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Coagulation

Improving the adoption of optimal venous thromboembolism prophylaxis in critically ill patients: A process evaluation of a complex quality improvement initiative

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ABSTRACT

Purpose: This study evaluated a complex initiative to increase evidence-based use of low molecular weight heparin for venous thromboembolism prophylaxis among adult medical-surgical ICU patients.
Materials and methods: This study included: quantitative survey and interviews. Participants were healthcare providers within four ICUs. Surveys collected knowledge of evidence underpinning best practice, exposure to the implementation strategies and their perceived utility, and recommendations. The interview expanded on survey topics. Descriptive statistics summarized the data and chi-squared tests were used to compare groups. Qualitative data were analyzed using a blended deductive and inductive coding approach.
Results: Providers had good knowledge of the evidence (range = 58% to 94%). Pharmacist-to-physician reminders (80%), other reminders (50%), and local guidelines (50%) were the most commonly observed strategies. Local champions (76%), on-site education (74%), and computerized decision support system (69%) were perceived to be most helpful. Interviews elicited five themes: provider roles, perceptions of the implementation strategies, facilitators and barriers to uptake of best practice, and recommendations. Assessment of the implementation strategies varied by professional group.
Conclusions: The findings of this process evaluation identified implementation strategies that can improve the use of evidence-informed practices, help interpret outcomes in the context of interventions and guide future quality improvement initiatives.

1. Introduction

Quality improvement (QI) initiatives designed to implement evidence informed practices into patient care have had inconsistent success (variably described as implementation science, dissemination and implementation, knowledge translation etc.) [1-4]. Evaluation of the strategies used is often lacking and rarely distinguished from the clinical outcomes [5,6]. Process evaluations provide a mechanism to understand the reasons for the success and failure of implementation strategies and are increasingly recognized as essential components of quality improvement to maximize the return on investment in quality improvement initiatives (i.e. continue using effective interventions and discontinue ineffective interventions) [7-11]. This can, in turn, facilitate iterative modification of the implementation strategies to increase their effectiveness in improving and sustaining quality of care.

Venous thromboembolism (VTE) prophylaxis is an evidence informed practice ideal for quality improvement initiatives that include process evaluations. VTE is a leading cause of preventable hospital deaths in high-income countries [12,13], which has made it a priority for QI in many hospitals [14-18]. Effective strategies to prevent VTE exist [19-21], but the delivery of the most efficacious, safe [19], and

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cost-effective [22] form of VTE prophylaxis (low molecular weight heparin [LMWH]) lags behind current evidence [23,24]. A recent audit within a network of Intensive Care Units (ICUs) in a province within Canada demonstrated that LMWH was administered an average of only 38% of ICU patient days [25]. As such, VTE prophylaxis was identified as a key opportunity to improve best practices and quality of care [26]. Studies examining factors that influence the use of LMWH for VTE prophylaxis have identified multiple barriers and facilitators to its use suggesting that a theory-based, complex quality improvement initiative comprised of multiple implementation strategies would likely be most successful [27-30]. The barriers to the adoption of LMWH for VTE prophylaxis include, insufficient knowledge or understanding, ICU culture, and absence of clinical guidelines; whereas the facilitators were on-site education and pre-set orders [31].

The objective of this study was to comprehensively evaluate a complex quality improvement initiative comprised of multiple implementation strategies to increase evidence-based use of LMWH for VTE prophylaxis among adult patients admitted to medical-surgical ICUs. Using mixed-methods, we were able to elucidate strategies perceived by healthcare providers as helpful to effect practice change.

2. Materials and methods

2.1. Aim

Implementation strategies selected for the quality improvement initiative were based on local stakeholder engagement [26], audit of current VTE prophylaxis practices, and identification of barriers and facilitators specific to the use of LMWH for VTE prophylaxis (Fig. 1) [25]. As such, this process evaluation had three key objectives: [7].

1. Describe the individual implementation strategies used in the QI initiative;
2. Evaluate to what extent ICU healthcare providers were successfully exposed to the implementation strategies (penetration/reach of the improvement initiative); and
3. Describe the acceptability, adoption, appropriateness, feasibility and sustainability of the implementation strategies, including recommendations for future initiatives.

2.2. Design

This mixed-methods study incorporated a cross sectional survey and semi-structured interviews with ICU providers six and eight months, respectively, after the start of the improvement initiative. The survey and interview guide were developed based on previous work identifying barriers and facilitators to the use of LMWH for VTE prophylaxis within this population [27] and informed by the Medical Research Council's (MRC) guidance on development and evaluation of complex interventions [32]. Survey results refined the interview guide for the semi-structured interviews by identifying topics that needed to be further explored to understand providers' perspectives and experiences with the implementation strategies.

2.3. Setting

This study included four adult, medical-surgical ICUs [33] in the largest city in a province within Canada, which operate in a publicly funded single payer healthcare system. These ICUs have 66 beds and admit approximately 2800 patients per year [34]. Patients are cared for by a multidisciplinary and multi-professional group of healthcare providers including ICU board certified physicians, nurse practitioners (NPs), medical trainees (residents and clinical fellows), nurses, and pharmacists.

2.4. Participants

All healthcare providers (described above) and decision-makers (medical directors, nurse managers, nurse educators) responsible for patient care in the four ICUs were invited to participate.

2.5. Improvement initiative

The goal of the improvement initiative was to optimize LMWH prescribing, based on current evidence that suggests, among medical-surgical ICU patients without a contraindication, LMWH is the first choice for VTE prophylaxis [19,35]. To achieve this goal, an improvement initiative comprised of multiple implementation strategies was developed based on information gathered in previous phases of a larger

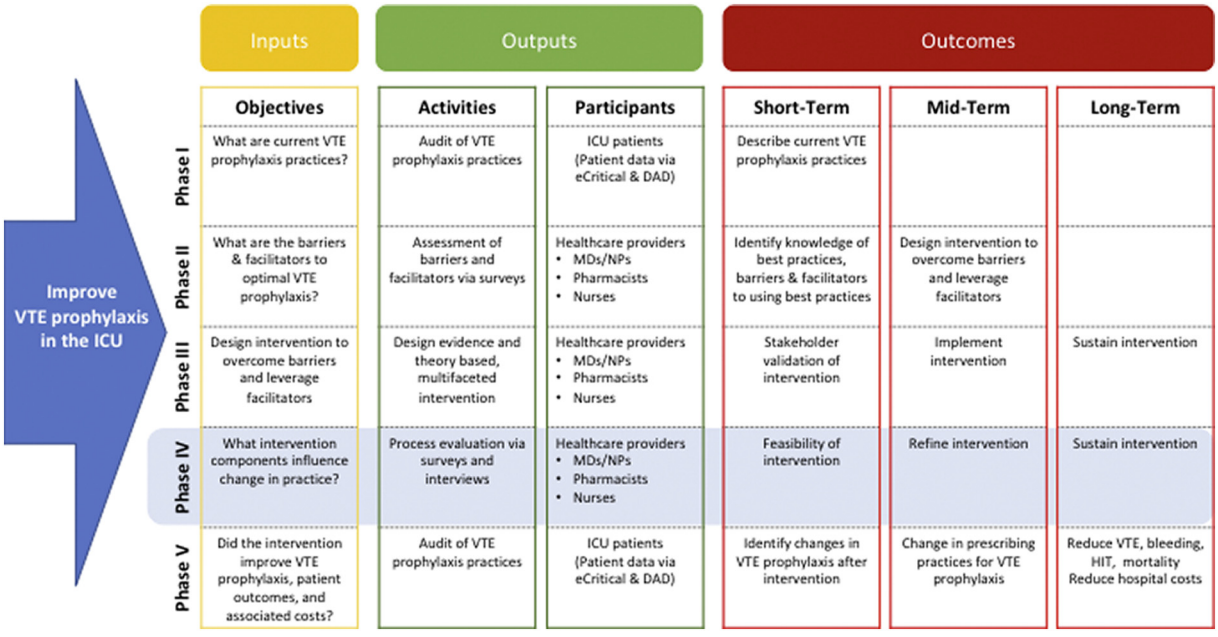

Fig. 1. Logic model outlining sequential steps of the improvement initiative*. * Phase IV, shaded in blue, reflects the current process evaluation. It is the fourth of five sequential steps that comprise the overall improvement initiative.

study to improve evidence-based practices in the ICU [25,26] and expert consultation within the Department of Critical Care Medicine and the provincial healthcare delivery organization.

The improvement initiative was comprised of four categories of implementation strategies: (1) education, (2) clinical decision support tools, (3) reminders, and (4) audit and feedback; each of which included multiple individual strategies tailored to each ICU [36]. The implementation strategies were launched between May and December 2016 and sustained through April 2017 (Fig. 2). The primary message in all materials was: choose LMWH as the optimal form of pharmacological VTE prophylaxis for patients without contraindications to chemoprophylaxis. Intended recipients were healthcare providers including: intensivists ($n = 30$), nurse practitioners (NPs, $n = 6$), clinical fellows ($n = 9$), residents rotating through the ICU during the study period (~20/four-week period), pharmacists ($n = 18$), and nurses ($n = 82$).

2.5.1. Education

On-site education included (1) an ICU grand rounds presentation by the principal investigator just prior to the release of revised local clinical practice guidelines, and (2) a slide presentation integrated into the one-day course for residents delivered every four weeks at the start of the ICU rotation. Web-based education consisted of electronic communication (emails and resources posted on the departmental website), and a newsletter (Supplementary File S1). Educational content highlighted key changes to the local clinical practice guideline, the evidence supporting these changes, and notice of the implementation strategies.

2.5.2. Clinical decision support tools

A new clinical practice guideline for VTE prophylaxis for medical-surgical ICU patients was developed by a local multi-disciplinary team, reviewed by healthcare providers, and endorsed by ICU leadership (Supplementary File S2). This guideline was disseminated across all study sites by clinical leads in each profession (medicine, pharmacy, nursing). The guideline outlined a clear VTE prophylaxis care pathway and recommended LMWH dosing, including adjustments for extreme weights and renal insufficiency. The new guideline also informed changes to the VTE prophylaxis order set within the established computerized order entry system used in all participating ICUs (Sunrise Clinical Manager © Eclipsys). This new order set was designed to facilitate selection of LMWH (rather than unfractionated heparin [UFH]) for VTE prophylaxis in ICU patients (Supplementary File S3).

2.5.3. Reminders

Identified as early adopters during planning of the improvement initiative and ideally suited in their professional role as therapeutic advisors, pharmacists provided verbal LMWH reminders to prescribers at the point-of-care, most commonly during daily multi-professional bedside rounds [37]. Other forms of reminders included paper (posters on the unit, reminder pocket cards; Supplementary File S4 and Supplementary File S5) and electronic messages using the regional paging system to remind prescribers of clinical decision support tools and the initiative.

2.5.4. Audit and feedback

Each month administrative data from the provincial health analytics system (eCritical [38], Metavision © iMDsoft) on VTE prophylaxis prescribing were collected, synthesized and presented to providers. Posters showing the percent of LMWH, UFH, and mechanical prophylaxis days in each ICU were circulated to prescribers and pharmacists via: (1) email; (2) intranet on the departmental home page; and (3) posters taped to the computer rounding cart as well as other key locations in individual ICUs (Supplementary File S6).

2.6. Survey

2.6.1. Participant ascertainment

The survey was disseminated six months after we began rolling out implementation strategies. In compliance with our provincial healthcare delivery organization research regulations, local ICU managers emailed the study invitation to ICU providers and decision-makers on our behalf. The invitation letter included a link to the electronic survey (Survey Monkey®). The decision to complete the survey indicated informed consent. Survey responses were anonymous. Survey reminders were sent three times to providers, seven to ten days apart.

2.6.2. Survey development

The survey was developed from a validated instrument used successfully in a previous national Canadian study [27] to identify barriers and facilitators to using LMWH for VTE prophylaxis in the ICU. The survey was divided into three sections: 1) professional demographic characteristics, 2) perception and knowledge of best practices for VTE prophylaxis, and 3) recollection of implementation strategies used to encourage prescribing of LMWH over UFH to measure acceptability, adoption, appropriateness, feasibility, and penetration (Supplementary File S7). Some of the implementation strategies described in the survey were not part of the improvement initiative, but were included to

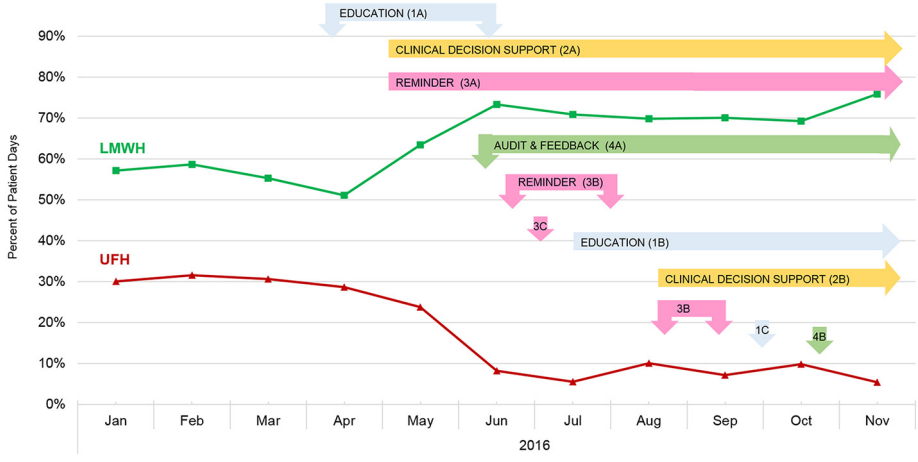

Fig. 2. Audit of LMWH and UFH administration over time. Arrows indicate when QI strategies were implemented. *Education* (1A) – Site visits, newsletter, meeting presentations, and grand rounds; (1B) – Resident presentation (each ICU rotation every 4 weeks); (1C) - Research seminar to frontline providers and decision makers. *Clinical Decision Supports* (2A) – Practice guideline release; (2B) – Change in electronic order set. *Reminders* (3A) - Verbal reminders during daily rounds; (3B) - Prescribing pocket cards and LMWH stickers tagged on ICU computers; (3C) - Resident paging if UFH is ordered for a patient instead of LMWH. *Audit & Feedback* (4A) – Monthly dissemination - unit posters; website, email; (4B) - Zone report to frontline providers and decision makers.

permit comparisons to previous surveys within the larger study [25] and to account for possible individual grass root implementation strategies. Survey questions included three types of response options: multiple-choice, a seven-point Likert scale (1 = never to 7 = always), and open-ended text boxes. The final question of the survey asked participants if they were interested in participating in interviews to expand their responses.

2.6.3. Data analysis

Descriptive statistics (medians with interquartile ranges [IQR], frequencies with proportions [%]) described participant demographics, knowledge of best practices for VTE prophylaxis, recollection of implementation strategies, and perceived utility of each implementation strategy to encourage LMWH use. ICU healthcare providers were categorized into three groups: 1) prescribers of VTE prophylaxis (physicians, medical trainees, and NPs), 2) advisers to the prescribers (pharmacists), and 3) those who administer VTE prophylaxis (nurses). Chi-squared tests were used to make statistical comparisons between groups. Open-ended questions were analyzed using the same methods as the interviews, described below.

2.7. Interviews

The full details of the methodology for the interviews can be found in Supplemental File 8 (Supplementary File S8). Briefly, interviews were conducted 8 months after rollout of the implementation strategy with the same group of participants that responded to the survey. The interviews were analyzed by two independent analysts using a blended approach of deductive coding, based on the known topics from existing evidence on barriers and facilitators to the adoption of LWMH for VTE prophylaxis [27], and inductive coding whereby new codes and themes developed from the data.

Agreement between the quantitative survey data, the open-ended qualitative data from the survey, and the qualitative interview data (triangulation) was examined.

2.8. Ethical considerations

This study was approved by the University of Calgary Health Research Ethics Board (REB16-0541).

3. Results

3.1. Survey

Of 149 surveys distributed; 90 were returned (response rate = 60.4%). The majority of respondents were nurses (46.6%), followed by prescribers (38.8%), and pharmacists (14.4%). Within the prescribers there was heterogeneity among response rates - the NPs had the highest response rate (83.3%) followed by intensivists and clinical fellows (66.7%), with residents having the lowest response rate (18.2%).

Most healthcare providers indicated that LMWH was 1) effective at preventing DVT (94%) and PE (77%), 2) had a low risk of bleeding (79%) and heparin induced thrombocytopenia, and 3) was most cost effective (89%; Fig. 3); which is congruent with the published evidence. Although 87.6% of participants correctly selected adjusted dosing of LMWH as the guideline concordant prescription for patients with extreme weights (<40 kg or > 100 kg), only 58.4% correctly selected adjusted dosing of LMWH as the guideline concordant prescription for patients with kidney impairment (CrCl<30 ml/min). Responses to all questions varied by professional group (not statistically significant for risk of bleeding); prescribers and pharmacists more frequently selected the response that was congruent with the published evidence (Fig. 3). On the seven-point scale (1 = never, 7 = always), healthcare providers perceived that VTE prophylaxis best practices were almost always being followed in the ICUs (median = 6, IQR = 6–6).

The implementation strategies most commonly observed by providers were verbal reminders from pharmacists to physicians (80%), followed by other practice reminders (50%), and local practice guidelines (50%) (Fig. 4). Observed implementation strategies considered to be most helpful to promote LMWH prescribing were local leader champions (76%), on-site education (74%), and computerized provider order entry system (69%; Fig. 4). Observed implementation strategies reported to be least helpful were web-based education (45%), other

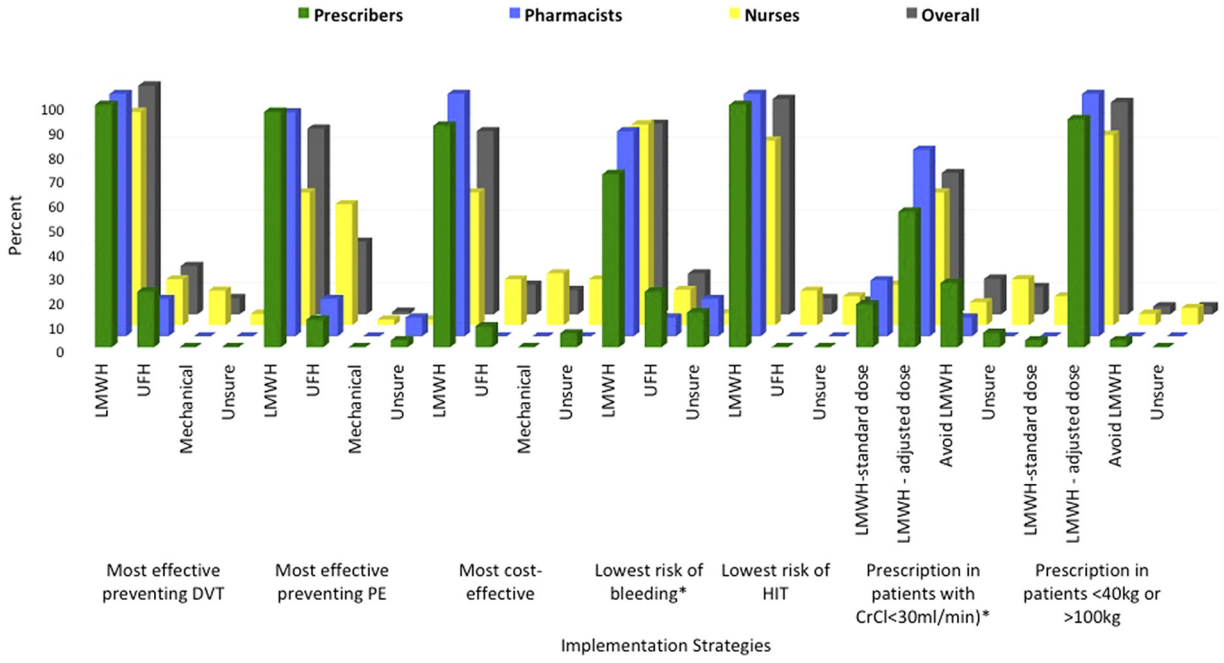

Fig. 3. ICU Healthcare Provider's Knowledge of Best practices for VTE prophylaxis†. Legend: ICU Healthcare Provider's Knowledge of Best practices for VTE prophylaxis†. † Responses are not mutually exclusive. * There was 1 missing response from a nurse for these two questions. *Abbreviations:* LMWH: Low molecular weight heparin; UFH: Unfractionated heparin; DVT: Deep vein thrombosis; kg: Kilogram; PE: Pulmonary embolism; HIT: Heparin induced thrombocytopenia.

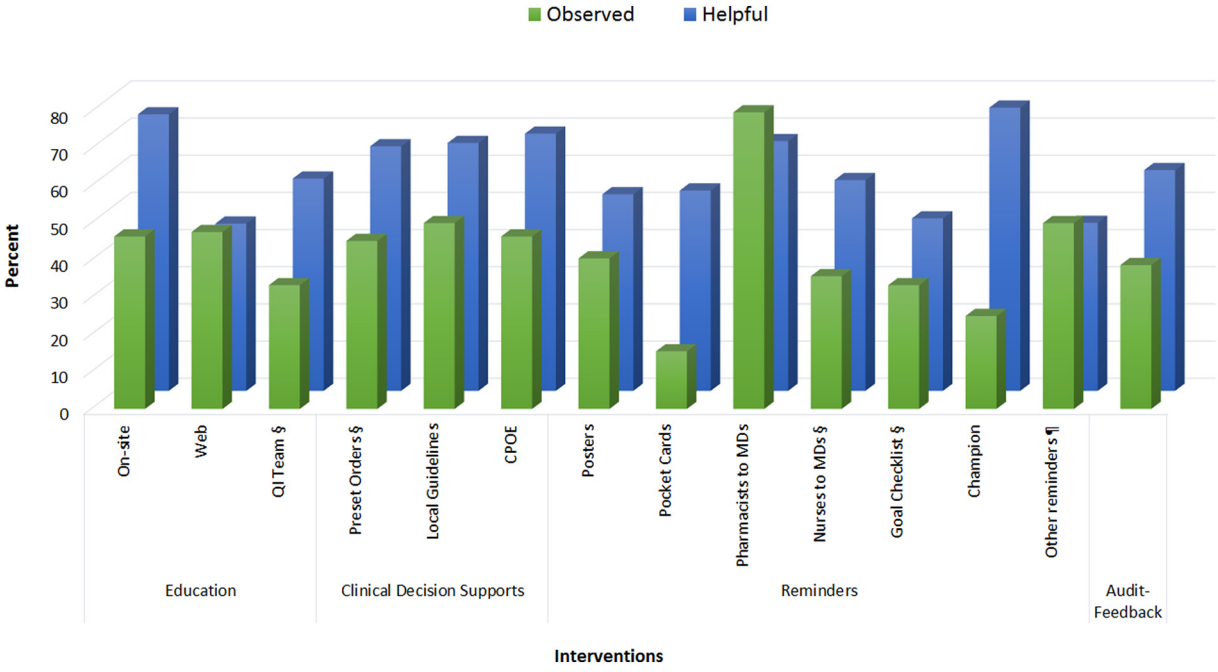

Fig. 4. Implementation strategies observed and perceived to be helpful. Legend: Percent of participants that reported observing each implementation strategy and percent of participants that found that intervention helpful if observed.* † ‡. * As responses are not mutually exclusive, the total percent can add up to >100%. † Five respondents did not answer questions on implementation strategies (3 prescribers and 2 nurses). ‡ Participant data within professional groups is presented as a table in supporting information (Supplementary Table S1). § Implementation strategies were not directly undertaken as part of the improvement initiative but were included to capture perceptions of possible implementation strategies that may have been initiated in individual ICUs or be a part of existing practice processes. ¶ Includes reminders sent to providers through email, paging, and website postings. *Abbreviations:* CPG: Clinical Practice Guideline, MD: Medical doctor; CPOE:Computerized provider order entry; QI: Quality improvement.

reminders (45%), and posters (53%; Fig. 4). The observed implementation strategies and their perceived helpfulness varied among professions (Supplementary Table S1). A verbal reminder from pharmacists to doctors was the most commonly reported implementation strategy observed by prescribers (81%) and nurses (78%), while pharmacists most commonly reported observing local guidelines and preset orders (92%). Of observed implementation strategies, prescribers identified local clinical champions as most helpful to encourage LMWH uptake (91%), while pharmacists found audit and feedback most helpful (78%) and nurses found on-site education most helpful (85%).

Qualitative analysis of the open-ended survey questions was consistent with interviews (Supplementary File S8).

3.2. Interviews

Twelve healthcare providers participated in the interviews, which identified five primary themes and fifteen sub-themes that explained providers' experiences with the implementation strategies and factors effecting VTE prophylaxis practices (Supplementary File S8). The primary themes included: healthcare professional roles, perceptions of the implementation strategies, key facilitators to LMWH uptake, key barriers to LMWH uptake, and recommendations for future initiatives/sustainability (Supplementary File S8).

4. Discussion

By systematically evaluating multiple implementation strategies within a complex improvement initiative, we identified potential factors that may have contributed to or impeded its success. Our study found most staff were aware of the overall improvement initiative to improve VTE prophylaxis and perceived many of the individual implementation strategies effective at changing VTE prophylaxis prescribing practices. Site champions, verbal reminders to prescribers, and changes within the computerized order entry system were frequently cited factors that increased prescribing LMWH for VTE prophylaxis. On the other hand, web-based education and reminders via posters, email, and paging were not consistently perceived as helpful implementation strategies.

Consistent with the evidence examining effectiveness of implementation strategies [39,40], the perceived positive impact of verbal reminders, specifically from pharmacists to prescribers, may be because of the general effectiveness of reminders as an implementation strategy; but it may also have been context-specific and related to the role pharmacists play in ICUs, specifically their expertise and credibility as pharmacology experts (natural champions and early adopters of LMWH prescribing) [37,41,42]. Similarly, the variable success of web-based education and audit and feedback may reflect a general ineffectiveness of these implementation strategies, or it may reflect the passive application of these implementation strategies in the present study. For example, aggregate audit data of LMWH prescribing were communicated to providers each month electronically and via posters posted at the point-of-care on computer carts used in daily rounding but was infrequently paired with facilitated discussion or with academic detailing, which have been suggested to be more effective, engaging approaches for audit and feedback [43-45]. While the implementation strategies used in our study were tailored to each ICU, they would likely translate well to other ICUs. The strategies were specifically designed for a non-urgent therapy and as such may be generalized to other quality improvement initiatives targeting routine prescribing (e.g., nutrition) or care processes (e.g., delirium screening). It is less clear how well they would translate to emergency care practices (e.g., resuscitation).

Self-reported differences across professions in this study were consistent with a previously conducted study examining facilitators and barriers to guideline concordant VTE prophylaxis in the ICU [25]. These inter-professional differences are congruent with a modest evidence base on the relationship between healthcare profession and effectiveness of implementation strategies [46]. For example, while nurses are keen to utilize evidence to inform their practice, there are several professional and organizational barriers to this [47]. A recent systematic review of strategies to increase evidence-informed

decision-making among nurses found mixed effects on various aspects of implementation [48]. Because most of the included studies involved multiple implementation strategies simultaneously, it is unclear which specific implementation strategies were related to any observed effect on clinical practice, and more importantly, if this differs from other professional groups such as physicians/NPs or pharmacists [48]. In our study, the transient nature of rotating residents was noted as a barrier to optimized prescribing of LMWH for VTE prophylaxis, suggesting that more tailored and perhaps periodic implementation strategies within, as well as among, professional groups may optimize best practices.

There are a few limitations to consider when interpreting our results. The delivery of healthcare is complex and context specific. As such, contextual factors unique to the care delivery setting and to the specific behavior change may facilitate or hinder implementation strategies. For example, the interplay between professions has been highlighted [49] and was observed in our study. Although our response rate was reasonable for a study of this scope, the response rate for residents was low. Similarly, we ascertained participants for our interviews from survey respondents who volunteered to participate in an interview – those who participated are likely more engaged and invested in the improvement initiative. Finally, because the objective of this process evaluation was to evaluate the perceived utility of the implementation strategies to inform real-time modifications to the overall improvement initiative, other than aggregate estimates of prescribing practices that were used for the purpose of audit and feedback (Fig. 2), we were not able to comprehensively evaluate the effect of each implementation strategy on prescribing practices, cost, and clinical outcomes. This limits inferences to the success of the implementation strategies in changing prescribing practices and knowledge over time, which will be reported in a separate manuscript.

5. Conclusions

This study identified which implementation strategies in our improvement initiative were perceived to be most and least helpful for increasing the prescribing of LMWH for VTE prophylaxis - reminders from pharmacists was perceived as most helpful while web-based education was perceived as least helpful. Differences between professions suggest implementation strategies need be tailored to the role of each profession in care delivery. These results can be used to select implementation strategies that are effective for clinical practice changes related to routine ICU care and prescription of medications, and highlight the importance of leveraging the support of the multi-professional ICU team. As no single implementation strategy is effective in all contexts [50], conducting process evaluations is crucial to understand the relative contributions of specific implementation strategies within complex improvement initiatives [51-53].

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcrc.2018.11.023.

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Disclosure of conflict of interests

The authors declare that they have no competing interests.

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