MA@PoC

Medicine Access @ Point of Care
2021, Volume 5: 1–8

DOI: 10.1177/23992026211062729
journals.sagepub.com/home/map
SAGE

# Assessment of proton-pump inhibitor use at a tertiary teaching hospital in Nigeria

**Roland Nnaemeka Okoro[1], Kasim Abdullahi[1] and Dauda Ayuba Dayar[2]**

## Abstract

**Background:** Proton-pump inhibitor (PPI) is a widely used medication class globally. Because of its good safety profile, there is a huge likelihood of inappropriate use.

**Objectives:** To determine the prevalence of PPI use and indications, describe its pattern of usage, and identify factors associated with inappropriate prescriptions at a federal tertiary teaching hospital in Maiduguri, Nigeria.

**Methods:** PPI prescriptions were retrospectively assessed in the General Outpatients' Department (GOPD) and Gastroenterology Unit (GITU) of a teaching hospital. Relevant data for the study were extracted from the patients' medical records. Chi-square or Fisher's exact tests where appropriate were used to identify factors associated with inappropriate PPI prescriptions. A $p < 0.05$ was considered to be significant.

**Results:** PPIs were prescribed to 73.3% (220/300) of patients, while inappropriate prescriptions were noted in 91.4% (201/220) of these patients. Epigastric pain (49.5%) was the most common PPI indication, while omeprazole was the highest prescribed (53.4%). Nearly all inpatients (98.2%), those with epigastric pain (95.7%), and patients who were prescribed intravenous PPIs had more inappropriate PPI prescriptions compared to others.

**Conclusion:** This study revealed a high prevalence of PPI use and inappropriate prescriptions at the study hospital. As a result, these findings highlight the importance PPI-based stewardship program at the study hospital.

## Keywords

Gastric acid–related diseases, guideline-recommended, inappropriate prescription, Nigeria, proton-pump inhibitor

Date received: 29 July 2021; accepted: 10 November 2021

## Introduction

Proton-pump inhibitor (PPI) is a class of medication that significantly reduces stomach acid output. It works by binding irreversibly to the parietal cell's H+/K+-ATPase pump, which inhibits acid generation in most of the active pumps.[1] It is the most effective class of medication for treating both common and serious upper gastrointestinal problems. For example, peptic ulcer disease (PUD), esophagitis, epigastric pain, dyspepsia, and gastroesophageal reflux disease (GERD) can all be treated with PPI.[2–4] It is also a significant component of the *Helicobacter pylori* eradication regimen,[5] and can also be used to prevent upper gastrointestinal harm caused by non-steroidal anti-inflammatory drugs (NSAIDs).[6] For most of these conditions, it is only meant to be used for a limited period of time and is rarely needed for more than 4–8 weeks.

[1]Department of Clinical Pharmacy and Pharmacy Administration, Faculty of Pharmacy, University of Maiduguri, Maiduguri, Nigeria
[2]Gastroenterology Unit, Department of Internal Medicine, University of Maiduguri Teaching Hospital, Maiduguri, Nigeria

**Corresponding author:**
Roland Nnaemeka Okoro, Department of Clinical Pharmacy and Pharmacy Administration, Faculty of Pharmacy, University of Maiduguri, Maiduguri 600230, Nigeria.
Email: orolandn@gmail.com

It is noteworthy that PPI has a strong safety track record,[7] thus, they are routinely prescribed and used worldwide. Although emerging concerns regarding its long-term adverse effects call for greater caution when prescribing and using this medication class. The adverse effects of PPI therapy include increased risk of *Clostridium difficile*–associated diarrhea,[8] *Campylobacter-*, *Salmonella-*, and *Shigella-associated enteric infections*,[9] and fracture,[10] deficiencies in iron, and vitamin $B_{12}$ absorption.[11,12] Others are hypomagnesemia,[13] acute interstitial nephritis,[14] chronic kidney disease,[15] sub-acute cutaneous lupus erythematosus,[16] and myocardial infarction.[17]

Despite the growing concerns about these adverse effects, PPI is often reported to be misused in several studies around the world.[18–47] In addition, suspected upper gastrointestinal hemorrhage—receiving care at the surgery units, non-emergency room physicians, non-intensive care unit (ICU) admission,[46] and the number of medications[40]—have been reported as significant factors associated with inappropriate PPI prescriptions.

There is an existence of vast international studies on PPI utilization, although, to the best of our knowledge, no such studies have been conducted in Africa, hence the need for this study. The aims of the study were to determine the prevalence of PPI use and indications, describe its pattern of usage, and identify factors associated with inappropriate prescriptions at a federal tertiary teaching hospital in Maiduguri, Nigeria. The findings of this study could assist in the formulation of policy to promote appropriate use of PPI in Nigeria.

## Methods

### Study design and setting

A retrospective, cross-sectional study was carried out in the General Outpatients' Department (GOPD) and Gastroenterology Unit (GITU) of a tertiary teaching hospital in Maiduguri, Nigeria.

### Inclusion and exclusion criteria

The study included patients aged 18 years and over who received care at the GOPD and GITU of the study hospital from 1 January to 31 December 2019. Conversely, patients who were less than 18 years and those who received care outside the GOPD and GITU of the study hospital during the year under review were excluded from the study.

### Sample size calculation

The sample size for the study was calculated based on the formula developed by Yamane[48] using a population size of 1000 ($N$) and a margin of error of 0.05 ($e$). Thus, the minimum sample size required for the study was 286 patients.

### Ethical considerations

The Health Research and Ethics Committee of the study hospital granted approval (UMTH/REC/21/716) prior to data collection. Obtaining written informed consent from the patients whose medical records were selected and reviewed was waived by the Health Research and Ethics Committee of the study hospital. The confidentiality of patients' information was maintained throughout the study duration.

### Sampling

Systematic random sampling with sampling intervals of six and three were utilized to select patients' medical records in the GOPD and GITU, respectively.

### Data collection

Data collection lasted for 4 months (1 March to 30 June 2021). Data extracted from the patients' medical records included patients' socio-demographics, chronic diseases, PPI information (indications, route of administration, name, dose, frequency, and duration), and the number of medications per prescription.

### Determination of appropriateness of PPI prescription

The latest Nigeria Standard Treatment Guidelines (NSTG)[49] and the Essential Medicine Index (EMDEX)[50] were used to assess for PPI prescriptions appropriateness. Prescriptions that fell short of guideline recommendations (Appendix 1) were considered inappropriate.

### Data analysis

All data were initially entered into Microsoft Excel Spread Sheet 2010, cleaned, coded, and transferred into SPSS for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA) for analysis. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as mean values ± standard deviation (SD). Chi-square or Fischer's exact tests where appropriate were used to compare groups for categorical variables. A $p < 0.05$ was considered statistically significant.

## Results

### Socio-demographic and medical characteristics of the study population

Three hundred patients who received care at the GOPD and GITU of the study hospital were included in the study. The average age of the study population was 36.7 ± 13.8 years. The majority of the patients were females (64.4%), while

**Table 1.** The socio-demographic and medical characteristics of the study population ($N = 300$).

| Variable | *n* (%) |
|---|---|
| *Sex* | |
| Female | 193 (64.4) |
| Male | 107 (35.7) |
| *Age group (years)* | |
| 18–29 | 106 (35.3) |
| 30–41 | 102 (44.0) |
| 42–53 | 54 (18.0) |
| 54–65 | 29 (9.7) |
| >65 | 9 (3.0) |
| *Marital status* | |
| Single | 91 (30.3) |
| Married | 204 (68.0) |
| Unreported | 5 (1.7) |
| *Religion* | |
| Islam | 272 (90.7) |
| Christianity | 28 (9.3) |
| *Chronic disease* | |
| None | 279 (93.0) |
| Hypertension | 17 (5.7) |
| Arthritis | 2 (0.7) |
| Chronic kidney disease | 2 (0.7) |

most of these patients were between the ages of 30 and 41 years. In addition, married patients (68.0%) and those of the Islamic faith (90.7%) constituted most of the study population, whereas the majority had no chronic diseases (93.0%) as presented in Table 1.

## *The overall prevalence of PPI use and indications in the study population*

Overall, 80 (26.7%) patients did not use PPI, while 220 (73.3%) patients used PPI at different time points during the study period. The analysis of cases requiring PPI prescriptions revealed a total of 279 indications. Note this number is higher than 220 because some patients visited the hospital more than once during the year under review on account of gastric acid–related disorders. However, the analysis of individual indications showed that epigastric pain ranked first with 49.5% (138/279) followed by dyspepsia with 30.5% (85/279). Others were PUD (19.0%, 53/279), gastritis (0.7%, 2/279), and GERD (0.4%, 1/279).

## *The prescription patterns of PPI during the study period*

Of the 1422 medications prescribed with an average of $3.94 \pm 1.76$ medications per patient at the study setting during the study period, 279 were PPIs with omeprazole ranking highest (53.4%) followed by rabeprazole (41.6%) as shown in Figure 1.

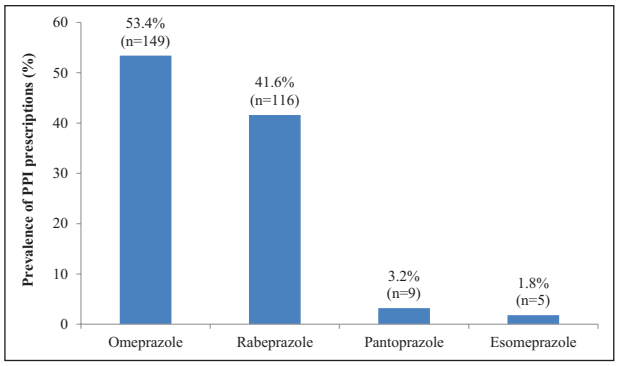


**Figure 1.** Prescription patterns of PPI during the study period ($N = 279$).

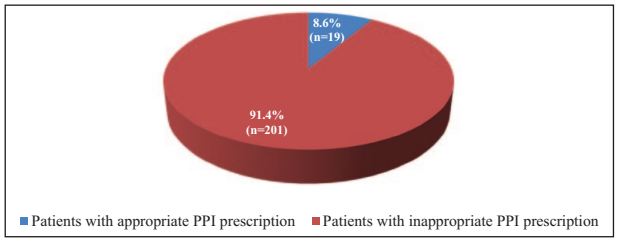


**Figure 2.** The proportion of patients prescribed PPI appropriately and inappropriately during the study period ($N = 220$).

## *The overall analysis of patients who received inappropriate PPI prescriptions during the study period*

Overall, an overwhelming proportion (91.4%) of the patients were prescribed PPI inappropriately ($\chi^2 = 15.06$, $p < 0.001$) during the study period as shown in Figure 2.

## *The description of inappropriate PPI prescriptions during the study period*

All patients who were prescribed PPI had its guideline-recommended indications. Nevertheless, 341 inappropriate PPI prescriptions were noted during the study period. Of these 52.1% were shorter duration, and 33.3% were higher frequency than the respective guidelines-recommendations as shown in Figure 3.

## *Comparison of appropriate and inappropriate PPI prescriptions based on the socio-demographic and medical/medication characteristics*

On the analysis of the patient population who received PPI based on socio-demographic and medical/medication characteristics, statistical difference was found when patients who received PPI appropriately were compared to those who did not according to patients' status when PPI

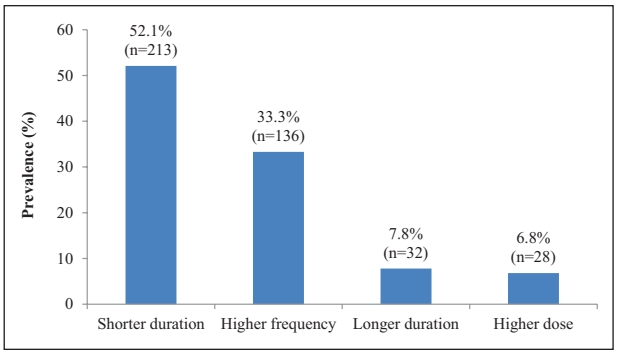


**Figure 3.** The distribution of inappropriate PPI prescriptions identified during the study period ($N = 341$).
Note: Some PPI prescriptions had more than one problem.

was initiated, indication, and route of administration. Significant proportions of inpatients, those who had epigastric pain, and those who received intravenous (IV) PPI had more inappropriate PPI prescriptions compared to their counterparts (Table 2).

## Discussion

To the best of our knowledge, this is the first study of African origin to assess PPI use. Therefore, this study adds to the knowledge of the subject in Africa. Second, the inclusion of both outpatients and inpatients data makes this study unique and outstanding. This study revealed that the majority of patients who received care at the GOPD and GITU of the study hospital were prescribed PPI and most of these prescriptions were found to be inappropriate. Epigastric pain was noted as the main indication for PPI prescriptions, while omeprazole was the most common PPI prescribed during the study period. The analysis of the potential factors associated with inappropriate PPI prescriptions among the study population revealed inpatient, epigastric pain, and IV PPI as significant.

The high prevalence of PPI use noted in the present study demonstrates that PPI is among the most commonly used medication class in the study settings. This finding calls for caution to ensure both appropriate prescribing and use. This is important because overuse of PPI could cause adverse effects, such as increased COVID-19 severity and mortality,[51] *C. difficile* infections,[8] and adverse renal outcomes.[13–15] Our result is comparable to 60% (33/55) found in a retrospective study of hospitalized patients in Ireland.[31] Conversely, our result is inconsistent with 30.6% (232/758) prevalence reported by a prospective study of hospitalized older patients in Greece,[40] and 33% (270/818) noted in a prospective observational study of hospitalized older patients in France.[28] In addition, a prevalence rate of 43% (130/300) was found in a previous study of hospitalized patients in the Netherlands,[27] whereas a retrospective analysis of inpatients records in Singapore showed a prevalence of 46.5% (477/1025).[37] In Switzerland, a review of electronic medical records of adult patients revealed a little above average prevalence of 53.9% (97/180).[41] The plausible reasons for the observed differences between our findings and that of these previous studies could be due to differences in gastric acid–related disorder burden, physicians prescribing culture across countries, and variations in the study populations.

The analysis of the reasons for PPI use in our study population showed that epigastric pains and dyspepsia prevailed over others. This finding differed from that of some previous studies that found GERD and prophylaxis of anti-platelet/NSAIDs in Italy,[19] and the prevention of medication-associated complications in the Netherlands.[27] A similar French study reported GERD and dyspepsia as the leading PPI indications,[28] whereas studies conducted in the United States (US) and Australia also reported GERD as the most common indication for PPI use.[34,42] Also, similar studies conducted in Canada reported gastrointestinal condition and GERD,[21] and receipt of anti-platelet/anticoagulant therapy or NSAIDs combined with two other established risk factors for upper gastrointestinal hemorrhage.[52] The discrepancies observed between the results of these studies and our study could be due to differences in diets and acid-related disease burden across continents.

In the present study, the investigation of the prescribing patterns of PPI showed that omeprazole was the highest prescribed. The cost-effectiveness of omeprazole compared to other PPIs may account for its highest utilization in our study population. This is because the majority of the population in low- and middle-income countries, including Nigeria is poor and the purchase of medications is mainly out-of-pocket due to an abysmal low coverage of health insurance.[53] Nevertheless, our finding is congruent with that of a US retrospective study that showed that most patients were also prescribed omeprazole.[34] A similar study conducted in Shanghai, China also reported omeprazole as the most frequently prescribed PPI.[39] In addition, a 4-year US retrospective review of the medical records and pharmacy prescription database also reported omeprazole as the highest-ranked PPI in 2007 and 2008.[33] In contrast, the same US study reported that pantoprazole ranked highest in 2005 and 2006,[33] while esomeprazole was reported in Ireland and Switzerland as the most frequently prescribed PPI.[32,41] Differences in the drug formularies and physicians' prescribing habits could be responsible for these variations in prescription patterns across countries.

The analysis of the present study data for appropriateness of PPI therapy revealed that an overwhelming proportion of patients (91.4%) received inappropriate PPI prescriptions during the study period. This finding is comparable to 60.0% in 162 older patients, 63.0% in 172 hospitalized adult patients, 63.6% in 302 older patients, 70.0% in 55 hospitalized patients, and 80.0% in 58 patients in

**Table 2.** Factors associated with inappropriate PPI prescriptions ($N = 279$).

| Variable | Inappropriate prescription | | $\chi^2$ or $f$ | $p$-value |
|---|---|---|---|---|
| | No | Yes | | |
| | *n* (%) | *n* (%) | | |
| *Sex* | | | | |
| Female | 20 (10.6) | 169 (89.4) | 1.106 | 0.293 |
| Male | 6 (6.7) | 84 (93.3) | | |
| *Age group (years)* | | | | |
| 18–29 | 11 (12.5) | 77 (87.5) | 2.237 | 0.684[f] |
| 30–41 | 6 (6.6) | 85 (93.4) | | |
| 42–53 | 6 (10.4) | 52 (89.6) | | |
| 54–65 | 2 (6.5) | 29 (93.5) | | |
| >65 | 1 (9.1) | 10 (90.9) | | |
| *Initiation of PPI* | | | | |
| During ambulatory care | 25 (11.2) | 198 (88.8) | 4.705 | 0.036*[f] |
| During hospitalization | 1 (1.8) | 55 (98.2) | | |
| *Indication* | | | | |
| Epigastric pain | 6 (4.3) | 132 (95.7) | 16.721 | 0.001*[f] |
| Dyspepsia | 7 (8.2) | 78 (91.8) | | |
| Peptic ulcer disease | 13 (24.5) | 40 (75.5) | | |
| Gastritis | 0 (0.0) | 2 (100.0) | | |
| Gastro esophageal disease | 0 (0.0) | 1 (100.0) | | |
| *PPI* | | | | |
| Omeprazole | 18 (12.1) | 131 (87.9) | 3.124 | 0.305[f] |
| Rabeprazole | 7 (6.0) | 109 (94.0) | | |
| Pantoprazole | 1 (11.1) | 8 (88.9) | | |
| Esomeprazole | 0 (0.0) | 5 (100.0) | | |
| *PPI administration route* | | | | |
| Intravenous | 0 (0.0) | 43 (100.0) | 5.224 | 0.019*[f] |
| Per oral | 26 (11.0) | 210 (89.0) | | |
| *Number of medications/prescriptions* | | | | |
| <5 | 18 (9.7) | 168 (90.3) | 0.085 | 0.771 |
| ⩾5 | 8 (8.6) | 85 (91.4) | | |

PPI: proton-pump inhibitor.
$\chi^2$: chi-Square test; *f*: Fisher's exact test.
*Significant at 0.05.

France,[28] the United Arab Emirates (UAE),[35] Spain,[20] and Ireland,[31,32] respectively. In Northern Cyprus, PPI (67.0%) was found as the most common inappropriate medication class prescribed.[47] A similar US study reported that 695/876 (79.0%) patients in 2005, 627/763 (82.0%) patients in 2006, 441/562 (78.0%) patients in 2007, and 397/485 (82.0%) patients in 2008, respectively received PPI inappropriately.[33] In Greece, an inappropriate PPI use prevalence of 84.0% (195/232 patients) was found.[40] In addition, another US study revealed a much higher prevalence rate of inappropriate PPI use of 90.5% (180/199 patients).[34] These findings demonstrate that widespread use of PPI is associated with a high prevalence of inappropriate use in several countries.[54,55] These findings underscore the need for country-specific educational interventions for prescribers as well as the general population to safeguard global health. In contrast, a much lower prevalence rate of 16% in 153 hospitalized adult patients was reported in Malaysia,[36] whereas a prevalence of 43.2% (206/477 inpatients) was noted in Singapore.[37] In the United Kingdom (UK), audits of medical inpatients revealed inappropriate PPI prescribing rates of 40.7%–54.0%.[29,30] In Canada, inappropriate PPI prescriptions were found in 30.7% (267/871) and 46% (70/152) of patients, respectively,[21,52] whereas another Canadian study reported a higher prevalence of inappropriate PPI prescriptions of 50% (13,589/25,850).[39] Differences in countries' PPI prescription policies and methods of assessing the prevalence of inappropriate PPI use could account for the different results got from these studies conducted in various countries.

The present study showed that all patients who were prescribed PPI had its guidelines-recommended indications. Nevertheless, the most frequent inappropriate PPI

prescription identified in this study was shorter than the guideline-recommended duration. Conversely, the most common cause of inappropriate PPI prescription reported in the UK,[29,30] Ireland,[32] the US,[34] Italy,[18] Jordan,[38] the Netherlands,[27] and France[28] was no clear indication for PPI prescription, whereas dose higher than the guideline-recommended dose was reported in the Netherlands[26] and untreated guideline-recommended indication was reported by other studies conducted in the Netherlands[25] and Greece.[40]

Furthermore, the analysis of factors that were associated with inappropriate PPI prescription in this study population revealed that a higher proportion of inpatients, those who had epigastric pain, and those that received IV PPI had more inappropriate prescriptions with significant differences. This result could be due to the majority of the inpatients and cases of epigastric pain being treated at a shorter than guideline-recommended duration. It is surprising that many inpatients included in this study did not continue their PPI medications with oral preparation after receiving the IV form. Despite hospitalization presenting a unique opportunity to address issues of inappropriate medication use, inappropriate PPI use observed during patients' hospitalization continued on discharge even in the presence of guideline-recommended indications. These findings highlight the need for hospital ward-based pharmacists and frequent educational interventions among physicians attending to inpatients with gastric acid–related diseases at the study hospital to ensure appropriate prescriptions. In contrast, other similar studies identified the number of medications, suspected upper gastrointestinal hemorrhage, receiving care at the surgery units, non-emergency room physicians, and non-ICU admission as significant factors associated with inappropriate PPI prescriptions.[40,46] Variations in the study settings and populations could be responsible for the observed disparities.

### *Limitation*

The main limitation of this study was that the study was conducted in two units of a teaching hospital, therefore, our results might not be generalizable to other units of the study hospital, as well as other categories of hospitals, such as primary, secondary, non-teaching tertiary, and private hospitals. Another limitation was the retrospective design which may not reflect the current use of PPI at the study hospital.

## Conclusion

This study found both a high prevalence of PPI use and inappropriate prescriptions in the study settings. The most frequent indication for PPI use was epigastric pain, while omeprazole was the highest utilized PPI. The significant factors associated with inappropriate PPI prescriptions were inpatients, epigastric pain, and IV PPI prescriptions. Thus, there is a need for the institution of a PPI-based stewardship program at the study hospital. Consequently, the clinical services of ward-based pharmacists are critical for its successful implementation. In addition, pharmacist-led educational interventions focusing on the identified significant factors of PPI misuse are also paramount to ensure appropriate prescriptions, thereby improving the quality of patient care at the study hospital.

### Author contributions

R.N.O. has full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Acquisition of data was done by K.A. Interpretation of the data was performed by D.A.D. Supervision was performed by R.N.O. and D.A.D. Drafting of the manuscript was performed by R.N.O. Study concept, design, and critical revision of the manuscript for important intellectual content were performed by all authors. All authors read and approved the final manuscript.

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

### Availability of data and materials

The data set generated and/or analyzed during this study is available from the corresponding author upon reasonable request.

### ORCID iD

Roland Nnaemeka Okoro https://orcid.org/0000-0002-6391-5000

### References

1. Lew EA. Review article: pharmacokinetic concerns in the selection of anti-ulcer therapy. *Aliment Pharmacol Ther* 1999; 13(suppl. 5): 11–16.
2. Dworzynski K, Pollit V, Kelsey A, et al. Management of acute upper gastrointestinal bleeding: summary of NICE guidance. *BMJ* 2012; 344: e3412.
3. Ford AC and Moayyedi P. Dyspepsia. *BMJ* 2013; 347: f5059.
4. Schellack N, Schellack G, Van der Sandt N, et al. Gastric pain. *S Afr Fam Pract* 2015; 57: 13–19.
5. Graham DY and Fischbach L. *Helicobacter pylori* treatment in the era of increasing antibiotic resistance. *Gut* 2010; 59(8): 1143–1153.
6. Laine L. GI risk and risk factors of NSAIDs. *J Cardiovasc Pharmacol* 2006; 47(suppl. 1): S60–S66.
7. Forgacs I and Loganayagam A. Overprescribing proton pump inhibitors. *BMJ* 2008; 336: 2–3.
8. Janarthanan S, Ditah I, Adler DG, et al. Clostridium difficile-associated diarrhea and proton pump inhibitor

therapy: a meta-analysis. *Am J Gastroenterol* 2012; 107(7): 1001–1010.
9. Leonard J, Marshall JK and Moayyedi P. Systematic review of the risk of enteric infection in patients taking acid suppression. *Am J Gastroenterol* 2007; 102(9): 2047–2056; quiz 2057.
10. Khalili H, Huang ES, Jacobson BC, et al. Use of proton pump inhibitors and risk of hip fracture in relation to dietary and lifestyle factors: a prospective cohort study. *BMJ* 2012; 344: e372.
11. McColl KE. Effect of proton pump inhibitors on vitamins and iron. *Am J Gastroenterol* 2009; 104(suppl. 2): S5–S9.
12. Lam JR, Schneider JL, Zhao W, et al. Proton pump inhibitor and histamine 2 receptor antagonist use and vitamin B12 deficiency. *JAMA* 2013; 310: 2435–2442.
13. Hess MW, Hoenderop JG, Bindels RJ, et al. Systematic review: hypomagnesaemia induced by proton pump inhibition. *Aliment Pharmacol Ther* 2012; 36(5): 405–413.
14. Blank ML, Parkin L, Paul C, et al. A nationwide nested case-control study indicates an increased risk of acute interstitial nephritis with proton pump inhibitor use. *Kidney Int* 2014; 86(4): 837–844.
15. Xie Y, Bowe B, Li T, et al. Proton pump inhibitors and risk of incident CKD and progression to ESRD. *J Am Soc Nephrol* 2016; 27(10): 3153–3163.
16. Sandholdt LH, Laurinaviciene R and Bygum A. Proton pump inhibitor-induced subacute cutaneous lupus erythematosus. *Br J Dermatol* 2014; 170: 342–351.
17. Shah NH, LePendu P, Bauer-Mehren A, et al. Proton pump inhibitor usage and the risk of myocardial infarction in the general population. *PLoS One* 2015; 10(6): e0124653.
18. Schepisi R, Fusco S, Sganga F, et al. Inappropriate use of proton pump inhibitors in elderly patients discharged from acute care hospitals. *J Nutr Health Aging* 2016; 20(6): 665–670.
19. Giannini EG, Crespi M, Djahandideh A, et al. Appropriateness of proton pump inhibitors treatment in clinical practice: prospective evaluation in outpatients and perspective assessment of drug optimisation. *Dig Liver Dis* 2020; 52: 862–868.
20. Mares-García E, Palazón-Bru A, Martínez-Martín Á, et al. Non-guideline-recommended prescribing of proton pump inhibitors in the general population. *Curr Med Res Opin* 2017; 33(10): 1725–1729.
21. Nguyen PV and Tamaz R. Inappropriate prescription of proton pump inhibitors in a community setting. *Can J Hosp Pharm* 2018; 71(4): 267–271.
22. Fawzi N, Varley O, Mulroy M, et al. De-prescribing the proton pump inhibitors—stopping the epidemic. *Age Ageing* 2019; 48: i1–i15.
23. Haastrup PF, Rasmussen S, Hansen JM, et al. General practice variation when initiating long-term prescribing of proton pump inhibitors: a nationwide cohort study. *BMC Fam Pract* 2016; 17: 57.
24. Haastrup PF, Paulsen MS, Christensen RD, et al. Medical and non-medical predictors of initiating long-term use of proton pump inhibitors: a nationwide cohort study of first-time users during a 10-year period. *Aliment Pharmacol Ther* 2016; 44: 78–87.
25. Van den Bemt PM, Chaaouit N, Van Lieshout EM, et al. Noncompliance with guidelines on proton pump inhibitor prescription as gastroprotection in hospitalized surgical patients who are prescribed NSAIDs. *Eur J Gastroenterol Hepatol* 2016; 28(8): 857–862.
26. Van Vliet EPM, Otten HJAM, Hoogsteden HC, et al. Inappropriate prescription of proton pump inhibitors in a hospital setting. *Eur J Gastroenterol Hepatol* 2006; 18: A54.
27. Van Vliet EPM, Otten HJAM, Rudolphus A, et al. Inappropriate prescription of proton pump inhibitors on two pulmonary medicine wards. *Eur J Gastroenterol Hepatol* 2008; 20(7): 608–612.
28. Dipanda M, Pioro L, Buttard M, et al. Evaluation of the prescription of proton pump inhibitors in persons aged 75 years and older in a geriatric acute-care unit. *Therapie* 2017; 72(6): 669–675.
29. Batuwitage BT, Kingham JG, Morgan NE, et al. Inappropriate prescribing of proton pump inhibitors in primary care. *Postgrad Med J* 2007; 83: 66–68.
30. Jarchow-Macdonald AA and Mangoni AA. Prescribing patterns of proton pump inhibitors in older hospitalized patients in a Scottish health board. *Geriatr Gerontol Int* 2013; 13(4): 1002–1009.
31. Molloy D, Molloy A, O'Loughlin C, et al. Inappropriate use of proton pump inhibitors. *Ir J Med Sci* 2010; 179: 73–75.
32. O'Mahony L and Yelverton E. Prescribing of proton pump inhibitors in an Irish general practice. *Ir Med J* 2019; 112: 932.
33. Leri F, Ayzenberg M, Voyce SJ, et al. Four-year trends of inappropriate proton pump inhibitor use after hospital discharge. *South Med J* 2013; 106(4): 270–273.
34. Dangler M, Ochs L and White R. Assessing the appropriate use of proton pump inhibitors in a veteran outpatient population. *Fed Pract* 2013; 30: 21–25.
35. Damji SS. Evaluation of the prescription pattern of proton pump inhibitors and the associated adverse drug reactions in the medicine unit of a secondary care hospital, Ras-al-Khaimah (RAK), United Arab Emirates (UAE). *J Gastrointest Dig Syst* 2017; 7(7 suppl.): 68.
36. Elnaem MH, Mohamed MH, Nazar AH, et al. Evaluation of proton pump inhibitors prescribing among non-critically ill hospitalized patients in a Malaysian Tertiary Hospital. *J Appl Pharm Sci* 2017; 7: 77–83.
37. Chia CTW, Lim WP and Vu CKF. Inappropriate use of proton pump inhibitors in a local setting. *Singapore Med J* 2014; 55(7): 363–366.
38. Zalloum N, Farha RA, Awwad O, et al. Inappropriate prescribing of proton pump inhibitors among patients in two Jordanian tertiary health facilities. *Trop J Pharm Res* 2016; 15: 2489–2495.
39. Liu Y, Zhu X, Li R, et al. Proton pump inhibitor utilisation and potentially inappropriate prescribing analysis: insights from a single-centred retrospective study. *BMJ Open* 2020; 10: e040473.
40. Voukelatou P, Vrettos I, Emmanouilidou G, et al. Predictors of inappropriate proton pump inhibitors use in elderly patients. *Curr Gerontol Geriatr Res* 2019; 2019: 7591045.
41. Lenoir C, El Biali M, Luthy C, et al. Snapshot of proton pump inhibitors prescriptions in a tertiary care hospital in

Switzerland: less is more? *Int J Clin Pharm* 2019; 41(6): 1634–1641.
42. Family Medicine Research Centre, The University of Sydney. *SAND abstract number 241 from the BEACH program 2015–16: proton pump inhibitor use among general practice patients*. Sydney, NSW, Australia: Family Medicine Research Centre, The University of Sydney, 2016.
43. Naunton M, Peterson GM and Bleasel MD. Overuse of proton pump inhibitors. *J Clin Pharm Ther* 2000; 25: 333–340.
44. Hughes JD, Tanpurekul W, Keen NC, et al. Reducing the cost of proton pump inhibitors by adopting best practice. *Qual Prim Care* 2009; 17(1): 15–21.
45. Naunton M, Peterson GM, Deeks LS, et al. We have had a gutful: the need for deprescribing proton pump inhibitors. *J Clin Pharm Ther* 2018; 43(1): 65–72.
46. Bischoff LM, Faraco LSM, Machado LV, et al. Inappropriate usage of intravenous proton pump inhibitors and associated factors in a high complexity hospital in Brazil. *Arq Gastroenterol* 2021; 58(1): 32–38.
47. Khamis S, Abdi AM, Uzan A, et al. Applying Beers Criteria for elderly patients to assess rational drug use at a university hospital in Northern Cyprus. *J Pharm Bioallied Sci* 2019; 11(2): 133–141.
48. Yamane T. *Statistics: an introductory analysis*. 2nd ed. New York: Harper & Row, 1967.
49. Federal Ministry of Health. *Nigeria standard treatment guidelines*. 2nd ed. Abuja, Nigeria: Federal Ministry of Health, 2016, pp. 15–26.
50. Essential Medicine Index (EMDEX). *Drug information for Nigeria's healthcare professionals*. 2020–2021 ed. Lagos, Nigeria: Lindoz Products Ltd, 2020, pp. 156–166.
51. Hariyanto TI, Prasetya IB and Kurniawan A. Proton pump inhibitor use is associated with increased risk of severity and mortality from coronavirus disease 2019 (COVID-19) infection. *Dig Liver Dis* 2020; 52(12): 1410–1412.
52. McDonald EG, Jones J, Green L, et al. Reduction of inappropriate exit prescriptions for proton pump inhibitors: a before-after study using education paired with a web-based quality-improvement tool. *J Hosp Med* 2015; 10(5): 281–286.
53. Okoro RN. Cushioning the economic burden of chronic kidney disease for patients in LMICs: the heightened need for a government-driven financial support policy. *Health Policy Technol* 2021; 10: 100507.
54. Hollingworth S, Duncan EL and Martin JH. Marked increase in proton pump inhibitors use in Australia. *Pharmacoepidemiol Drug Saf* 2010; 19(10): 1019–1024.
55. Freedberg DE, Kim LS and Yang YX. The risks and benefits of long-term use of proton pump inhibitors: expert review and best practice advice from the American Gastroenterological Association. *Gastroenterology* 2017; 152(4): 706–715.

## Appendix 1

Recommended indications for PPI use and their dosage regimen.

| | Indications | Proton-pump inhibitor recommended dosage regimen | | | |
|---|---|---|---|---|---|
| | | Esomeprazole | Omeprazole | Pantoprazole | Rabeprazole |
| 1. | Gastroesophageal reflux disease (GERD) | 20 mg once daily × 4 weeks | 20 mg once daily × 4 weeks | 20–80 mg once daily × 4–8 weeks | 20 mg once daily 4–8 weeks |
| 2. | *H. pylori* eradication | 20 mg twice daily × 7 days (triple therapy regimen) | 20 mg twice daily × 7 days (triple therapy regimen) | 40 mg twice daily × 7 days (triple therapy regimen) | 20 mg twice daily × 7 days (triple therapy regimen) |
| 3. | Epigastric pain/ dyspepsia | 20 mg once daily × 4 weeks | 20 mg once daily × 4 weeks | 20–80 mg once daily × 4–8 weeks | 20 mg once daily × 4–8 weeks |
| 4. | Peptic ulcer disease | – | 20 mg once daily × 2–8 weeks | 40–80 mg once daily 2–8 weeks | 10–20 mg once daily × 4 weeks |
| 5. | Gastritis | – | 20 mg once daily as required | – | – |