Original Research

A Successful Pharmacist-Based Quality Initiative to Reduce Inappropriate Stress Ulcer Prophylaxis Use in an Academic Medical Intensive Care Unit

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Abstract

Stress ulcer prophylaxis (SUP) is often inappropriately utilized, particularly in critically ill patients. The objective of this study is to find an effective way of reducing inappropriate SUP use in an academic medical intensive care unit (ICU). Medical ICU patients receiving SUP were identified over a 1-month period, and their charts were reviewed to determine whether American Society of Health-System Pharmacists guidelines were followed. Inappropriate usage was calculated as inappropriate patient-days and converted to incidence per 100 patient-days. Two interventions were implemented: (1) Pharmacists reviewed indications for SUP on each patient during daily team rounds and daily medication reconciliation and (2) residents rotating on ICU services were educated on a bimonthly basis. Postintervention data were obtained in a similar fashion. Prior to intervention, the incidence of inappropriate SUP usage was calculated to be 26.75 per 100 patient-days (n = 1099 total patient-days). Total cost attributable to the inappropriate use was $2433. Post intervention, we were able to decrease the inappropriate incidence of SUP usage to 7.14 per 100 patient-days (n = 1149 total patient-days). In addition, total cost of inappropriate use was reduced to $239.80. Our study highlights an effective multidisciplinary approach to reduce the inappropriate use of SUP in an academic medical ICU. We were able to reduce the incidence of inappropriate use of SUP by 73.31% ($P < .001$). Furthermore, we were able to decrease the costs by approximately $2200/month.

Keywords

quality, inappropriate, stress ulcer prophylaxis, pharmacist, proton pump inhibitors

Background

Stress ulcers are a significant cause of morbidity and mortality in patients admitted to the intensive care unit (ICU). Without prophylactic therapy, the incidence of stress ulcers can be as high as 15% in this patient population. This risk can be reduced to 1.5% in patients who receive prophylactic therapy.[1] The bleeding resulting from stress ulcers can increase the length of stay and mortality.[2] The underlying pathophysiology of stress ulcer formation involves decreased blood flow to the gastric mucosa with subsequent breakdown of the gastric mucosal barrier and hypersecretion of acid.[3] Therefore, acid suppression is often utilized to prevent ulcer formation, a practice known as stress ulcer prophylaxis (SUP). SUP is a widely utilized practice in hospitalized patients, particularly in the ICU. While there are certain patients who are at increased risk of stress ulcers in the ICU, pharmacological SUP is often overutilized.[4] Oftentimes, the initiation of SUP in the ICU is continued during the patient's hospitalization and through discharge, increasing health care costs, side effects, and medication interactions.[2] The primary pharmacological agents used to prevent stress ulcers include proton pump inhibitors (PPIs) and histamine 2 receptor blockers (H2 blockers). As PPIs are more potent suppressors of hydrogen ion secretion than H2 blockers, PPIs are preferentially used for SUP in the ICU.[5]

Chronic use of PPIs is found to be associated with various detrimental side effects. As gastric acid normally protects against enteric bacteria, its inhibition increases the risk of enteric infections including *Clostridium difficile* colitis.[6,7] PPIs are also suspected to increase the risk of both

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community- and hospital-acquired pneumonia by allowing pathogens to easily colonize the upper gastrointestinal (GI) tract.[8,9] Acid suppression also affects the absorption capabilities of the GI tract. Malabsorption of iron, vitamin B12, magnesium, and calcium have all been implicated with the long-term use of PPIs.[10,11] PPI usage is also associated with increased risk of osteoporosis and fractures particularly in the elderly population.[12] In addition to calcium malabsorption, acid suppression is thought to inhibit osteoclastic activity and thereby decreases bone mineral density.[13] PPIs are found to be associated with kidney disease such as acute interstitial nephritis, chronic kidney disease (CKD), CKD progression, and end-stage renal disease.[14,15] Finally, chronic acid suppression has been shown to lead to atrophic gastritis, which may increase the incidence of gastric cancer.[16]

Established guidelines on who should receive SUP in critically ill patients are not followed consistently. The American Society of Health-System Pharmacists (ASHP) has published widely accepted guidelines for SUP.[17] As per those guidelines, SUP should be administered to critically ill patients who are at increased risk of GI bleeding. While coagulopathy, mechanical ventilation ≥48 hours, history of GI ulcerations, traumatic brain or spinal cord injury, or burn injuries are considered major risk factors, length of ICU stay ≥7 days, occult GI bleeding, sepsis, and glucocorticoids use are considered minor risk factors for GI bleeding.[17]

Lately, there has been a trend toward overutilization of SUP in patients in the ICU as well as those admitted to general internal medicine wards.[18-20] Furthermore, studies have shown that these medications are continued beyond the ICU stay and after hospital discharge placing patients at risk of their long-term side effects.[21,22] The objective of this study is to effectively identify and reduce the inappropriate use of SUP in an academic medical ICU.

Methods

Our study is a retrospective observational pre- and post-implementation study in an academic medical ICU. The medical ICUs at Upstate Medical University Hospital are two 20-bed ICUs run by 2 different teams. In addition to the nursing staff, the teams consist of physicians, residents, and pharmacists. The project was presented to the Institutional Review Board (IRB) and approved prior to its initiation. All medical patients admitted to the ICU were chart-reviewed for the month of May 2016 to determine baseline SUP utilization. Patients being treated for acute GI bleeding were excluded from analysis. A thorough chart review was then performed to identify indications for the use of SUP. ASHP guidelines were used to judge the appropriateness of SUP administration.[17] Patients who were taking PPIs or H2 blockers at home were also identified using their home medication list on their electronic medical record on admission. Those patients were considered to be receiving inappropriate acid suppressive therapy if given via the intravenous route while they were able to tolerate an oral route for the purpose of SUP (as indicated on the medication order) rather than their outpatient indication. Number of doses and route of each administration during the ICU course were documented for cost analysis. For time-dependent risk factors (ICU stay for instance), dosages were counted as inappropriate until appropriate time (after 7 days for ICU stay, for instance) was reached if that factor was used to fulfill SUP indication. Furthermore, if the risk factors resolved, dosages were counted as inappropriate for the latter days. Last, the total number of inappropriate patient-days and total patient-days for the month of May were also recorded. The data were used to represent the inappropriate use in incidence per 100 days. This was calculated by dividing the inappropriate patient-days by total patient-days and then converting them proportionately to incidence per 100 patient-days.

After obtaining initial SUP utilization data, a pharmacist-based quality initiative was started. Pharmacists reviewed patients on SUP during medical ICU rounds and made appropriate changes according to the guidelines. Furthermore, they performed daily chart reviews on all ICU patients after rounds. They were given prescriptive authority to make such changes (ie, continue, discontinue, or modify route of medication administration) for the purpose of SUP only. After making the changes, they notified the ICU team. Residents and fellows were educated on the indications of SUP and the implemented initiative on a bimonthly basis when starting their ICU rotations. During these education sessions, house staff were provided with printed copies of SUP indications for reference. Postintervention data for the duration of September 2016 were then obtained to determine utilization of SUP.

Our primary end-point was chosen to be incidence of inappropriate SUP use per 100 patient-days rather than number of patients for the purpose of accuracy and to minimize the impact of variation in duration of therapy. Statistical analysis was performed using Microsoft Excel 2007 with "Real Statistics Resource pack." *P* value was calculated using a chi-square analysis hypothesis.

Results

There were a total of 202 patients who received care in the ICU in the preintervention month. Of those, 151 received PPIs while none received H2 blockers. Eleven patients were excluded as they were being treated for active GI bleeding. For the 140 patients reviewed, there were a total of 294 inappropriate patient-days. Total patient-days were calculated to be 1099 in the preintervention period. This translated into an inappropriate incidence of 26.75 per 100 patient-days. The total cost of inappropriate use of SUP was calculated to be $2433/month prior to intervention.

There were a total of 162 patients who received care in the ICU in the postintervention month. Of those, 104 received PPIs while none received H2 blockers. Six patients were excluded as they were being treated for active GI bleeding.

Table 1. Comparison of Total Patient-Days, Inappropriate Patient-Days, Incidence of Inappropriate Stress Ulcer Prophylaxis Use Per 100 Patient-Days, and Associated Costs Before and After Intervention.

	Preintervention	Postintervention
Total patient-days	1099	1149
Inappropriate patient-days	294	82
Incidence per 100 patient-days	26.75	7.14
Associated costs	$2433	$239.80

For the 98 patients reviewed, there were a total of 82 inappropriate patient-days. Total patient-days were calculated to be 1149 in the postintervention period. This translated into an inappropriate incidence of 7.14 per 100 patient-days. The total cost of inappropriate SUP was calculated to be $239.80 after the intervention (Table 1). This entails a reduction of 73.31% in inappropriate patient-days between the intervention pools ($P < .001$).

The rate of patients not receiving SUP when it was indicated did not change significantly between data pools ($P = 1.00$), that is, 9.67% in the preintervention (6 of 62 patients) and 10.93% in the postintervention pool (7 of 64 patients). In terms of the distribution of risk factors, mechanical ventilation ≥48 hours (29.41%) was the most common major risk factor and sepsis (54.20%) was the most common minor risk factor (Table 2 and Figure 1).

Cost analysis was performed using the cost of formulation used at our institute; for example, an oral dose of 40 mg of pantoprazole costs $1.30, whereas an intravenous dose costs $9.20.

Discussion

Our initial approach to studying the overuse of SUP was to identify and quantify the extent of overutilization. As mentioned, we used the widely accepted ASHP guidelines to deem appropriateness of SUP.[17] As mentioned, we identified an incidence of inappropriate use of SUP of 26.75 per 100 patient-days. Total cost amounting to this inappropriate use was approximately $2500/month. After identifying a high rate of inappropriate SUP use, we considered various methodologies to mitigate overuse. As our ICU is part of an academic institution, resident education was considered as one of the possible interventions. As education can be a nonsustainable quality intervention and the indications for SUP were also thought to be cumbersome to remember and apply in a busy academic institute with a high turnover rate, we charged the pharmacy team to aid us in this effort. Similar to many institutions, our pharmacy team is an integral part of the ICU team as they participate in daily multidisciplinary rounds. We decided that our pharmacists would review patients on SUP during ICU rounds in addition to daily medicine reconciliation of all ICU patients as our principal intervention. They were given authority to inform the ICU team and make appropriate changes. Furthermore, we incorporated bimonthly education sessions for the ICU team residents and fellows at the start of their rotation.

As mentioned, our data were analyzed in terms of patient-days. We were able to reduce the incidence of inappropriate SUP usage by 73.31% inappropriate patient-days with statistical significance ($P < .001$). This decreased the cost expenditure by $2200 for the corresponding month. There were no extra costs associated with pharmacists' time as they worked their usual hours. This intervention has the potential to result in $26500 annual cost savings from the medical ICU unit alone.

As mentioned, the inappropriate use of SUP has been demonstrated multiple times in the literature.[18-22] Whereas some studies were conducted on specialty wards such as ICUs, some encompassed general medicine wards. Various strategies have been suggested to tackle the issue of inappropriate SUP use. While resident education has been part of some strategies, pharmacist-based strategies have been suggested by only a few and with promising results.[22-27] For instance, Buckley et al established a strictly pharmacist-based intervention and was able to reduce inappropriate ICU SUP use by 58.3%.[24] All studies except Buckley et al utilized pharmacists to inform physicians of appropriate SUP use rather than providing pharmacists with prescriptive authority like our study. On the contrary, Buckley et al. established a strictly pharmacist-driven program without any involvement of the house staff at their academic facility. In this study, verbal communication with the respective treatment teams was not done as the process was deemed to be "time-consuming." Our study is unique as we established a 2-tier system involving our pharmacy team, that is, review during ICU team rounds and chart review after rounds. Furthermore, we implemented resident and fellow education as it was deemed integral to the principles of an academic institution. This promoted a closed-loop communication between the involving parties preventing any confusion about changes in orders. Hatch et al established a similar system to reduce inappropriate prescription of acid suppressive therapy after hospital discharge.[22] Finally, unlike some studies, our study also demonstrated that rates of patients inappropriately not receiving SUP did not change significantly between interventions. This fact is very important as studies trying to reduce inappropriate administration rates can often cause appropriate administration rates to decline placing patients under risk of stress ulcers and their serious complications.

Our study had several limitations. First, it was short in terms of the duration, which only provides a rough estimate of associated annual savings. This further limited us to determine whether clinical outcomes such as GI bleeding or adverse affects of PPIs such as incidence of *C difficile* or nosocomial pneumonia were affected. As we studied the hospital course of patients while they were in the ICU during the corresponding months, we did not account for dosages and

Table 2. Distribution of Major and Minor Risk Factors for Gastrointestinal Bleeding Among Pre and Postintervention Groups.

	Coagulopathy	Mechanical ventilation ≥48 h	History of GI bleed	Head trauma or burns	Occult GI bleed	Steroid use	Sepsis	ICU stay ≥7 days
Preintervention (n = 140), n (%)	28 (20.00)	34 (24.29)	23 (16.43)	3 (2.14)	3 (2.14)	3 (2.14)	52 (37.14)	18 (12.86)
Postintervention (n = 98), n (%)	23 (23.47)	36 (36.73)	8 (8.16)	7 (7.14)	1 (1.02)	2 (2.04)	77 (78.57)	9 (9.18)
Total (N = 238), n (%)	51 (21.43)	70 (29.41)	31 (13.03)	10 (4.20)	4 (0.84)	5 (0.42)	129 (54.20)	27 (12.60)

Note. GI = gastrointestinal; ICU = intensive care unit.

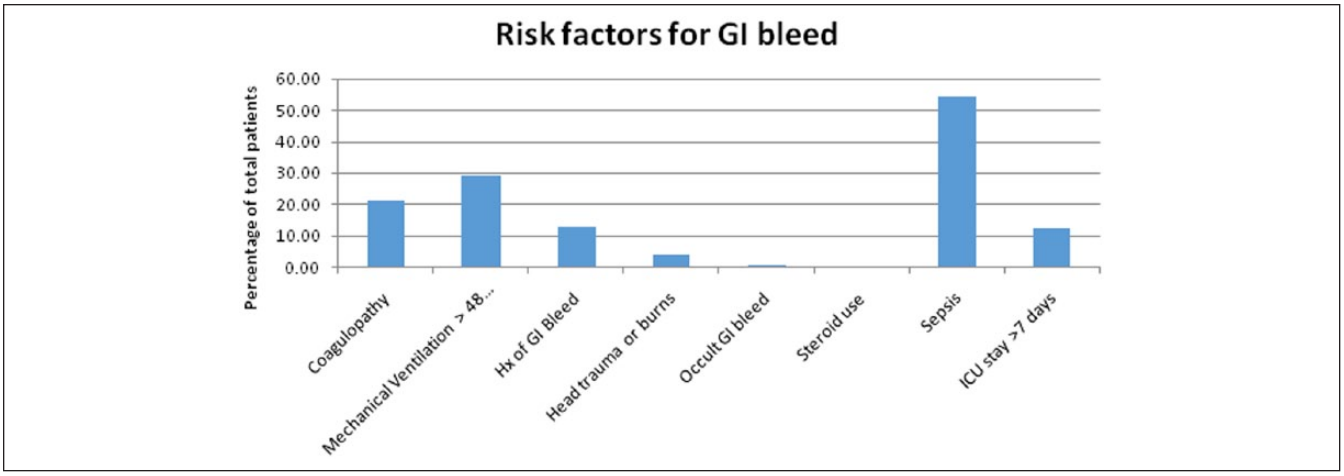

Figure 1. Distribution of risk factors for gastrointestinal bleeding among all pre- and postintervention patients.
Note. GI = gastrointestinal; ICU = intensive care unit.

associated costs for inappropriate SUP use beyond the ICU stay. If the project was expanded to the whole hospital course, it would likely show greater cost savings. In terms of the sustainability of the initiative, it is difficult to predict as we only looked at a single 1-month postintervention period. Although we believe our intervention is sustainable with such robust involvement of the pharmacy team, another post-implementation period may be needed to confirm this. Finally, our study was retrospective and relied on clinical documentation, which can lead to variability based on the accuracy of documentation.

Conclusion

In conclusion, we were able to identify a successful method of reducing the inappropriate use of SUP in an academic medical ICU. By utilizing our pharmacy team and educating medical trainees, we were able to achieve highly significant results, which translated into major reduction in costs associated with inappropriate SUP use. Due to its significant findings, we plan on continuing this approach in our medical ICU and expanding it to other ICUs such as surgical, cardiac, and neurology. Furthermore, this interdisciplinary model can also be used widely to address other prescribing practices such as antibiotic stewardship and venous thromboembolism prophylaxis.

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Declaration of Conflicting Interests

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