Potential strategies to reduce inappropriate prescribing and dispensing of antimicrobials in Bangladesh building on the experiences in other developing countries

Mainul Haque[1], Brian Godman[2,3,4]*

In our previous editorial, we discussed that antimicrobial resistance (AMR) is a growing problem world-wide increasing morbidity, mortality and costs[1-3]. This needs to be urgently addressed with the World Bank recently documenting that the costs associated with AMR could exceed US$1 trillion annually after 2030, and potentially up to US$3.4 trillion annually, unless activities are instigated across countries to improve the prescribing and dispensing of antibiotics[4]. This is equivalent to 3.8% of annual Gross Domestic Product (GDP)[4], with the costs associated with AMR typically greatly exceeding the costs of any antibiotic prescribed or dispensed[5]. We are aware that mortality rates from AMR are likely to be greatest among low- and middle-income countries (LMICs), including Asian countries such as Bangladesh by 2050, which is a concern going forward[6,7]. This builds on considerable resistance already to commonly prescribed antibiotics among LMICs including Bangladesh, with AMR rates continuing to rise[2,8-15] enhanced by appreciable usage in animal and food production alongside humans[16-18]. In their recent study, Ara *et al.* (2021) found high rates of resistance to colistin as well as amoxicillin/ clavulanic acid and the cephalosporins in isolates of women attending out-patient clinics for urinary tract infections[9]. This needs to be urgently addressed.

Rising AMR rates in Bangladesh and other LMICs have been enhanced by considerable over-prescribing and dispensing of antibiotics for essentially viral infections such as acute respiratory tract infections (ARIs)[12,19-21]. This is important with up to 80% or more of patients in LMICs receiving antibiotics unnecessarily for ARIs[21-23]. This over-use of antibiotics has been exacerbated by the COVID-19 pandemic[24-26], with studies suggesting high rates of antibiotic utilisation, including broad spectrum antibiotics, even without proven bacterial infections[27-29]. Overall, less than 10% of COVID 19 patients appear to have concomitant fungal or bacterial infections necessitating antimicrobials[30], which could be as low as 3.2% in some studies[31,32]. Despite this, an appreciable number of patients with actual or suspected COVID-19 are prescribed or dispensed antibiotics, increasing shortages, costs and AMR[31,33-35].

High levels of inappropriate use of antibiotics in ambulatory care in Bangladesh and other LMICs mirrors concerns with their prescribing in hospitals including inappropriate timing of the first dose of antibiotics to prevent surgical site infections as well as extended use[1,36].

1. Unit of Pharmacology, Faculty of Medicine and Defence Health, Universiti Pertahanan Nasional Malaysia (National Defence University of Malaysia), Kem Perdana Sungai Besi, 57000 Kuala Lumpur, Malaysia.

2. Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow G4 0RE, United Kingdom.

3. Division of Public Health Pharmacy and Management, School of Pharmacy, Sefako Makgatho Health Sciences University, Pretoria, South Africa

4. School of Pharmaceutical Sciences, Universiti Sains Malaysia, Penang, Malaysia

Correspondence to: Brian Godman, Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow G4 0RE, United Kingdom. Email: Brian.Godman@strath.ac.uk. Telephone: +44 (0141) 5483825. Fax: +44 (0141) 552 2562

The concerns with inappropriate use of antimicrobials and the impact on AMR has resulted in many countries including Bangladesh launching their National Action Plans (NAPs) following guidance from the World Health Organisation[1,14,37,38]. Typically, the first steps in hospitals to reduce inappropriate prescribing of antibiotics include undertaking point prevalence studies to document current utilisation patterns and their rationale coupled with the instigation of antimicrobial stewardship groups[1,39-42]. Our previous editorial discusses such activities in more detail[1]. However, in this editorial we will just focus on ambulatory care especially among LMICs including Bangladesh.

Key stakeholders involved with improving antimicrobial usage in Bangladesh in ambulatory care include physicians, pharmacists/ drug store owners and patients[14,19,43]. Community pharmacies and drug stores are particularly important in countries such as Bangladesh with high patient co-payments, patients having difficulties with purchasing both medicines as well as paying for physician fees, stores open for longer hours than physician offices, and antimicrobials freely available over-the-counter despite legislation, similar to other LMICs including Pakistan [14,44-47].

We have seen among LMICs including Kenya, Namibia, the Republic of Srpska and Sri Lanka (Figure 1) that trained pharmacists, coupled with guideline availability, can appreciably reduce inappropriate dispensing of antibiotics especially for ARIs including patients with COVID 19[48-53]. This has important ramifications for countries such as Bangladesh, and it is encouraging to see that community pharmacists in Bangladesh, especially in rural areas, are a preferred and trusted source of information and medicines for managing infections[45]. This mirrors the situation in other countries with the growing involvement of pharmacies in the management of diseases including infectious diseases[54-56]. The development of the Model Pharmacy Programme should help alongside greater education regarding antibiotics and infectious diseases among pharmacy students in Bangladesh during their training given current concerns, although we have seen greater knowledge regarding antimicrobials among biological versus non-biological students in Bangladesh[43,44,57]. Concerns with pharmacists' knowledge regarding antibiotics and AMR in Bangladesh mirror those in other LMICs, necessitating greater input during undergraduate training as well as post qualification[44,53,58-60].

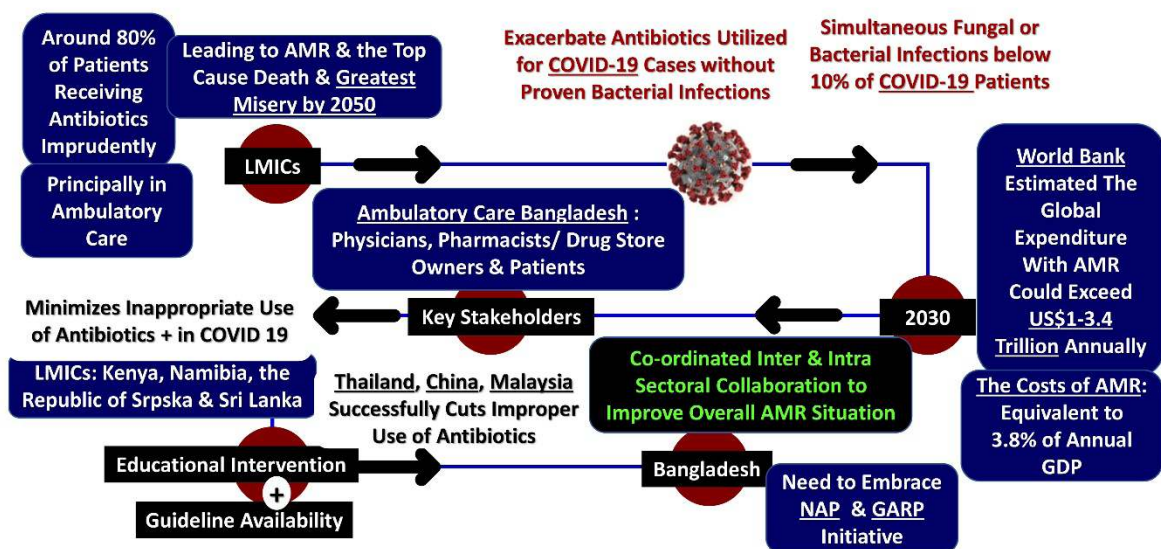A key way forward could also be to restrict the range of antibiotics that can be dispensed within

Figure 1 : Overview of activities to improve antibiotic utilisation in ambulatory care and the rationale

community pharmacies and drug stores based on the WHO AWaRe list of antibiotics, especially with concerns with rising resistance rates to critical antibiotics such as colistin[9,18,61,62], alongside improving pharmacists' knowledge. We have seen regulations in other LMICs restricting antimicrobials that can be dispensed by grade of pharmacy, which provide guidance to the authorities in Bangladesh [63]. This may be preferrable to fining pharmacists for dispensing antimicrobials without a prescription, which could be counter-productive especially in rural settings and slum areas where patients have limited incomes and cannot afford to take time off work to visit a physician[19,64,65]. This could be accompanied by the use of mobile and other technologies to track antimicrobial dispensing in pharmacies [65], especially if there are concerns with the extent of antibiotics being dispensed for essentially viral infections exacerbated by commercial pressures, which include those from pharmaceutical companies[44,66].

Concomitant with this, instigating targeted educational programmes among patients building on the experiences with COVID-19, which includes improving hygiene and the water supply as well as addressing the implications of misinformation[14,34,67].

We have also seen a number of activities among physicians in LMICs to reduce inappropriate prescribing of antibiotics especially for patients with ARIs (Figure 1). Boonyasiri *et al.* (2014) in Thailand ascertained that the instigation of multiple educational initiatives limited the prescribing of antibiotics to just 13% of patients with ARIs[68], and Wei *et al.* (2019)

in China also found that multiple interventions, especially surrounding education, resulted in a 49% reduction in the prescribing of antibiotics for ARIs after 6 months, with this reduction persisting[69]. More recently, Tay *et al.* (2019) in Malaysia also found that multiple interventions including toolkits appreciably reduced antibiotic prescribing for ARIs down from 29.1% of patients to 13.7%[70]. This follows similar activities and findings in higher-income countries[19], with such activities helping to reduce adverse influences from pharmaceutical companies[71].

In conclusion in Bangladesh, the first steps have been taken by the authorities to improve future antimicrobial use through the development and publication of their NAP as well as the Global Antibiotic Resistance Partnership (GARP) initiative. The next steps involve co-ordinated activities especially in ambulatory care to improve future prescribing and dispensing of antimicrobials along with similar activities in animal management and food production. Co-ordinated activities among physicians, pharmacists and patients have worked well in other countries to improve utilisation compared with countries with limited measures[72-75]. As a result, providing direction and guidance to key groups in Bangladesh. We will continue to monitor such developments and the need for additional activities given concerns with rising AMR rates in Bangladesh.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors Orcid ID
Mainul Haque   https://orcid.org/0000-0002-6124-7993
Brain Godman   https://orcid.org/0000-0001-6539-6972

References:

1. Haque M, Godman B. Potential Strategies to Improve Antimicrobial Utilisation in Hospitals in Bangladesh Building on Experiences Across Developing Countries. *Bangladesh Journal of Medical Science*. 2021; **19 (3)**: 469-77. DOI: https://doi.org/10.3329/bjms.v20i3.52787.

2. Haque M. Antimicrobial Use, Prescribing, And Resistance in Selected Ten Selected Developing Countries: A Brief Overview. *Asian J Pharm Clin Res*. 2017; **10(8)**:37-45.

   DOI: http://dx.doi.org/10.22159/ajpcr.2017.v10i8.19468

3. Hofer U. The cost of antimicrobial resistance. *Nature reviews Microbiology*. 2019;**17(1)**:3. doi: 10.1038/s41579-018-0125-x.

4. The World Bank. Final Report - DRUG-RESISTANT INFECTIONS. A Threat to Our Economic Future March 2017. Available at URL: http://documents1.worldbank.org/curated/en/323311493396993758/pdf/final-report.pdf.

5. Shrestha P, Cooper BS, Coast J, Oppong R, Do Thi Thuy N, Phodha T, et al. Enumerating the economic cost of antimicrobial resistance per antibiotic consumed to inform the evaluation of interventions affecting their use. *Antimicrobial Resistance & Infection Control*. 2018;**7(1)**:98. doi: 10.1186/s13756-018-0384-3

6. O'Neill. TACKLING DRUG-RESISTANT INFECTIONS GLOBALLY: FINAL REPORT AND RECOMMENDATIONS. 2016. Available at URL: https://amr-review.org/sites/default/files/160518_Final%20paper_with%20cover.pdf.

7. Dadgostar P. Antimicrobial Resistance: Implications and Costs. *Infection and drug resistance*. 2019;**12**:3903-10. doi: 10.2147/IDR.S234610

8. Urmi UL, Nahar S, Rana M, Sultana F, Jahan N, Hossain B, et al. Genotypic to Phenotypic Resistance Discrepancies Identified Involving β-Lactamase Genes, blaKPC, blaIMP, blaNDM-1, and blaVIM in Uropathogenic Klebsiella pneumoniae. *Infection and drug resistance*. 2020;**13**:2863-75. doi: 10.2147/IDR.S262493

9. Ara B, Urmi UL, Haque TA, Nahar S, Rumnaz A, Ali T, et al. Detection of mobile colistin-resistance gene variants (mcr-1 and mcr-2) in urinary tract pathogens in Bangladesh: the last resort of infectious disease management colistin efficacy is under threat. *Expert review of clinical pharmacology*. 2021. doi: 10.1080/17512433.2021.1901577

10. Ahmed I, Rabbi Md. B, Sultana S. Antibiotic resistance in Bangladesh: A systematic review. *International Journal of Infectious Diseases*. 2019; **80**: 54–61. doi: 10.1016/j.ijid.2018.12.017

11. Mannan A, Shohel M, Rajia S, Mahmud NU, Kabir S, Hasan I. A cross sectional study on antibiotic resistance pattern of Salmonella typhi clinical isolates from Bangladesh. *Asian Pac J Trop Biomed*. 2014;**4(4)**:306-11. doi: 10.12980/APJTB.4.2014C770

12. The GARP-Bangladesh National Working Group. Antibiotic Use and Resistance in Bangladesh: Situation Analysis and Recommendations. 2018. Available at URL: https://cddep.org/wp-content/uploads/2018/08/antibiotic-use-and-resistance-in-bangladesh.pdf.

13. Hameed F, Khan MA, Bilal H, Muhammad H, Tayyab Ur R. Detection of MCR-1 Gene in Multiple Drug Resistant Escherichia coli and Klebsiella pneumoniae in Human Clinical Samples from Peshawar, Pakistan. *Comb Chem High Throughput Screen*. 2020. doi: 10.2174/1386207323666200914100119

14. Hoque R, Ahmed SM, Naher N, Islam MA, Rousham EK, Islam BZ, et al. Tackling antimicrobial resistance in Bangladesh: A scoping review of policy and practice in human, animal and environment sectors. *PloS one*. 2020;**15(1)**:e0227947. doi: 10.1371/journal.pone.0227947

15. Islam A, Rahman Z, Monira S, Rahman MA, Camilli A, George CM, et al. Colistin resistant Escherichia coli carrying mcr-1 in urban sludge samples: Dhaka, Bangladesh. *Gut Pathog*. 2017;**9**:77. doi: 10.1186/s13099-017-0227-4

16. Van Boeckel TP, Pires J, Silvester R, Zhao C, Song J, Criscuolo NG, et al. Global trends in antimicrobial resistance in animals in low- and middle-income countries. *Science*. 2019;**365(6459)**. doi: 10.1126/science.aaw1944

17. Wang Y, Hu Y, Cao J, Bi Y, Lv N, Liu F, et al. Antibiotic resistance gene reservoir in live poultry markets. *The Journal of infection*. 2019;**78(6)**:445-53. doi: 10.1016/j.jinf.2019.03.012

18. Islam S, Urmi UL, Rana M, Sultana F, Jahan N, Hossain B, et al. High abundance of the colistin resistance gene mcr-1 in chicken gut-bacteria in Bangladesh. Sci Rep. 2020;**10(1)**:17292. doi: 10.1038/s41598-020-74402-4

19. Godman B, Haque M, McKimm J, Abu Bakar M, Sneddon J, Wale J, et al. Ongoing strategies to improve the management of upper respiratory tract infections and reduce inappropriate antibiotic use particularly among lower and middle-income countries: findings and implications for the future. *Current medical research and opinion*. 2020;**36(2)**:301-27. doi: 10.1080/03007995.2019.1700947

20. Shaikhan F, Rawaf S, Majeed A, Hassounah S. Knowledge, attitude, perception and practice regarding antimicrobial use in upper respiratory tract infections in Qatar: a systematic review. *JRSM open*. 2018;**9(9)**:2054270418774971. doi: 10.1177/2054270418774971

21. Sulis G, Adam P, Nafade V, Gore G, Daniels B, Daftary A, et al. Antibiotic prescription practices in primary care in low- and middle-income countries: A systematic review and meta-analysis. *PLoS Med*. 2020;**17(6)**:e1003139. doi: 10.1371/journal.pmed.1003139

22. Al-Amin S, Hassan MZ, Saif-Ur-Rahman KM, Chowdhury MAB, Morrison SD, Donevant SB, et al. Pattern of antibiotic use for acute respiratory infections among out-patients in South Asian Region: Protocol for a systematic review. *Medicine*. 2021;**100(4)**:e22398. doi: 10.1097/MD.0000000000022398

23. Zhang Z, Hu Y, Zou G, Lin M, Zeng J, Deng S, et al. Antibiotic prescribing for upper respiratory infections among children in rural China: a cross-sectional study of outpatient prescriptions. *Glob Health Action*. 2017;**10(1)**:1287334. doi: 10.1080/16549716.2017.1287334

24. Majumder MAA, Rahman S, Cohall D, Bharatha A, Singh K, Haque M, et al. Antimicrobial Stewardship: Fighting Antimicrobial Resistance and Protecting Global Public Health. *Infection and drug resistance*. 2020;**13**:4713-38. doi: 10.2147/IDR.S290835

25. UNA-SUS. FIOCRUZ IN THE AIR: Covid-19 and antibiotic self-medication: a dangerous combination. 2020. Available at URL: https://www.unasus.gov.br/noticia/fiocruz-no-ar-covid-19-e-a-automedicacao-de-antibioticos-uma-combinacao-perigosa.

26. Schueler P. Antibiotic resistance and COVID-19. 2020. Available at URL: https://www.bio.fiocruz.br/index.php/br/noticias/1823-modernidade-e-sustentabilidade-no-centro-tecnologico-de-plataformas-vegetais.

27. Strathdee SA, Davies SC, Marcelin JR. Confronting antimicrobial resistance beyond the COVID-19 pandemic and the 2020 US election. *Lancet*. 2020;**396(10257)**:1050-3. doi: 10.1016/S0140-6736(20)32063-8

28. Rawson TM, Moore LSP, Zhu N, Ranganathan N, Skolimowska K, Gilchrist M, et al. Bacterial and Fungal Coinfection in Individuals With Coronavirus: A Rapid Review To Support COVID-19 Antimicrobial Prescribing. *Clinical infectious diseases*. 2020;**71(9)**:2459-68. doi: 10.1093/cid/ciaa530

29. Rodríguez-Álvarez M, López-Vidal Y, Soto-Hernández JL, Miranda-Novales MG, Flores-Moreno K, Ponce de León-Rosales S. COVID-19: Clouds Over the Antimicrobial Resistance Landscape. *Archives of medical research*. 2021;**52(1)**:123-6. doi: 10.1016/j.arcmed.2020.10.010

30. Hsu J. How covid-19 is accelerating the threat of antimicrobial resistance. *BMJ*. 2020;**369**:m1983. doi: 10.1136/bmj.m1983

31. Sriram A, Kalanxhi E, Kapoor G, Craig J, Balasubramanian R, Brar S et al. State of the world's antibiotics 2021: A global analysis of antimicrobial resistance and its drivers. Center for Disease Dynamics, Economics & Policy, Washington DC. 2021. Available at URL: https://cddep.org/wp-content/uploads/2021/02/The-State-of-the-Worlds-Antibiotics-in-2021.pdf.

32. Nori P, Cowman K, Chen V, Bartash R, Szymczak W, Madaline T, et al. Bacterial and fungal coinfections in COVID-19 patients hospitalized during the New York City pandemic surge. *Infection control and hospital epidemiology*. 2021;**42(1)**:84-8. doi: 10.1017/ice.2020.368

33. Langford BJ, So M, Raybardhan S, Leung V, Soucy JR, Westwood D, et al. Antibiotic prescribing in patients with COVID-19: rapid review and meta-analysis. *Clinical microbiology and infection*. 2021; **27(4)**:520-531. doi: 10.1016/j.cmi.2020.12.018

34. Godman B, Haque M, Islam S, Iqbal S, Urmi UL, Kamal ZM, et al. Rapid Assessment of Price Instability and Paucity of Medicines and Protection for COVID-19 Across Asia: Findings and Public Health Implications for the Future. *Frontiers in Public Health*. 2020;**8(744)**. doi: 10.3389/fpubh.2020.585832

35. Haque M, Islam S, Iqbal S, Urmi UL, Kamal ZM, Shuvo SA et al. Availability and price changes of potential medicines and equipment for the prevention and treatment of COVID-19 among pharmacy and drug stores in Bangladesh; findings and implications. B*angladesh Journal of Medical Science* 2020; 19 Special Issue on Covid19: S36-S50. DOI:https://doi.org/10.3329/bjms.v19i0.48106

36. Mwita JC, Ogunleye OO, Olalekan A, Kalungia AC, Kurdi A, Saleem Z, et al. Key Issues Surrounding Appropriate Antibiotic Use for Prevention of Surgical Site Infections in Low- and Middle-Income Countries: A Narrative Review and the Implications. *Int J Gen Med*. 2021;**14**:515-30. doi: 10.2147/IJGM.S253216

37. IACG. NO TIME TO WAIT: SECURING THE FUTURE FROM DRUG-RESISTANT INFECTIONS. REPORT TO THE SECRETARY-GENERAL OF THE UNITED NATIONS. April 2019. Available at URL: https://www.who.int/antimicrobial-resistance/interagency-coordination-group/IACG_final_report_EN.pdf.

38. Ministry of Health and Family Welfare (MoHFW), Government of Bangladesh. National Action Plan: Antimicrobial Resistance Containment in Bangladesh 2017-'22. 2017. Available from URL: https://www.flemingfund.org/wp-content/uploads/d3379eafad36f597500cb07c21771ae3.pdf.

39. Saleem Z, Godman B, Hassali MA, Hashmi FK, Azhar F, Rehman IU. Point prevalence surveys of health-care-associated infections: a systematic review. *Pathogens and global health*. 2019;**113(4)**:191-205. doi: 10.1080/20477724.2019.1632070

40. Saleem Z, Hassali MA, Godman B, Versporten A,

Hashmi FK, Saeed H, et al. Point prevalence surveys of antimicrobial use: a systematic review and the implications. *Expert review of anti-infective therapy*. 2020;**18(9)**:897-910. doi: 10.1080/14787210.2020.1767593

41. Yusuf DMA. Antimicrobial Stewardship: Bangladesh Perspective. Bangladesh Journal of Infectious Diseases. 2018;5:1.

42. Nathwani D, Varghese D, Stephens J, Ansari W, Martin S, Charbonneau C. Value of hospital antimicrobial stewardship programs [ASPs]: a systematic review. *Antimicrob Resist Infect Control*. 2019;**8**:35. doi: 10.1186/s13756-019-0471-0

43. Rousham EK, Islam MA, Nahar P, Lucas PJ, Naher N, Ahmed SM, et al. Pathways of antibiotic use in Bangladesh: qualitative protocol for the PAUSE study. *BMJ open*. 2019;9(1):e028215. doi: 10.1136/bmjopen-2018-028215

44. Darj E, Newaz MS, Zaman MH. Pharmacists' perception of their challenges at work, focusing on antimicrobial resistance: a qualitative study from Bangladesh. Glob Health Action. 2019;**12(sup1)**:1735126. doi: 10.1080/16549716.2020.1735126

45. Chowdhury M, Stewart Williams J, Wertheim H, Khan WA, Matin A, Kinsman J. Rural community perceptions of antibiotic access and understanding of antimicrobial resistance: qualitative evidence from the Health and Demographic Surveillance System site in Matlab, Bangladesh. *Glob Health Action*. 2019;**12(sup1)**:1824383. doi: 10.1080/16549716.2020.1824383

46. Atif M, Asghar S, Mushtaq I, Malik I, Amin A, Babar ZU, et al. What drives inappropriate use of antibiotics? A mixed methods study from Bahawalpur, Pakistan. *Infection and drug resistance*. 2019;**12**:687-99. doi: 10.2147/IDR.S189114.

47. Elong Ekambi G-A, Okalla Ebongue C, Penda IC, Nnanga Nga E, Mpondo Mpondo E, Eboumbou Moukoko CE. Knowledge, practices and attitudes on antibiotics use in Cameroon: Self-medication and prescription survey among children, adolescents and adults in private pharmacies. *PloS one*. 2019;**14(2)**:e0212875. doi: 10.1371/journal.pone.0212875

48. Markovic-Pekovic V, Grubisa N, Burger J, Bojanic L, Godman B. Initiatives to Reduce Nonprescription Sales and Dispensing of Antibiotics: Findings and Implications. *J Res Pharm Pract*. 2017;**6(2)**:120-5. doi: 10.4103/jrpp.JRPP_17_12

49. Kamati M, Godman B, Kibuule D. Prevalence of Self-Medication for Acute Respiratory Infections in Young Children in Namibia: Findings and Implications. *Journal of Research in Pharmacy Practice*. 2019;**8(4)**:220-4. doi: 10.4103/jrpp.JRPP_19_121

50. Opanga SA, Rizvi N, Wamaitha A, Sefah IA, Godman B. Availability of Medicines in Community Pharmacy to Manage Patients with COVID-19 in Kenya; Pilot Study and Implications. *Sch Acad J Pharm*. 2021; **10(3)**: 36-42. DOI: 10.36347/sajp.2021.v10i03.001

51. Mukokinya M, Opanga S, Oluka M, Godman B. Dispensing of antimicrobials in Kenya: A cross-sectional pilot study and its implications. *Journal of Research in Pharmacy Practice*. 2018;**7(2)**:77-82. doi: 10.4103/jrpp.JRPP_17_88

52. Sefah I, Ogunleye O, Essah D, Opanga S, Rizvi N, Wamaitha A, et al. Rapid assessment of the potential paucity and price increases for suggested medicines and protection equipment for COVID-19 across developing countries with a particular focus on Africa and the implications. Frontiers in pharmacology. 2021;11(2055). doi: 10.3389/fphar.2020.588106

53. Zawahir S, Lekamwasam S, Aslani P. A cross-sectional national survey of community pharmacy staff: Knowledge and antibiotic provision. *PloS one*. 2019;**14(4)**:e0215484-e. doi: 10.1371/journal.pone.0215484

54. Erku DA, Belachew SA, Abrha S, Sinnollareddy M, Thomas J, Steadman KJ, et al. When fear and misinformation go viral: Pharmacists' role in deterring medication misinformation during the 'infodemic' surrounding COVID-19. *Research in social & administrative pharmacy*. 2021;17**(1)**:1954-63. doi: 10.1016/j.sapharm.2020.04.032

55. Cadogan CA, Hughes CM. On the frontline against COVID-19: Community pharmacists' contribution during a public health crisis. *Research in social & administrative pharmacy*. 2021;**17(1)**:2032-5. doi: 10.1016/j.sapharm.2020.03.015

56. Czech M, Balcerzak M, Antczak A, Byliniak M, Piotrowska-Rutkowska E, Drozd M, et al. Flu Vaccinations in Pharmacies-A Review of Pharmacists Fighting Pandemics and Infectious Diseases. *Int J Environ Res Public Health*. 2020;**17(21)**. doi: 10.3390/ijerph17217945

57. Marzan M, Islam DZ, Lugova H, Krishnapillai A, Haque M, Islam S. Knowledge, Attitudes, and Practices of Antimicrobial Uses and Resistance Among Public University Students in Bangladesh. *Infection and drug resistance*. 2021;**14**:519-33. doi: 10.2147/IDR.S289964

58. Soumya R, Devarashetty V, Jayanthi CR, Sushma M. Drug dispensing practices at pharmacies in Bengaluru: A cross-sectional study. Indian Journal of Pharmacology. 2016;**48(4)**:360-4. doi: 10.4103/0253-7613.186204

59. Hoxha I, Malaj A, Kraja B, Bino S, Oluka M, Markovic-Pekovic V, et al. Are pharmacists' good knowledge and awareness on antibiotics taken for granted? The situation in Albania and future implications across countries. *Journal of global antimicrobial resistance*. 2018;**13**:240-5. doi: 10.1016/j.jgar.2018.01.019

60. Saleem Z, Hassali MA, Hashmi FK, Godman B, Saleem F. Antimicrobial dispensing practices and determinants of antimicrobial resistance: a qualitative study among community pharmacists in Pakistan. *Family medicine and community health*. 2019;**7(3)**:e000138. doi: 10.1136/fmch-2019-000138

61. Sharland M, Gandra S, Huttner B, Moja L, Pulcini C, Zeng M, et al. Encouraging AWaRe-ness and discouraging inappropriate antibiotic use-the new 2019 Essential Medicines List becomes a global antibiotic stewardship tool. *The Lancet Infectious diseases*. 2019;**19(12)**:1278-80. doi: 10.1016/S1473-3099(19)30532-8

62. Saleem Z, Hassali MA, Godman B, Fatima M, Ahmad Z, Sajid A, et al. Sale of WHO AWaRe groups antibiotics without a prescription in Pakistan: a simulated client study. *Journal of Pharmaceutical Policy and Practice*. 2020;**13(1)**:26. doi: 10.1186/s40545-020-00233-3

63. Mwita S, Jande M, Marwa K, Hamasaki K, Katabalo D, Burger J , Godman B et al. Medicines dispensers' knowledge on the implementation of an artemisinin-based combination therapy policy for the treatment of uncomplicated malaria in Tanzania. *Journal of Pharmaceutical Health Services Research*. 2017;**8**:227-33. DOI 10.1111/jphs.12187

64. Alrasheedy AA, Alsalloum MA, Almuqbil FA, Almuzaini MA, Aba Alkhayl BS, Albishri AS, et al. The impact of law enforcement on dispensing antibiotics without prescription: a multi-methods study from Saudi Arabia. *Expert review of anti-infective therapy.* 2020;**18(1)**:87-97. doi: 10.1080/14787210.2020.1705156

65. Kalungia A, Godman B. Implications of non-prescription antibiotic sales in China. *The Lancet Infectious diseases*. 2019;**19(12)**:1272-3. doi: 10.1016/S1473-3099(19)30408-6

66. Sakeena MHF, Bennett AA, McLachlan AJ. Non-prescription sales of antimicrobial agents at community pharmacies in developing countries: a systematic review. *International journal of antimicrobial agents*. 2018;**52(6)**:771-82. doi: 10.1016/j.ijantimicag.2018.09.022

67. Godman B. Combating COVID-19: Lessons learnt particularly among developing countries and the implications. Bangladesh Journal of Medical Science, Special Issue on Covid19. 2020; S103-8. DOI: https://doi.org/10.3329/bjms.v19i0.48413.

68. Boonyasiri A, Thamlikitkul V. Effectiveness of multifaceted interventions on rational use of antibiotics for patients with upper respiratory tract infections and acute diarrhea. Journal of the Medical Association of Thailand. 2014;97 Suppl 3:S13-9.

69. Wei X, Zhang Z, Hicks JP, Walley JD, King R, Newell JN, et al. Long-term outcomes of an educational intervention to reduce antibiotic prescribing for childhood upper respiratory tract infections in rural China: Follow-up of a cluster-randomised controlled trial. *PLoS Med*. 2019;**16(2)**:e1002733. doi: 10.1371/journal.pmed.1002733

70. Tay KH, Ariffin F, Sim BL, Chin SY, Sobry AC. Multi-Faceted Intervention to Improve the Antibiotic Prescriptions among Doctors for Acute URI and Acute Diarrhoea Cases: The Green Zone Antibiotic Project. *The Malaysian journal of medical sciences*. 2019;**26(4)**:101-9. doi: 10.21315/mjms2019.26.4.12

71. Mohiuddin M, Rashid SF, Shuvro MI, Nahar N, Ahmed SM. Qualitative insights into promotion of pharmaceutical products in Bangladesh: how ethical are the practices? BMC medical ethics. 2015;16(1):80.

72. Bojanic L, Markovic-Pekovic V, Skrbic R, Stojakovic N, Ethermanovic M, Bojanic J, et al. Recent Initiatives in the Republic of Srpska to Enhance Appropriate Use of Antibiotics in Ambulatory Care; Their Influence and Implications. *Frontiers in pharmacology*. 2018;**9**:442. doi: 10.3389/fphar.2018.00442

73. Furst J, Cizman M, Mrak J, Kos D, Campbell S, Coenen S, et al. The influence of a sustained multifaceted approach to improve antibiotic prescribing in Slovenia during the past decade: findings and implications. *Expert review of anti-infective therapy*. 2015;**13(2)**:279-89. doi: 10.1586/14787210.2015.990381

74. Wojkowska-Mach J, Godman B, Glassman A, Kurdi A, Pilc A, Rozanska A, et al. Antibiotic consumption and antimicrobial resistance in Poland; findings and implications. *Antimicrobial Resistance & Infection Control*. 2018;**7(1)**:136. doi: 10.1186/s13756-018-0428-8

75. Abilova V, Kurdi A, Godman B. Ongoing initiatives in Azerbaijan to improve the use of antibiotics; findings and implications. *Expert review of anti-infective therapy*. 2018;**16(1)**:77-84.doi:10.1080/14787210.2018.1417835