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ORIGINAL

PHARMACIST-LED PROTOCOLS FOR THE PREVENTION AND MANAGEMENT OF STRESS ULCERS IN ATHLETES: A MODEL FOR INTENSIVE CARE UNITS

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ABSTRACT

Objective: To evaluate the effectiveness of a pharmacist-led model for the prevention and management of stress ulcers in athletes admitted to intensive care units (ICUs). **Methods:** This retrospective study analyzed patient data from January 2020 to January 2023. A total of 80 ICU admissions were reviewed, with 40 cases before and 40 after implementing a pharmacist-led stress ulcer prevention (SUP) protocol. The study compared the rationality of SUP medication, occurrence of adverse reactions, drug costs, and instances of irrational drug use before and after the protocol implementation. **Results:** The rational drug use rate for SUP improved significantly from 65.00% to 92.50% ($P < 0.05$), and the timing of intravenous and oral administration was optimized from 77.50% to 97.50% ($P < 0.05$). Timely discontinuation of medication also increased from 72.50% to 95.00% ($P < 0.05$). Adverse reactions were reduced overall, with gastric bleeding dropping from 5.00% to 2.50%, and pneumonia cases reduced to zero ($P > 0.05$). Drug costs associated with inappropriate SUP decreased significantly, indicating substantial cost savings ($P < 0.05$). The rate of irrational drug use notably decreased from 35.00% to 7.50% after implementing the pharmacist-led model. **Conclusion:** Implementing a pharmacist-led model for stress ulcer prevention in ICUs is both feasible and effective, particularly for athlete patients who require rapid and rational management to return to training and competition swiftly. This model not only improves medication rationality but also reduces the likelihood of adverse

reactions and lowers healthcare costs, supporting better overall outcomes for high-performance individuals in intensive care settings. This approach underscores the importance of specialized pharmaceutical care in managing athlete health in critical care scenarios

KEYWORDS: Pharmacist; ICU； Stress ulcer prevention; Pharmaceutical management mode; Effect; Assessment

1. INTRODUCTION

Stress ulcers are a significant clinical concern in intensive care units (ICUs), particularly affecting patients under severe physical and psychological stress, including athletes. These acute gastric lesions can lead to complications like bleeding and infection, potentially prolonging hospital stays and complicating recovery processes. Athletes, with their rigorous physical demands and tight performance schedules, are uniquely impacted by such setbacks(Bulloch, Shunnarah, Gwaltney, & Hendricks, 2023). Ensuring effective prevention and management of stress ulcers in this population is therefore critical, not only for their immediate health but also for their professional careers. Pharmacological management of stress ulcers typically involves the use of prophylactic medications such as proton pump inhibitors (PPIs) and H2 receptor antagonists. However, the administration of these drugs must be carefully managed to avoid overuse and potential adverse effects, including increased risk of infections and drug interactions (KUNDU et al., 2022). This necessitates a well-structured approach to medication management in ICUs, especially for athletes whose optimal body function is crucial for their return to sport. Pharmacists play a pivotal role in the healthcare team, particularly in critical care settings where their expertise in pharmacokinetics and pharmacodynamics can significantly influence patient outcomes. A pharmacist-led model in the ICU can provide a structured approach to stress ulcer prevention (SUP), ensuring that prophylaxis is used rationally, efficiently, and effectively. Such a model not only aims to optimize therapeutic outcomes but also minimizes unnecessary drug use and its associated costs and complications(He Li et al., 2022).In recent years, there has been a growing recognition of the value that pharmacists add to the ICU team, particularly in terms of medication management and patient safety. By leading the SUP efforts, pharmacists can ensure that the prophylaxis is tailored to each patient's specific needs, taking into account their medical history, current condition, and potential risks. This is particularly important for athletes, where even minor health issues can become significant hindrances to performance and career longevity(Briscoe, McGraw, Smith, Miller, & Bar-Or, 2023).This study aims to analyze the implementation and effects of a pharmacist-led SUP pharmaceutical management model in the ICU, with a particular focus on athlete patients. It evaluates how such a model affects the rationality of drug use, the incidence of adverse reactions, and overall drug costs, providing

insights into the potential benefits of involving pharmacists more directly in patient care processes in critical settings. By focusing on this approach, the research seeks to provide a framework that could improve outcomes not only in general(Yin, Li, Rao, Li, & Du, 2022) ICU populations but also in specialized groups like athletes, who have distinct health management needs(Cascone et al., 2023).

2. Data and methods

2.1 General data

This study began in January 2020, and completed the analysis and statistics of the study data in January 2023, and retrospectively analyzed the information of patients admitted to ICU. The total number of samples included was 80 (the remaining number after exclusion). And the number of included samples was 40 (the remaining number after exclusion) before the drug management of stress ulcer prevention from January 2020 to June 2021. The details of patients: there were 23 male patients and 17 female patients in total, including 3 patients with digestive ulcer, 2 patients receiving dual antiplatelet therapy or both antiplatelet and anticoagulant therapy. Seven patients were under 18 years old, two were women before and after delivery, and six were reflux esophagitis. The average age was (59.24 ± 16.24) years old. The number of samples treated with pharmaceutical management of stress ulcer prevention from July 2021 to January 2023 (the remaining number after exclusion) was 40. The patient details: there were 22 male patients and 18 female patients in total, including 4 patients with digestive ulcer, 3 patients receiving dual antiplatelet therapy or both antiplatelet and anticoagulant therapy. Five patients under the age of 18, one patient was a prenatal and postnatal woman, and four patients were reflux esophagitis, with an average age of (58.34 ± 15.47) years. The general data of patients before and after the management of stress ulcer preventive medicine were less different ($P>0.05$).

Inclusion criteria: (1) The patients who were volunteered to participate in the study and knew the content of the study and was over 18 years old; (2) The basic data of the patients included are complete and correct.

Exclusion criteria: (1) Patients with gastric bleeding, gastroesophageal reflux disease, gastrointestinal ulcer or receiving acid suppression treatment; (2) Women before or after childbirth; (3) Patients who had recently undergone total gastrectomy; (4) Patients who were receiving dual antiplatelet therapy or both antiplatelet and anticoagulant therapy.

2.2 Methods

The pharmaceutical management mode of stress ulcer prevention in ICU led by pharmacists: (1) The establishment stage of the pharmaceutical

management mode of stress ulcer prevention (SUP): it was necessary to consult the corresponding medical records and use tables to record the clinical information of ICU patients. Based on the investigation of above data, the ICU-SUP pharmaceutical management model in the hospital was established, and the corresponding management standard plan for stress ulcer prevention was formulated, and the doctors, pharmacists and nurses were trained accordingly. The management norms of ICU-SUP are as follows:

① Indications for drug use: if patients had more than one of the following factors, the stress ulcer prevention should be given to them. Patients with respiratory failure should be given continuous mechanical ventilation for more than 48 hours. Non-anticoagulation intervention would cause coagulation disorder. The value of platelet was 50 × 109/L or international standardized ratio was above 105 or activated partial prothrombin time was 2 times of the baseline value. There was traumatic brain damage. There was spinal cord injury. The patients had the history of hemorrhagic disease and gastrointestinal ulcer within 1 year. There were severe burns. Partial hepatectomy had been performed. There were multiple trauma and liver failure and so on. If the patients had more than 2 of the following factors, the corresponding stress ulcer prevention intervention should be implemented for the patients. Recessive bleeding lasts more than 6 days, and hypoperfusion (organ failure, shock, acute renal failure, sepsis, etc.); the length of stay in ICU was more than 7 days; patients had a history of using non-steroidal anti-inflammatory drugs; glass scored above 10 or could not understand simple language; patients used 250mg hydrocortisone or 250mg other glucocorticoid drugs.

② The clinical standard of intravenous drug transfer to oral administration: the patients' gastrointestinal function recovery period was 12-24 hours, and the intravenous drug could be transferred to oral administration.

③ Clinical criteria for stopping medication: if the patients had the risk factors of bleeding mentioned above, the medication could be stopped after elimination. (2) The implementation stage of the stress ulcer prevention (SUP) pharmaceutical management model: pharmacists should use the computer system to call out the data of ICU patients every day. The standard was the ICU-SUP management standard developed by this research, and the patients should be monitored. In case of non-standard conditions, they should report in time and give suggestions. (3) Effect evaluation: evaluation of the rationality of stress ulcer prevention (SUP) medication: the evaluation criteria were mainly based on the self-made ICU-SUP management specifications in the hospital, and the evaluation contents included the indications of stopping medication, the indications of preventive medication, and the indications of intravenous administration to oral administration and so on.

2.3 Evaluation criteria

(1) Analysis and comparison of the rationality of stress prevention medication before and after the implementation of the stress ulcer prevention management model: mainly including the rational rate of medication, the rational rate of intravenous administration and the rational rate of stopping medication (Jones et al., 2022).

(2) Comparison of the occurrence of adverse reactions before and after the application of stress ulcer prevention and management model: diarrhea, gastric bleeding and pneumonia and so on (Isik et al., 2022).

(3) Analysis and comparison of drug costs for stress ulcer prevention before and after the implementation of stress ulcer prevention management model (Saeed, Bass, & Chaisson, 2022).

(4) Analysis and comparison of the incidence of irrational drug use before and after the implementation of the stress ulcer prevention and management model, including over-dosage, over-frequency and no indication of drug use (Bořilová Linhartová et al., 2022).

2.4 Statistical analysis method

The statistical software SPSS 20.0 was used to evaluate the data obtained in this study. The t-test was selected to inspect the measurement data, and the results used the standard of ($\bar{x}$±s). The chi-square was selected to test the count data, and the results were in form of percentage. In the analysis of whether there was a difference between the two groups, the P value was used. The critical value of the P value was 0.05. When P<0.05, it meant that the data was statistically significant.

3. Results

3.1 Reasonability evaluation of drug use before and after the application of stress ulcer prevention management model

The results of comparison before and after the management of patients showed that the rational rate of drug use was 92.50% after the management, which was better than that before the management (65.00%), and the data difference between groups was significant (P<0.05). The rational rate of intravenous oral administration was 97.50% after administration, which was better than that before administration (77.50%), with significant difference between groups (P<0.05). The rational rate of stop medication in time after administration was 95.00%, which was better than that before administration (72.50%). The data difference between groups was statistically significant (P<0.05), as shown in Table 1.

Table 1: Analysis and comparison of rationality of stress prevention medication before and after the implementation of stress ulcer prevention management model (n, %)

CATEGORY	TIME	REASONABLE RATE	UNREASONABLE RATE	X2	P VALUE
REASONABLE RATE	Before management	26（65.00）	14（35.00）	nine point zero three eight	P＜0.05
	After management	37（92.50）	3（7.50）		
INTRAVENOUS ADMINISTRATION AND ORAL ADMINISTRATION	Before management	31（77.50）	9（22.50）	seven point three one four	P＜0.05
	After management	39（97.50）	1（2.50）		
STOP MEDICATION IN TIME	Before management	29（72.50）	11（27.50）	seven point four four zero	P＜0.05
	After management	38（95.00）	2（5.00）		

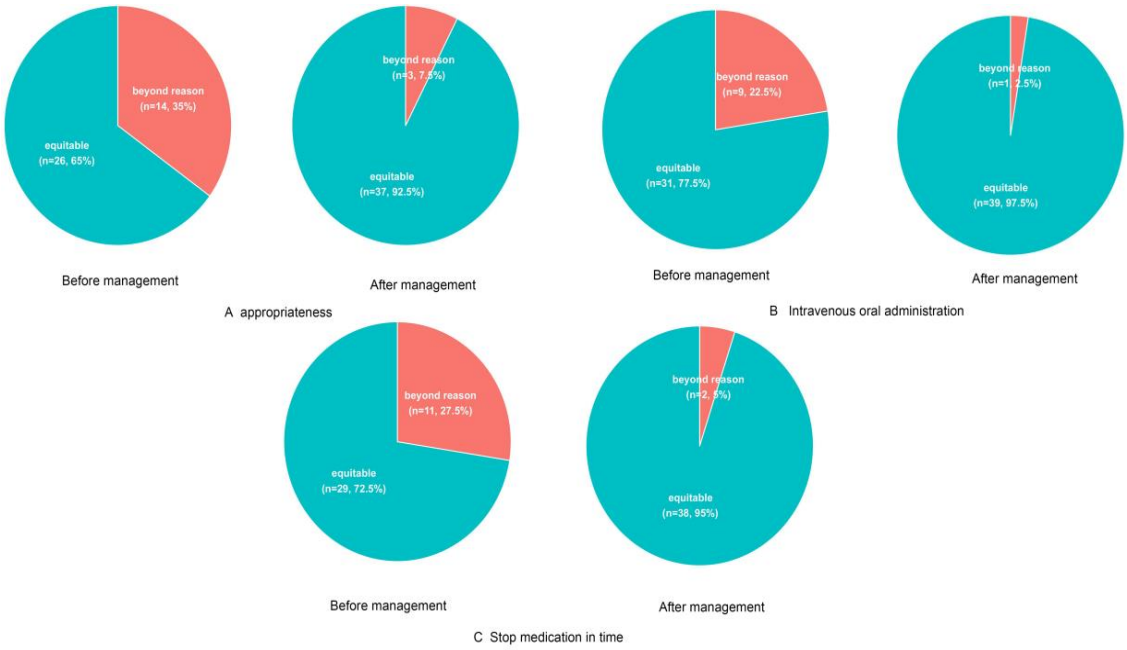

Figure 1: Analysis and comparison of rationality of stress prevention medication before and after the implementation of stress ulcer prevention management model

3.2 Analysis and comparison of the occurrence of adverse reactions before and after the implementation of stress ulcer prevention management mode

The adverse reactions before and after the implementation of the stress ulcer prevention management model were compared, and the data were not significantly different (P>0.05), as shown in Table 2.

Table 2: Analysis and comparison of the occurrence of adverse reactions before and after the implementation of stress ulcer prevention and management mode (n, %)

GROUP	NUMBER OF CASES	GASTRIC BLEEDING	DIARRHEA	PNEUMONIA	TOTAL OCCURRENCE RATE (%)
BEFORE MANAGEMENT	40	2（5.00）	2（5.00）	2（5.00）	6（15.00）
AFTER MANAGEMENT	40	1（2.50）	2（5.00）	0（0.00）	3（7.50）
X^2 VALUE	-	-	-	-	one point one two seven
P VALUE	-	-	-	-	P＞0.05

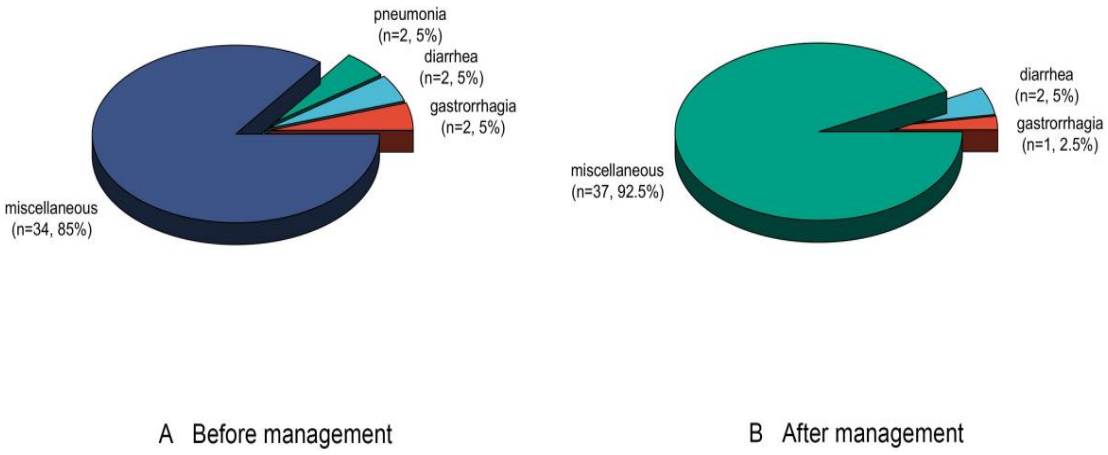

Figure 2: Analysis and comparison of the occurrence of adverse reactions before and after the implementation of stress ulcer prevention and management mode

3.3 Comparison of medication costs before and after the application of stress ulcer prevention management model

The cost before the implementation of stress ulcer prevention and management mode was (18206.24 ± 243.25) yuan. However, the cost after the implementation of the stress ulcer prevention and management model was (2768.47 ± 25.74) yuan, and the data before and after the implementation were significantly different (t=399.15737, P<0.05).

3.4 Comparison of irrational drug use rate before and after the application of stress ulcer prevention management model

Before implementation, the irrational rate of drug use was 35.00%, and

after management was 7.50%. The difference between the groups was statistically significant (P<0.05). See Table3 for details.

Table 3: Analysis of the difference in the incidence of irrational drug use between groups (n, %)

GROUP	NUMBER OF CASES	OVERDOSE	OVERFREQUENCY MEDICATION	NON-INDICATED MEDICATION	TOTAL OCCURRENCE RATE (%)
BEFORE MANAGEMENT	40	3（7.50）	3（7.50）	8（20.00）	14（35.00）
AFTER MANAGEMENT	40	0（0.00）	1（2.50）	2（5.00）	3（7.50）
X^2 VALUE	-	-	-	-	nine point zero three eight
P VALUE	-	-	-	-	P＜0.05

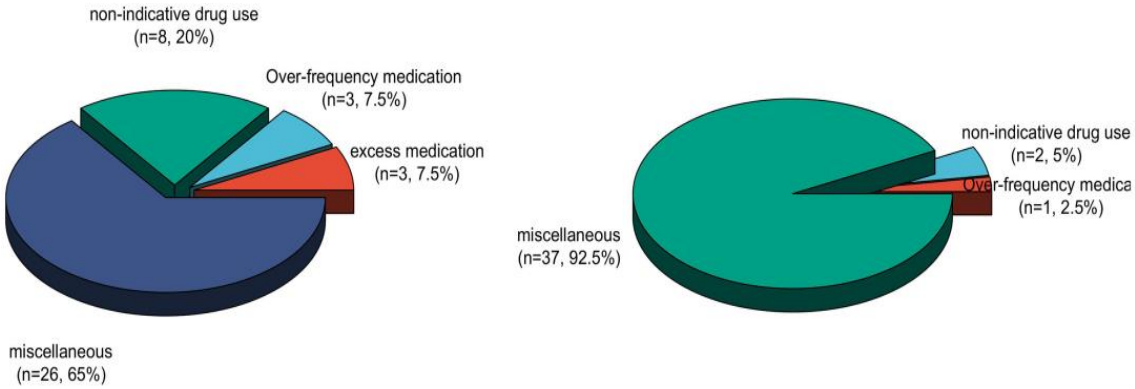

Figure 3: Analysis of the difference in the incidence of irrational drug use between groups

4. Discussion

There are many reasons for the occurrence of stress ulcer, and the main stress sources are: complex major surgery, severe systemic infection, severe trauma and various difficulties, severe brain injury, severe burns, shock, multiple organ dysfunction syndrome, multiple organ failure, cardiovascular and cerebrovascular accident, cardiac, pulmonary, cerebral resuscitation, and postoperative severe psychological stress such as over-tension and mental

trauma (Sun, Hou, Zhang, & Jiang, 2022). The main pathogenesis are the weakening of gastric mucosal defense skills and the relatively enhanced role of gastric mucosal injury factors. Its main clinical manifestations are upper gastrointestinal bleeding and hemorrhagic crab shell. For patients without obvious bleeding, the hemoglobin concentration in gastric juice or stool will be low and the occult blood will be positive (Kong et al., 2022). When patients suffer from stress ulcer perforation, they may show acute abdominal symptoms, and the onset time is 3-5 days after the occurrence of the primary disease, and some patients will not show symptoms until 2 weeks after the occurrence of the primary disease (Haiyan Li et al., 2022). After endoscopic examination of the patients, the clinical features were as follows: ① The lesions were mainly located in the stomach body, and the lesions can also be found in the duodenum, esophagus and jejunum; ② The main pathological changes are multiple erosions (multiple bleeding or mountain blood spots) and ulcers, and the ulcers can reach the lower part of the mucosa, the intrinsic muscular layer and the serous layer. The diagnosis method is as follows: if the patients have a history of stress disease, it may appear as bleeding and perforation of the upper digestive tract within 14 days after the onset of the primary disease. If the occurrence of ulcer and erosion is found through endoscopic examination, it means that it is a stress ulcer, and this disease has a serious impact on the quality of life of patients (Chehade et al., 2022). Therefore, it is necessary to implement stress ulcer prevention for them, and the high-risk groups of stress ulcer are those aged over 65 years old, with severe trauma (difficult major surgery, complicated chest and abdomen, craniocerebral trauma and burn), severe systemic infection, combined shock and continuous low blood pressure, organ transplantation, blood coagulation dysfunction, etc. (P. M. Reynolds, Wells, Powell, & MacLaren, 2023). However, previous studies have shown that when stress ulcer prevention is carried out for patients, irrational drug use may occur, which can lead to adverse events for patients. Therefore, it is very important to implement stress ulcer prevention management for patients (Roberts et al., 2022). According to the contents of the "Guidelines for the Prevention and Treatment of Stress Ulcer" in the United States, it is not recommended that non-ICU patients with low risk of gastrointestinal bleeding implement stress ulcer prevention measures. Only ICU patients with increased risk of gastrointestinal bleeding can be given stress ulcer prevention measures (P. Reynolds, Wells, Powell, & MacLaren, 2022). The factors of gastrointestinal bleeding include mechanical ventilation for more than 48 hours, coagulation dysfunction, burns, history of gastrointestinal ulcer, occult gastrointestinal bleeding, glucocorticoid use, and ICU length of stay for more than 7 days. Therefore, it is necessary to imitate the work mode of the American ICU-SUP pharmaceutical management model, and formulate the ICU-SUP pharmaceutical management model of our hospital to regulate the use of drugs according to relevant literatures. The indications for preventive medication of stress ulcer, the criteria for stopping medication for stress ulcer prevention, and

the criteria for switching from intravenous to oral administration are stipulated (Chammas et al., 2022). For patients with stress ulcer prevention indications, there is no clear answer to the variety of stress ulcer prevention drugs. Previous studies have found that most patients choose H2 receptor antagonists when taking preventive drugs for stress ulcer, but this study was carried out before proton pump inhibitors were not widely used in clinical practice (Seals & Sovalska, 2022). Other scholars believe that the majority of stress ulcer prevention drugs are PPLs, a few are H2 receptor antagonists, and fewer are combined drugs. PPLs are mainly selected as drugs for stress ulcer prevention (He, Yan, Su, Ge, & Zhai, 2022). Therefore, the existing PPLs and H2 receptor antagonists in our hospital are omeprazole, rabeprazole, pantoprazole, lansoprazole, lamotidine, and esomeprazole and others. Before and after the implementation of the stress ulcer prevention pharmaceutical management model, omeprazole is mainly used. It is suggested in the American Guidelines for the Prevention and Treatment of Stress Ulcer that the variety of stress ulcer prevention drugs should be selected correspondingly according to the specific drug conditions (adverse reactions or drug prices) of each local medical institution (Huang, Han, Song, & Kuang, 2023). At present, there is no corresponding literature to show that PPLs and H2 receptor antagonists have different therapeutic effects on the prevention of stress ulcer. Therefore, our hospital selected omeprazole (the first dose was 80mg, and then 40mg. q8h maintenance) or famotidine (40mg) when carrying out the management of stress ulcer prevention.

In this study, the rationality of stress prevention medication before and after the implementation of the stress ulcer prevention management model was analyzed: the rational medication rate of stress ulcer prevention was 65.00% before the implementation and 92.50% after the implementation, of which, the proportion of timely intravenous administration was 77.50% before the implementation and 97.50% after the implementation, and the proportion of timely discontinuation of medication was 72.50% before the implementation and 95.00% after the implementation. This shows that the implementation of stress ulcer prevention and management led by pharmacists for patients can effectively improve the rational rate of medication. Comparison and analysis of the occurrence of adverse reactions before and after the implementation of stress ulcer prevention and management mode: before the implementation of the stress ulcer prevention and management model, the incidence of adverse reactions was 15.00%, including 5.00% of gastric bleeding, 5.00% of diarrhea and 5.00% of pneumonia; and after the implementation of stress ulcer prevention and management mode, the incidence of adverse reactions was 7.50%, including 2.50% of gastric bleeding, 5.00% of diarrhea and 0.00% of pneumonia. This shows that the implementation of stress ulcer prevention and management led by pharmacists for patients can effectively avoid the occurrence of adverse reactions. A detailed analysis of the drug costs before and after the implementation of the stress ulcer prevention and management

model was carried out: the drug costs of inappropriate stress ulcer prevention were (18206.24 ± 243.25) yuan before the implementation and (2768.47 ± 25.74) yuan after the implementation. This is because after the intervention of clinical pharmacists, the number of length of stay can be reduced after the management of patients with inappropriate stress ulcer prevention, thus reducing the costs. At the same time, in this study, omeprazole was the main drug for the prevention of stress ulcer before and after the implementation of stress ulcer in patients. And the reasons for the cost reduction are also related to the reduction of the use of drugs without indications, the timely transfer of intravenous administration to oral administration and the timely withdrawal of drugs. The incidence of irrational drug use before and after the implementation of the stress ulcer prevention and management mode was analyzed in detail: before the implementation of the stress ulcer prevention and management mode, the irrational rate of drug use was 35.00%, including 7.50% of the over-dose rate, 7.50% of the over-frequency rate, 20.00% of the no-indicated rate. And the irrational rate of drug use was 7.50% after the implementation, including 0.00% of the over-dose rate, 2.50% of the over-frequency rate, and 5.00% of the no-indicated rate. This also shows that the prevention and management of stress ulcer led by pharmacists can effectively reduce the irrational rate of drug use. The implementation of a pharmacist-led model for stress ulcer prevention (SUP) in intensive care units (ICUs) has demonstrated significant benefits, particularly for high-risk populations such as athletes. This study has successfully illustrated that with the involvement of pharmacists in the management of SUP, there is a marked improvement in the rationalization of medication use, a reduction in adverse reactions, and considerable cost savings in drug expenditures. The enhanced outcomes observed in the study are attributable to the specialized knowledge and targeted approach pharmacists bring to medication management. By leading SUP strategies, pharmacists ensure that each patient's treatment is optimized based on individual risk factors, current health status, and specific needs. For athletes, this tailored approach is crucial as it directly impacts their recovery speed and ability to return to training and competition safely and effectively. Furthermore, the reduction in irrational drug use and the increase in timely medication adjustments highlight the role of pharmacists in improving overall treatment efficacy and patient safety. These findings support the argument for more robust involvement of pharmacists in patient care teams, particularly in settings as critical as the ICU, where the stakes for patient outcomes are exceptionally high. Considering the positive implications of this study, it is recommended that healthcare systems consider integrating and possibly mandating a pharmacist-led approach to SUP in ICUs. Future research should aim to explore long-term outcomes of such models and expand the scope to include other critical care areas. This could potentially lead to broader healthcare improvements and set a standard for pharmacist involvement in patient care, ensuring that all patients, including athletes, receive the most effective, safe, and cost-efficient care

possible during their critical care experiences.

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