Open Forum Infectious Diseases

REVIEW ARTICLE

A Behavioral Analysis of Factors That Influence Antibiotic Prescribing in Hospitals: A Metasynthesis of Reviews

Gracia Mabaya,[1,2] Jenna M. Evans,[1] Christopher J. Longo,[1,3,4] and Andrew M. Morris[5,6]

[1]Health Policy and Management, DeGroote School of Business, McMaster University, Hamilton, Ontario, Canada, [2]Clinical and Quality Standards, Quality, Ontario Health, Toronto, Ontario, Canada, [3]Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, Ontario, Canada, [4]Health Technology Assessment, Canadian Centre for Applied Research in Cancer Control, Toronto, Ontario, Canada, [5]Department of Medicine, Sinai Health and University Health Network, Toronto, Ontario, Canada, and [6]Department of Medicine, Faculty of Medicine, University of Toronto, Toronto, Ontario, Canada

Antibiotic resistance is a global public health threat driven, in part, by antibiotic overprescription. Behavior change theories are increasingly used to try to modify prescriber behavior. A metasynthesis of 8 reviews was conducted to identify factors influencing antibiotic prescribing for adults in hospital settings and to analyze these factors using 4 behavior change frameworks. Forty-three factors were identified across 7 thematic categories and then mapped to the theoretical domains framework and capability-opportunity-motivation model of behavior. The behavior change wheel and behavior change techniques taxonomy were then used to identify appropriate interventions and their components. The domain "environmental context and resources" was coded the most often, followed by "social influences" and "beliefs about consequences," revealing that prominent sources of antibiotic prescribing behavior are "physical opportunity" and "social opportunity." Based on these results, suggested interventions include environmental prompts/cues, education on consequences of antibiotic overuse, social comparison and support, and incentives.

Keywords. antibiotic prescribing; antibiotic resistance; behavior change; hospitals; quality improvement.

Antibiotic resistance reduces the efficacy of antibiotics [1] and contributes to disease spread, severe illness, disability, death, and high economic and health system costs [2–4]. An important driver of antibiotic resistance is overuse of antibiotics; 30% to 50% of antibiotic prescriptions are inappropriate and have no benefit [5–7]. Despite published guidelines and antimicrobial stewardship programs, antibiotic overprescription persists.

Behavior change theories are often used to understand and influence prescriber behavior. Examples include dual process theory, theory of planned behavior, and social cognitive theory [8–12]. The theoretical domains framework (TDF) consolidates 33 such theories into 14 domains [13], thus enabling a more comprehensive analysis of behavior vs a single theory. The TDF is part of a suite of behavior change frameworks developed by the Centre for Behaviour Change [14]. The capability-opportunity-motivation model of behavior (COM-B) consolidates the TDF's 14 domains of influencing factors into 6 higher-order sources of behavior [15]. Based on a TDF and COM-B analysis, the behavior change wheel (BCW) identifies 9 intervention functions and 6 types of policy [15], while the behavior change technique taxonomy (BCTT) outlines 93 techniques that could make up potential interventions [16]. Together, these 4 frameworks provide a comprehensive theory-based approach to identifying and analyzing factors influencing prescriber behavior and designing interventions to change prescriber behavior.

The TDF is increasingly used in empirical studies and reviews to examine the determinants of antibiotic prescribing behavior [17–22] and to design or evaluate interventions to modify antibiotic prescribing behavior [23, 24]. However, most studies and reviews focus on primary care [18, 19, 23], with fewer focusing on hospitals [20, 22] and long-term care facilities [21, 24]. These articles also usually used only the TDF. Acampora et al [25] are a notable exception, using 3 of the 4 frameworks (excluding the BCTT), and their results are more generalizable to primary care than other settings. Given the many reviews on determinants of antibiotic prescribing in hospitals paired with the underuse of all 4 behavioral frameworks, there is a need to consolidate available evidence to support clinical quality improvement in hospitals.

This metasynthesis of reviews aims to (1) synthesize the literature on factors influencing antibiotic prescribing in hospitals, (2) map identified factors to the TDF and COM-B,

Received 05 September 2024; editorial decision 06 December 2024; accepted 13 December 2024; published online 17 December 2024

Correspondence: Gracia Mabaya, MSc, MPH, Health Policy and Management, DeGroote School of Business, McMaster University, 1280 Main St W, DSB 104, Hamilton, ON L8S 4M4, Canada (mabayag@mcmaster.ca); Jenna M. Evans, PhD, Health Policy and Management, DeGroote School of Business, McMaster University, 1280 Main St W, DSB 222, Hamilton, ON L8S 4M4, Canada (jenna.evans@mcmaster.ca).

Open Forum Infectious Diseases®

https://doi.org/10.1093/ofid/ofae728

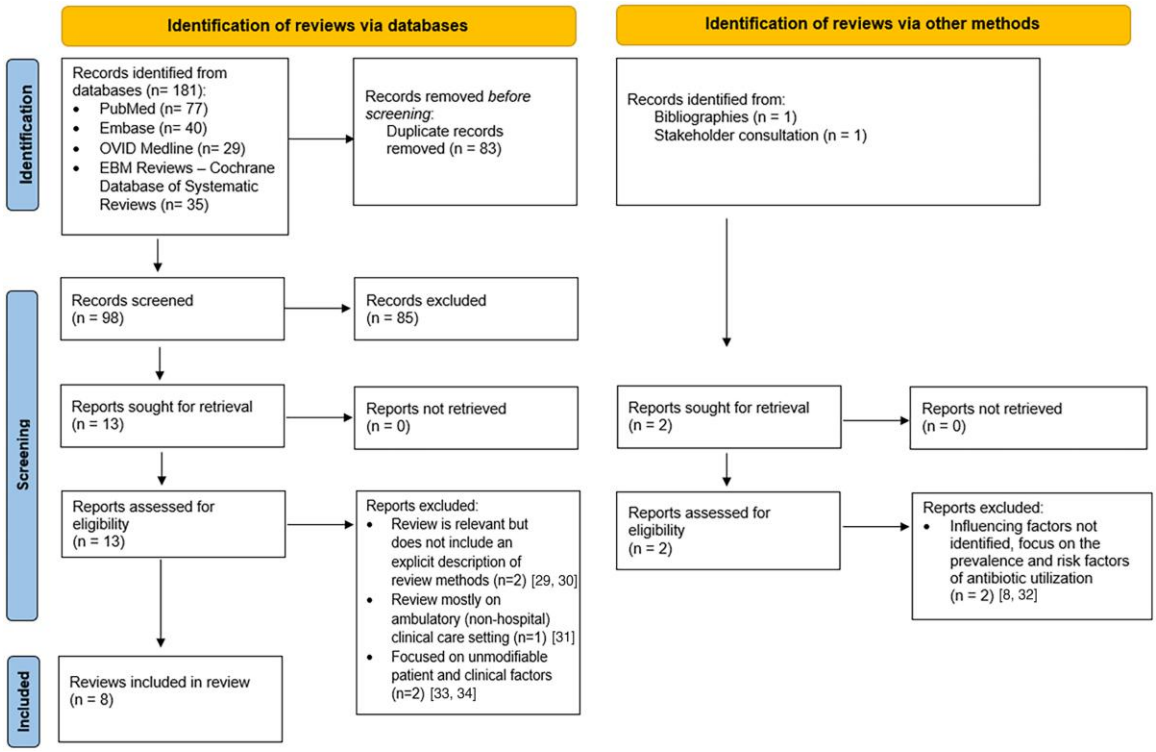

Figure 1. PRISMA flow diagram.

(3) align the results to the appropriate interventions via the BCW, and (4) identify the appropriate behavior change techniques with the BCTT.

METHODS

This metasynthesis [26, 27] of reviews was conducted in accordance with the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-analyses) [28].

Search Strategy

The search strategy was developed with input from a librarian and 2 researchers with expertise in antimicrobial stewardship. The search was conducted in September 2023 in PubMed, Ovid MEDLINE, Embase, and EBM Reviews–Cochrane Database of Systematic Reviews. A combination of free text, indexing, and MeSH terms was used across the databases. See Supplementary Appendix A for the full search strategy.

Eligibility Criteria

The process of searching, screening, and selecting reviews for inclusion is detailed in a PRISMA diagram in Figure 1 [28, 35, 36]. To be included, reviews had to focus on modifiable factors influencing antimicrobial prescribing for adults in the hospital (ie, the emergency department or inpatient care settings). Reviews addressing only unmodifiable patient or clinical risk factors were excluded. All review types were considered for inclusion as long as the methods were described.

Screening

Rayyan software [37] was used to screen references. Two reviewers (G. M. and J. M. E.) independently screened 16 abstracts and 10 full-text articles, meeting to discuss and reach consensus on disagreements at both screening stages. One reviewer (G. M.) then screened remaining abstracts and full-text articles using agreed-upon guidelines. Reviews were excluded for many reasons, such as clinical care setting (not hospital), population (not adult humans), language (not available in English), methods (not a review or no description of review methods), antimicrobial prescribing not included as an outcome, or a focus on interventions (not influencing factors). Eight reviews were included. Given that all reviews focused on antibiotic (not antimicrobial) prescribing, the scope of this metasynthesis was narrowed to antibiotics only.

Quality Assessment

Using the Health Evidence Quality Assessment Tool [38, 39], 2 independent reviewers (G. M. and J. M. E.) assessed the methodological quality of the reviews.

Data Extraction and Synthesis

One author (G. M.) extracted study characteristics on each review. Using definitions of TDF domains proposed by Atkins et al [13] and agreed-on guidelines for coding to each TDF domain (Supplementary Appendix B), 2 authors (G. M. and J. M. E.) independently extracted data related to influencing factors across reviews, categorized and consolidated factors, and mapped these factors to the domains of the TDF as either a "primary" example of that domain (direct or strong) or a "secondary" example of that domain (indirect or weak). The authors then compared their mapped factors and resolved discrepancies by discussion. Next, the categories of factors and their associated TDF domains were mapped to the COM-B, BCW, and BCTT frameworks to facilitate behavioral analysis and development of recommendations. These mapping processes were informed by the framework developers' prior work [13, 15], empirical evidence [40, 41], and discussion among authors to resolve any coding discrepancies.

RESULTS

Study Characteristics

Eight reviews published between 2013 and 2022 were included (Table 1). Most reviews consisted of studies that were conducted in developed countries, such as Australia (n = 1) [44], Portugal (n = 1) [49], the United States (n = 1) [42], and the United Kingdom (n = 4) [34–36, 46], while 1 review focused on low- and middle-income countries [48]. Four reviews (50%) were systematic reviews of qualitative studies [42, 43, 45, 47], 3 (38%) were narrative reviews of the literature [44, 48, 49], and 1 (13%) was a realist review [46]. Clinical care settings included the emergency department, the intensive care unit, and other inpatient hospital settings. In addition to hospital settings, 4 (50%) reviews comprised studies on hospital and primary care settings [46–49]. Reviews mentioned physicians as the main prescribers: 3 (38%) made reference to medical residents or junior physicians [43, 45, 46], 2 (25%) to nurses [42, 44], 1 (13%) to physician assistants [42], and another (13%) to medical teams working in surgery [43]. Only 1 review [45] mentioned using theory to inform its analysis.

Methodological Quality of Reviews

The methodological quality of reviews was strong, with scores between 8 and 10. The reviews had focused research questions, used appropriate inclusion and search criteria, described the level of evidence in the primary studies, and used reliable and transparent methods. The primary methodological weakness was that 3 reviews did not adequately assess the methodological quality of their primary studies [42, 45, 46].

Factors Influencing Antibiotic Prescribing

Seven thematic categories of factors influencing antibiotic prescribing were identified and are listed alongside the number of reviews for each:

- Prescriber characteristics (n = 7, 88%)
- Complex risk perceptions, emotions, and judgments (n = 6, 75%)
- Effects of the work environment on prescriber cognition (n = 7, 88%)
- Features of the clinical setting, organization, or environment (n = 6, 75%)
- Team structures and relationships (n = 5, 63%)
- Hierarchy and power dynamics (n = 3, 38%)
- Patient factors (n = 5, 63%)

Table 2 outlines the 7 thematic categories, their 43 associated factors across reviews, the primary and secondary TDF domains on to which they map, and the relevant COM-B domain. In what follows, we briefly describe the thematic categories and their associated domains from the TDF and COM-B frameworks, followed by a synthesis of the results using all 4 frameworks. Figure 2 provides a visual illustration of these results.

Prescriber Characteristics. The thematic category "prescriber characteristics" was identified by 7 reviews (88%) and consists of 3 influencing factors, 2 of which were recognized by ≥4 reviews: (1) prescriber education and experience and (2) prescriber knowledge of and confidence in antibiotic prescribing and resistance [42–45, 47–49]. The influencing factors in this category were coded to 3 primary TDF domains: (1) social/professional role and identity, (2) knowledge, and (3) psychological skills. Knowledge and psychological skills were cited by 6 of the 7 reviews. The COM-B framework identifies the sources of behavior as "psychological capability," defined as knowledge or psychological skills and ability or stamina to engage in necessary mental processes, and "reflective motivation," defined as thought processes involving planning and evaluating [15].

Complex Risk Perceptions, Emotions, and Judgments. The thematic category "complex risk perceptions, emotions, and judgments" covers prescribers' perceptions and fears associated with antibiotic prescribing and consists of 9 influencing factors. This category was addressed in 6 reviews (75%) [43, 45–49]. Only 2 of the 9 influencing factors were identified by ≥4 reviews, suggesting that these are particularly important factors that shape antibiotic prescribing: (1) prescriber perceptions of the short- vs long-term risks and benefits of antibiotic prescribing and (2) prescriber perceptions of diagnostic uncertainty paired with individual tolerance for uncertainty.

The following 7 primary TDF domains were linked to this thematic category, more than any other category, which suggests that this category may be the most complex and dynamic: beliefs about consequences, beliefs about capabilities, goals, social/professional role and identity, emotion, knowledge, and skills. "Beliefs about consequences' was coded most often as a primary domain in this category (4 times), while the remaining

Table 1. Characteristics of the Reviews (N = 8)

Review	Aim	Type of Review	Included Studies	Clinical Care Setting	Prescribers Studied	Methodological Quality: Score, Rating[a]
Lim (2022) [42]	To identify factors associated with antibiotic use for uncomplicated acute respiratory tract infections in adults presenting at the emergency department	Systematic review	12 studies published between 2005–2017	Emergency department	Physicians, nurse practitioners, and physician assistants	8, strong
Parker (2022) [43]	To synthesize qualitative studies on surgical antimicrobial prescribing behavior in hospital settings to explain how and why contextual factors act and interact to influence practice	Systematic review (metaethnography)	14 studies published between 2016–2021	Secondary care settings: surgical wards, ambulatory clinics, and theaters	Physicians	10, strong
Padigos (2021) [44]	To identify and critically evaluate primary studies that examined knowledge, perspectives, and experiences of nurses associated with antimicrobial use and optimization in intensive care units	Systematic review	26 studies published between 2001–2020	Hospital inpatient (intensive care unit)	Physicians, nurses	10, strong
Krockow (2019) [45]	To provide a systematic review of qualitative research on antibiotic prescribing decisions in hospitals worldwide, including broad-spectrum antibiotic use	Systematic review	34 studies published between 2007 and 2017	Hospital inpatient	Junior and senior physicians	8, strong
Papoutsi (2017) [46]	To highlight the complex social and professional dynamics underlying antimicrobial prescribing decisions of doctors in training	Realist review	131 studies published between 2000 and 2015	Hospital inpatient and ambulatory, emergency department, and primary care	Doctors in training (ie, junior physicians), nursing staff, and senior clinicians	9, strong
Ness (2016) [47]	To present the findings of a systematic review that explored the influences on the antimicrobial prescribing behavior of independent nurse prescribers	Systematic review	7 studies published between 2001 and 2013	Hospital inpatient, primary care, community based, and ambulatory care	Nurse prescribers	8, strong
Rezal (2015) [48]	To systematically review knowledge, perceptions, and prescribing behavior key to antibiotic prescribing	Narrative review	19 studies published between 1990 and 2014	Hospital inpatient and primary care	Physicians	9, strong
Rodrigues (2013) [49]	To explore physicians' perceptions of factors influencing antibiotic prescribing	Narrative review	35 studies published between 1996 and 2011	Hospital inpatient and ambulatory care	Physicians	9, strong

[a]Health Evidence Quality Assessment Tool (score out of 10).

Table 2. Factors Influencing Antibiotic Prescribing: A Behavioral Analysis Based on the COM-B and TDF

COM-B Source of Behavior	Primary and Secondary TDF Domains	Factors From the Literature	Reviews That Include Factors							
			Lim (2022) [42]	Parker (2022) [43]	Padigos (2021) [44]	Krockow (2019) [45]	Papoutsi (2017) [46]	Ness (2016) [47]	Rezal (2015) [48]	Rodrigues (2013) [49]
Prescriber characteristics										
Reflective motivation	Social/professional role and identity	Sociodemographic profile of prescriber: age, profession (eg, physician, nurse practitioner), and medical specialization	✓							
Psychological capability	Knowledge and psychological skills[a] *Secondary:* Social/professional role and identity Beliefs about consequences	Prescriber's education and experience: • University education on prescribing and resistance • Continuing medical education on prescribing and resistance • Years of practice • Seniority • Previous clinical experiences (consequences of prescribing and resistance)		✓		✓		✓		✓
	Knowledge and psychological skills *Secondary:* Beliefs about capabilities Beliefs about consequences	Knowledge of and confidence in (1) antibiotics and their selection and use, (2) current scale of resistance and local resistance patterns, (3) link between overprescribing and resistance, and (4) preventing antibiotic-related medication errors			✓	✓		✓	✓	✓
Complex risk perceptions, emotions, and judgments										
Reflective motivation	Beliefs about consequences *Secondary:* Memory, attention, and decision processes	Assessment of potential short- and long-term risks and benefits of antibiotics to patient, prescriber, and health system		✓		✓		✓		✓
	Beliefs about consequences	Perception of influence of prescribing decisions (vs other factors) on resistance				✓				
	Beliefs about consequences *Secondary:* Behavioral regulation Environmental context and resources	Extent of trust in and agreement with evidence and guidelines based on perceptions regarding their credibility and usefulness: their source, development process, recency, gaps and limitations, coherence with own experience, and specificity and applicability to individual patients		✓			✓		✓	
	Beliefs about consequences *Secondary:* Emotion Social/professional role and identity Goals	Bias toward action vs inaction (particularly on short-term risks) to "be on the safe side" and "do right by the patient"; antibiotics viewed as a "safety net" and "conservative intervention" (ie, safety from litigation, personal responsibility for a complication or adverse outcome, reputational damage, loss of patient to other clinician; there is fear associated with these outcomes)		✓		✓				✓
	Beliefs about capabilities	Perception of personal susceptibility to inappropriate prescribing decisions and/or resistance				✓				
	Goals *Secondary:* Beliefs about consequences Memory, attention, and decision processes	Perception of importance or priority of antibiotic management relative to other clinical tasks		✓						✓

Table 2. Continued

COM-B Source of Behavior	Primary and Secondary TDF Domains	Factors From the Literature	Reviews That Include Factors							
			Lim (2022) [42]	Parker (2022) [43]	Padigos (2021) [44]	Krockow (2019) [45]	Papoutsi (2017) [46]	Ness (2016) [47]	Rezal (2015) [48]	Rodrigues (2013) [49]
	Social/professional role and identity	Perception of who owns the risks associated with prescribing		✓						
Automatic motivation	Emotion *Secondary:* Beliefs about consequences	Fear of adverse patient outcomes and associated consequences for patient and prescriber		✓						✓
Psychological capability	Knowledge and psychological skills	Perception of diagnostic uncertainty paired with individual tolerance for uncertainty (includes uncertainty if bacterial or viral infection)		✓				✓	✓	✓
Effects of the work environment on prescriber cognition										
Psychological capability	Memory, attention, and decision processes *Secondary:* Goal Environmental context and resources	High patient volumes, high workload, time pressures, and associated decision fatigue and desire for a quick fix		✓	✓					✓
	Memory, attention, and decision processes *Secondary:* Knowledge and psychological skills Environmental context and resources Behavioral regulation	Availability of decision support tools in the clinical setting (eg, diagnostic tests, policies, guidelines, antibiograms, order sets, structured handover tools, electronic health records, alert systems, colleague to consult with)	✓	✓	✓			✓	✓	✓
	Memory, attention, and decision processes *Secondary:* Environmental context and resources	Ease of prescribing (ie, prescribing antibiotics, using the same prescription, and using default options presented in systems require less cognitive effort)				✓				✓
Automatic motivation	Reinforcement *Secondary:* Environmental context and resources	Availability of feedback on prescribing decisions and patient outcomes (eg, adverse effects)		✓						
Features of the clinical setting, organization, or environment										
Physical opportunity	Environmental context and resources *Secondary:* Memory, attention, and decision processes	Workflow and routines that influence timing of antibiotic administration								✓
	Environmental context and resources	Access to diagnostic facilities and/or timeliness of receiving diagnostic test results							✓	✓
	Environmental context and resources	Availability and supply of antibiotics		✓	✓				✓	
	Environmental context and resources	Private vs public ownership of practice or organization								✓

Table 2. Continued

COM-B Source of Behavior	Primary and Secondary TDF Domains	Factors From the Literature	Reviews That Include Factors							
			Lim (2022) [42]	Parker (2022) [43]	Padigos (2021) [44]	Krockow (2019) [45]	Papoutsi (2017) [46]	Ness (2016) [47]	Rezal (2015) [48]	Rodrigues (2013) [49]
	Environmental context and resources	Accreditation level of practice or organization								✓
	Environmental context and resources *Secondary:* Social influences	Pharmaceutical companies (eg, advertising, interactions with pharmaceutical representatives)							✓	✓
	Environmental context and resources	Season of the year	✓							
	Environmental context and resources	Wait times in select settings, such as the emergency department	✓							
	Environmental context and resources *Secondary:* Knowledge and psychological skills Behavioral regulation	Access to educational resources and opportunities on prescribing and resistance	✓		✓	✓			✓	
Automatic motivation	Reinforcement *Secondary:* Environmental context and resources	Financial incentives that promote or suppress antibiotic prescribing							✓	✓
Team structures and relationships										
Physical opportunity	Environmental context and resources *Secondary:* Social/ professional role and identity	Number of teams managing patient cases resulting in heterogeneous management			✓					
Social opportunity	Social influences *Secondary:* Environmental context and resources	Extent to which antimicrobial stewardship and/or infectious diseases teams are integrated with surgical teams (ie, physically in terms of proximity and figuratively in terms of being considered part of the surgical team vs a "consulting service")		✓						
	Social influences *Secondary:* Environmental context and resources Psychological skills Social/professional role and identity	Relationship dynamics and quality of communication and collaboration within and across teams and professionals: extent of discussion on antibiotic prescribing among clinicians or between clinicians and patients		✓	✓				✓	✓
Reflective motivation	Social/professional role and identity *Secondary:* Environmental context and resources Social influences	Perceptions about professional roles, scopes of practice, and implicit vs explicit rules of engagement regarding antibiotic management and preventing resistance (eg, between prescriber and pharmacist, between senior and junior physicians, or among physicians caring for the same patient)		✓	✓		✓			✓

Table 2. Continued

COM-B Source of Behavior	Primary and Secondary TDF Domains	Factors From the Literature	Reviews That Include Factors							
			Lim (2022) [42]	Parker (2022) [43]	Padigos (2021) [44]	Krockow (2019) [45]	Papoutsi (2017) [46]	Ness (2016) [47]	Rezal (2015) [48]	Rodrigues (2013) [49]
Hierarchy and power dynamics										
Social opportunity	Social influences	Perception of what is conventional practice and what knowledge, practices, risk assessments, and sources of support (eg, guidelines or other professionals' opinions) are accepted by those in senior roles		✓			✓			
	Social influences	Extent to which senior doctors are engaged in stewardship efforts		✓						
	Social influences *Secondary:* Environmental context and resources	Extent to which nurses are aware of prescriptions and included in rounds and team discussions			✓					
	Social influences *Secondary:* Environmental context and resources	Extent to which nurses are empowered and engaged to be advocates for antimicrobial stewardship through training, guidelines, and leadership roles (eg, to prompt antibiotic review without experiencing prescriber pushback)		✓	✓					
Automatic motivation	Emotion *Secondary:* Social influences Beliefs about consequences	Fear associated with questioning or challenging prescribing decisions of senior doctors; includes fear of criticism, reprimand, rejection, embarrassment, conflict, appearing ignorant or incompetent, upsetting professional relationships, losing the respect of the seniors, losing one's position in the hierarchy and not fitting in, developing a negative reputation, damaging one's career progression, and individual responsibility for patients deteriorating while under one's care					✓			
Reflective motivation	Social/professional role and identity *Secondary:* Environmental context and resources Social influences	Medical hierarchy and culture of deference to physicians, which results in junior physicians and nonphysicians not questioning or challenging senior physicians		✓	✓		✓			
Patient factors										
Physical opportunity	Environmental context and resources	Patient's sociodemographic profile and medical condition: age, gender, smoking status, allergies, critically ill or immunocompromised, clinical symptoms and diagnosis, comorbidities, anxiety, education level, severity of illness, duration of infection	✓					✓	✓	✓
	Environmental context and resources *Secondary:* Beliefs about consequences	Perception of cost to patients based on their financial capability and insurance coverage	✓	✓				✓	✓	✓
	Environmental context and resources	Patient's ability to receive follow-up care	✓							

Table 2. Continued

COM-B Source of Behavior	Primary and Secondary TDF Domains	Factors From the Literature	Reviews That Include Factors: Lim (2022) [42]	Parker (2022) [43]	Padigos (2021) [44]	Krockow (2019) [45]	Papoutsi (2017) [46]	Ness (2016) [47]	Rezal (2015) [48]	Rodrigues (2013) [49]
	Environmental context and resources	Exposure to others who are sick and require antibiotics								✓
Social opportunity	Social influences	Perceived patient expectation, demand, or pressure for antibiotics, sometimes driven by a desire for a "quick fix" by patients or caregivers							✓	✓
	Social influences	Expected patient compliance						✓		
	Social influences *Secondary:* Emotion Beliefs about consequences	Maintaining patient satisfaction and fear of losing patients	✓	✓					✓	

Abbreviations: COM-B, capability-opportunity-motivation model of behavior; TDF, theoretical domains framework.

[a]In the TDF, "knowledge" and "skills" are separate domains. However, all of the identified factors are "psychological skills," not "physical skills." "Knowledge" and "psychological skills" both fit under the COM-B domain "psychological capability." Furthermore, in some cases it is difficult to distinguish between knowledge and psychological skills. Therefore, we often coded these 2 domains together, where deemed applicable.

domains were coded only once. Based on the COM-B, this suggests that "reflective motivation" is the key source of behavior for this category.

Effects of the Work Environment on Prescriber Cognition. The thematic category "effects of the work environment on prescriber cognition" refers to how the work environment shapes prescribers' thinking and problem solving. This category consists of 4 influencing factors and was addressed in 7 (88%) reviews, making this category, with "prescriber characteristics," the most identified across the reviews [42–45, 47–49]. One influencing factor was noted by 6 reviews—"availability of decision support tools in the clinical setting." The remaining influencing factors were cited by ≤3 reviews.

Two primary TDF domains were coded within this thematic category: (1) memory, attention, and decision processes and (2) reinforcement. "Memory, attention, and decision processes" was coded primary most often, with "environmental context and resources" coded as a secondary domain for all 4 influencing factors, suggesting that, per the COM-B framework, "psychological capability" and "physical opportunity" (ie, opportunity afforded by the environment) are the key sources of behavior for this category.

Features of the Clinical Setting, Organization, or Environment. The thematic category "features of the clinical setting, organization, or environment" captures all contextual factors external to the prescriber. This category consists of 10 factors and was identified by 6 (75%) reviews [42–45, 48, 49]. One of the 10 factors was cited by 4 reviews—"access to educational resources and opportunities on prescribing and resistance"—while another was noted by 3 reviews: "availability and supply of antibiotics." The remaining 8 factors were indicated by only 1 or 2 reviews. The TDF domain coded most often in this category was "environmental context and resources," which was coded to 9 factors as a primary TDF domain, while "reinforcement" was coded as a primary TDF domain for 1 factor. Therefore, the key source of behavior for this category according to the COM-B framework was "physical opportunity."

Team Structures and Relationships. The thematic category "team structures and relationships" refers to how teams and their members operate and how they relate to and perceive one another. This category consists of 4 factors and was identified by 5 (63%) reviews [43, 44, 46, 48, 49]. Two of the 4 factors were cited by 4 reviews each: (1) relationship dynamics and quality of communication and collaboration within and across teams and professionals and (2) perceptions about professional roles, scopes of practice, and implicit vs explicit rules of engagement.

The influencing factors in this thematic category were coded to 3 primary TDF domains: environmental context and resources, social influences, and social/professional role and

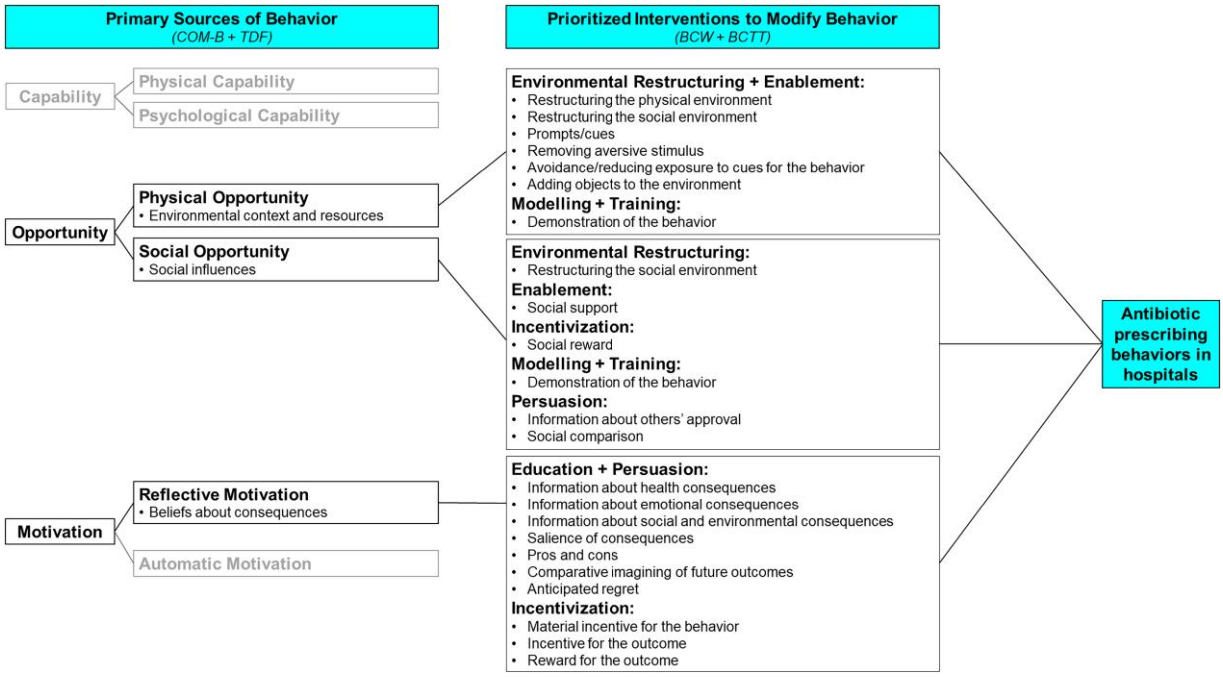

Figure 2. Primary sources of antibiotic prescribing behavior in hospitals and prioritized behavior change interventions and techniques. Note that the intervention function "restriction" from the behavior change wheel (BCW) was not included because there are no behavior change techniques associated with it [15]. BCTT, behavior change technique taxonomy; COM-B, capability-opportunity-motivation model of behavior; TDF, theoretical domains framework.

identity. All 3 of these TDF domains were coded often as primary and secondary domains, suggesting that they are intertwined. In terms of the COM-B framework, the key sources of behavior for this thematic category are "social opportunity" (ie, opportunity afforded by interpersonal influences, social cues, and cultural norms), "physical opportunity," and "reflective motivation."

Hierarchy and Power Dynamics. The thematic category "hierarchy and power dynamics" refers to how placement in the medical hierarchy based on profession or seniority influences prescribing decisions. This category consists of 6 factors and was identified by 3 (38%) reviews [43, 44, 46]. Most of the factors were noted by only 1 or 2 reviews; just 1 factor—"medical hierarchy and cultural deference to physicians"—was reported by 3 reviews.

The factors were coded to 3 primary TDF domains: social influences, emotion, and social/professional role and identity. "Social influences" was the most dominant primary and secondary TDF domain, meaning that "social opportunity" is the key source of behavior per the COM-B framework.

Patient Factors. The thematic category "patient factors" consolidates factors related to patients and to prescribers' perceptions of patients. This category consists of 6 factors and was identified by 5 (63%) reviews [42, 43, 47–49]. Two factors were cited by ≥4 reviews: (1) patient's sociodemographic profile and medical condition and (2) prescriber's perception of cost to the patient.

The factors in this thematic category were coded to 2 primary TDF domains—(1) environmental context and resources and (2) social influences—suggesting that the key sources of behavior are "physical opportunity" and "social opportunity" according to the COM-B framework.

Synthesizing Results and Identifying Appropriate Interventions. The 7 thematic categories and their influencing factors mapped onto 12 of 14 TDF domains as a primary or secondary domain; none of the factors mapped onto the TDF domains of "optimism" or "intentions." Supplementary Appendix C shows how often each TDF domain was coded primary vs secondary across the reviews and the associated COM-B domains. "Environmental context and resources" was coded the most as a primary TDF domain (30%), particularly for "features of the clinical setting, organization, or environment" and "patient factors"; it was also coded most as a secondary domain (30%), mainly for "effects of the work environment on prescriber cognition." "Social influences" was the second-most coded primary TDF domain (20%), mainly for "team structures and relations" and "hierarchy and power dynamics." "Beliefs about consequences" was the second-most coded secondary TDF domain (18%) across various thematic categories and factors. The least-coded TDF domains were "goals," "reinforcement," "beliefs about capabilities," "behavioral regulation," and "emotion," which were coded as primary and secondary TDF domains <5 times total (2%–4%).

Our results suggest that the 2 most critical sources of prescribing behavior are "physical opportunity" based on the environment (eg, time, resources) and "social opportunity" based on interpersonal influences, social cues, and cultural norms. While "motivation" and "capability" also play a role, most influencing factors were coded to "opportunity," suggesting that interventions should focus on modifying the context in which antibiotic prescribing occurs.

The BCW supports the development of recommendations to address antibiotic prescribing. Eight of the 9 intervention functions in the BCW were identified multiple times across the aforementioned thematic categories; only "coercion" to create an expectation of punishment or cost was not cited [15]. For "physical opportunity" and "social opportunity," the BCW suggests prioritizing environmental restructuring to change the physical and social context, among other interventions (Figure 2) [15]. "Beliefs about consequences" was also a prominent TDF domain, suggesting the importance of exploring clinician perceptions of consequences and using those data to inform interventions such as education, persuasion, and incentivization [15]. The BCW identifies all 7 policy categories as potential options to enable these intervention functions: guidelines, fiscal measures, regulation, legislation, environmental or social planning, communication or marketing, and service provision [15].

The BCTT facilitates the development of more specific recommendations [15, 40, 41]. Empirical evidence on the BCTT [40, 41] and our analysis suggest that the following behavior change techniques are most likely to address "environmental context and resources": restructuring the physical environment, restructuring the social environment, prompts/cues, removing aversive stimulus, avoidance/reducing exposure to cues for the behavior, adding objects to the environment, and demonstration of the behavior. Those most likely to address "social influences" are restructuring the social environment, social support, social reward, demonstration of the behavior, information about others' approval, and social comparison. Finally, for "beliefs about consequences," empirical evidence on the BCTT [40, 41] suggests the following: information about health consequences, information about emotional consequences, information about social and environmental consequences, salience of consequences, pros and cons, comparative imaging of future outcomes, anticipated regret, material incentive for the behavior, incentive for the outcome, and reward for the outcome. In summary, our behavioral analysis prioritized 23 behavior change techniques out of the possible 93 in the BCTT (25%); see Table 3 for practical examples.

DISCUSSION

This metasynthesis of reviews consolidates and analyzes determinants of antibiotic prescribing by using the TDF, COM-B, BCW, and BCTT. We identified 7 thematic categories containing 43 influencing factors that span multiple interrelated issues at the patient, clinician, team, organizational, and environmental levels. Mapping these factors to the TDF and COM-B highlights the potent influence of the physical and social environment as well as prescriber beliefs about consequences. The results of our TDF and COM-B mapping were used to determine recommendations for intervention design via the BCW and BCTT, which highlighted the need for environmental prompts/cues for appropriate prescribing, education on consequences of antibiotic overuse, social comparison and support, and incentives. These frameworks suggest that coercion through punishment or costs will not be effective interventions [15].

Our results align with previous reviews of antibiotic prescribing that use the TDF. In a review of nonmedical prescribers, Chater et al [18] cited "beliefs about consequences" and "social influences" as the most common determinants, with "environmental context and resources" close behind, similar to our results. In the Acampora et al [25] review of various health care settings, "environmental context and resources" and "social influences" were the top 2, as in our metasynthesis. However, "beliefs about consequences" was ranked much lower in their results. In a review of primary care, Thompson et al [19] mapped the identified factors to the TDF but did no further analysis with the TDF results. Like our results, none of these reviews offered examples of "intentions" or "optimism."

Notably absent from the reviews is the influence of public policy on antibiotic prescribing, such as through funding, incentives, and the work of governmental agencies. It is unclear whether public policy plays little to no role in antibiotic prescribing patterns or if it has just been overlooked. Furthermore, reviews largely overlooked inequities as an influencing factor. While most reviews acknowledged the role of clinicians' and patients' sociodemographic profiles and prescribers' perceptions of cost to the patient, there was no consideration for how inequities may influence the antibiotic prescribing process. For example, regarding 2 of our categories, "team structure and relationships" and "hierarchy and power dynamics," race and gender of the prescriber and their teammates and supervisors may play a role but were not studied.

Strengths and Limitations

A strength of our metasynthesis of reviews is that we consolidated results from multiple reviews. We used a more nuanced coding approach by coding for primary and secondary influences for a more comprehensive and dynamic analysis that considers complex relationships among factors. Finally, we used all 4 frameworks developed by the Centre for Behaviour Change to support a deep analysis of behavior that links identified determinants to appropriate interventions.

This metasynthesis also has limitations. First, relevant reviews may have been missed. However, the databases were selected in consultation with a librarian and provided broad coverage of health care literature. We also reviewed reference lists and

Table 3. Practical Examples of Behavior Change Techniques Relevant to Appropriate Antibiotic Prescribing

Most Prominent TDF Domains Influencing Antibiotic Prescribing in Hospitals	Associated BCTT Behavior Change Technique	Definition [15]	Application to Antibiotic Prescribing
Environmental context and resources: most coded primary and secondary domain	Restructuring the physical environment	Change or advise to change the physical environment to facilitate performance of the wanted behavior or create barriers to the unwanted behavior (other than prompts/cues, rewards, and punishments).	Station antimicrobial stewardship team members and infectious disease specialists close to the clinical units with the highest antibiotic prescribing rates to facilitate consultations.
	Restructuring the social environment	Change or advise to change the social environment to facilitate performance of the wanted behavior or create barriers to the unwanted behavior (other than prompts/cues, rewards, and punishments).	Train senior attending physicians to give junior physicians or medical residents a safe space to rationalize and discuss their prescribing decisions [50].
	Prompts/cues	Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behavior. The prompt or cue would normally occur at the time or place of performance.	Use prompts or pop-up windows in electronic prescribing tools for self-directed antibiotic reassessment, also known as "antibiotic timeouts." These are structured reminders or conversations that prompt clinicians to reassess an antibiotic prescription to ensure continued appropriateness [51, 52].
	Removing aversive stimulus	Advise or arrange for the removal of an aversive stimulus to facilitate behavior change.	Remove long wait-times for obtaining diagnostic test results through use of rapid point-of-care diagnostic tests and the involvement of microbiology laboratory staff to guide the proper use of tests and the flow of results as part of "diagnostic stewardship" to facilitate appropriate antibiotic prescribing [52, 53].
	Avoidance/reducing exposure to cues for the behavior	Advise on how to avoid exposure to specific social and contextual/physical cues for the behavior, including changing daily or weekly routines.	Remove outdated antibiotic prescribing guidelines, including those that are printed, posted, or embedded in electronic tools.
	Adding objects to the environment	Add objects to the environment to facilitate performance of the behavior. Note: Provision of information (eg, written, verbal, visual) in a booklet or leaflet is insufficient.	Embed recommendations from institution-specific antibiotic prescribing guidelines or institution-specific antimicrobial stewardship priorities within clinical pathways in electronic systems, facilitated by prompts [54].
	Modeling or demonstration of the behavior	Provide an observable sample of the performance of the behavior, directly in person or indirectly (eg, via film, pictures), for the person to aspire to or imitate.	Demonstrate how to navigate and respond to antibiotic prescribing prompts in the electronic system.
Social influences: second-most coded primary domain	Restructuring the social environment	Change or advise to change the social environment to facilitate performance of the wanted behavior or create barriers to the unwanted behavior (other than prompts/cues, rewards, and punishments).	Implement a team-based approach to making prescribing decisions for select antibiotics involving antimicrobial stewardship team members, pharmacists, or infectious diseases physicians.
	Social support	Advise on, arrange, or provide social support (eg, from friends, relatives, colleagues, buddies, or staff) or noncontingent praise or reward for performance of the behavior. It includes encouragement and counseling but only when it is directed at the behavior. Note: attending a group class and/or mention of "follow-up" does not necessarily apply this behavior change technique; support must be explicitly mentioned.	Require input and/or authorization from antimicrobial stewardship team members, pharmacists, or infectious diseases physicians for prescribing select antibiotics before they are released from the pharmacy for administration to patients [51].
	Social reward	Arrange verbal or nonverbal reward if and only if there has been effort and/or progress in performing the behavior (includes "positive reinforcement").	Verbally thank clinicians when they have followed institutional protocols, such as consulting other members of the clinical team to review the appropriateness of their antibiotic prescriptions.
	Modeling or demonstration of the behavior	Provide an observable sample of the performance of the behavior, directly in person or indirectly (eg, via film, pictures), for the person to aspire to or imitate.	Demonstrate appropriate prescribing via a role-play exercise, using case studies.
	Social comparison	Draw attention to others' performance to allow comparison with the person's own performance. Note: being in a group setting does not necessarily mean that social comparison is actually taking place.	As part of audit and feedback, via face-to-face meetings (also known as "handshake stewardship"), providing clinicians with information comparing their antibiotic prescribing practice with the desired practice as described in evidence-based guidelines or in comparison with their peers [52, 55].

Table 3. Continued

Most Prominent TDF Domains Influencing Antibiotic Prescribing in Hospitals	Associated BCTT Behavior Change Technique	Definition [15]	Application to Antibiotic Prescribing
	Information about others' approval	Provide information about what other people think about the behavior. The information clarifies whether others will like, approve of, or disapprove of what the person is doing or will do.	Inform clinicians of the involvement of senior clinicians or department heads in the development of institution-specific antibiotic prescribing guidelines or algorithms, as well as their approval of it by embedding quotes submitted by those involved within internal newsletters.
Beliefs about consequences: second-most coded secondary domain	Information about health consequences	Provide information (eg, written, verbal, visual) about health consequences of performing the behavior. Note: consequences can be for any target, not just the recipients of the intervention; emphasizing importance of consequences is not sufficient.	Develop written and visually appealing materials describing how prescribing antibiotics inappropriately can increase patients' susceptibility to future infections and give rise to antimicrobial resistance within the institution and community, including relevant data on these health consequences.
	Information about emotional consequences	Provide information (eg, written, verbal, visual) about emotional consequences of performing the behavior. Note: consequences can be related to emotional health disorders (eg, depression, anxiety) and/or states of mind (eg, low mood, stress).	Use internal newsletters or posters displayed at the point of care to inform clinicians about how adverse events related to inappropriate antibiotic prescribing could negatively affect them and the team emotionally, leading to feelings of depression, anxiety, and stress.
	Information about social and environmental consequences	Provide information (eg, written, verbal, visual) about social and environmental consequences of performing the behavior. Note: consequences can be for any target, not just the recipients of the intervention.	Use internal newsletters or posters displayed at the point of care to inform clinicians about how inappropriate prescribing affects the institution's overall prescribing data, which are monitored by government agencies and the health system.
	Salient consequences	Use methods specifically designed to emphasize the consequences of performing the behavior with the aim of making them more memorable (goes beyond informing about consequences).	Share patient stories or data on patients who have contracted an antibiotic-resistant infection such as methicillin-resistant Staphylococcus aureus (MRSA) and experienced fatal health outcomes due to previous inappropriate antibiotic prescriptions.
	Pros and cons	Advise the person to identify and compare reasons for wanting (pros) and not wanting (cons) to change the behavior (includes "decisional balance").	Advise clinicians during department meetings or retreats to list and compare the advantages and disadvantages of inappropriately prescribing antibiotics for certain health conditions (eg, upper respiratory tract infections).
	Comparative imaging of future outcomes	Prompt or advise the imagining and comparing of future outcomes of changed vs unchanged behavior.	Conduct a session during department meetings or retreats where clinicians are prompted to imagine future outcomes associated with appropriate and inappropriate antibiotic prescribing. These outcomes could be related to patient outcomes, the clinicians' performance or reputation, and the institution as a whole.
	Anticipated regret	Induce or raise awareness of expectations of future regret about performance of the unwanted behavior.	Raise awareness among clinicians that inappropriate prescribing threatens patient safety, leading to fatal adverse events, such as increased morbidity or mortality in some cases.
	Material incentives for the behavior	Inform that money, vouchers, or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behavior (includes "positive reinforcement").	Inform clinicians that the clinical unit with the highest attendance at institutional antibiotic prescribing information sessions will be given additional funds to support their local quality improvement initiatives.
	Incentive for the outcome	Inform that a reward will be delivered if and only if there has been effort and/or progress in achieving the behavioral outcome (includes "positive reinforcement").	Inform clinicians that sustained improvement in the appropriateness of their antibiotic prescribing practice of ≥10% over a specific period will be noted in their performance development plan, potentially leading to increased financial remuneration.
	Reward for the outcome	Arrange for the delivery of a reward if and only if there has been effort and/or progress in achieving the behavioral outcome (includes "positive reinforcement").	Arrange for clinicians with sustained improvement in the appropriateness of their antibiotic prescribing practice of ≥10% over a specific period to receive increased financial remuneration.

Abbreviations: BCTT, behavior change technique taxonomy; TDF, theoretical domains framework.

consulted with experts to find relevant articles. Second, reviews that addressed only unmodifiable patient factors such as race were excluded. These patient factors are associated with clinician biases [34] that should be examined through a behavior change lens in future research. Third, only reviews published in English were included; relevant reviews published in other languages may have been missed. Fourth, 4 of the reviews contained studies on primary care and hospitals, and the authors did not distinguish between them. Thus, we were unable to exclude factors that may have been relevant only to primary care. It is worth noting that there are relatively few reviews in the literature focused on hospitals and/or long-term care as compared with primary care. Fifth, our results are based on descriptions provided by the reviews, not the primary studies. Yet, primary studies were consulted, as needed, when information in the reviews was unclear or lacking depth. Sixth, we assessed the methodological quality of the reviews, not the primary studies in each review. Finally, the recommendations that we identified using the BCW are generic. They provide direction for intervention design, but future research is needed to operationalize them. Future research on antibiotic prescribing interventions should use the BCTT to determine the intervention's "active ingredients"; widespread use of the BCTT will enable standardized comparison and evidence accumulation on intervention design and effectiveness.

CONCLUSION

This metasynthesis of reviews revealed a complex array of determinants of antibiotic prescribing in hospitals. A behavioral analysis of these determinants suggests that the environmental context, social influences, and prescriber beliefs about consequences are the most prominent determinants, requiring interventions that prioritize modification of perceptions, context, social dynamics, and culture. Policy makers, managers, clinicians, and researchers can use the results of this behavioral analysis of antibiotic prescribing to design and evaluate prescribing interventions for quality improvement.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Acknowledgments. We thank our information specialist from McMaster University's Health Sciences Library, Susanna Galbraith, for her expertise and support in designing the search strategy. We also acknowledge Brad Langford and Valerie Leung from Public Health Ontario for providing feedback on the review protocol.

Author contributions. G. M. conceived and designed the review with J. M. E., C. J. L., and A. M. M., who provided input on the review protocol and final report. G. M. and J. M. E. screened reviews for inclusion, completed data extraction, discussed categorization of findings, and resolved discrepancies, and all authors were involved in discussions on the interpretation of results. G. M. drafted the manuscript, and all authors critically reviewed it. All authors approved the final submitted version of the manuscript.

Financial support. This review of reviews was carried out as part of the authors' academic and/or routine work.

Potential conflicts of interest. All authors: No reported conflicts.

References

1. National Institute for Health and Care Excellence. News and features: use antibiotics effectively to reduce drug-resistance. **2017**. Available at: https://www.nice.org.uk/news/article/use-antibiotics-effectively-to-reduce-drug-resistance. Accessed 30 October 2023.
2. World Health Organization. Antimicrobial resistance. **2023**. Available at: https://www.who.int/en/news-room/fact-sheets/detail/antimicrobial-resistance. Accessed 30 October 2023.
3. Infectious Diseases Society of America. Antimicrobial resistance. **2023**. https://www.idsociety.org/public-health/antimicrobial-resistance/antimicrobial-resistance/. Accessed 30 October 2023.
4. United Nations Environment Programme. Bracing for superbugs: strengthening environmental action in the one health response to antimicrobial resistance. Geneva, Switzerland: United Nations Environment Programme, **2023**.
5. McCubbin KD, Anholt RM, de Jong E, et al. Knowledge gaps in the understanding of antimicrobial resistance in Canada. Front Public Health **2021**; 9:726484.
6. Fleming-Dutra KE, Hersh AL, Shapiro DJ, et al. Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010–2011. JAMA **2016**; 315:1864–73.
7. Shively NR, Buehrle DJ, Clancy CJ, Decker BK. Prevalence of inappropriate antibiotic prescribing in primary care clinics within a Veterans Affairs health care system. Antimicrob Agents Chemother **2018**; 62:e00337-18.
8. Langford BJ, Daneman N, Leung V, Langford DJ. Cognitive bias: how understanding its impact on antibiotic prescribing decisions can help advance antimicrobial stewardship. JAC Antimicrob Resist **2020**; 2:dlaa107.
9. Donisi V, Sibani M, Carrara E, et al. Emotional, cognitive and social factors of antimicrobial prescribing: can antimicrobial stewardship intervention be effective without addressing psycho-social factors? J Antimicrob Chemother **2019**; 74: 2844–7.
10. Hemenway AN, DuBois DL. A scoping review of the use of social and behavioral change in acute care antimicrobial stewardship initiatives. Hosp Pharm **2022**; 57: 138–45.
11. Lorencatto F, Charani E, Sevdalis N, Tarrant C, Davey P. Driving sustainable change in antimicrobial prescribing practice: how can social and behavioural sciences help? J Antimicrob Chemother **2018**; 73:2613–24.
12. Meeker D, Linder JA, Fox CR, et al. Effect of behavioral interventions on inappropriate antibiotic prescribing among primary care practices: a randomized clinical trial. JAMA **2016**; 315:562–70.
13. Atkins L, Francis J, Islam R, et al. A guide to using the theoretical domains framework of behaviour change to investigate implementation problems. Implement Sci **2017**; 12:77.
14. Centre for Behaviour Change. Behaviour change techniques. **2024**. Available at: https://www.ucl.ac.uk/behaviour-change/resources/online-tools-behaviour-change. Accessed 13 March 2024.
15. Michie S, Atkins L, West R. The behaviour change wheel: a guide to designing interventions. Sutton, Great Britain: Silverback Publishing, **2014**.
16. Michie S, Richardson M, Johnston M, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Ann Behav Med **2013**; 46:81–95.
17. Acampora M, Guasconi M, Schiroli C, et al. Uncovering doctors' perceived barriers and facilitators of antibiotic prescribing behaviours: a qualitative study using the theoretical domains framework. Acta Biomed **2023**; 94:e2023265.
18. Chater A, Family H, Lim R, Courtenay M. Influences on antibiotic prescribing by non-medical prescribers for respiratory tract infections: a systematic review using the theoretical domains framework. J Antimicrob Chemother **2020**; 75: 3458–70.
19. Thompson W, Tonkin-Crine S, Pavitt SH, et al. Factors associated with antibiotic prescribing for adults with acute conditions: an umbrella review across primary care and a systematic review focusing on primary dental care. J Antimicrob Chemother **2019**; 74:2139–52.
20. Talkhan H, Stewart D, McIntosh T, et al. Investigating clinicians' determinants of antimicrobial prescribing behaviour using the theoretical domains framework. J Hosp Infect **2022**; 122:72–83.
21. Fleming A, Bradley C, Cullinan S, Byrne S. Antibiotic prescribing in long-term care facilities: a qualitative, multidisciplinary investigation. BMJ Open **2014**; 4: e006442.

22. Talkhan H, Stewart D, McIntosh T, et al. Exploring determinants of antimicrobial prescribing behaviour using the theoretical domains framework. Res Social Adm Pharm **2024**; 20:401–10.
23. Wushouer H, Du K, Chen S, et al. Evaluation of prescription review and feedback policy on rational antibiotic use in primary healthcare settings in Beijing, China: a qualitative study using the theoretical domains framework and the behaviour change wheel. JAC Antimicrob Resist **2023**; 5:dlad128.
24. Laur C, Sribaskaran T, Simeoni M, et al. Improving antibiotic initiation and duration prescribing among nursing home physicians using an audit and feedback intervention: a theory-informed qualitative analysis. BMJ Open Qual **2021**; 10: e001088.
25. Acampora M, Paleologo M, Graffigna G, Barello S. Uncovering influential factors in human antibiotic prescribing: a meta-synthesis study informed by the theoretical domains framework. J Hosp Infect **2024**; 144:28–55.
26. Walsh D, Downe S. Meta-synthesis method for qualitative research: a literature review. J Adv Nurs **2005**; 50:204–11.
27. Lachal J, Revah-Levy A, Orri M, Moro MR. Metasynthesis: an original method to synthesize qualitative literature in psychiatry. Front Psychiatry **2017**; 8:269.
28. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Syst Rev **2021**; 10:89.
29. Calbo E, Alvarez-Rocha L, Gudiol F, Pasquau J. A review of the factors influencing antimicrobial prescribing. Enferm Infecc Microbiol Clin **2013**; 31(suppl 4):12–5.
30. Charani E, Castro-Sánchez E, Holmes A. The role of behavior change in antimicrobial stewardship. Infect Dis Clin North Am **2014**; 28:169–75.
31. Richards AR, Linder JA. Behavioral economics and ambulatory antibiotic stewardship: a narrative review. Clin Ther **2021**; 43:1654–67.
32. Guo S, Sun Q, Zhao X, Shen L, Zhen X. Prevalence and risk factors for antibiotic utilization in Chinese children. BMC Pediatr **2021**; 21:255.
33. Harvey EJ, De Brún C, Casale E, Finistrella V, Ashiru-Oredope D. Influence of factors commonly known to be associated with health inequalities on antibiotic use in high-income countries: a systematic scoping review. J Antimicrob Chemother **2023**; 78:861–70.
34. Kim C, Kabbani S, Dube WC, et al. Health equity and antibiotic prescribing in the United States: a systematic scoping review. Open Forum Infect Dis **2023**; 10: ofad440.
35. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med **2009**; 6: e1000097.
36. Cronin P, Ryan F, Coughlan M. Undertaking a literature review: a step-by-step approach. Br J Nurs **2008**; 17:38–43.
37. RAYYAN. AI powered tool for systematic literature reviews. **2022**. Available at: https://www.rayyan.ai/. Accessed 10 September 2023.
38. Health Evidence. Quality assessment tool—review articles. **2018**. Available at: https://www.nccmt.ca/knowledge-repositories/search/275. Accessed 10 September 2023.
39. Dobbins M, DeCorby K, Robeson P, Husson H, Tirilis D, Greco L. A knowledge management tool for public health: health-evidence.ca. BMC Public Health **2010**; 10:496.
40. Carey RN, Connell LE, Johnston M, et al. Behavior change techniques and their mechanisms of action: a synthesis of links described in published intervention literature. Ann Behav Med **2019**; 53:693–707.
41. The Human Behaviour Change Project. The theory and techniques tool. Available at: https://theoryandtechniquetool.humanbehaviourchange.org/. Accessed 2 April 2024.
42. Lim DW, Htun HL, Ong LS, Guo H, Chow A. Systematic review of determinants influencing antibiotic prescribing for uncomplicated acute respiratory tract infections in adult patients at the emergency department. Infect Control Hosp Epidemiol **2022**; 43:366–75.
43. Parker H, Frost J, Day J, et al. Tipping the balance: a systematic review and meta-ethnography to unfold the complexity of surgical antimicrobial prescribing behavior in hospital settings. PLoS One **2022**; 17:e0271454.
44. Padigos J, Reid S, Kirby E, Broom J. Knowledge, perceptions and experiences of nurses in antimicrobial optimization or stewardship in the intensive care unit. J Hosp Infect **2021**; 109:10–28.
45. Krockow EM, Colman AM, Chattoe-Brown E, et al. Balancing the risks to individual and society: a systematic review and synthesis of qualitative research on antibiotic prescribing behaviour in hospitals. J Hosp Infect **2019**; 101:428–39.
46. Papoutsi C, Mattick K, Pearson M, Brennan N, Briscoe S, Wong G. Social and professional influences on antimicrobial prescribing for doctors-in-training: a realist review. J Antimicrob Chemother **2017**; 72:2418–30.
47. Ness V, Price L, Currie K, Reilly J. Influences on independent nurse prescribers' antimicrobial prescribing behaviour: a systematic review. J Clin Nurs **2016**; 25: 1206–17.
48. Rezal RS, Hassali MA, Alrasheedy AA, Saleem F, Yusof FA, Godman B. Physicians' knowledge, perceptions and behaviour towards antibiotic prescribing: a systematic review of the literature. Expert Rev Anti Infect Ther **2015**; 13:665–80.
49. Rodrigues AT, Roque F, Falcão A, Figueiras A, Herdeiro MT. Understanding physician antibiotic prescribing behaviour: a systematic review of qualitative studies. Int J Antimicrob Agents **2013**; 41:203–12.
50. Crockett C, Joshi C, Rosenbaum M, Suneja M. Learning to drive: resident physicians' perceptions of how attending physicians promote and undermine autonomy. BMC Med Educ **2019**; 19:293.
51. WHO Regional Office for Europe. Antimicrobial stewardship interventions: a practical guide. **2021**. Available at: https://iris.who.int/bitstream/handle/10665/340709/9789289054980-eng.pdf. Accessed 30 November 2023.
52. Centers for Disease Control and Prevention. Core elements of hospital antibiotic stewardship programs. 2024. Available at: https://www.cdc.gov/antibiotic-use/hcp/core-elements/hospital.html. Accessed 30 November 2023.
53. Review on Antimicrobial Resistance. Rapid diagnostics: stopping unnecessary use of antibiotics. **2015**. Available at: https://amr-review.org/sites/default/files/Paper-Rapid-Diagnostics-Stopping-Unnecessary-Prescription-Low-Res.pdf.
54. Jamtvedt G, Flottorp S, Ivers N. Clinical pathways as a quality strategy. In: Busse R, Klazinga N, Panteli D, et al, eds. Improving healthcare quality in Europe: characteristics, effectiveness and implementation of different strategies. Copenhagen, Denmark: European Observatory on Health Systems and Policies, **2019**:12.
55. Jamtvedt G, Flottorp S, Ivers N. Audit and feedback as a quality strategy. In: Busse R, Klazinga N, Panteli D, et al, eds. Improving healthcare quality in Europe: characteristics, effectiveness and implementation of different strategies. Copenhagen, Denmark: European Observatory on Health Systems and Policies, **2019**:10.