

https://dspace.org/

Is this pill an antibiotic or a painkiller Improving the identification of oral antobiotics for better use

AA Monnier; NTT Do; KP Asante; Francesc Gomez-Olive Casas; S Afari-Asiedu ...

ELSEVIER SCI LTD
https://hdl.handle.net/10539/43191
WOS

Downloaded from a DSpace repository. https://dspace.org/

Is this pill an antibiotic or a painkiller? Improving the identification of oral antibiotics for better use

*Annelie A Monnier, Nga T T Do, Kwaku Poku Asante, Samuel Afari-Asiedu, Wasif Ali Khan, Khátia Munguambe, Esperanca Sevene, Toan K Tran, Chuc T K Nguyen, Sureeporn Punpuing, F Xavier Gómez-Olivé, H Rogier van Doorn, Céline Caillet, Paul N Newton, Proochista Ariana, Heiman F L Wertheim, on behalf of the ABACUS II consortium**

In this Viewpoint, we discuss how the identification of oral antibiotics and their distinction from other commonly used medicines can be challenging for consumers, suppliers, and health-care professionals. There is a large variation in the names that people use to refer to antibiotics and these often relate to their physical appearance, although antibiotics come in many different physical presentations. We also reflect on how the physical appearance of medicine influences health care and public health by affecting communication between patients and health-care professionals, dispensing , medicine use, and the public understanding of health campaigns. Furthermore, we report expert and stakeholder consultations on improving the identification of oral antibiotics and discuss next steps towards a new identification system for antibiotics. We propose to use the physical appearance as a tool to support and nudge awareness about antibiotics and their responsible use.

Introduction

Considering the alarming development of antimicrobial resistance and the increase of antibiotic consumption globally, it is crucial to curb the misuse and overuse of antibiotics.

The Antibiotic Access and Use (ABACUS) project was initiated in 2017 to explore community-based antibiotic access and consumption practices across communities in low-income and middle-income countries (LMICs) to subsequently inform the design of, and identify targets for, community-based interventions aimed to improve antibiotic use. The project was conducted in rural communities in Africa (ie, South Africa, Ghana, and Mozambique) and Asia (ie, Thailand, Viet Nam, and Bangladesh). An important ABACUS finding was the confusion among medicine suppliers (eg, both formal or informal antibiotic suppliers, from pharmacists to street vendors) and community members regarding how to recognise an antibiotic. In both Africa and Asia, antibiotics could be mistaken for different medicines such as painkillers.[1]

Until now, using the physical appearance (defined as any physical attributes of a medicine that can be visually perceived and identified by consumers or health-care providers) of antibiotics remains a relatively unexplored strategy to nudge awareness on responsible antibiotic use among users and suppliers. Previously, the Red Line campaign initiated in 2016 in India mandated a red line on the packages of prescription-only medicine including, but not limited to, antibiotics.[2] However, implementation and awareness about this campaign among the general public and health-care professionals seems limited.[2] Several examples of alignment or changes to physical appearances to benefit patient safety can be found in the medical field, such as the colour coding of bottle caps of topical ophthalmic medications in the USA; more details on this example and other examples of changes to the physical appearances of medication are in the appendix (p 1).

In this Viewpoint, we discuss how physical appearance influences the ability of consumers, medicine suppliers, and health-care professionals to distinguish antibiotics from other oral medicines; and how the appearance of medicine affects health care and global public health; and we report expert and stakeholder consultations conducted on improving the identification of oral antibiotics. Furthermore, we discuss next steps towards a new identification system for antibiotics.

How can (oral) medicine be confusing?

Medicines that are taken orally have an many names, shapes, colours, sizes, and types of packaging. As a result, medicines with the same active pharmaceutical ingredient (API) can be found with different physical features and designs, whereas two medicines with different APIs can look the same or very similar. Medicines dispensed as capsules are often considered to be antibiotics by community members and medicine suppliers,[1] despite the fact that many antibiotics are not dispensed as capsules and, importantly, other classes of medicines (eg, painkillers) are commonly sold as capsules (figure A). The perception of capsules as antibiotics is also reflected in the local names for how people refer to antibiotics. In Viet Nam, one of the words used to refer to antibiotics is *con nhộng*, which means capsule. Communities in Mozambique also use the word capsule to identify antibiotics (appendix p 3). In both Ghana and Mozambique, antibiotics are referred to as red and yellow, corresponding to two-colour capsules.[4,5] Strikingly, red and yellow can either correspond to tetracycline or amoxicillin capsules, which are two completely different classes of antibiotics (figure A). There is a large diversity in how people refer to antibiotics in the six countries where the ABACUS project was conducted (appendix p 3). Moreover, it is also important to realise that different names can be used for the same medicine (ie, the international non-proprietary names and the various brand names of innovative and generic manufacturers).[6,7]

Lancet Glob Health 2023; 11: e1308–13

*Members are listed at the end of the Viewpoint

Department of Medical Microbiology and Radboudumc Center for Infectious Diseases, Radboudumc, Nijmegen, Netherlands (A A Monnier PhD, Prof H F L Wertheim PhD); **Oxford University Clinical Research Unit, Hanoi, Viet Nam** (N T T Do PhD, H R van Doorn PhD); **Kintampo Health Research Centre, Research and Development Division of Ghana Health Service, Kintampo, Ghana** (K P Asante PhD, S Afari-Asiedu PhD); **International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh** (W A Khan MHS); **Faculty of Medicine, Eduardo Mondlane University, Maputo, Mozambique** (K Munguambe PhD, E Sevene PhD); **Manhiça Health Research Centre, Manhiça, Mozambique** (K Munguambe, E Sevene); **Department of Family Medicine, Hanoi Medical University, Hanoi, Vietnam** (T K Tran PhD, C T K Nguyen PhD); **Institute for Population and Social Research, Mahidol University, Nakhonpathom, Thailand** (S Punpuing PhD); **MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt), School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa** (F X Gómez-Olivé PhD); **Centre for Tropical Medicine and Global Health** (H R van Doorn, C Caillet PhD, Prof P N Newton PhD, P Ariana PhD) **and Infectious Diseases Data Observatory** (C Caillet, Prof P N Newton), **Nuffield Department of Clinical Medicine, University of Oxford, Oxford, UK; Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit,**

Microbiology Laboratory, Mahosot Hospital, Vientiane, Laos (C Caillet, Prof P N Newton)

Correspondence to:
Prof Heiman Wertheim, Department of Medical Microbiology and Radboudumc Center for Infectious Diseases, Radboudumc, Nijmegen 6525 GA, Netherlands
heiman.wertheim@radboudumc.nl

See Online for appendix



Figure: **Pictures taken as part of the ABACUS project highlighting that the identification of medicines is challenging**
(A) Three common capsules sold in Kintampo, Ghana. From left to right the capsules are: amoxicillin, tetracycline, and tramadol. Capsules that were referred to as red and yellow by the general public and medicine suppliers in several countries were found to be either tetracycline or amoxicillin, which are two different classes of antibiotic. Tramadol—a painkiller—can be mistaken for an antibiotic because it is dispensed as a capsule in settings where patients consider capsules to be antibiotics. Pictures taken as part of the ABACUS project in November, 2022. (B) Bags of *yaa chud* (ie, mixture of unknown medicines) sold in the Kanchanaburi Health and Demographic Surveillance System area, Thailand. *Yaa chud* are often sold to people with respiratory symptoms and contain various unidentifiable medicines. The common practice of *yaa chud* highlights the key issue of medicine identification (ie, which pill is what?). Picture taken as part of the ABACUS project in February, 2017.[3]

We also observed that community members in Viet Nam and Ghana confused antibiotics for analgesics (eg, paracetamol or tramadol) or non-steroidal anti-inflammatory drugs.[4,8] Data from the USA and Europe also show suboptimal medicine identification and confusion among patients and health-care professionals, especially in primary and older adult care.[9–12] This finding suggests that the issue of medicine misidentification is of global relevance.[9,10]

The issue of medicine misidentification should also be considered together with the notion of medicine access. In most parts of the world—including several European countries[13]—antibiotics can be accessed without a prescription and are increasingly purchased on the internet.[14,15] Furthermore, in many countries, non-licensed medicine suppliers are common and antibiotics can be accessed easily. Of the total mapped suppliers, 325 (65%) of 502 in Viet Nam, 156 (52%) of 301 in Bangladesh, and ten (21%) of 47 in Mozambique operated without legal authorisation.[1] ABACUS data also indicated that a considerable number of medicine suppliers were not always aware of the fact that some of the medicines that they were dispensing were indeed antibiotics.[1] This lack of awareness does not seem to be restricted to LMICs. In Poland, where furazidin (an antibiotic of the same chemical group as nitrofurantoin) is available without a prescription, data suggest common use but low awareness about furazidin being an antibiotic among both health-care professionals and patients.[16] In some countries, medicines are sold in shop-made syndromic drug packages with a mix of various tablets or capsules, or both, in unlabelled plastic resealable bags (eg, *yaa chud* in Thailand, which are typically sold to people with respiratory symptoms; figure B).[3] By mixing different medicines, it becomes even harder for users, suppliers, and health-care professionals to identify the medicines and therefore to know how to use them appropriately. Also, antibiotics are known to be commonly stored by households in LMICs, which can lead to inappropriate medicine use, confusion about medicine identity, and medicine mix-ups.[17]

How does the appearance of medicine affect health care and public health?

Using the physical appearance (including colour, inscription, shape, or packaging) of medicines is a common and intuitive way for patients to discuss their medications with health-care professionals,[1,10] because for many of these patients, medicine names are difficult to read, understand, or remember. However, it seems unrealistic to expect health-care professionals to know what each medicine looks like, especially considering the high number of manufacturers and the high frequency of changes in appearance of the same APIs over time.[18] Altogether, the absence of features that enable the recognition of medicines is a barrier to effective communication between patients, suppliers, and health-care professionals about both past and current medication use. In turn, a clear understanding of past and current antibiotic use is relevant for both good clinical and antibiotics stewardship practices.

Medicine appearance is known to affect the process of taking the medication (ie, through medication identification and memorability, medication handling, and swallowability).[19] Several studies indicate that changing the appearance of a pill affects patient compliance. A larger tablet or capsule size is associated with increases in patient complaints related to swallowing difficulties.[20] Changes in pill colour increased the odds of discontinuation of anti-epileptic medication.[21] In patients with cardiovascular disease, the odds of non-compliance increased by 34% after a change in pill colour and 66% after a change in pill shape.[18]

Medicine misidentification and confusion issues are also embedded in the topic of medicines that look similar, have similar sounding names, or have shared features of product appearance or product packaging (ie, look alike, sound alike medications). Look alike, sound alike medications are a frequent cause of dispensing errors across the globe. Mixing up medicine because of their appearance is reported to be common in the community

setting in different European countries.[9,10] Good estimates of the global prevalence and the clinical implications of errors caused by look alike, sound alike medications are challenging due to heterogeneous definitions and measurements used. Moreover, the estimates rely mainly on hospital data from high-income countries whereas there is scarcity of data from community settings and from lower income settings. With the ageing of the global population and with the increase of polypharmacy (ie, the use of multiple medicines), medication errors due to the physical appearance of medicine can be expected to increase. Errors related to medicine appearance, unlike other forms of medication error (eg, wrong patient or wrong route of administration), show that the responsibility for medication errors is not restricted to health-care professionals (involved with the prescription, dispensing, or administration) and patients. Indeed, a broader set of stakeholders including the manufacturers, regulators, and medicine-naming bodies are involved in this issue.

Addressing the misuse and overuse of antibiotics should be an important focus of the medical and public health sectors because both the consumption of antibiotics and the development of resistance are increasing globally. So far, one way to approach this problem is through health campaigns to educate the general public on responsible antibiotic use. To date, increasing awareness about antibiotics and responsible use recommendations remains challenging because it requires the understanding of several biomedical concepts (eg, what is a bacteria, what is an infection, and what resistance means for the patient and for the pathogen) that need careful and contextualised translation for various languages and cultures. However, an important question should be raised: how can individuals be properly educated not to use an antibiotic for influenza-like illness, if they have not been trained to differentiate between an antibiotic and a painkiller and recognise antibiotics clearly? Global initiatives to improve responsible antibiotic use will not work optimally if the antibiotics cannot be recognised easily and linked to public health messages. Therefore, improving the potential for recognition and identification of antibiotics should be seen as a prerequisite to the success of awareness campaigns on antibiotics. As we have highlighted, there is a large variation in the names that people use to refer to antibiotics and these often relate to the physical appearance of the antibiotics. The diversity in names and terminologies used in the community contrast with the use of the term antibiotic in public health messaging, which is therefore less likely to be correctly understood. Moreover, the absence of features that identify antibiotics also adds to the challenges of surveillance of antibiotic use, which is key for the implementation of targeted and well informed interventions to address antibiotic consumption.[22] Being able to distinguish between an antibiotic and a painkiller requires improving personal health literacy (defined as the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others)[23] and health equity (defined as the absence of unfair and avoidable or remediable differences in health among socially, economically, demographically, or geographically varied populations).[24]

How is the physical appearance of medicines established and regulated?

There are important distinctions in the drivers of a medicine's physical appearance between patented and generic medicines.[12] Innovator companies usually seek physical differentiation from already marketed products whereas generic companies often aim for physical resemblance with the brand product. However, manufacturers of innovative medicines typically claim exclusive ownership of the physical aspects of their medicines, including size, shape, colour, texture, aroma, and flavour, which is known as trade dress.[12] As a result, most generic products generally look different from the original brands. Moreover, generic medicines can differ from each other depending on the manufacturers.

Leading regulatory agencies such as the US Food and Drug Administration[20] and the European Medicines Agency[25] recognise that the physical features of oral dosage forms affect human medicine consumption and can lead to medication errors, especially considering generic medicines and their brand name counterparts. These agencies have issued guidance for manufacturers and recommend aligning sizes between generic products and their reference products and designing medicines that are easy to swallow (ie, considering shape, size, and coating). Indeed, perceived swallowability is an important factor that affects patient compliance. Other physical characteristics that affect patient consumption include a general preference for light and medium colour shades over darker ones, high gloss finish or coating, and specific shapes (eg, triangles and double arrow marks).[26,27] However, patient preferences could vary between and within different target populations (eg, older adults and children) and across different geographical and cultural settings.[19] Medicine colour is a physical feature with important marketing benefits to increase brand recognition that can trigger certain associations (eg, red, yellow, and orange are associated with a stimulant effect, whereas green and blue are associated with a tranquillising effect)[28] in some societies, which in turn influences patient consumption. In 2020, the shape of a pill was shown to have an effect on the perceived benefit of the medicine, bodily sensations, and emotional associations with the treatment.[29]

The packaging of a medicine also plays an important role in the identification of oral medicines (including tablets and capsules). Two main categories of medicine packaging are relevant for patients and health-care professionals. Primary packaging components (eg, bottles, closures, and blisters) are in direct contact with the product, whereas the secondary components are not

(eg, aluminium caps and cardboard boxes).[30] Regulators typically list requirements to be included on the packaging of medicines. Key information typically includes the name of the medicine, its international non-proprietary name, expiry date, batch number, list of active pharmaceutical ingredients, and contact details of the manufacturers.[30]

Exploring how to improve the appearance of antibiotics: a summary of expert and stakeholder consultations

We conducted five online roundtable meetings and additional consultations to discuss improving the identification of oral antibiotics from 2020 to 2022. A total of 58 experts and stakeholders were consulted, including pharmacists, policy makers, regulators, public health experts, prescribers, nurses, and representatives of the pharmaceutical industry (including manufacturers and capsule designers). Recruitment of relevant experts and stakeholders was achieved through the network of the ABACUS II consortium and through snowballing (ie, a recruitment technique in which participants are asked to assist researchers in identifying other potential participants). A full list of participants and more detailed information on the methodology are documented in the appendix (pp 4–28).

Panel: **Summary of the five roundtable discussions on improving the appearance of oral antibiotics**

Intended effects

- Address the rise of antimicrobial resistance globally
- Contribute to patient education on responsible antibiotic use and patient empowerment and participation in treatment decisions; optimise the effect of existing responsible antibiotic use campaigns including for communities with lower literacy rates (eg, symbol, colour, and shape)
- Reduce self-medication with antibiotics
- Improve awareness about antibiotics among health-care workers
- Reduce medication errors (eg, medicines that look alike or have similar sounding names)
- Improve communication between physicians and patients and guidance of treatment decisions (eg, identify previous antibiotic treatments)
- Facilitate identification of falsified antibiotics

Potential barriers

- Data on the burden of the antibiotic misidentification issue are scattered across different fields in the scientific literature (eg, medication safety, antimicrobial resistance, medicine dispensing practices, and medicine quality)
- Costs of implementing a change to the appearance of pills or packaging of antibiotics, especially for generic manufacturers; even a slight increase in costs could potentially negatively affect antibiotic cost and hence access
- Need for consensus between the many manufacturers and regulators on the exclusive use of any physical feature (eg, colour, shape, imprint, symbol or any combination of those)
- Chemistry, manufacturin,g and controls aspects to consider in relation to stability of medicines
- The use of colours could be a potential source of confusion (eg, for people who are colour blind)
- Many cultural and socioeconomic factors influence antibiotic consumption behaviours and thus an improved ability to recognise and identify antibiotics could also lead to increase in demand and consumption
- Misuse of physical features by criminal organisations (eg, falsified medicines)

Potential facilitators

- The right financial incentives might be instrumental for the manufacturers in place to support a transition to the new proposed labelling and identification system
- Lessons learned from labelling initiatives in the medical field (eg, the eye drop colour code chart in the USA and the Red Line campaign for prescription medicines in India) and in other fields (eg, the Forest Stewardship Council symbol and the tobacco and alcohol industries)
- Early involvement of regulators and the pharmaceutical industry for support and input
- Global and regional regulatory harmonisation on a new identification system for antibiotics
- Support from laws and regulations and robust policies reinforcement
- Antimicrobial resistance recognised as a global public health priority

Suggested approaches

- Improved labelling or identification features should be paired with other patient education measures on health literacy (ie, improved labelling or identification should not be a stand-alone strategy)
- Align labelling or identification system with ongoing antimicrobial resistance awareness messaging
- Start small (eg, a prioritisation of the most commonly used antibiotics or newly developed antibiotics and first target the packaging and gradually move to targeting the individual pills)
- Include some simple responsible antibiotic use messaging (eg, discouraging self-medication or use for upper respiratory tract symptoms) in the labelling or identification system
- Combine any physical feature with a QR code providing details and information on the manufacturing process (to hinder falsification)
- Consider applicability of the labelling or identification system for antibiotics in general and antibiotics containing feed used for animals
- Collaboration with ongoing developments, (eg, track and trace systems, barcodes, and QR codes)
- Contextualised approach considering local cultural and social conditions to facilitate implementation

These five discussions focused on the intended effects of improving the identification of oral antibiotics; the facilitators and barriers to achieving this improvement; and the proposed ways forward (panel). Being able to distinguish antibiotics from other commonly sold medicines (eg, painkillers) was broadly recognised as an important public health objective among the consulted experts and stakeholders. The issue of misidentification of antibiotics was also largely recognised as a global problem rather than only being restricted to lower income settings. There are many examples of confusion surrounding the misidentification of medicines discussed in older adult care and primary care in higher income countries where polypharmacy is widespread.

An important challenge to consider in the design of a new identification system for antibiotics is to avoid different classes of oral antibiotics looking too similar. Indeed, the identification system should allow for sufficient visible distinctions between different types of antibiotics to avoid confusion and mix-ups, and to avoid the suggestion that the medicines are the same or interchangeable.

It was also recommended that the antibiotic identification system should be combined with some clear and simple responsible antibiotic use messaging. Furthermore, the system should be introduced and implemented alongside robust public health campaigns to increase understanding of the system (panel).

During the expert and stakeholder discussions, inappropriate antibiotic use was highlighted as a complex and multifactorial problem that could not be solely solved by modifying the appearance of antibiotics. Instead, improving the identification of antibiotics should be seen as a complementary strategy alongside many other efforts to improve responsible antibiotic use and thereby preserve their effectiveness for the future. Examples include efforts to reinforce existing regulations, improve access to high quality public health care, enhance health literacy, and implement stewardship practices.

It is important to also consider the following main risks that are associated with the use of an identification system for antibiotics: first, costs of implementing a change to appearance of pills or packaging of antibiotics, especially for generic manufacturers. Indeed, even a slight increase in costs could potentially negatively affect antibiotic cost and hence antibiotic access for patients in need of them; second, improved ability to recognise and identify antibiotics could lead to increase in demand and consumption by community members, which further leads to inappropriate use and thus contributes to antimicrobial resistance; and third, the identification features could potentially be replicated by falsified medicine suppliers.

Next steps should involve working with regulators to explore ways to improve identification and recognition of antibiotics and to reduce the many different physical presentations of antibiotics. In the meantime, we advocate for more awareness of the topic of antibiotic recognition and identification in future research including studies exploring medicine access and use practices but also studies evaluating responsible medicine or antibiotic use campaigns, medication errors, and dispensing practices, and patient compliance studies.

Conclusion

With the alarming antimicrobial resistance developments and increasing antibiotic consumption, the paucity of patient-friendly identification systems for medicine classes poses a major health concern that needs to be mitigated in both low-income and high-income settings. Global initiatives to improve responsible antibiotic use will not work optimally if the medicine cannot be recognised easily and linked to public health messages. We propose the use of physical appearance tools to improve the identification of oral antibiotics and distinction from other commonly sold medicines such as painkillers. The use of these tools would contribute to the overarching aim of increasing awareness of responsible antibiotic use among health-care professionals, medicine suppliers, and community members. More research is being done by the ABACUS team to shed light on this topic.

The ABACUS II consortium

Heiman FL Wertheim, Annelie A Monnier (Radboud University Medical Center, Nijmegen, Netherlands); Paul N Newton, Céline Caillet, Proochista Ariana, Taniya Sharmeen (University of Oxford, Oxford, UK); Kwaku-Poku Asante, Samuel Afari-Asiedu (Kintampo Health Research Center, Kintampo, Ghana); Khátia Munguambe, Esperanca Sevene, Helena Boene, Olga Cambaco (Manhiça Health Research Centre, Manhiça, Mozambique); Wasif Ali Khan, Mohammed Abdul Matin (International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh); Toan K Tran, Chuc T K Nguyen, Tuyet A Phuong (Hanoi Medical University, Hanoi, Viet Nam); Sureeporn Punpuing, Malee Sunpuwan, Wipaporn Jarruruengpaisan (Mahihol University, Bangkok, Thailand); F Xavier Gómez-Olivé, Georgina Pujol-Busquets Guillén, Sizzy Ngobeni, Floidy Wafawanaka (University of the Witwatersrand, Johannesburg, South Africa); Nga T T Do and H Rogier van Doorn (Oxford University Clinical Research Unit, Hanoi, Viet Nam).

Contributors

All authors were involved in the literature searches, the organisation of the expert and stakeholder consultations, the drafting of the figure and panel, and the writing of the Viewpoint.

Declaration of interests

We declare no competing interests.

Acknowledgments

We would like to thank the following members of the ABACUS II steering committee for their comments and suggestions on the manuscript: Jude Nwokike and Chibuzor Uchea. We would like to thank all the consulted experts and stakeholders for their contributions to this work: Arjun Srinivasan, Bert Leufkens, Christine Årdal, Dominique L Monnet, Geetanjali Kapoor, Ghada Zoubiane, Sujith J Chandy, Souha Kanj, Vera Vlahović-Palčevski, Elizabeth (Libby) Dodds Ashley, Pieter van den Hombergh, Philip Howard, Mary Lou Manning, Tiago Villanueva, Richard White, John Rex, Elizabeth D. Hermsen, Jay Edward Purdy, Lucas Jan Wiarda, Walter Fuller, Iruka N Okeke, Wuraola Akande-Sholabi, Kwame Ohene Buabeng, Luísa Namburete, Eduardo Soares, George Hedidor, Otridah Kapona, Hoa Ngo Thi, Abdul Ghafur, Hasan Habib, Anuj Sharma, David Lye, Sabrina Yesmin, Benedikt Huttner, Bernadette Cappello, Radu Botgros,

Annabel Bordmann, and Charlotte Miller. A full list of participants and their affiliations are in the appendix (p 5). This article reflects the authors' opinions. No unanimity agreement among participating experts and stakeholders was sought. This research was funded by the Wellcome Trust (219403/Z/19/Z).

References

1 Do NTT, Vu HTL, Nguyen CTK, et al. Community-based antibiotic access and use in six low-income and middle-income countries: a mixed-method approach. *Lancet Glob Health* 2021; **9:** e610–19.
2 Mathew P, Thomas SA, Chandy SJ. The role of Schedule H1 and Red Line campaign in improving antibiotic use in India. *J Family Med Prim Care* 2022; **11:** 2656–61.
3 Sunpuwan M, Punpuing S, Jaruruengpaisan W, Kinsman J, Wertheim H. What is in the drug packet?: access and use of non-prescribed poly-pharmaceutical packs (*yaa chud*) in the community in Thailand. *BMC Public Health* 2019; **19:** 971.
4 Afari-Asiedu S, Hulscher M, Abdulai MA, Boamah-Kaali E, Asante KP, Wertheim HFL. Every medicine is medicine; exploring inappropriate antibiotic use at the community level in rural Ghana. *BMC Public Health* 2020; **20:** 1103.
5 Cambaco O, Alonso Menendez Y, Kinsman J, et al. Community knowledge and practices regarding antibiotic use in rural Mozambique: where is the starting point for prevention of antibiotic resistance? *BMC Public Health* 2020; **20:** 1183.
6 Carney SL, Gazarian M, Denholm JT, et al. What's in a name? Brand name confusion and generic medicines. *Med J Aust* 2011; **195:** 650–51.
7 Aronson JK. Medication errors resulting from the confusion of drug names. *Expert Opin Drug Saf* 2004; **3:** 167–72.
8 Nguyen HH, Ho DP, Vu TLH, et al. "I can make more from selling medicine when breaking the rules" - understanding the antibiotic supply network in a rural community in Viet Nam. *BMC Public Health* 2019; **19:** 1560.
9 Mira JJ, Ortiz L, Lorenzo S, Royuela C, Vitaller J, Pérez-Jover V. Oversights, confusions and misinterpretations related to self-care and medication in diabetic and renal patients. *Med Princ Pract* 2014; **23:** 246–52.
10 Tranchard F, Gauthier J, Hein C, et al. Drug identification by the patient: perception of patients, physicians and pharmacists. *Therapie* 2019; **74:** 591–98.
11 Tranchard F, Hein C, Lacombe J, Villars H, Montastruc JL, Despas F. Medication errors and look-alike tablets: the splitting issue. *Pharmacoepidemiol Drug Saf* 2016; **25:** 1002–03.
12 Greene JA, Kesselheim AS. Why do the same drugs look different? Pills, trade dress, and public health. *N Engl J Med* 2011; **365:** 83–89.
13 Machowska A, Stålsby Lundborg C. Drivers of irrational use of antibiotics in Europe. *Int J Environ Res Public Health* 2018; **16:** 27.
14 Boyd SE, Moore LSP, Gilchrist M, et al. Obtaining antibiotics online from within the UK: a cross-sectional study. *J Antimicrob Chemother* 2017; **72:** 1521–28.
15 Sun N, Gong Y, Liu J, et al. Prevalence of antibiotic purchase online and associated factors among Chinese residents: a nationwide community survey of 2019. *Front Pharmacol* 2021; **12:** 761086.
16 Hartman EAR, Groen WG, Heltveit-Olsen SR, et al. Decisions on antibiotic prescribing for suspected urinary tract infections in frail older adults: a qualitative study in four European countries. *Age Ageing* 2022; **51:** afac134.
17 Jafarzadeh A, Mahboub-Ahari A, Najafi M, Yousefi M, Dalal K. Medicine storage, wastage, and associated determinants among urban households: a systematic review and meta-analysis of household surveys. *BMC Public Health* 2021; **21:** 1127.
18 Kesselheim AS, Bykov K, Avorn J, Tong A, Doherty M, Choudhry NK. Burden of changes in pill appearance for patients receiving generic cardiovascular medications after myocardial infarction: cohort and nested case-control studies. *Ann Intern Med* 2014; **161:** 96–103.
19 Shariff Z, Kirby D, Missaghi S, Rajabi-Siahboomi A, Maidment I. Patient-centric medicine design: key characteristics of oral solid dosage forms that improve adherence and acceptance in older people. *Pharmaceutics* 2020; **12:** 905.
20 US Food and Drug Administration. Size, shape, and other physical attributes of generic tablets and capsules guidance for industry. 2015. https://www.fda.gov/files/drugs/published/Size--Shape--and-Other-Physical-Attributes-of-Generic-Tablets-and-Capsules.pdf (accessed Feb 6, 2023).
21 Kesselheim AS, Misono AS, Shrank WH, et al. Variations in pill appearance of antiepileptic drugs and the risk of nonadherence. *JAMA Intern Med* 2013; **173:** 202–08.
22 Dixon J, MacPherson E, Manyau S, et al. The 'drug bag' method: lessons from anthropological studies of antibiotic use in Africa and south-east Asia. *Glob Health Action* 2019; **12:** 1639388.
23 Brach C, Harris LM. Healthy People 2030 health literacy definition tells organizations: make information and services easy to find, understand, and use. *J Gen Intern Med* 2021; **36:** 1084–85.
24 WHO. Social determinants of health. https://www.who.int/health-topics/social-determinants-of-health#tab=tab_3 (accessed Feb 6, 2023).
25 European Medicines Agency. Good practice guide on risk minimisation and prevention of medication error. 2015. https://www.ema.europa.eu/en/documents/regulatory-procedural-guideline/good-practice-guide-risk-minimisation-prevention-medication-errors_en.pdf (accessed Feb 6, 2023).
26 Yoder S, Rajabi J, Miller C, Oza K. Physical appearance preferences for oral solid dosage formulations. *AAPS Poster* 2014; **2018:** 1–4.
27 Overgaard ABA, Højsted J, Hansen R, Møller-Sonnergaard J, Christrup LL. Patients' evaluation of shape, size and colour of solid dosage forms. *Pharm World Sci* 2001; **23:** 185–88.
28 de Craen AJ, Roos PJ, de Vries AL, Kleijnen J. Effect of colour of drugs: systematic review of perceived effect of drugs and of their effectiveness. *BMJ* 1996; **313:** 1624–26.
29 lazhenkova O, Dogerlioglu-Demir K. The shape of the pill: perceived effects, evoked bodily sensations and emotions. *PLoS One* 2020; **15:** e0238378.
30 WHO. Guidelines on packaging for pharmaceutical products. 2002. https://cdn.who.int/media/docs/default-source/medicines/norms-and-standards/guidelines/regulatory-standards/trs902-annex9.pdf?sfvrsn=82b4c57d_2 (accessed Feb 6, 2023).

Copyright © 2023 The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY 4.0 license.