ARTICLE

Audit of IV Pantoprazole: Patterns of Use and Compliance with Guidelines

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ABSTRACT

Background: Institutional guidelines were developed to promote appropriate use of the IV proton pump inhibitor pantoprazole. The guidelines restricted use of this drug to patients with upper gastrointestinal bleeding who were hemodynamically unstable or at high risk of rebleeding and patients requiring a proton pump inhibitor but designated NPO (unable to receive enteral medication or feeding).

Objective: To describe patterns of use of pantoprazole and to determine compliance with the guidelines at a tertiary-care, university-affiliated institution.

Methods: Drug utilization and compliance with guidelines were audited retrospectively. The medical records of all patients who received IV pantoprazole during the initial 6 months of use of this drug at the institution (February to July 2000) were reviewed.

Results: Fifty-seven patients received IV pantoprazole during the study period: 46 for upper gastrointestinal bleeding and 11 because they were NPO. In the group with upper gastrointestinal bleeding, 30 (65%) of the orders were recommended by the gastroenterology service; however, only 16 (35%) of the cases clearly met the eligibility criteria of hemodynamic instability or high risk of rebleeding. Adherence to the dosing regimen in this group was 70% (32 cases), and mean duration of therapy was acceptable, at 73.0 h. In the NPO group, 6 (55%) of the treatment courses met the criteria set out in the guidelines. Continuous infusion was prescribed inappropriately for 4 (36%) of these patients. Mean duration of therapy was much longer, at over 200 h. Total expenditures for IV pantoprazole were approximately $13 000 over the 6-month audit period.

Conclusions: Despite guidelines and prescribing restrictions, this criteria-based audit found that IV pantoprazole was used inappropriately in a substantial proportion of treatment courses. Prospective monitoring and intervention by pharmacists are recommended to ensure cost-effective use of this new therapeutic modality.

Key words: pantoprazole, IV medication, gastrointestinal hemorrhage, drug use evaluation

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RÉSUMÉ

Historique : Des lignes directrices pour l'établissement de santé ont été élaborées afin de favoriser l'utilisation adéquate de l'inhibiteur de la pompe à protons par voie intraveineuse, le pantoprazole. Les lignes directrices limitaient l'administration de ce médicament aux patients souffrant d'hémorragies digestives hautes et présentant une instabilité hémodynamique ou un risque élevé de récidive hémorragique, et aux patients nécessitant un inhibiteur de la pompe à protons qui ne pouvaient rien prendre par voie orale (chez qui l'alimentation ou la médication entérales étaient impossibles).

Objectif : Décrire les habitudes d'utilisation du pantoprazole et déterminer le degré d'observance des lignes directrices dans un établissement de soins tertiaires affilié à une université.

Méthodes : L'utilisation du médicament et l'observance des lignes directrices ont été évaluées à posteriori. Les dossiers médicaux de tous les patients qui ont reçu du pantoprazole I.V. au cours des premiers six mois de l'utilisation de ce médicament à l'établissement de santé (de février à juillet 2000) ont été passés en revue.

Résultats : Au total, 57 patients ont reçu du pantoprazole I.V., dont 46 pour des hémorragies digestives hautes et 11 parce que l'administration entérale de médicaments était impossible. Dans le groupe hémorragies digestives hautes, 30 (65 %) des ordonnances ont été rédigées par le service de gastroentérologie; toutefois, seulement 16 (35%) de ces ordonnances répondaient clairement aux critères d'administration en cas d'instabilité hémodynamique ou de risque élevé de récidive hémorragique. Le taux d'observance du schéma posologique dans ce groupe était de 70 % (32 cas) et la durée moyenne du traitement était acceptable, soit 73,0 h. Dans le groupe administration entérale impossible, 6 (55 %) des ordonnances répondaient aux critères des lignes directrices. Une perfusion continue a été prescrite indûment chez 4 (36 %) de ces patients. La durée moyenne du traitement était beaucoup plus longue, soit plus de 200 h. Les coûts en pantoprazole I.V. étaient d'environ 13 000 $ au cours de la période d'étude de six mois.

Conclusions : Malgré les lignes directrices et les restrictions d'ordonnance, cette vérification fondée sur les critères a révélé que le pantoprazole I.V. était utilisé de façon non appropriée dans un nombre considérable de schémas thérapeutiques. La surveillance prospective et l'intervention par les pharmaciens sont recommandées pour assurer l'utilisation rentable de cette nouvelle modalité thérapeutique.

Mots clés : pantoprazole, médicaments I.V., hémorragie digestives hautes, évaluation de l'utilisation des médicaments

INTRODUCTION

IV pantoprazole (Panto IV, Byk Canada Inc., Oakville, Ontario) was first marketed in Canada in 1999. It is approved for the treatment of conditions in which a rapid reduction of gastric acid secretion is required, such as severe reflux esophagitis in hospital inpatients who cannot tolerate oral medication. The manufacturer's recommended adult dose is 40 mg IV once daily.[1]

Almost immediately after the approval of IV pantoprazole, there was clinical interest in using the agent in the management of upper gastrointestinal bleeding. This interest was based on data obtained with the IV formulation of omeprazole in patients with acute peptic ulcer hemorrhage.[2,3] The rationale for using an IV proton pump inhibitor in patients with peptic ulcer bleeding is based on *in vitro* data showing that hemostatic mechanisms are highly dependent on pH. When the pH is below 5.4, platelet aggregation and plasma coagulation are virtually absent, and at pH less than 4.0, fibrin clots are dissolved by the proteolytic activity of pepsin in the gastric juice. Inhibition of gastric acid secretion to maintain a neutral pH should stabilize clots and help prevent recurrent bleeding.[2-4] There are *in vivo* data to indicate that by administering large IV doses of either omeprazole or pantoprazole (80 mg IV bolus followed by a continuous infusion at 8 mg/h), the intragastric pH can be maintained above 6.0.[3,4]

At present, there are no published clinical trials evaluating the efficacy of IV pantoprazole in the management of upper gastrointestinal bleeding due to peptic ulcers. However, there are several randomized clinical trials of omeprazole for this indication (Table 1). In all of these clinical trials, endoscopy was performed before initiation of therapy with the proton pump inhibitor.[5-10] In most of these clinical trials,[6-10] the inclusion criteria specified endoscopic findings suggestive of a high risk of rebleeding. As well, in several trials,[7-10] the patients routinely received endoscopic therapy for bleeding peptic ulcers (e.g., injection with epinephrine, thermocoagulation, or electrocoagulation) before initiation of IV omeprazole. In general, the available studies indicate that therapy with a proton pump inhibitor, in combination with endoscopic therapy, reduces the risk of recurrent bleeding.[9,10] Significant effects on the requirement for surgery and the mortality rate have not been consistently demonstrated.

IV omeprazole is not commercially available in Canada. Because of a lack of other medical treatment options for patients with nonvariceal upper gastrointestinal bleeding, the clinicians at the authors' institution were interested in using IV pantoprazole in selected patients with this condition . In addition, it was necessary to stock the drug for the occasional patient receiving maintenance therapy with an oral proton pump inhibitor and temporarily unable to take oral therapy (NPO status). Although the drug was not formally added to the hospital formulary, IV pantoprazole was made available at this institution starting in January 2000, and guidelines were set out for its use (Table 2). The guidelines were developed by the Pharmacy Department, in collaboration with the Division of Gastroenterology. The institution is a tertiary care university-affiliated hospital with approximately 500 acute care beds and a regional trauma program.

The purpose of this report is to describe compliance with the IV pantoprazole guidelines and to describe patterns of utilization of this drug during the first 6 months that it was available at this institution.

METHODS

All patients who received IV pantoprazole within the first 6 months that the drug was available at this institution (February to July 2000) were identified through reports of drug usage generated by the inpatient pharmacy computer system. The medical record of each patient was reviewed by a pharmacy student (J.P.) under the direction of a pharmacist (P.C.), and the following information was recorded on a standardized data collection form: basic patient characteristics, indication for use of IV pantoprazole, endoscopic findings, presence or absence of criteria for use of IV pantoprazole, dosage regimen of IV pantoprazole and duration of administration, prior medications (e.g., ulcerogenic or anticoagulant medications, acid-reducing regimen), concomitant medication (e.g., histamine H_2-receptor antagonist [H_2RA], octreotide); and oral step-down regimen. The data were analyzed according to indication for use (upper gastrointestinal bleeding or NPO status), and descriptive statistics were generated using SPSS for Windows (release 10.0.5, SPSS Inc., Chicago, Illinois).

RESULTS

During the 6-month audit period, a total of 60 patients received IV pantoprazole. However, the complete medical records of 3 patients were not available for review. Therefore, data are presented on a total of 57 patients.

Table 1. Randomized Clinical Trials of Proton Pump Inhibitors in Patients with Upper Gastrointestinal Bleeding

Reference	Study Design	No. of Patients	Inclusion Criteria	Endoscopic Therapy	Drug Regimen	Re-bleeding	Surgery	Mortality Rate	Comments
Daneshmend and others[5]	Double-blind RCT	1147	Unselected patients with upper gastrointestinal bleeding within 24 h of admission	None	Omeprazole 80 mg IV bolus + 40 mg IV q8h x 3 doses, then 40 mg PO q12h x 6 doses versus placebo	At day 40 *Drug:* 15% *Placebo*: 18% (p = NS)	At day 40 *Drug:* 11% *Placebo:* 11% (p = NS)	At day 40 *Drug:* 6.9% *Placebo:* 5.3% (p = NS)	Intermittent IV omeprazole failed to reduce rate of rebleeding, need for surgery, or mortality rate
Khuroo and others[6]	Double-blind RCT	220	Endoscopy within 12 h of admission with the following findings: peptic ulcer with spurting vessel, visible, nonbleeding vessel, oozing from ulcer, or adherent clot	None	Omeprazole 40 mg PO q12h x 5 days versus placebo	At day 5 *Omeprazole:* 10.9% *Placebo:* 36.4% (p < 0.001)	At day 5 *Omeprazole:* 7.2% *Placebo:* 23.6% (p < 0.001)	At day 5 *Omeprazole:* 1.8% *Placebo:* 5.4% (p = NS)	Oral omeprazole associated with lower rate of further bleeding and need for surgery; study population was younger and had fewer coexisting medical conditions than typical patients with bleeding ulcers
Schaffalitzky de Muckadell and others[7]	Double-blind RCT	265	Endoscopy within 12 h of admission with the following findings: peptic ulcer with spurting bleeding, oozing bleeding, visible vessel, or adherent clot or black base	Injection, thermocoagulation, or electrocoagulation	Omeprazole 80 mg IV bolus, 8 mg/h x 72 h 20 mg PO daily on days 4–21 versus placebo + omeprazole 20 mg PO daily on days 4–21	At day 21 *Omeprazole only:* 7.1% *Placebo regimen:* 12.4% (p = 0.06)	At day 21 *Omeprazole only:* 10.8% *Placebo regimen:* 13.3% (p = 0.04)	At day 21 *Omeprazole only:* 6.1% *Placebo regimen:* 5.9% (p = NS)	IV omeprazole associated with lower rate of surgery when given with endoscopic therapy, but not associated with any change in rate of recurrent bleeding or mortality rate
Hasselgren and others[8]	Double-blind RCT	322	Patient ≥ 60 years old, endoscopy within 12 h of admission with the following findings: peptic ulcer with spurting arterial bleeding, oozing bleeding, visible vessel, or black base or clot	Performed but not specified	Omeprazole 80 mg IV bolus, 8 mg/h x 72 h + 20 mg PO daily on days 4–21 versus placebo + omeprazole 20 mg PO daily on days 4–21	At day 21 *Omeprazole only:* 3.1% *Placebo regimen:* 2.5% (p > 0.20)	At day 21 *Omeprazole only: 4.4%* *Placebo regimen:* 10.4% (p > 0.20)	At day 21 *Omeprazole only:* 6.9% *Placebo regimen:* 0.6% (p = 0.012)	Elderly study population with imbalances in risks between groups at baseline
Lin and others[9]	Randomized	100	Endoscopy within 12 h of admission with the following findings: peptic ulcer with active bleeding or visible, nonbleeding vessel	Hemostasis	Omeprazole 40 mg IV bolus, 160 mg/day x 3 days, then 20 mg PO daily for 2 months versus cimetidine 300 mg IV bolus, 1200 mg/day x 3 days, then 400 mg PO bid for 2 months	At day 14 *Omeprazole:* 4% *Cimetidine:* 24% (p < 0.001)	At day 14 *Omeprazole:* 0% *Cimetidine:* 0% (p > 0.05)	At day 14 *Omeprazole:* 0% *Cimetidine:* 2% (p > 0.05)	Not blinded; after endoscopic therapy, omeprazole associated with higher intragastric pH and fewer episodes of rebleeding than cimetidine
Lau and others[10]	Double-blind RCT	240	Endoscopy within 24 h of admission with the following findings: peptic ulcer with spurting or oozing hemorrhage, visible, nonbleeding vessel, or adherent clot	Injection with epinephrine or thermocoagulation	Omeprazole 80 mg IV bolus, 8 mg/h x 72 h, then 20 mg PO daily for 8 weeks versus placebo for 72 h, then omeprazole 20 mg PO daily for 8 weeks	At day 30 *Omeprazole only:* 6.7% *Placebo regimen:* 22.5% (p < 0.001)	At day 30 *Omeprazole only:* 2.5% *Placebo regimen:* 7.5% (p = 0.14)	At day 30 *Omeprazole only:* 4.2% *Placebo regimen:* 10% (p = 0.13)	After endoscopic therapy of bleeding peptic ulcers, high-dose infusion of omeprazole was associated with significantly lower risk of recurrent bleeding

RCT = randomized placebo-controlled trial, NS = not significant

Table 2. Guidelines for IV Pantoprazole at a Tertiary Care, University-Affiliated Institution

Guideline	Non-Variceal Upper Gastrointestinal Bleeding	NPO Status
Criteria for use	Instability of vital signs (e.g., hypotension) despite adequate fluid resuscitation OR Endoscopic evidence of high risk for rebleeding (e.g., visible nonbleeding vessel, actively bleeding vessel, or adherent clot)	Patients on oral PPI who are temporarily strictly NPO (i.e., no other medications or feeding either orally or through a feeding tube)
Prescribing restriction	Orders must be written or approved by gastroenterology service	None
Dose of pantoprazole	80 mg IV bolus followed by continuous infusion at 8 mg/h; maximum duration of infusion 72 h	If oral PPI dose ≤ 40 mg daily, use 40 mg IV once daily If oral PPI dose > 40 mg daily, use 40 mg IV bid
Step-down regimen	Convert to oral omeprazole (20 mg daily or bid) as soon as possible; if patient is still NPO after 72 h infusion, convert to pantoprazole 40 mg IV daily	Convert to previous oral PPI as soon as possible

PPI = proton pump inhibitor.

Table 3. Baseline Characteristics of 46 Patients with Upper Gastrointestinal Bleeding

Characteristic	No. (and %) of Patients*
Sex	
Male	35 (76)
Female	11 (24)
Age (years)	
Mean ± SD	66.4 ± 15.6
Range	26–87
Onset of bleeding	
In hospital	29 (63)
Before admission	17 (37)
Presenting symptoms	
Hematemesis	18 (39)
Melena	18 (39)
Coffee ground emesis	22 (48)
Blood on nasogastric suctioning	8 (17)
Recent use of H_2RA or PPI	28 (61)
Risk factors for bleeding peptic ulcer	
Use of NSAID	9 (20)
Use of ASA	17 (37)
Use of anticoagulant†	30 (65)
Use of glycoprotein IIb/IIIa receptor antagonist	2 (4)
Length of hospital stay (days)	
Mean ± SD	20.0 ± 20.5
Range	(2–96)
Median	13
Deaths	3 (7)

SD = standard deviation, H_2RA = histamine H_2-receptor antagonist, PPI = proton pump inhibitor, NSAID = nonsteroidal anti-inflammatory drug, ASA = acetylsalicylic acid.
*Except where indicated otherwise.
†Includes heparin, warfarin, and low-molecular-weight heparin.

The patients were divided into 2 groups according to the indication for which they received IV pantoprazole: upper gastrointestinal bleeding or NPO status.

Upper Gastrointestinal Bleeding

Forty-six patients had a presumed or confirmed diagnosis of upper gastrointestinal bleeding at the time IV pantoprazole was ordered (Table 3). More than half of these patients developed signs and symptoms of upper gastrointestinal bleeding during a hospital admission for another reason; only 17 (37%) were admitted to hospital with this diagnosis. Most of the patients had used acid-reducing therapy (i.e., H_2RA or a proton pump inhibitor) before the onset of the signs and symptoms of upper gastrointestinal bleeding. Not surprisingly, a significant proportion of patients were receiving drug therapy that might increase the risk of bleeding peptic ulcer (nonsteroidal anti-inflammatory drugs, acetylsalicylic acid, anticoagulants, or glycoprotein IIb/IIIa receptor antagonists). Three patients died during their hospital stay from causes unrelated to upper gastrointestinal bleeding.

Most of the orders for IV pantoprazole were written or approved by the gastroenterology service (Table 4). However, for 16 (35%) of the patients, IV pantoprazole was initiated without the involvement of the gastroenterology service. The most common dosage regimen was pantoprazole 80 mg IV bolus, followed by a continuous infusion of 8 mg/h (Table 4). In the remaining patients, a variety of other dosage regimens were used, which theoretically would not produce the desired effect on gastric pH. The mean duration of pantoprazole infusion was 73.0 h. After completion of the infusion, most patients were converted to a proton

Table 4. Pantoprazole Therapy and Criteria for Use in 46 Patients with Upper Gastrointestinal Bleeding

Variable	No. (and %) of Patients*
Prescribing service	
Gastroenterology	30 (65)
Surgery	6 (13)
Critical care	4 (9)
Medicine	4 (9)
Other	2 (4)
Pantoprazole dose	
80 mg IV bolus, then 8 mg/h	32 (70)
40 mg IV bolus, then 4 mg/h	2 (4)
No bolus; 8 mg/h	1 (2)
40 mg IV bid	6 (13)
40 mg IV daily	5 (11)
Duration of use (h)	
Mean ± SD	73.0 ± 58.8
Range	2–288
Median	64
Step-down regimen	
Intermittent IV pantoprazole	5 (11)
Oral or nasogastric PPI	38 (83)
Oral or IV H_2RA	3 (6)
Cost of IV pantoprazole ($)	
Mean per patient ± SD	210 ± 155
Range	17–522
Median	195
Total for group	9668
Concomitant therapy	
Octreotide	7 (15)
IV H_2RA	1 (2)

SD = standard deviation, PPI = proton pump inhibitor, H_2RA = histamine H_2-receptor antagonist.
*Except where indicated otherwise.

Table 5. Endoscopy and Criteria for Pantoprazole Infusion in 46 Patients with Upper Gastrointestinal Bleeding

Variable	No. (and %) of Patients*
Time to endoscopy	
Before starting IV pantoprazole	15 (33)
≤24 h after starting IV pantoprazole	20 (44)
>24 h after starting IV pantoprazole	1 (2)
Not performed	10 (22)
Endoscopic findings	
Esophagitis	25 (54)
Gastric ulcer or erosions	12 (26)
Duodenal ulcer or erosions	12 (26)
Obstruction of gastric outlet	5 (11)
Esophageal varices	3 (7)
Mallory–Weiss tear	2 (4)
Endoscopic treatment	
Epinephrine	9 (20)
Epinephrine and ethanolamine	3 (7)
Criteria for IV pantoprazole infusion	
Hemodynamic instability	2 (4)
Endoscopic findings suggestive of high risk for rebleeding	14 (30)
No obvious criteria	30 (65)

pump inhibitor administered orally or through a feeding tube; only 5 (11%) were converted to intermittently administered IV pantoprazole. In 7 (15%) of the patients, IV octreotide infusion was initiated concurrently with IV pantoprazole because of a suspicion of bleeding from esophageal varices. The mean cost per patient was $210, and the total cost for this group of 46 patients was $9668.

Most of the patients who received IV pantoprazole for presumed upper gastrointestinal bleeding underwent endoscopy (Table 5). For almost all of the patients who underwent endoscopy, the procedure was performed before IV pantoprazole was started or within 24 h of initiation of therapy (Table 5). A total of 12 patients (26%) received endoscopic treatment (epinephrine with or without ethanolamine).

Notations in the medical records indicated that only 2 of the patients were hemodynamically unstable (Table 5). Fourteen of the patients had findings at endoscopy suggestive of high risk for rebleeding. Therefore, it appeared that only 16 (35%) of patients met the pre-established criteria for use of IV pantoprazole in upper gastrointestinal bleeding. Interestingly, 14 (47%) of the 30 patients for whom IV pantoprazole was prescribed by the gastroenterology service clearly met the criteria for use, whereas only 2 (13%) of the 16 patients for whom the drug was ordered by another medical or surgical service met the criteria.

NPO Status

Eleven patients for whom IV pantoprazole was prescribed had no evidence of upper gastrointestinal bleeding (Table 6). Only 4 (36%) of these patients had previously been receiving a proton pump inhibitor, either orally or through a feeding tube; the same number had been receiving a H_2RA, and 3 (27%) had not received any prior acid-reducing therapy. The reason for prescribing IV pantoprazole in patients who had not previously been receiving a proton pump inhibitor was a new diagnosis of peptic ulcer disease or esophagitis in a patient with temporary NPO status. The patients who had been receiving a H_2RA were switched to IV pantoprazole because of inadequate control of symptoms with the H_2RA.

The gastroenterology service was involved in only 3 (27%) of the orders for IV pantoprazole in this group (Table 7). The most commonly prescribed dose was 40 mg IV daily (Table 7). Continuous infusion was prescribed for 4 (36%) of the patients, and 1 patient received a dose of 40 mg IV bid. The mean duration of IV pantoprazole use was 236.2 h; however, because the

Table 6. Baseline Characteristics of 11 Patients with NPO Status

Characteristic	No. (and %) of Patients*
Sex	
Male	5 (45)
Female	6 (55)
Age (years)	
Mean age ± SD	64.3 ± 17.3
Range	43–96
Prior acid-reducing regimen	
Oral or nasogastric PPI	4 (36)
H_2RA	4 (36)
None	3 (27)
Length of hospital stay (days)	
Mean ± SD	22.8 ± 11.7
Range	3–39
Median	20
Deaths	1 (9)

SD = standard deviation, PPI = proton pump inhibitor, H_2RA = histamine H_2-receptor antagonist.
*Except where indicated otherwise.

Table 7. Pantoprazole Therapy and Criteria for Use in 11 Patients with NPO Status

Variable	No. (and %) of Patients*
Prescribing service	
Gastroenterology	3 (27)
Medicine	3 (27)
Surgery	2 (18)
Critical care	2 (18)
Oncology	1 (9)
Pantoprazole dose	
40 mg IV daily	6 (55)
80 mg IV, then 8 mg/h	2 (18)
40 mg IV bid	1 (9)
40 mg IV, then 8 mg/h	1 (9)
No bolus; 8 mg/h	1 (9)
Duration of use (h)	
Mean ± SD	236.2 ± 288.8
Range	12–1008
Median	120
Step-down regimen	
Oral or IV H_2RA	6 (55)
Oral or nasogastric PPI	4 (36)
None	1 (9)
Cost of IV pantoprazole ($)	
Mean per patient ± SD	326 ± 450
Range	17–1428
Median	136
Total for group	3583
Criteria for use	
Patient strictly NPO	6 (55)
Patient not strictly NPO	5 (45)

SD = standard deviation, H_2RA = histamine H_2-receptor antagonist, PPI = proton pump inhibitor.
*Except where indicated otherwise.

duration was excessively long for one patient, the median duration of 120 h may be more representative of the group. The mean cost per patient for IV pantoprazole was $326, and the total cost for this group was $3583 (Table 7). The criteria for use of IV pantoprazole in NPO patients were met for 6 (55%) of the group; the remaining patients were receiving other medications or food orally or through a feeding tube while receiving IV pantoprazole.

DISCUSSION

During the first 6 months of IV pantoprazole use at this institution, most patients (46 [81%]) received the drug for the management of presumed or confirmed upper gastrointestinal bleeding. In a comparison of actual use of IV pantoprazole in patients with upper gastrointestinal bleeding with the pre-established guidelines for such use, several observations can be made. Overall, there was 65% compliance with the prescribing restriction to the gastroenterology service (30 patients), and there was 70% adherence to the dosing regimen (32 patients). As well, the duration of infusion was acceptable. Only 35% of this group clearly met the eligibility criteria. Compliance with the criteria was much higher when pantoprazole was ordered by the gastroenterology service (47%) than was the case when other medical or surgical services ordered the drug (13%). However, this audit was conducted retrospectively and depended on the objective notation of clinical parameters indicating high risk in the medical record. If indicators of hemodynamic instability and high-risk endoscopic findings were not clearly noted in the medical record, then compliance with the criteria may be underestimated. As well, this audit was conducted soon after IV pantoprazole became available at this institution. It is possible that, with time, staff will become more familiar with the appropriate use of IV pantoprazole and that compliance with the guidelines will improve.

The remaining 11 (19%) patients received IV pantoprazole for indications other than upper gastrointestinal bleeding. Only 6 (55%) of the patients in this group met the pre-established criteria of being unable to receive any medications or food either orally or through a feeding tube. As well, in 4 (36%) of the patients in this group, infusion was used unnecessarily and at substantially higher cost than intermittent IV dosing.

The cost of IV pantoprazole during the first 6 months of its use at this institution was approximately $13 000. On the basis of the estimates derived from this audit, the financial impact of noncompliance with the institutional guidelines was approximately $8000.

Although this represents a relatively small percentage of the overall drug budget, it is important to continue monitoring IV pantoprazole use to ensure appropriate prescribing. The results of this audit will be reviewed by the Pharmacy and Therapeutics Committee, and addition to the formulary will be considered. As well, the appropriateness of the current guidelines and criteria for use will be evaluated. An important study evaluating IV omeprazole was published after the original guidelines were developed.[10] That study indicated that high-dose IV omeprazole therapy reduces the rate of recurrent bleeding in patients with high-risk ulcers, even after successful endoscopic therapy. The feasibility of restricting the use of IV pantoprazole to this setting must be evaluated at the authors' institution.

The findings of this audit indicate that pharmacists have a significant role in ensuring that prescribing restrictions are enforced, that appropriate dosing regimens are used, and that patients are appropriately assessed for eligibility criteria before receiving IV pantoprazole.

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