients.

CRRT patients were mobilized to lesser of a degree than a matched cohort of similar illness severity. Over half of

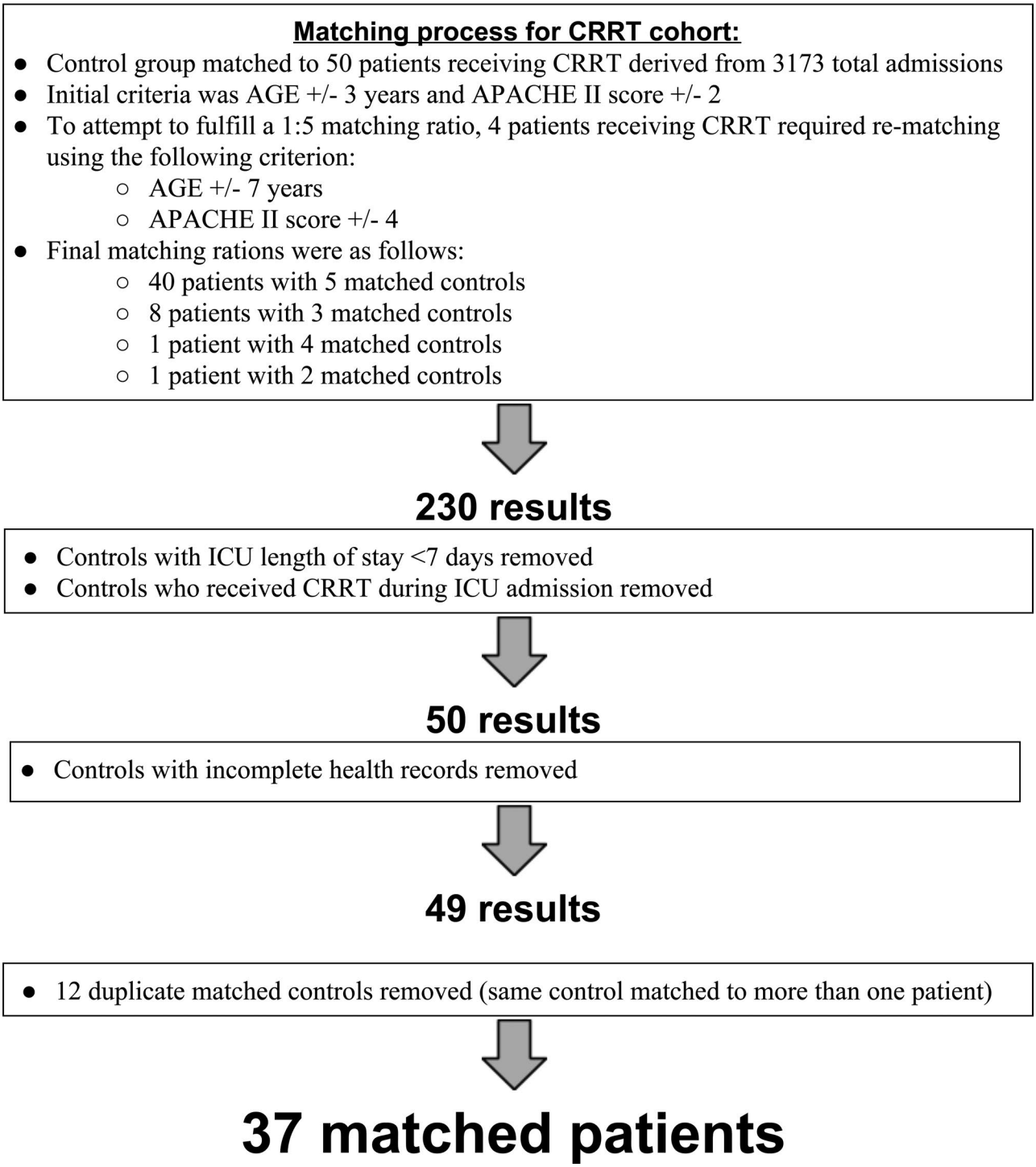

Figure 1. Matching process.

CRRT patients received only passive or no mobilization. Increased intervention, being tied to an extracorporeal circuit and treatment intensity can potentially create perceived barriers to mobilization. However, our control group of similar illness severity had nearly 60% of patients ambulating before ICU discharge, demonstrating a clear discrepancy of mobilization efforts in CRRT patients. Only one adverse event was noted in the CRRT group, affirming that mobilization in this group is safe and feasible. This provides an opportunity to improve and increase the degree of mobilization in patients receiving CRRT.

A CRRT specific mobilization procedure checklist was required and has been created in parallel with the development and results of this project. This checklist was created in collaboration with all relevant stakeholders in the GSICU and carefully identified CRRT specific barriers and facilitators to mobilization. The clear primary barrier identified in this process was the hazard of extracorporeal circuits when mobilizing, something this cohort audit has demonstrated as safe. This procedure checklist will now be implemented across our local medical administrative medical authority. This will facilitate increased mobilization, as well as allow

Table 2. Summary of mobilization events.

Characteristic	CRRT Patients (n = 50)	Non-CRRT Patients (n = 37)	*p*-value
Length of stay (days)			
Mobilization Assessment	5.3 (0.5)	5.1 (0.6)	0.820
Mobilization Initiation	7.4 (0.7)	6.1 (0.7)	0.190
Level of Mobility Achieved, n (%)			
None	19 (38.0)	3 (8.1)	0.002
Passive	13 (26.0)	2 (5.4)	0.010
Active	17 (34.0)	10 (27.0)	0.450
Ambulation	1 (2.0)	22 (37.3)	<0.001
Adverse Events, n (5)	1 (2.0)	3 (8.1)	0.180

Abbreviations: CRRT, continuous renal replacement therapy.

monitoring of changes in mobilization after the introduction of evidence-based guidelines.

Interpretation with previous literature and implications for health policy

Early mobilization and rehabilitation are now becoming the standard of care in ICUs, even in the most complex and critically ill patients. Clinical practice has grown to reflect the resounding evidence supporting early mobilization and its role in decreasing morbidity and mortality.[5,6,18,19] Previous studies that have examined mobilization on extracorporeal circuits have consistently shown that it is safe and efficacious when performed by an experienced team and performed in stages.[20] Furthermore, there has been the suggestion that the decreased morbidity and mortality previously associated with early mobilization applies to these patients as well.[21] Previous studies examining mobilization in those receiving CRRT have demonstrated reproducible confidence in safety and feasibility.[15,17] Ultimately, a proposed change in mobilization practice at our institution warranted this individualized and local audit in this population, which again has demonstrated safe practices with no significant adverse events.

One of the ongoing concerns regarding mobilization while on CRRT pertains to the location of the vascular catheter.[5] Historically, there were significant concerns for circuit disruption and adverse events associated with femoral vascular catheters. In the patient cohort, 48% patients had catheters in their femoral veins. There were no increased filter occlusions, failures or adverse events reported in this patient group. This is consistent with previously reported data that has demonstrated that mobilization is safe and feasible for patients undergoing CRRT with vascular catheters in femoral, subclavian or internal jugular veins.[15]

The researchers believe this affirmation warrants a change in practice for CRRT mobilization, just as has been done for early mobilization in the general patient population. In conjunction with various stakeholders, including intensivists, physiotherapist, clinical nurse educators and administrators, a site-specific CRRT mobilization procedure checklist was developed that helps guide this change in practice. The developed guide outlines general concepts and evidence behind mobilization in this population, procedures to be followed prior to and during mobilization, as well as troubleshooting should alarms occur. It also provides guidelines for appropriate charting following mobilization events for medical record as well as quality improvement purposes. Talley et al. have previously conducted an audit of their ICU and created a CRRT mobilization protocol; however, this protocol excluded patients with femoral dialysis catheters and did not include common troubleshooting strategies.[22] Future work will focus on expanded application of this procedure checklist to other ICU in the local health authority and beyond. Additionally, it is hoped that this will solidify the appreciation and understanding of the impact of evidenced based protocols and their role in quality improvement, both in medical/surgical ICUs and other care settings.

Strengths and limitations

This quality assurance audit project extends existing knowledge and reexamines mobilization in patients receiving CRRT. This was performed at a high-volume quaternary care center with extensive expertise in CRRT. Patients included in this study are broad in admission criteria and had a high severity of illness. This audit exhibited a rigorous matching process to ensure a similar matched control cohort to highlight the high severity of illness of our CRRT patients. An in-depth chart review was undertaken to identify any and all potential barriers to mobilization to both patient groups as well as to identify any recorded adverse events. Finally, we consulted with all of our important stakeholder groups including intensivists, physiotherapists, educators and bedside CRRT providers.

This audit does have limitations that warrant consideration. First, this was an audit of a single quaternary academic ICU with a small sample size subject to practice variation. While limited by its size, it was from inception intended to be an initial audit kept broad to be generally transferable to common practice and still maintains as currently being the largest audit of CRRT mobilization practices recorded. Second, the researchers relied on clinical information and retrospective data from charting by physiotherapist and nursing of mobility through written free text descriptions. Although detailed and in depth, unavoidable and expected inconsistencies in the style and details of reporting of mobilization practices limited identification of barriers to mobilization. Of note, daily free text mobilization summaries were unfortunately not necessarily filed or time stamped at the time of the actual mobilization event, making precise timeline data collection and interpretation difficult. While many of these shortcomings were clinical information systems related rather than personnel, our physiotherapist group was involved in discussions surrounding consistent documentation that could lend best to future quality assurance audits. Third, the matched cohort consisted of a smaller number of patients that initially intended. Although a more sizable comparison group is desirable, the degree of illness severity of the CRRT cohort patients was a factor. This created limitations on identifying similarly ill patients that did not die soon after admission or who went an entire ICU stay without receiving CRRT. We sought to include only those controls that realistically had the

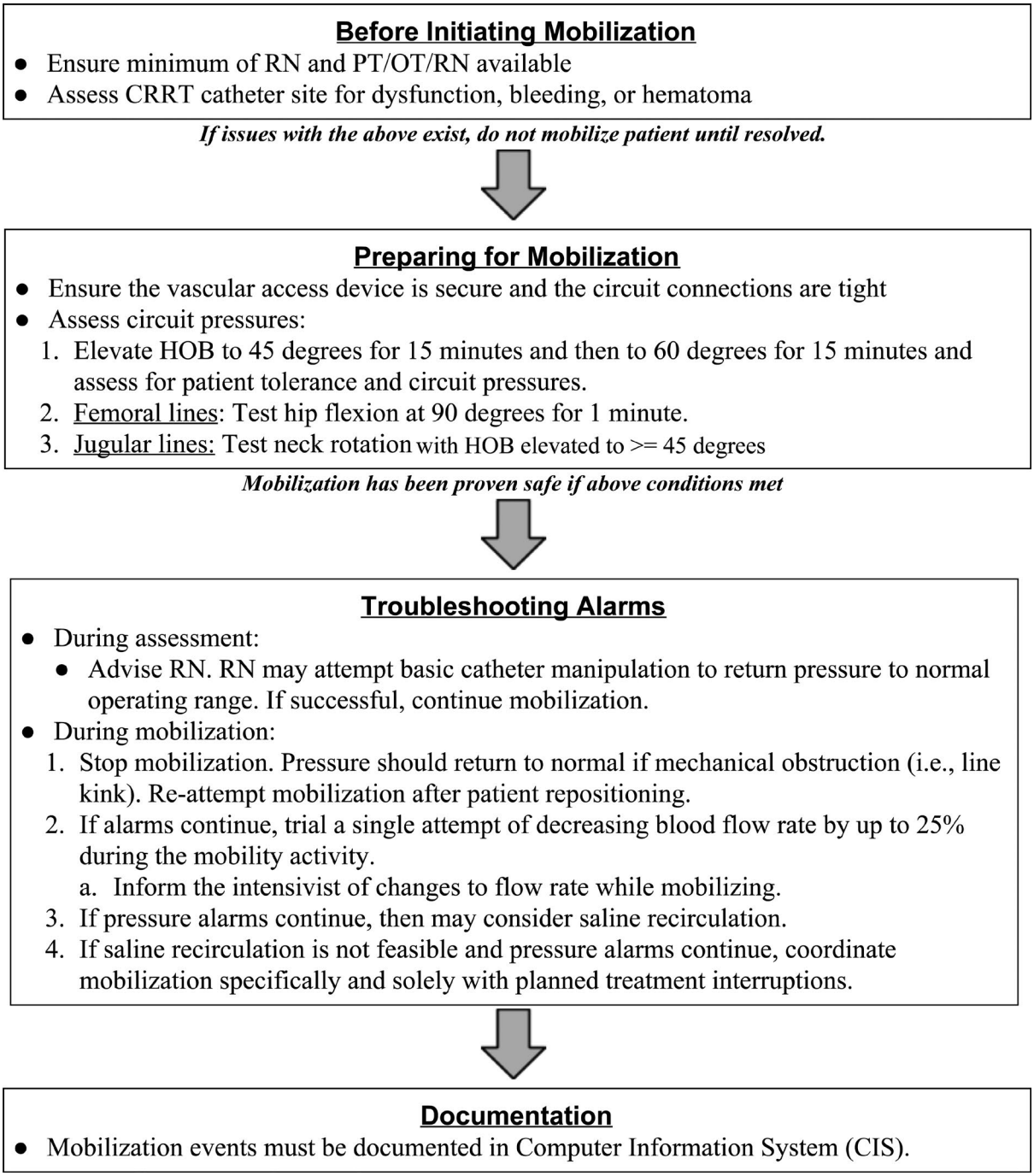

Figure 2. Mobilization protocol.

opportunity to participate in standard mobilization protocols free from CRRT or death soon after admission. The strict matching criteria ensured that patients were appropriately identified and matched, and this permitted adjustment for multiple factors that would have otherwise confounded results. Lastly, it has now been two years since the end of the audit window. This time frame was initially chosen at the start of ICU mobilization review when considering ethics review and planning for future protocol development. After minor delays, the initial phases of the review focused on developing a mobility procedure checklist when results gleaned from the audit became available. The second and current phase of this review has resulted in the development of this original article. The researchers continue to use the information gained from the review in clinical practice and are confident that it is still broadly applicable in the same sense to patient care today.

Conclusions

This study demonstrated that mobilization while on CRRT is feasible and safe; however, it is conducted less frequently and to a lesser degree when compared to similarly acute patients not receiving CRRT. Despite the availability of

and applicability of evidence on mobilization in patients receiving CRRT, practice guidelines are lacking. A safe and feasible procedure checklist to improve mobilization while on CRRT was developed. Future work will focus on its effects following its implementation into health-care policy.

Declarations

Ethics approval and consent to participate

Please see ethics in the Methods section.

Availability of data and materials

Available upon request.

Competing interests

S.M. Bagshaw is supported by Canadian Research Chair in Critical Care Nephrology. O.G. Rewa and S.M. Bagshaw have consulted and received honoraria from Baxter Inc.

Authors' contributions

D.E. Trumble carried out the study design, data collection, and qualitative analysis and drafted the manuscript. J. DeVries and E. Reil developed the mobilization protocol and assisted in standardization processes for data collection. X. Wang assisted in statistical analysis. S.M. Bagshaw and O. Rewa assisted in study design, standardization of data collection, and manuscript drafting.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix 1. Mobilization definitions

Degree of mobilization	Definition
Ambulation	Any activity, with or without assistance, that involved a patient actively being involved in ambulating out of bed to a chair, to and from bed with several steps in between, or similar sequences. This excludes passive patient transfers that solely utilized power lifts or other similar devices.
Active	Patient-initiated movement of extremities or trunk up to and including standing, but not ambulation.
Passive	Provider-facilitated movement of extremities or trunk that may include patient participation, but an inability to initiate or sustain the activity without facilitation.
None	Either no physiotherapist assessment, or a patient visit by a physiotherapist that included an assessment but no mobilization intervention.