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RESEARCH ARTICLE

Impact of multi-approach strategy on acid suppressive medication use in a teaching hospital in Qatar

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Abstract *Objective* To evaluate the impact of a multi-approach strategy to improve the appropriate usage of acid suppressive medication (ASM) in medical inpatients and compare it with the baseline data from 2007. *Setting* Five general medicine wards in a 600-bed teaching hospital in Doha, Qatar. *Method* A prospective evaluation of the usage of ASM 1 year after a multi-approach strategy. This consisted of four main interventions: audit and feedback method (including awareness lectures to all medical and pharmacy staff), implementation of a usage guideline for medical inpatients, circulating a logarithmic chart on the proper usage of ASM for medical inpatients from admission through to discharge and participation of clinical pharmacists in the multidisciplinary rounds. All medical patients admitted from May through June 2009 were evaluated. Data about the usage of ASM were collected upon and during admission, at discharge and at the next follow-up visit. Justified indications for its usage were based on the approved product information and on evidence-based literature recommendations. Data were compared with the findings of the baseline clinical audit done 2 years earlier. *Main outcome measure* The usage of ASM in justified and non-justified indications upon and during admission, at discharge and at the next follow up visit. *Results* A total of 414 patients were admitted during the study period, 208 patients (50%) received ASM compared to 53% in 2007 (206 patients out of 389). Seventy-four patients (36%) were using ASM upon admission compared to 48 patients (23%) in the 2007 clinical audit. Inappropriate ASM use decreased with 51% during admission (66 to 32%, $P < 0.0001$), 62% at discharge (34 to 13%, $P < 0.0001$) and 67% at the next follow up visit (15 to 5%, $P = 0.0008$). *Conclusion* Despite the higher number of patients receiving ASM upon admission, the multi-approach strategy used in our institution resulted in a significant improvement in the appropriate usage of ASM in medical inpatients.

Keywords Acid suppressive medications · Drug use · Prescribing intervention · Qatar · Teaching hospital

Impact of findings on clinical practice

- Overuse of acid suppressive medication can successfully be handled by a multi-approach strategy.
- Clinical pharmacists can play a major role in ensuring the proper usage of acid suppressive medication by endorsing clinical guidelines, performing audits and participating in the clinical rounds.
- Limiting inappropriate usage of acid suppressive medication will result in reduced adverse events, drug–drug interactions and overall cost.

Introduction

Acid suppressive medication (ASM), namely proton pump inhibitors (PPI) and histamine 2 receptor antagonists (H2RA) are a valuable cornerstone for treating and

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preventing gastric acid related problems. However, they are prescribed to the majority of hospitalized patients often without a certain indication or justified reason, especially in non-intensive care units [1–7]. The reported use of ASM in general medicine inpatients ranges from 26.8 to 71% [4]. Many were prescribed as stress ulcer prophylaxis (SUP), which is a justified indication in high-risk patients in intensive-care units [3, 8]. Furthermore, inappropriate ASM prescribing continued upon patients' discharge from the hospital and in the out-patient setting [1–4, 8]. Mayet AY reported 43% of unjustified use of ASM in hospitalized patients in a Saudi tertiary care teaching hospital [5]. A similar finding was observed in our institution in 2007, in which the unjustified use in medical inpatients was 66% [1].

Several strategies have been used to overcome this poor prescribing and usage practice. These include the issuing of guidelines, restriction policies, passive education and hand-over of educational materials, and economic measures. More success however is expected from these initiatives when it is based on multiple strategies that are actively implemented [9]. Collaborative work between pharmacists and physicians to develop evidence-based practice guidelines resulted in a 50% improvement in the correct use of PPIs [6]. Regal et al. found that combining a beginning-of-year lecture to all interns with an early-in-the-month rotation reminder lecture and rounding of clinical pharmacists with healthcare teams reduced the inappropriate ASM usage from 59 to 19%, while the usage of PPIs reduced from 66 to 53% [8]. Hospital and health care managers are advised to critically review recommendations for PPI medication use, especially for patients at discharge. Moreover prescribers should clearly document the reason for PPI use and the need for continuous prescription [10].

Aim of the study

The specific aim of this study was to evaluate the impact of a multi-approach strategy implemented after a baseline audit done in 2007, to improve the prescribing and usage of ASM in medical inpatients in Hamad General Hospital (HGH).

Method

HGH, a 600-bed hospital, is a tertiary care teaching hospital and a member of Hamad Medical Corporation (HMC), the premier non-profit healthcare provider in the State of Qatar. The patient population includes locals as well as a variety of expatriates mainly from other Arab countries and South Asia. Healthcare (including medication) is free for locals and highly subsidized for residents.

Description of the multi-approach strategy (the intervention)

A baseline audit on the usage of ASM in medical inpatients took place from May through June 2007. This revealed an unjustified use of ASM in 66% of these patients [1].

Following these results, a so called multi-approach strategy was implemented. The interventions consisted of:

1. Feedback on 2007 audit: several sessions were organized to inform medical and pharmacy staff about the usage pattern of ASM in medical inpatients in our institution.
2. Development and implementation of an ASM-usage guideline: based on the findings of the 2007 audit, prescribers were committed to improve the usage pattern of ASM for their patients. A guideline, based on evidence based criteria, was developed and agreed upon by all parties involved and endorsed by the chairman of medicine department. This guideline (see Table 1) was handed to all prescribers of the general medicine department and was made available through the hospital's intranet system.
3. Flyer with algorithmic chart: a flyer with a simple algorithm (Fig. 1) providing the prescriber a step-wise approach to reassess the patient at different stages of his/her admission for the possible need of ASM, facilitates the usage of the guideline.
4. Active involvement of clinical pharmacists: clinical pharmacists round with the clinical teams on a daily basis (5 days a week) and ensure the prescribers use the algorithm as well as the agreed ASM-usage guidelines for all relevant patients.

The definitions of the study interventions are summarized in Table 2.

Evaluation of the prescribing pattern after the intervention

From May through June 2009, 2 years after the baseline audit (further referred to as Audit 1) and almost 1 year after implementation of the multi-approach strategy, a second audit (further referred to as Audit 2) was performed. A 1 year gap was likely to reflect the real impact of the multi-approach strategy, allowing the initial enthusiasm of following the institutional guidelines to settle. Audit 2 was also conducted in the exact same months as Audit 1. This would limit a possible variation in the seasonal influx of patients. As for Audit 1, none of the medical staff was informed about the data collection, minimizing any temporary and artificial change in the prescribing and usage pattern of ASM.

Table 1 Guideline for indicated and justified criteria for prescribing ASM in medical patients

Indicated use of ASM, FDA-Based:
Treatment of duodenal and benign gastric ulcers.
Symptomatic gastro-esophageal reflux disease (GERD).
Erosive esophagitis.
Helicobacter pylori eradication (used in combination with antibiotics).
Prophylaxis of acid aspiration.
Pathological hypersecretory conditions (e.g. Zollinger-Ellison syndrome).
Bleeding peptic ulcer (intravenous PPI only).
Treatment and prophylaxis of NSAID-associated benign gastric ulcers, duodenal ulcers and gastroduodenal erosions in patients with a previous history of gastroduodenal lesions, which require continued NSAID treatment (PPI only).
Justified use of ASM, Literature-Based:
Bleeding peptic ulcer (high-dose oral PPI) [11].
Stress ulcer prophylaxis (ASHP Guidelines) [12].
Organ transplantation [13].
Liver cirrhosis [14].
Corticosteroids (when combined with NSAID) [15].
Prophylaxis of NSAID or aspirin gastro-duodenal toxicity in at least one of the following risk factors (PPI only) [16]:
A history of an ulcer or GI hemorrhage
Age above 60 years
High (more than twice the customary) dosage of a NSAID
Concurrent use of glucocorticoids
Concurrent use of anticoagulants

ASHP American Society of Health System Pharmacists, *ASM* acid suppressive medication, *FDA* Food and Drug Administration, *NSAID* non-steroidal anti-inflammatory drug, *PPI* proton pump inhibitor

In this prospective study, all patients admitted to all general medical wards in HGH, in May and June 2009, were evaluated for the usage of ASM. Their medical records were reviewed and monitored for ASM usage at 3 stages: during the hospital stay, upon discharge and at the follow-up visit in the outpatient clinic.

The data collection form included the date of admission and discharge, length of stay, admitting diagnosis, gender, age, nationality, medical and drug history (including details about non steroidal anti-inflammatory drugs (NSAIDs), anti-coagulants and corticosteroids), type of ASM used, indication for its use, duration of therapy, and number of medications at discharge. Specific records were made for the ASM usage upon discharge and at the follow-up visit in the outpatient clinic (to monitor the possible discontinuation of the ongoing ASM therapy). The available ASM in our institution at the time of this study were ranitidine as H_2RA, and lansoprazole, omeprazole and rabeprazole as PPI.

Similar to Audit 1, the indicated use was based on the product information leaflet and the American Food and Drug Administration (FDA) approved indications. The justified use was based on strong literature recommendations for the use of ASM in certain patients [11–16].

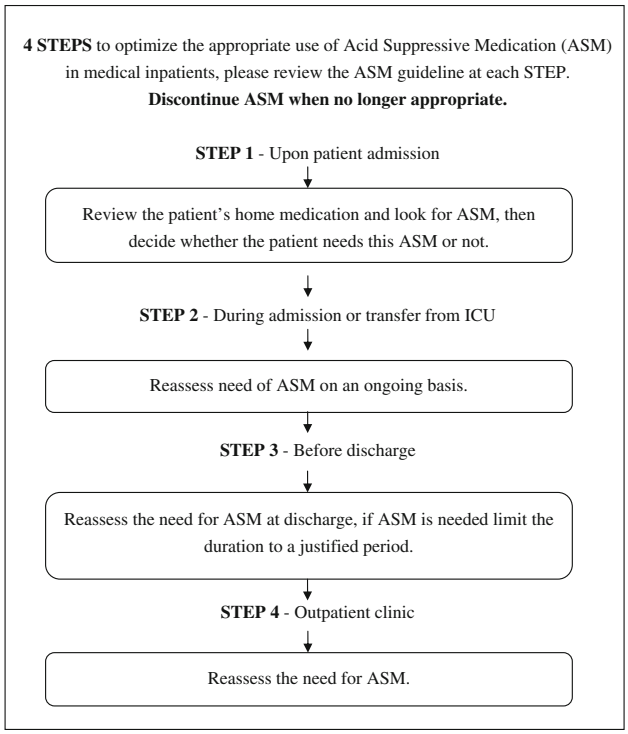

Fig. 1 Algorithm summarizing the Acid Suppressive Medication guideline

Waiver of Informed Consent was obtained and the study was approved by the institution's medical research committee (Protocol # 9034/09).

Statistics

Data were analyzed by using the statistical packages SPSS 16.0 and MegaStat 10.0 to obtain descriptive statistics (mean, standard deviation and range for interval data, frequency and percentage for categorical variables). Differences between independent and dependent variables were assessed using *t* tests for continuous variables and exact χ^2 tests for categorical variables. A *P* value equal or less than 0.05 (two-tailed) was considered significant. Normality test was examined through Shapiro–Wilk Test and homogeneity of variance was explored by the Levene's test. For skewed data, we tested the difference between independent and dependent variables by independent sample Mann–Whitney *U* test for continuous variables.

Results

A total of 414 patients were admitted during the study period, 208 (50%) used ASM. Out of this 208, 74 patients

Table 2 Definition of study interventions

Intervention	Definition
Audit [17]	Process of reviewing healthcare records to determine aspects of the appropriateness of the process of care delivered.
Feedback [17]	Method whereby prescriber performance is measured and the results presented to the healthcare prescriber, generally in printed or electronic format.
Clinical guideline [17]	A series of systematically developed statements based on evidence and/or consensus regarding the health care of patients with specific conditions.
Clinical pharmacist [18]	Healthcare staff that are experts in the therapeutic use of medications. They routinely provide medication therapy evaluations and recommendations to patients and health care professionals.

(36%) were receiving ASM before admission and the remaining 134 patients (64%) received ASM during hospitalization. Characteristics of the study population of both audits are summarized in Table 3. Diagnosis upon admission and patients' medical history are presented in Table 4. A total of 194 patients (93%) received PPI and 14 patients (7%) received H2RA. Out of 194 PPI-users, 136 (70%) did so for approved indications while 10 out of 14 (71%) H2RA-users complied with approved usage.

Figure 2 summarizes the overall study population and the usage of ASM at different stages of the patient's hospital stay.

In Audit 1, the most frequent approved use of ASM during the inpatient stay was dyspepsia and gastro-esophageal reflux disease (GERD) (26%), followed by prophylaxis of NSAID's and aspirin induced-ulcers in high-risk patients (21%) and renal/hepatic transplant patients (21%). In Audit 2, prophylaxis of NSAID's and aspirin induced-ulcers in high-risk patients became the most dominant indication (34%), followed by dyspepsia and GERD (24%), and upper gastrointestinal bleeding (13%). Correct usage of ASM increased from 34% in Audit 1 to 68% in Audit 2. Comparative data for the approved ASM usage (indicated/justified) for both audits are provided in Table 5.

On the other hand, the inappropriate use of ASM in Audit 1 was mainly as prophylaxis of NSAID's and aspirin induced-ulcers in low-risk patients (21%), followed by step-down from ICU (14%) and treatment of vomiting (13%). In Audit 2, non-specific abdominal pain was the most predominant indication (21%), followed by prophylaxis of NSAID's and aspirin induced-ulcers in low-risk patients (11%) and acute pancreatitis (11%). The ASM usage for non-approved and unjustified indications during both audits is summarized in Table 6.

Table 3 Characteristics of the study populations in 2007 audit (audit 1) and 2009 audit (audit 2)

Characteristic	Audit 1 ($n = 206$) n (%)	Audit 2 ($n = 208$) n (%)	P value
Gender			0.0007
Male	166 (81)	137 (66)	
Female	40 (19)	71 (34)	
Age in years (mean ± SD [range])	51.0 ± 16.5 [14–90 years]	52.6 ± 19.3 [14–93 years]	0.3811
14–29	22 (11)	34 (16)	
30–39	28 (14)	20 (10)	
40–49	40 (19)	41 (20)	
50–59	51 (25)	32 (15)	
≥60	65 (32)	81 (39)	
Ethnicity			0.2242
African	7 (3.5)	18 (9)	
Middle Eastern	124 (60)	113 (54)	
South Asian	62 (30)	62 (30)	
Southeast Asian	12 (6)	12 (6)	
Caucasian	1 (0.5)	2 (1)	
Length of stay in days (mean ± SD [range])	9.1 ± 7.4 [1–65 days]	12.4 ± 15.7 [2–73 days]	0.2380
Total patient days	1,873	2,587	
1–3 days	31 (15)	17 (8)	
4–6 days	75 (36)	61 (29)	
7–9 days	37 (18)	42 (20)	
10–12 days	18 (9)	28 (14)	
>12 days	33 (16)	46 (22)	
Patients died	12 (6)	14 (7)	
Number of medications at discharge (mean ± SD [range])	5.2 ± 3.6 [0–16 items]	4.8 ± 3.8 [0–18 items]	0.1980
Exempted from payment of medication	84 (41)	83 (40)	0.8564
Admission status:			0.9716
Through emergency department	182 (88)	184 (88)	
Transferred from ICU	24 (12)	24 (12)	

ASM acid suppressive medication, *ICU* intensive care unit, *SD* standard deviation

The multi-approach strategy resulted in a decrease of inappropriate use of ASM with 51% during admission (66 to 32%, $P < 0.0001$), with 62% at discharge (34 to 13%, $P < 0.0001$) and with 67% at the follow-up visit in the outpatient clinic (15 to 5%, $P = 0.0008$).

Table 4 Diagnosis upon admission and patient's status in 2007 audit (Audit 1) and 2009 audit (Audit 2)

Diagnosis upon admission	Audit 1 ($n = 206$) n (%)	Audit 2 ($n = 208$) n (%)
Gastrointestinal	54 (26)	55 (26)
Neurology	50 (24)	42 (20)
Infectious diseases	46 (22)	36 (17)
Kidney diseases	22 (11)	25 (12)
Cardio-vascular diseases	7 (3)	17 (8)
Respiratory diseases	4 (2)	12 (6)
Endocrine and metabolic diseases	8 (4)	6 (3)
Malignancy and immunology diseases	1 (1)	6 (3)
Poison	10 (5)	4 (2)
Dermatology	2 (1)	1 (1)
Nutritional	2 (1)	0
Connective and joint diseases	0	4 (2)
Patient's status		
Patients with 1 or more chronic diseases[a]	140 (68)	86 (41)
Renal failure	44 (21)	28 (14)
Hepatic failure	13 (6)	13 (6)
Bedridden	12 (6)	38 (18)

[a] Chronic diseases include: diabetes mellitus, hypertension, congestive heart disease and chronic obstructive pulmonary disease

Basic hospital-drug cost of inappropriate ASM usage at patient's discharge and in the follow-up outpatient clinic were substantially lower in audit 2 compared to audit 1 (from €1753 to €712, a reduction of 59%).

An overall comparison between both audits about the ASM usage at different stages of the patient's hospital stay, type of ASM used and drug cost is shown in Table 7.

A total of seven patients were kept on SUP after being transferred from ICU as their risk factors were not completely resolved. Five of them (two with Guillain–Barré syndromes and three with chronic lung diseases) were still mechanically ventilated and continued their weaning process in the medical ward. The other two patients were having coagulopathy diseases (1 with disseminated intravascular coagulation and the other with thrombocytopenia). On the other hand, unnecessary SUP was observed in 9 out of 208 patients (4%).

Discussion

This prospective interventional study showed the success of our multi-approach strategy to improve the appropriate prescribing and usage of ASM in general medical inpatients. Combining interventions to create a multifaceted approach appears to improve physicians prescribing practice [17]. Despite the fact that the total ASM use in our patient population was not statistically different between the two audits (53% in 2007 vs. 50% in 2009), the implementation of this strategy significantly decreased the inappropriate use. This improvement was identified during all patients' stages; upon admission, hospitalization, upon discharge and follow-up in the outpatient clinic. The multi-approach strategy decreased the unnecessary patient's exposure, reduces the side effects and drug interactions of these medications, saves hospital resources, and reduces the overall cost.

The initial audit in 2007 provided useful baseline data about the current ASM prescribing in our institution. Our findings corresponded with those from similar audits from other parts of the world and the audit identified the need for improvement [1]. After discussing the results of the baseline audit with the leadership of the medicine department, it was decided to improve the current ASM usage by different interventions. The first intervention was "Audit and Feedback". This method was selected because it shows a consistent pattern of effectiveness in impacting the prescribing practices in most of the systematic reviews. It is also the most effective method in an area where baseline compliance with recommendations is low [17].

The second and third interventions were agreed during the discussions following the presentation of the initial audit findings. It was decided to develop an institutional guideline to be followed whenever an ASM was prescribed for a medical patient. The guideline aimed to provide clinicians with graded recommendations based on evidence of best practice. Several attributes are needed for the physicians to comply with guideline recommendations [9]. Disseminating guidelines passively has little impact on the prescribing practice and should not be deployed alone. If a guideline was part of a comprehensive intervention, the change in prescribing pattern is likely to be detectable and significant [9, 17].

A study from a university hospital in The Netherlands showed that the implementation of a usage guideline on pulmonary wards reduced the initiation of PPIs from 21 to 13% while appropriateness was not affected [19]. Development of local and national guidelines for the proper use of ASM helps in minimizing their adverse risks [20].

Knowing that reminders consistently impact prescribing practice, the guideline was advertised during departmental meetings [17]. To improve adherence to the guideline, a flyer—our third intervention—with a simple algorithm was provided to all prescribers and. Furthermore, the leadership of the medicine department endorsed the guideline and flyer through an internal memo and ensured the guideline was available through the hospital's intranet.

The fourth strategy was ensuring that the clinical pharmacists were on "high alert" during the clinical rounds and

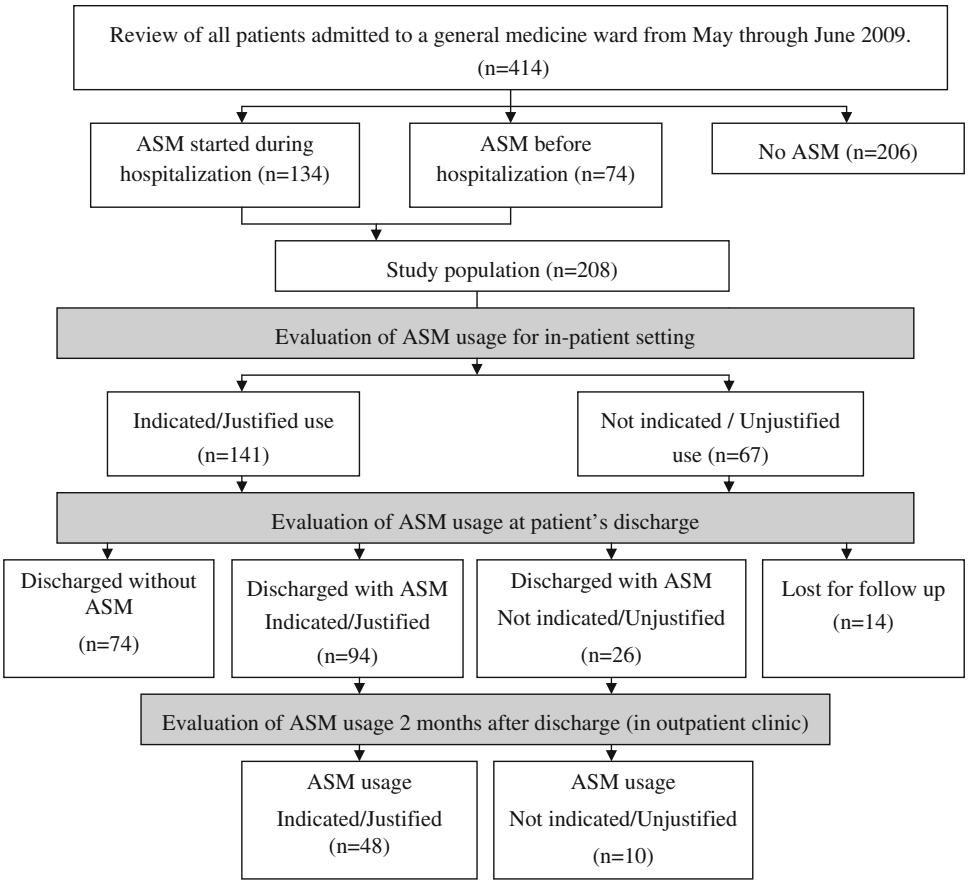

Fig. 2 Summary of patients at different stages of their medical record review

ASM - acid suppressive medication

Table 5 Acid suppressive medicines usage for approved/justified indications in 2007 audit (Audit 1) and 2009 audit (Audit 2)

Reason for use (Inpatient setting)	Audit 1 ($n = 206$) $n = 70$ (%)	Audit 2 ($n = 208$) $n = 141$ (%)
NSAID and aspirin ulcer prophylaxis (high risk)	15 (21)	48 (34)
Dyspepsia	9 (13)	26 (19)
Upper Gastrointestinal bleeding	5 (7)	18 (13)
SUP (according to ASHP criteria)	2 (3)	7 (5)
Hepatic Failure (cirrhotic)	6 (9)	10 (7)
GERD	9 (13)	7 (5)
Prophylaxis of acid aspiration	0	6 (4)
Gastric/Duodenal ulcer	4 (6)	6 (4)
Erosive esophagitis	0	3 (2)
Helicobacter pylori eradication regimen	5 (7)	8 (6)
Renal/Hepatic transplant	15 (21)	2 (1)

NSAID non-steroidal anti-inflammatory drug, *SUP* stress ulcer prophylaxis, *ASHP* American Society of Health-system Pharmacists, *GERD* gastro-esophageal reflux disease

at the time of the patient's discharge. Assessing and re-assessing the need of an ASM at any prescribing stage was done on a daily basis. To achieve this goal, clinical pharmacists involved in the rounds of the medical teams were reminding the prescribers of the institutional guidelines and the algorithm.

Clinical pharmacists induce a positive and sustained change in the prescribing practice and are increasingly recognized as an important part of the healthcare team [17]. Including clinical pharmacists in general medicine teams reduce the total volume of ASM used in the hospital and the number of inappropriate ASM prescriptions significantly [8]. This approach is also in-line with recently published recommendations by Heidelbaugh et al. [20]. Pharmacy-driven step-down orders combined with proper medication reviews ensure proper and cost-effective usage of PPI [20]. Moreover, clinical pharmacists are found to be more effective through face to face interventions (which is the case in our hospital with the clinical pharmacist participating in the multidisciplinary rounds) when compared to a written recommendation in the patient's medical record [21]. Clinical pharmacists also improve the medication adherence and outcomes, improve the prescribing

Table 6 ASM usage for non approved/unjustified indications in 2007 audit (Audit 1) and 2009 audit (Audit 2)

Reason for ASM usage	Audit 1			Audit 2		
	Inpatient $n = 136$	Discharge $n = 70$	OP clinic $n = 30$	Inpatient $n = 67$	Discharge $n = 26$	OP clinic $n = 10$
Abdominal pain (non-specific)	9	5	2	13	3	0
Prophylaxis of NSAID and aspirin induced ulcer (low risk)	29	19	9	7	4	1
Acute pancreatitis	6	4	1	7	2	0
Systematic steroid therapy	3	1	1	5	2	2
Warfarin therapy	3	0	0	5	2	2
Vomiting	17	6	3	4	2	1
Stress ulcer prophylaxis (low risk)	12	7	3	9	4	0
Step-down from ICU	19	8	2	3	0	0
Renal disease (without GI symptoms)	11	6	4	2	0	0
Esophageal candidiasis	0	0	0	2	0	0
Lower GI bleeding	7	4	2	1	0	0
Gastroenteritis	6	5	2	1	1	0
Crohn's disease	1	1	0	1	1	1
Alcohol intoxication	5	1	1	0	0	0
Others[a]	4	1	0	0	0	0
No reason found	4	2	0	7	5	3

[a] Others: maintenance of peptic ulcer disease despite treatment for *H. pylori*, acute cholecystitis

ASM Acid suppressive medication, *GI* Gastrointestinal, *ICU* Intensive care unit, *NSAID* Non-steroidal anti inflammatory drug, *OP* Outpatient

Table 7 Overall comparison in ASM usage between 2007 audit (Audit 1) and 2009 audit (Audit 2)

Characteristics	Audit 1 *n* (%)	Audit 2 *n* (%)	Change (%)[a]	95% CI	*P* value
Total number of patient admissions	389	414			
Patients receiving ASM & included in the study[b]	206 (100)	208 (100)			
Patient already on ASM upon admission	48 (23)	74 (36)	+57	−0.21 to −0.04	0.0062
Started ASM in hospital	170 (83)	134 (64)	−23	0.09 to 0.26	<0.0001
Non indicated and unjustified usage	136 (66)	67 (32)	−51	0.25 to 0.43	<0.0001
ASM prescribed at discharge	140 (68)	134 (64)	−6	−0.06 to 0.13	0.4468
Non indicated and unjustified usage	70 (34)	26 (13)	−62	0.15 to 0.3	<0.0001
ASM in the outpatient clinic	87 (42)	58 (28)	−33	0.05 to 0.23	0.0022
Non indicated and unjustified re-prescribing	30 (15)	10 (5)	−67	0.04 to 0.15	0.0008
Acid suppressive medication group				−0.09 to 0.01	0.1539
Proton pump inhibitors usage	184 (89)	194 (93)	+5		
Histamine 2 receptor antagonists usage	22 (11)	14 (7)	−36		
Estimated cost for non indicated and unjustified ASM usage at discharge and follow up visit	€1,753	€712	−59		

[a] Percentage change is calculated using following formula: percentage of Audit 2 (1 year after multi-approach strategy) minus percentage of Audit 1 (baseline) divided by the percentage of Audit 1

[b] The total number of patients receiving any ASM in Audit 1 and Audit 2 is defined as 100% for subsequent calculations

ASM acid suppressive medication

practices and patient satisfaction, decrease physician office visits, and are cost-effective [22]. In general, clinical pharmacists add value to healthcare teams and result in an improved patient safety [8].

In our setting, probably typical for a teaching hospital, the turnover of interns and medical residents is high. The clinical pharmacist on the medical team can ensure proper education of the new medical staff. Regal et al. came to a

similar conclusion when auditing the ASM usage in an American university hospital; providing educational lectures for the interns was found to be helpful in reducing the inappropriate use of ASM, but the benefit was increased when a clinical pharmacist was a member of the team [8]. Moreover, educational sessions about the proper use of ASM may lead to substantial reduction in healthcare costs without impairment of patients' outcome [3].

Other interventions have been described with variable rates of success. Letters with results of audits combined with written recommendations proved having little impact on the proper usage of ASM [9, 23]. Educational outreach visits (being personal visits by a trained person to healthcare professionals in their own setting) showed some promise [24] while educational sessions by opinion leaders has resulted in mixed effects on the prescribing habits of healthcare professionals [25].

Limitations of our study include the fact that the audit was performed in medical inpatients only. So far no data have been retrieved from other adult disciplines neither from pediatric patients. Surgical patients, cardiology patients and patients transferred from intensive care units to chronic care wards are likely to be over consumers of ASM. Because of the shortage of staff, there are currently no clinical pharmacists rounding with surgical and chronic care teams in our institution. Hopefully, this will be addressed in the near future.

Secondly, we did not evaluate the possible impact of each of the individual strategies in our institution. Based on published data, we believe that a multi-approach strategy provides a better chance for success. Moreover, this prospective study design does not allow to exclude the influence of possible other confounding factors.

Thirdly, we could not really clarify why more patients were using ASM upon admission in the second audit compared to the first audit 2 years earlier. The fact more patients were using ASM for approved and justified indications proofed however the success of the multi-approach strategy.

Conclusion

The introduction of a multi-approach strategy for the usage of ASM in medical inpatients in our institution resulted in a reduction in the inappropriate usage of ASM with more than 50%. Combining different strategies namely; "audit and feedback", issuing guidelines endorsed by the departmental leadership and continuous awareness guaranteed by the participation of clinical pharmacists during multidisciplinary rounds resulted in a drastic improvement in the proper usage of ASM. The usage of ASM in approved and justified indications improved upon admission, during the patient's hospital stay, upon discharge and at the follow up visit in the outpatient clinic.

Finally this multi-approach strategy also resulted in avoiding potential adverse drug events, drug interactions and unnecessary cost.

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Conflicts of interest The authors have no conflicts of interest to declare.

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