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# Content and Mechanism of Action of National Antimicrobial Stewardship Interventions on Management of Respiratory Tract Infections in Primary and Community Care

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**Abstract:** A major modifiable factor contributing to antimicrobial resistance (AMR) is inappropriate use and overuse of antimicrobials, such as antibiotics. This study aimed to describe the content and mechanism of action of antimicrobial stewardship (AMS) interventions to improve appropriate antibiotic use for respiratory tract infections (RTI) in primary and community care. This study also aimed to describe who these interventions were aimed at and the specific behaviors targeted for change. Evidence-based guidelines, peer-review publications, and infection experts were consulted to identify behaviors relevant to AMS for RTI in primary care and interventions to target these behaviors. Behavior change tools were used to describe the content of interventions. Theoretical frameworks were used to describe mechanisms of action. A total of 32 behaviors targeting six different groups were identified (patients; prescribers; community pharmacists; providers; commissioners; providers and commissioners). Thirty-nine interventions targeting the behaviors were identified (patients = 15, prescribers = 22, community pharmacy staff = 8, providers = 18, and commissioners = 18). Interventions targeted a mean of 5.8 behaviors (range 1–27). Influences on behavior most frequently targeted by interventions were psychological capability (knowledge and skills); reflective motivation (beliefs about consequences, intentions, social/professional role and identity); and physical opportunity (environmental context and resources). Interventions were most commonly characterized as achieving change by training, enabling, or educating and were delivered mainly through guidelines, service provision, and communications & marketing. Interventions included a mean of four Behavior Change Techniques (BCTs) (range 1–14). We identified little intervention content targeting automatic motivation and social opportunity influences on behavior. The majority of interventions focussed on education and training, which target knowledge and skills though the provision of instructions on how to perform a behavior and information about health consequences. Interventions could be refined with the inclusion of relevant BCTs, such as goal-setting and action planning (identified in

only a few interventions), to translate instruction on how to perform a behavior into action. This study provides a platform to refine content and plan evaluation of antimicrobial stewardship interventions.

**Keywords:** antimicrobial stewardship; primary care; behavior change wheel; behavior change techniques; theoretical domains framework; respiratory tract infection; RTI

## 1. Introduction

The number of serious infections resistant to treatment is increasing and antimicrobial resistance (AMR) is one of the major risks facing public health [1,2]. In Europe, AMR is associated with approximately 25,000 deaths per year and 700,000 globally [3]. It is estimated that a continued rise in resistance would cost the world 100 trillion USD by 2050 if AMR is not addressed effectively [4]. The Interagency Coordination Group on Antimicrobial Resistance report to the WHO recommends countries reduce the need for antimicrobials and enhance their responsible and prudent use, as well as advises the use of behavior change interventions aimed at both public and professionals [5].

One of the major modifiable factors contributing to AMR is inappropriate use and overuse of antimicrobials such as antibiotics [3]. In the UK, 72% of antibiotics are prescribed in General Practice (GP) [6]. Although consumption of antibiotics in UK primary care decreased by 16.7% between 2014–2018 [6], this more than a third higher than some other European countries, such as Sweden and The Netherlands [7].

The first step in intervention design is to specify the behavior(s) the intervention is aimed at changing [8]. Both prescribers' and patients' behavior is associated with the inappropriate use and misuse of antibiotics [9]. Prescribers may issue unnecessary prescription of antibiotics to patients with self-limiting infections [10] or inappropriately select the type and duration of the medication [11]. A European Center for Disease Prevention and Control survey of healthcare professionals reported that only 63% agreed or strongly agreed they have a key role in helping control antibiotic resistance [12]. Public misconceptions on the indications and effectiveness of antibiotics are prevalent with only 43% of respondents in a European Commission survey of general public views of antimicrobial resistance knowing that antibiotics are ineffective against viruses [13]. Patient's expectations around the use of antibiotics can influence the GP's prescribing behavior and lead to inappropriate prescribing and overuse [14].

The optimization of prescribing practice through antimicrobial stewardship (AMS) programs was one of seven key priority areas for action in the UK Five Year Antimicrobial Resistance Strategy 2013 to 2018 [15]. AMS includes various initiatives to tackle AMR and improve patient safety, for example: establishing optimal standards for antimicrobial use within the healthcare setting, interventions aiming to promote appropriate prescribing, and reviewing the impact of the AMS initiatives. Multifaceted AMS programs aimed at the public, as well as frontline healthcare professionals, are needed to tackle AMR [16,17]. Moreover, there is evidence that the culture of the healthcare organization may also influence the prescribing behavior [18].

A number of policies and interventions have been developed and nationally implemented. However, it is unclear if these interventions focus on the behaviors that would optimally impact on AMR and whether they use the full range of intervention types and policy levers available. It is also unclear if the current program of AMS interventions aim to change behavior through the mechanisms hypothesized to be effective in behavior change theory.

Pinder et al. [19] conducted a review of 150 studies and identified key behaviors that should be targeted in AMS interventions and proposed potential opportunities for new interventions. They also identified a small number of nationally implemented interventions that were mapped to the barriers and facilitators found in the literature. To optimize the potential of AMS programs, the behaviors and

populations targeted by these interventions, as well as their content and mechanisms of action of these needs, to be articulated. Tools developed in behavioral science can support such work.

The Behavior Change Wheel (BCW) [20] is a synthesis of 19 frameworks of behavior change and can be used to characterize the content of interventions. The BCW is linked to a model of behavior, COM-B (Capability, Opportunity, Motivation–Behavior), which can be used to identify the mechanisms of action of interventions. The Theoretical Domains Framework (TDF) can be considered an elaboration of COM-B (see Table S1). McParland [21] used the TDF and the Behavior Change Technique (BCT) Taxonomy version 1 (BCTTv1) [22], a classification of "active ingredients" that are used to change behavior, to describe public awareness AMR interventions. The authors concluded that there is a clear potential for improvement of interventions. However, the review focused on 20 peer-reviewed studies of interventions aimed at the general public only. There remains a need to review nationally implemented interventions that target both healthcare professionals, as well as the public. To the authors' knowledge, the BCW has not been used to review AMS interventions already implemented nationally across England to analyze and improve the AMS initiatives.

The overarching aim of this study was to build on the work of Pinder et al. [19] by characterizing nationally implemented AMS primary care programs to identify any gaps in coverage and opportunities for refinement. The specific aims were to:

- identify the behaviors and target populations related to AMS for respiratory tract infection (RTI) in primary care;
- identify interventions targeting AMS for RTI in primary care;
- describe their content using the Behavior Change Wheel and BCT;
- describe their mechanisms of action of interventions using COM-B and TDF.

Research identifying gaps between the influences and behavioral content of AMS interventions to highlight potential avenues for improvement will be reported in a separate study.

## 2. Methods

We drew on the following sources to identify behaviors relevant to patient self-care and/or appropriate antibiotic advice for the management of signs and symptoms of self-limiting respiratory tract infections:

- A literature review and high level behavioral analysis of antibiotic prescribing in the public, primary and secondary care [19].
- Relevant official guidance [17,23–32].
- UK AMR five-year strategy [15].
- Consultation with experts in epidemiology, pharmacy, infection management, and behavioral science.
- Self-limiting respiratory tract infections and symptoms of respiratory tract infections, included acute cough/acute bronchitis, common colds, flu, acute otitis media, acute otitis externa, (middle) ear infections, acute sinusitis, sore throat (tonsillitis), pharyngitis, laryngitis, bronchitis, respiratory tract infection, tracheitis, and acute rhinitis.

To describe the content of nationally adopted AMS interventions in England, authors identified potentially relevant programs for inclusion based on their knowledge of the policy area, consultation with key stakeholders and review of relevant documentation.

We included interventions implemented nationally in England between January 2014 and February 2018, where the primary objective was antimicrobial stewardship activities related to patient self-care and/or appropriate antibiotic advice for the management of respiratory tract infections. Interventions were excluded if local implementation only had occurred. Two authors (AS and VdLM) sought descriptions of the interventions from publicly available material and in some instances contacted the program leads for elaboration and to ensure accurate descriptions.

Providers and commissioners were defined as follows: providers defined as professionals in organizations providing care for the management of signs and symptoms of RTIs, e.g., Trusts, General Practice, private providers, and commissioners defined as professionals in organizations commissioning services for the management of signs and symptoms of self-limiting RTIs, e.g., Local Authorities, Clinical Commissioning Groups, Clinical Services Units, and National Health Service England.

*Data Extraction Tools*

The BCW and BCTTv1 were used to classify intervention content identified in intervention materials or descriptions of interventions into intervention types, policy options (see Table S2), and BCTs.

To describe the intervention mechanisms of action, we were guided by three matrices—two linking BCTs to TDF domains [33,34] and one linking intervention types to COM-B and TDF [8] to determine from the BCTs we identified in interventions, which influences on behavior (characterized using COM-B and TDF) the BCTs were likely to be targeting.

## 3. Data Analysis

For each intervention, we recorded the total number of COM-B components and TDF domains, intervention types, policy options, and BCTs, and calculated the mean and range. We recorded the number of interventions in which each COM-B component, TDF domain, intervention types, BCT, and policy option was present (mean and range).

*Interrater Reliability*

One researcher (LA) conducted 100% of the coding, and a second researcher (AS) coded 20% to establish reliability. Percentage agreement for each section of intervention coded was calculated where both coders assigned the same code(s) to the same section of intervention material. PABAK (Prevalence And Bias-Adjusted Kappa) statistic [35] was used to assess the presence or absence of codes within each intervention. This statistic adjusts for shared bias in the coders' use of options and high prevalence of negative agreement, i.e., when both coders agree that codes are not present. Interrater reliability of 0.60–0.79 = 'substantial' reliability, >0.80 = 'outstanding' [36].

## 4. Results

We identified 32 behaviors related to AMS for RTI in primary care. These are summarized in Table 1 (see Table S3 for the sources from which behaviors were identified). Five were patient behaviors, 11 related to prescribers, five were community pharmacist behaviors, two related to providers, one related to commissioners), and eight related to both providers and commissioners.

**Table 1.** Behaviors related to antibiotic prescribing for respiratory tract infections (RTI) in primary care.

| Behavior (Number of Behaviors) | Number of Interventions Targeting the Behavior |
|---|---|
| **Patients/Public (and or carers) (*n* = 5)** | |
| Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | 13 |
| Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | 12 |
| Use back-up prescriptions as directed by a suitably qualified healthcare professional (HCP). | 3 |
| Take antibiotics as prescribed (do not save for later use or share with others) by a suitably qualified HCP. | 4 |
| Return unwanted antibiotics to the pharmacy. | 3 |

**Table 1.** *Cont.*

| Behavior (Number of Behaviors) | Number of Interventions Targeting the Behavior |
|---|---|
| **Primary care prescribers (including non-medical prescribers, such as nurses and pharmacists) *n* = 11** | |
| Follow/adhere to local antibiotic formulary—general behaviors. | 13 |
| Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | 19 |
| Give alternative, non-antibiotic self-care advice, where appropriate. | 12 |
| Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | 9 |
| Provide safety netting advice whether or not the patient has been prescribed antibiotics (e.g., what to do if condition gets worse or side effects of medication). | 7 |
| When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | 9 |
| Provide 'delayed/back-up' antibiotic strategy where appropriate. | 14 |
| Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | 10 |
| Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice. | 6 |
| Undertake POCT in patients 18–65 years old presenting with acute cough/bronchitis in whom antibiotics are being considered. | 5 |
| Limit prescribing over the telephone to exceptional cases for self-limiting RTIs. | 3 |
| **Community pharmacists and pharmacy staff (*n* = 5)** | |
| Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | 7 |
| Use/share written resources with the public when providing self-care advice for self-limiting RTIs. | 5 |
| When giving an antibiotic prescription for a self-limiting RTI, inform the patients of the dose and duration or to take their antibiotics exactly as prescribed. | 3 |
| Check that antibiotic prescriptions comply with local guidance and query with the prescriber for those that do not. | 5 |
| Accept and dispose appropriately of returned antibiotics. | 2 |
| **Providers and commissioners (*n* = 11)** | |
| Provide education and training in prudent antimicrobial use/AMR (using the antimicrobial resistance and stewardship competencies as a framework). | 6 |
| Commission, develop, or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR. | 11 |
| Commission, develop, or implement interventions (e.g., guidance, services, programs, or campaigns) to support self-care. | 6 |
| Monitor antibiotic prescribing in relation to local and national resistance patterns or targets. | 12 |
| Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change. | 6 |
| Provide regular feedback on antimicrobial prescribing and resistance indicators at prescriber, team, and organization level benchmarked against local or national antimicrobial prescribing/resistance rates. | 5 |
| Provide feedback to prescribers on patient safety incidents related to antimicrobial use, including hospital admissions for potentially avoidable life-threatening infections, infections with Clostridium difficile or adverse drug reactions, such as anaphylaxis. | 1 |

**Table 1.** *Cont.*

| Behavior (Number of Behaviors) | Number of Interventions Targeting the Behavior |
|---|---|
| Providers have a formulary in place for antibiotic prescribing. * | 5 |
| Commissioners seek evidence/providers make evidence available for adherence to local or national guidance for antibiotic prescribing. ** | 5 |
| Commissioners ensure information and resources are available for healthcare professionals to use during consultations with people seeking advice about managing self-limiting RTIs. ** | 2 |
| Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | 7 |

* Providers only.** Commissioners only.

A total of 83 interventions were identified for content analysis of nationally adopted AMS interventions in England. Thirty-nine met the inclusion criteria (Table 2 with the target group(s)). Of the 44 excluded interventions: 31 were not aimed at the relevant behaviors or target groups; five were information, general media, or links to resources only; four were not nationally implemented; and four were part of other already identified interventions.

**Table 2.** Intervention and target group.

| Intervention | Target Group |
|---|---|
| Public Health England Antibiotic Guardian [37] | Patients |
| | Prescribers |
| | Community pharmacists and pharmacy staff |
| | Providers |
| | Commissioners |
| TARGET Antibiotics Toolkit (Treat Antibiotics Responsibly, Guidance, Education, Tools) [38] | Patients |
| | Prescribers |
| | Community pharmacists and pharmacy staff |
| | Providers |
| | Commissioners |
| British Society for Antimicrobial Chemotherapy: Antibiotic Action [39] | Patients |
| | Prescribers |
| | Community pharmacists and pharmacy staff |
| | Providers |
| | Commissioners |
| Treat Yourself Better [40] | Patients |
| UK Department of Health and Public Health England Antimicrobial Prescribing and Stewardship Competencies [41] | Prescribers |
| | Providers |
| | Commissioners |
| theLearningpharmacy.com [42] | Community pharmacists and pharmacy staff |
| Royal College of Nursing (RCN) and Infection Prevention Society (IPS) Infection Prevention and Control Commissioning Toolkit [43] | Providers |
| Stemming the Tide of Antibiotic Resistance (STAR) e-learning [44] | Prescribers |
| Managing Acute Respiratory Tract Infections (MARTI) e-learning [45] | Prescribers |
| Public Health England 'Beat the Bugs' course [46] | Patients |
| NHS England Patient Safety Alert—addressing antimicrobial resistance through implementation of an antimicrobial stewardship program [47] | Providers |
| | Commissioners |
| Public Health England Keep Antibiotics Working campaign [48] | Patients |
| | Providers |
| | Commissioners |

**Table 2.** *Cont.*

| Intervention | Target Group |
| --- | --- |
| NHS England Quality Premium: 2016/17 Guidance for CCGs [49] | Providers |
| | Commissioners |
| Public Health England Fingertips platform [50] | Providers |
| | Commissioners |
| PrescQIPP Antimicrobial Stewardship [51] | Prescribers |
| | Providers |
| | Commissioners |
| UK Chief Medical Officer letter to high prescribers of antibiotics [52] | Prescribers |
| Self Care Forum: Self Care Week [53] | Patients |
| | Providers |
| | Commissioners |
| The Health and Social Care Act (HSCA) 2008. Code of Practice on the prevention and control of infections and related guidance [54] | Providers |
| | Commissioners |
| NICE Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use [NG15] [17] | Prescribers |
| | Community pharmacists and pharmacy staff |
| | Providers |
| | Commissioners |
| NICE Infection Prevention and Control [QS61] [27] | Patients |
| | Prescribers |
| | Providers |
| | Commissioners |
| UK Five Year Antimicrobial Resistance Strategy 2013 to 2018 [15] | Prescribers |
| | Providers |
| | Commissioners |
| NHS website advice on common cold [55] | Patients |
| NICE Antimicrobial stewardship: changing risk-related behaviors in the general population [NG63] [23] | Prescribers |
| | Community pharmacists and pharmacy staff |
| | Providers |
| | Commissioners |
| Center for Pharmacy Postgraduate Education distance course: Antibacterial resistance—a global threat to public health: the role of the pharmacy team [56] | Prescribers |
| | Community pharmacists and pharmacy staff |
| UK Clinical Pharmacy Association / Royal Pharmaceutical Society—professional practice curriculum [57] | Prescribers |
| FeverPAIN [58] | Prescribers |
| Public health England Managing Common Infections Guidance [28] | Prescribers |
| NICE Respiratory tract infections (self-limiting): prescribing antibiotics [CG69] [59] | Patients |
| | Prescribers |
| NICE Antimicrobial Stewardship [QS121] [29] | Prescribers |
| | Providers |
| | Commissioners |
| Self Care Forum: Factsheet 7 (Cough in Adults); Factsheet 12 (Common Cold) [60] | Patients |
| OpenPrescribing.net [61] | Providers |
| | Commissioners |
| CENTOR [62] | Prescribers |
| Health Education England 'Antimicrobial Resistance: A Guide for GPs' [63] | Prescribers |
| NICE Sinusitis (acute): antimicrobial prescribing [NG79] [24] | Patients |
| | Prescribers |

**Table 2.** *Cont.*

| Intervention | Target Group |
| --- | --- |
| NICE Sore throat (acute): antimicrobial prescribing [NG84] [26] | Prescribers |
| Department of Health & Social Care 'Take Care not Antibiotics' videos [64] | Patients |
| Patient.info webpages on colds, sore throats, antibiotics, bronchitis and sinusitis [65] | Patients |
| Health Education England 'Awareness of Antimicrobial Resistance (AMR) Animation' [66] | Patients |
| Royal Pharmaceutical Society: Antimicrobial Stewardship Quick Reference Guide [31] | Community pharmacists and pharmacy staff |
| | Commissioners |

Of the 39 included interventions, 15 were aimed at patients/public, 22 at prescribers, eight at community pharmacy staff, 18 at providers, and 18 at commissioners. Almost half of the interventions (n = 19) were aimed at one target group only, nine were aimed at two target groups and three interventions (Public Health England's Antibiotic Guardian [37], TARGET Antibiotics Toolkit (Treat Antibiotics Responsibly, Guidance, Education, Tools) [38], and British Society for Antimicrobial Chemotherapy's Antibiotic Action [39]) were aimed at all five target groups. A mean of 5.8 behaviors were targeted by interventions.

Patient interventions were largely aimed at encouraging self-care and reducing requests for antibiotics for self-limiting respiratory tract infections (e.g., Antibiotic Guardian, Treat Yourself Better [40]). Interventions aimed at prescribers targeted various behaviors, but most commonly the behavior that antibiotic prescriptions 'should be written only when there is a clear clinical benefit' (e.g., UK Department of Health and Public Health England's Antimicrobial Prescribing and Stewardship Competencies [41]), followed by the behavior to 'provide a backup prescription where appropriate' (e.g., TARGET). The behavior targeted least was that prescribing antibiotics following a telephone consultation should only occur in exceptional circumstances (e.g., NICE Infection Prevention and Control (QS61) [27]). Interventions targeting pharmacies were largely aimed at provision of self-care advice (e.g., NICE Antimicrobial stewardship: changing risk-related behaviors in the general population NICE guideline (NG63) [23]) and sharing written resources with the patient (e.g., The Learning Pharmacy [42]). The most frequently targeted behavior for providers and commissioners was 'monitor antibiotic prescribing in relation to local and national resistance patterns or targets' (e.g., TARGET).

### *4.1. Interrater Reliability*

The kappa ranged from 0.60 to 0.89 suggesting good to very good inter-rater reliability. The PABAK was from 0.75 to 0.95, suggesting substantial to outstanding agreement. Kappa and PABAK for behaviors, mechanism of action (COM-B, TDF), and intervention content (intervention types, policy options, BCTs) are presented in Table 3.

**Table 3.** Interrater reliability.

| | Kappa | PABAK |
| --- | --- | --- |
| **Behaviors** | 0.89 | 0.90 |
| **COM-B** | 0.68 | 0.75 |
| **TDF** | 0.60 | 0.77 |
| **Intervention types** | 0.67 | 0.76 |
| **Policy options** | 0.77 | 0.88 |
| **BCTs** | 0.69 | 0.95 |

### 4.2. Intervention Types Identified in Interventions

Eight of a potential nine intervention types were identified across all interventions (Table 4). The mean number of intervention types per intervention was 3 (range 1–6). Figure 1 shows the number of types identified in interventions split by target group. Patient interventions often used education, training and persuasion. Prescriber interventions included seven out of nine intervention types, primarily training, education, and persuasion. Pharmacy interventions frequently used enablement and training but also used education and persuasion covering four of the nine possible intervention types. Provider and commissioner interventions were most frequently training, enablement, and education. No interventions used restriction.

**Table 4.** Frequency of types in interventions.

| Intervention Type | Number of Interventions (Max 39) | Example of Coded Intervention |
|---|---|---|
| Training | 32 | "Ensure resources and advice are also available for people who are prescribed or supplied with antimicrobials, to ensure they take them as instructed by their healthcare professional. This should include taking the correct dose for the time specified and via the correct route". |
| Education | 29 | "Taking antibiotics encourages harmful bacteria that live inside you to become resistant". |
| Enablement | 25 | Resources listed to become an Antibiotic Guardian. |
| Persuasion | 18 | "Once the bugs are resistant, the antibiotics don't work and we're back in the 'the Stone Age'". |
| Incentivization | 6 | CPD points for completing a course. |
| Modeling | 3 | Film of a consultation where a physician manages a patient's expectations. |
| Coercion | 3 | "If we don't act now, any one of us could go into hospital in 20 years for minor surgery and die because of an ordinary infection that can't be treated by antibiotics". |
| Environmental restructuring | 1 | "Service providers (such as hospitals and dental practices) ensure that prescribers of antimicrobials have access to electronic prescribing systems that link indication with the antimicrobial prescription". |
| Restriction | 0 | - |

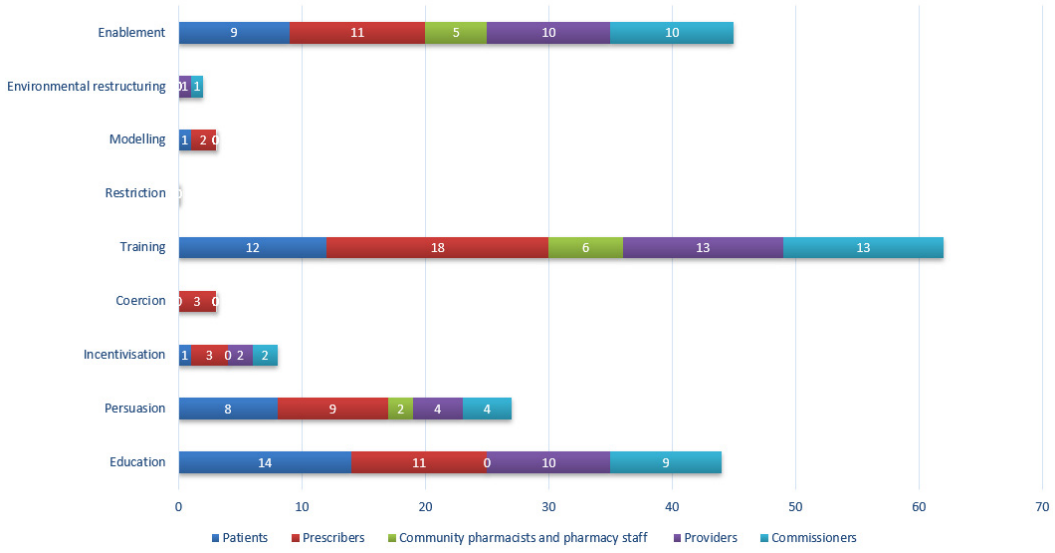


**Figure 1.** Frequency of identification of intervention types by target group. Total count will exceed the maximum number of interventions ($n$ = 39) as many interventions were aimed at more than one target group.

### *4.3. Policy Options Identified in Interventions*

Five policy options were identified across the 39 interventions. 'Service provision,' e.g., website, was the most frequently identified (15/39), followed by 'guidelines,' e.g., NICE guidance, (14/39), 'communication / marketing,' e.g., poster, (10/39), 'legislation,' i.e., Health and Social Care Act (1/39), and 'fiscal measures', i.e., NHS Quality Premiums for CCGs (1/39). Figure 2 shows the number of policy options identified in interventions split by target group. No interventions were delivered through environmental/social planning or regulation. Patient interventions were commonly delivered using communication/marketing and service provision, while prescriber interventions were delivered mainly through guidelines, followed by service provision. Provider and commissioner interventions were delivered largely through guidelines and service provision, with some communication/marketing and legislation.

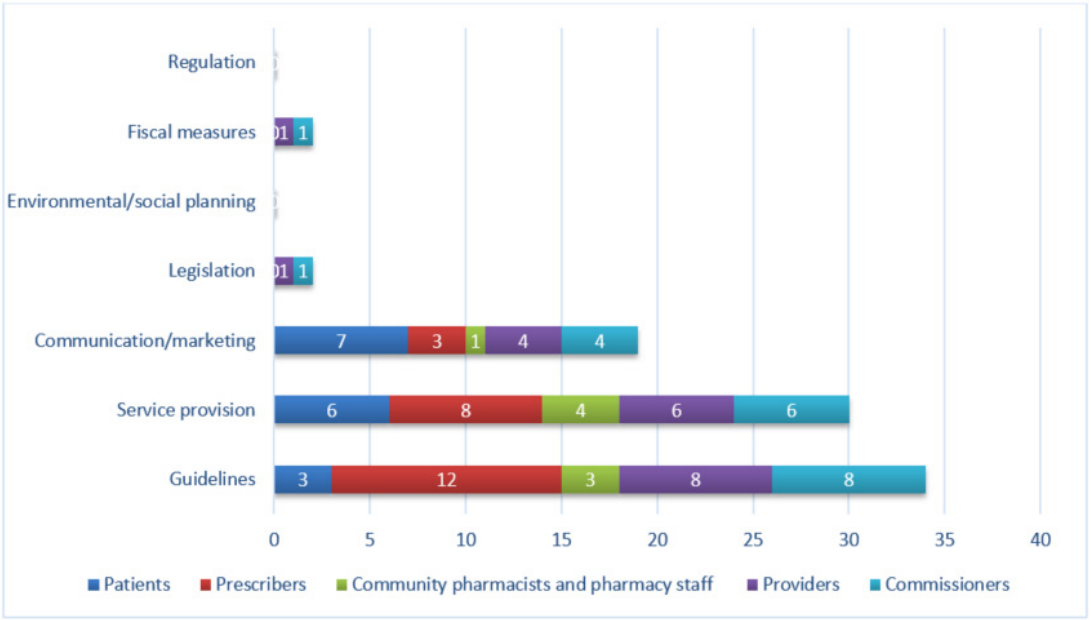


**Figure 2.** Frequency of identification of policy options, by target group. Total count will exceed the maximum number of interventions ($n$ = 39) as many interventions were aimed at more than one target group.

### *4.4. BCTs Identified in Interventions*

A total of 30 BCTs were identified across all interventions with the mean number of 4 per intervention (range 1–14) as shown in Table 5. Figure 3 shows the number of BCTs identified in interventions split by target group. Patient and prescriber interventions most commonly used the BCTs 'information about health consequences' and 'instruction on how to perform the behavior'. The most frequently used BCT in pharmacy, provider, and commissioner interventions was 'instruction on how to perform the behavior'.

Figures 4 and 5 show the influences on behavior targeted in interventions split by target groups. The most frequently targeted influence on behavior was psychological capability for all target groups. For patients, prescribers and commissioners reflective motivation was the next most frequently targeted influence on behavior, whilst for pharmacy and provider interventions, it was physical opportunity. Automatic motivation and social opportunity were infrequently targeted. Only one intervention aimed to change physical capability.

**Table 5.** Frequency of Behavior Change Techniques (BCTs) in interventions.

| BCT | Number of Interventions Identified in (Max 39) | Example of BCT Identified in an Intervention |
|---|---|---|
| Instruction on how to perform the behavior | 33 | "Rest, drink plenty of fluids, take pain relievers, such as paracetamol or ibuprofen, and talk to your pharmacist for advice on getting the relief you need". |
| Information about health consequences | 25 | "Most common winter ailments, such as colds, sore throat, cough, sinusitis, or painful middle ear infection (earache), can't be treated with antibiotics". |
| Adding objects to the environment | 11 | Providing decision aids for antibiotic prescription. |
| Credible source | 11 | Letter from the Chief Medical Officer. |
| Action planning | 8 | Provision of an implementation spreadsheet in Antibiotic stewardship Quality Standard QS121. |
| Feedback on the behavior | 8 | Comparative data on national and local prescribing. |
| Identification of self as role model | 8 | "All pharmacists, regardless of setting, have AMS obligations and with over 1.6 million visits each day, community pharmacy teams have a key role". |
| Information about social environmental consequences | 6 | "Antibiotic prescribing is a huge cost for the NHS. For instance annual prescribing for acute cough alone exceeds £15 million (NICE, 2008)". |
| Feedback on outcome(s) of the behavior | 6 | National and local data on prescribing outcomes. |
| Social support (practical) | 5 | "If you are not sure, ask your doctor, nurse practitioner or pharmacist for help and advice". |
| Social comparison | 4 | "Ranking - Looks at how you compare, and rank, against the 211 CCGs nationally, your 10 'cluster' CCGs (most like you), and within the PrescQIPP Community. We also provide the Range within these groups" |
| Demonstration of the behavior | 4 | Video clip of a consultation showing GPs explaining why antibiotics are not useful to treat a virus. |
| Salience of consequences | 4 | "If no antibiotics work, it will be like going back to the 1930s". |
| Self-monitoring of behavior | 4 | "Review and monitor how well the guideline is being implemented through the project group". |
| Future punishment | 3 | "The rapid spread of multi-drug resistant (MDR) bacteria means that we could be close to reaching a point where we may not be able to prevent or treat everyday infections or diseases". |
| Self-monitoring of outcomes of behavior | 3 | Testing GPs knowledge on completion of an RTI self-management training module. |
| Non-specific reward | 2 | "Certificate for course completion". |
| Prompts/cues | 2 | 'Choose self-care for life' posters/web buttons/TV screens. |
| Material reward | 1 | "Reward for improvements in service quality". |
| Behavioral practice/rehearsal | 1 | "Rehearsal and discussion of what to do when have cough or cold" |
| Behavioral substitution | 1 | Recommending providing patients with a leaflet on UTI management rather than prescribing antibiotics. |
| Commitment | 1 | Making a pledge, e.g., "I will ensure all prescribers in my practice including locums have easy access to the local antibiotic guidance". |
| Focus on past success | 1 | Reminding pharmacists about their experience in providing self-care advice. |
| Framing reframing | 1 | Suggesting that leaflets are viewed as a tool for self-management rather than a parting gift. |
| Goal setting (behavior) | 1 | "Quality standards are intended to drive up the quality of care, and so achievement levels of 100% should be aspired to". |
| Pharmacological support | 1 | "Talk to your local pharmacist about other ways to help with symptoms, such as taking painkillers". |
| Problem solving | 1 | "Identifying barriers to change in prescribers own practice". |
| Pros and cons | 1 | Conducting a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) in planning implementing a patients self-care intervention. |
| Restructuring the physical environment | 1 | "Electronic prescribing systems that link indication with the antimicrobial prescription". |
| Social reward | 1 | "Thank you for your ongoing commitment to reduce antimicrobial resistance (AMR) and drug resistance infections". |

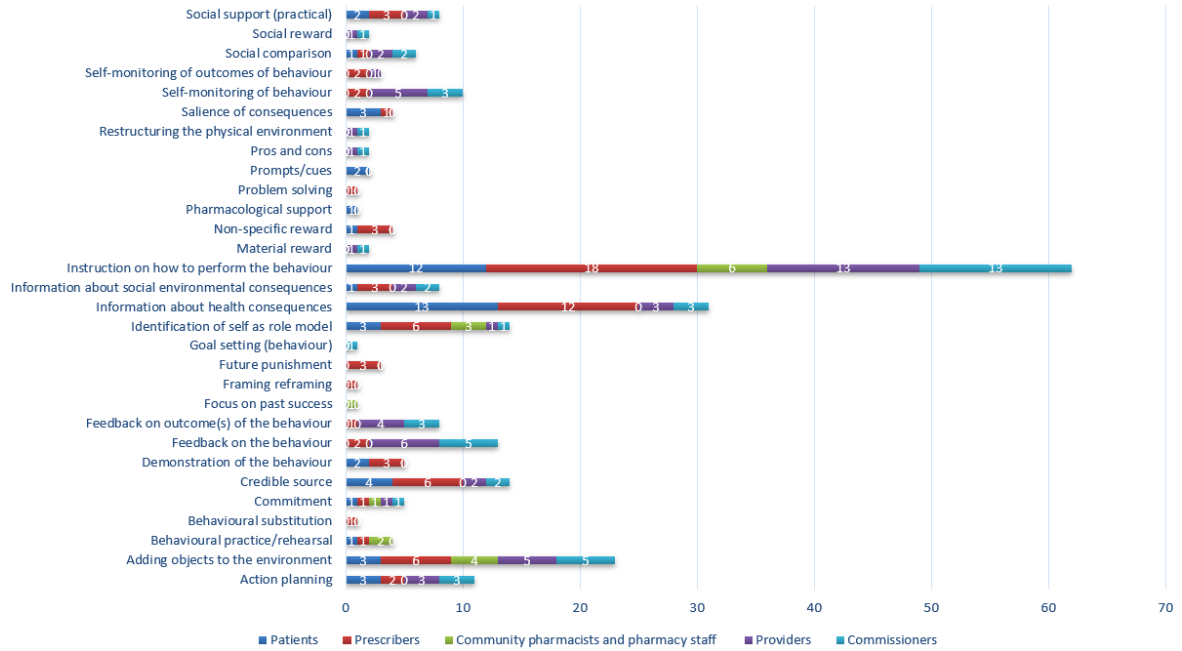


**Figure 3.** Frequency of identification of BCTs, by target group.

The frequency of mechanisms of action identified in interventions is outlined in Table 6.

**Table 6.** Frequency of interventions targeting influences on behavior.

| | Number of Interventions (Max 39) |
|---|---|
| **COM-B** | |
| Psychological capability | 38 |
| Reflective motivation | 22 |
| Physical opportunity | 12 |
| Automatic motivation | 8 |
| Social opportunity | 6 |
| Physical capability | 1 |
| **TDF** | |
| Knowledge | 33 |
| Skills | 16 |
| Beliefs about consequences | 15 |
| Environmental Context and Resources | 13 |
| Behavioral Regulation | 12 |
| Intention | 11 |
| Social Professional Role and Identity | 7 |
| Social Influences | 6 |
| Reinforcement | 5 |
| Memory, Attention, and Decision Making | 4 |
| Emotion | 3 |
| Optimism | 2 |
| Beliefs about capabilities | 1 |
| Goals | 1 |

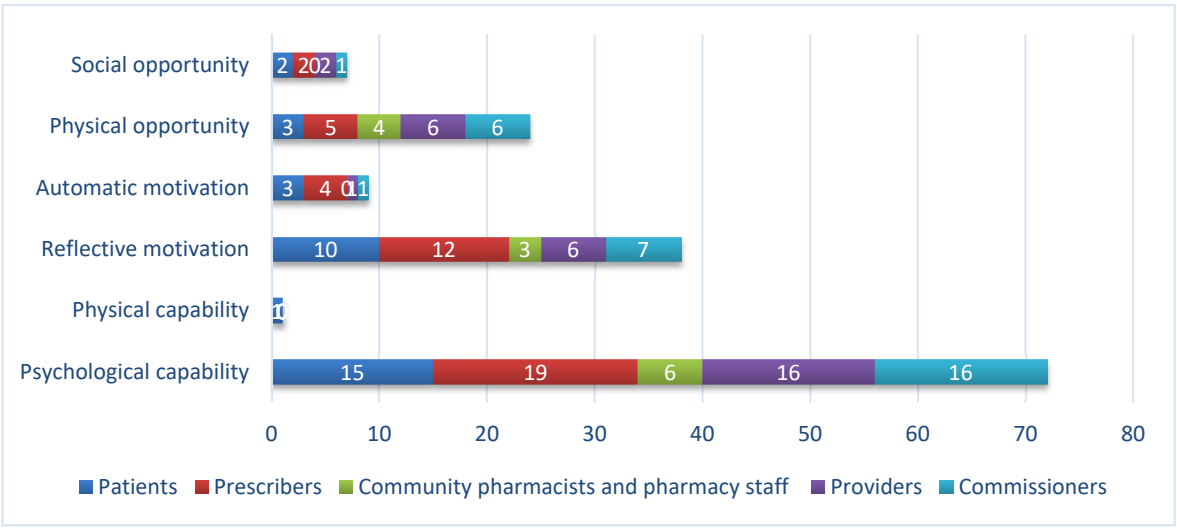


**Figure 4.** Influences (Capability, Opportunity, Motivation–Behavior (COM-B)) on behavior targeted in interventions, by target group.

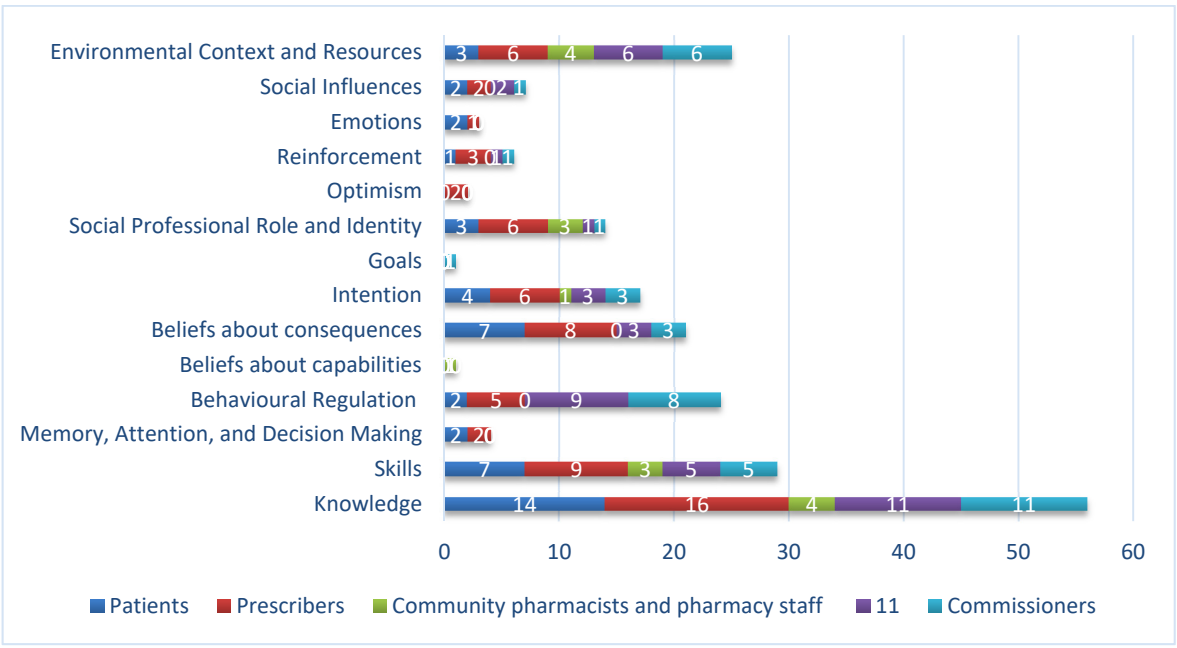


**Figure 5.** Influences (Theoretical Domains Framework (TDF)) on behavior targeted in interventions, by target group.

The TDF domain, knowledge, was the most frequently targeted influence for all target groups; for pharmacy interventions, 'environmental context and resources' was equally prevalent. For patients and prescribers, the next most commonly targeted influences were beliefs about consequences and skills. For pharmacy it was social and professional role and identity and skills. Interventions for providers and commissioners also targeted behavioral regulation and environmental context and resources.

A summary of interventions, the behaviors and groups they target, and their content and mechanism of action is given in Table A1. The same information structured by behavior is provided in Table S4.

## 5. Discussion

The overall aim of current research was to gain a detailed understanding of existing AMS national interventions, to pinpoint key areas of focus, and potential gaps and opportunities for future interventions. This study identified behaviors and target populations related to AMS for RTI in primary care and characterized the content and mechanism of action of interventions of nationally implemented AMS interventions targeted in primary care (patients and public, prescribers, providers, commissioners, and pharmacy).

Of the 32 behaviors identified, approximately one-third were related to prescribers, one third related both to providers and commissioners, and the remaining third was evenly split between patients and community pharmacy staff. The focus of interventions for patients was on self-care and not requesting antibiotics at consultations. The majority of prescriber interventions encouraged 'prescribing only when there is a clear clinical benefit', 'giving alternative self-care advice', 'providing a back-up prescription where appropriate', and 'following local antibiotic formularies'. Few interventions addressed limiting prescribing following telephone consultation and undertaking point of care tests (POCT), such as CRP. Given the potential for POCT to reduce inappropriate prescribing [67] related behaviors should be considered in the design or refinement of future interventions. Pharmacy interventions were aimed at provision of self-care advice, sharing written resources and checking antibiotic prescriptions comply with local guidance and querying those that do not. Provider and commissioner interventions focused on 'monitoring prescribing in relation to local and national resistance patterns', and 'commissioning, developing, and implementing interventions to support AMS'.

We identified 39 national AMS interventions for RTI in primary care. Interventions were typically in the form of 'service provision', such as a website or clinical guidelines followed by communications/marketing. Approximately three-quarters of the interventions were 'training' mainly using the BCT, 'instruction on how to perform the behavior' and includes training programs, such as TARGET [38], Stemming the Tide of Antibiotic Resistance (STAR) e-learning [44], Managing Acute Respiratory Tract Infections (MARTI) e-learning [45], and Public Health England's 'Beat the Bugs' course [46]. The same proportion served were classed as 'education' mostly frequently using the BCT 'information about health consequences'. Twenty-five interventions were classed as 'enabling,' delivered most frequently with the BCT 'adding objects to the environment,' such as the provision of a checklist to prevent antimicrobial misuse. Eighteen interventions used 'persuasion' mostly through the BCT 'credible source,' for example, providing an experienced GP's view of implementing delayed prescriptions. Few to no interventions used restriction, environmental restructuring, modeling and coercion.

The most frequently identified mechanisms of action, by which interventions aimed to change behavior, were 'psychological capability' ('knowledge', 'skills' and 'behavioral regulation'); 'reflective motivation' ('beliefs about consequences' and 'intention') and 'physical opportunity' ('environmental context and resources, e.g., sharing leaflets with patients); the latter particularly so for community pharmacy interventions. These findings suggest that intervention designers believe that increasing knowledge and motivation among all target groups is key to decreasing inappropriate antibiotic consumption.

Psychological capability was targeted in all groups, delivered largely through 'instruction on how to perform the behavior. Reflective motivation and psychological capability were targeted in patients and prescribers using the BCT 'information about health consequences'. Interventions targeting patients and prescribers through 'beliefs about consequences' (e.g., NHS England's Patient Safety Alert [47], Public Health England's Keep Antibiotics Working campaign [48]) could have drawn on a much wider range of techniques. For example, BCT 'information about emotional consequences' (e.g., the anxiety of becoming ill knowing antibiotics would not be effective), or BCT 'anticipated regret' (e.g., the degree of regret prescribers may feel in the future if they do not modify their antibiotic prescribing), or by employing incentives or rewards. Provider and commissioner interventions focused more on 'Feedback on behavior', for example interventions giving feedback on prescribing and local

antimicrobial resistance rates (e.g., NHS England Quality Premium: 2016/17 Guidance for CCGs [49], Public Health England Fingertips platform [50] and PrescQIPP Antimicrobial Stewardship [51]) with the aim of facilitating a change in behavioral regulation (the mental skills to carry out the mental tasks required to perform the behavior).

Physical opportunity was another commonly targeted domain in interventions aimed at all target groups. The most frequently used technique was 'adding objects to the environment' (i.e., provision of information leaflets). Many other techniques appropriate for targeting this domain were not used, for example, avoiding/reducing exposure to cues for the behavior which could, e.g., involve diverting patients with self-limiting infections to the pharmacy via appointment booking lines as suggested in Pinder et al. [19].

With the exception of community pharmacy, Interventions were identified across all settings, which targeted social opportunity through social comparison with peers (e.g., UK Chief Medical Officer letter to high prescribers of antibiotics [52]) and practical social support (e.g., Self Care Forum: Self Care Week [53]).

We identified few (8/39) interventions which aimed to change behavior by targeting 'automatic motivation', such as routines and habits (e.g., encouraging routine feedback where antibiotics are not prescribed according to guidelines), emotional drives (e.g., addressing concerns about the negative consequences of not prescribing antibiotics), and reinforcement (e.g., incentivizing participation in AMS training), which can be powerful influences on behavior. Designing new interventions and refining existing interventions may merit considering targeting these influences.

## 6. Limitations

There are three key limitations to this study. First, the interventions included in this study are implemented at a national level. The devolution of responsibility to local health and public health teams means the many interventions which were designed and implemented locally are not included. Secondly, we did not establish the extent to which included interventions were effective in changing behavior nor the extent to which they are implemented. Thirdly, whilst we obtained most of the materials and documents related to each included intervention, we were unable to access all materials.

## 7. Future Research Directions

The mechanisms of action of interventions were determined by applying available resources which link COM-B and TDF to intervention content (intervention types and BCTs). This process established how interventions are likely to have an effect on behavior. Future intervention design and refinement would be supported by establishing the barriers and facilitators to the behaviors identified in this study and then comparing them with intervention content to determine the extent to which intervention content appropriately targets identified barriers and facilitators. Establishing the extent to which interventions are effective will support interpretation of these findings. Establishing which behaviors are key in influencing AMR will support the prioritization of intervention design and refinement.

Intervention design and refinement would be aided with the provision of accessible guidance on processes such as that described above to support intervention designers with a range of expertise in behavior change.

## 8. Conclusions

Although changing behaviors alone cannot fully halt the AMR problem, patient and physician behaviors in primary care offer a unique opportunity for AMR interventions. Targeting behaviors amenable to change using effective, evidence-based BCTs, may offer new cost-effective methods to reduce antibiotic prescribing and thus halt the rise in the number of patients suffering from infections due to AMR. This study highlights the need to review existing interventions to ensure they are optimized to influence AMR-related behaviors. Any gaps identified in current provision should be

considered for future intervention design and refinement, ensuring these are aligned to work within the NHS's changing provision of primary care.

## 9. Declarations

### *9.1. Ethics Approval and Consent to Participate*

Not applicable.

### *9.2. Consent for Publication*

Not applicable.

### *9.3. Availability of Data and Material*

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Supplementary Materials:** The following are available online at http://www.mdpi.com/2079-6382/9/8/512/s1, Table S1: Labels, definitions and examples of COM-B and Theoretical Domains Framework; Table S2: Behaviour Change Wheel labels, definitions and examples; Table S3: Source materials for behavior; Table S4: Summary of intervention content, mechanism of action and target behaviour.

**Author Contributions:** Conceptualization, T.C. and A.S.; formal analysis, L.A. and A.S.; investigation, L.A., P.B., N.H., V.d.L.M., M.G.-I. and A.S.; methodology, L.A., T.C. and A.S.; supervision, T.C.; writing—original draft, L.A. and A.S.; writing—review & editing, T.C., P.B., D.A.-O., E.B., N.H., V.d.L.M, M.G.-I., S.H. and C.M. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest:** T.C., P.B., D.A.-O., S.H. and A.S. are employed by project funders, Public Health England.

## Appendix A

**Table A1.** Summary of intervention, target group, behavior, mechanism of action, and intervention content.

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| **Public Health England Antibiotic Guardian [37]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Education | Commitment | Service provision |
| | Prescribers | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Social influences | Persuasion | Adding objects to the environment | Communication and marketing |
| | Community pharmacists and pharmacy staff | 3. Take antibiotics as prescribed (do not save for later use or share with others) by a suitably qualified HCP. | Automatic motivation | Beliefs about consequences | Training | Credible source | |
| | Providers | 4. Return unwanted antibiotics to the pharmacy. | Physical opportunity | Intention | Incentivization | Social reward | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | Commissioners | 5. Prescribe an antibiotic only when there is likely to be clear clinical benefit (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | Social opportunity | Environmental context and resources | Enablement | Instruction on how to perform the behavior | |
| | | 6. Give alternative, non-antibiotic self-care advice, where appropriate. | | Memory attention and decision making | Modeling | Prompts/cues | |
| | | 7. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | | Emotion | | Information about health consequences | |
| | | 8. Provide safety netting advice whether or not the patient has been prescribed antibiotics (e.g., what to do if condition gets worse or side effects of medication). | | Social professional role and identity | | Salience of consequences | |
| | | 9. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | | | Demonstration of the behavior | |
| | | 10. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | | | | Identification of self as role model | |
| | | 11. Use/share written resources with the public when providing self-care advice for self-limiting RTIs. | | | | | |
| | | 12. When giving an antibiotic prescription for a self-limiting RTI, inform the patients of the dose and duration or to take their antibiotics exactly as prescribed. | | | | | |
| | | 13. Check that antibiotic prescriptions comply with local guidance and query with the prescriber for those that do not. | | | | | |
| | | 14. Accept and dispose appropriately of returned antibiotics. | | | | | |
| | | 15. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR | | | | | |
| | | 16. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR. | | | | | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 17. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>18. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change. | | | | | |
| **UK Department of Health and Public Health England Antimicrobial Prescribing and Stewardship Competencies [41]** | Prescribers<br>Providers<br>Commissioners | 1. Follow/adhere to local antibiotic formulary—general behaviors.<br>2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition.<br>3. Give alternative, non-antibiotic self-care advice, where appropriate.<br>4. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs.<br>5. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose.<br>6. Provide 'delayed/back-up' antibiotic strategy where appropriate.<br>7. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics.<br>8. Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice.<br>9. Provide education and training in prudent antimicrobial use/AMR (using the antimicrobial resistance and stewardship competencies as a framework).<br>10. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets. | Psychological capability | Knowledge<br>Behavioral regulation | Education<br>Training | Information about health consequences<br>Self-monitoring of outcomes of behavior<br>Social support (practical)<br>Instruction on how to perform the behavior | Guidelines |
| **The Health and Social Care Act (HSCA) 2008. Code of Practice on the prevention and control of infections and related guidance [54]** | Providers<br>Commissioners | 1. Provide education and training in prudent antimicrobial use/AMR (using the antimicrobial resistance and stewardship competencies as a framework).<br>2. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR.<br>3. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>4. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change. | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Regulation |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 5. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change.<br>6. Providers have a formulary in place for antibiotic prescribing | | | | | |
| **NICE Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use [NG15] [17]** | Providers<br>Commissioners<br>Prescribers<br>Community pharmacists and pharmacy staff | 1. Follow/adhere to local antibiotic formulary—general behaviors.<br>2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition.<br>3. Give alternative, non-antibiotic self-care advice, where appropriate.<br>4. Provide safety netting advice whether or not the patient has been prescribed antibiotics (e.g., what to do if condition gets worse or side effects of medication).<br>5. Provide 'delayed/back-up' antibiotic strategy where appropriate.<br>6. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics.<br>7. Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice.<br>8. Undertake POCT in patients 18–65 years old presenting with acute cough/bronchitis in whom antibiotics are being considered.<br>9. Check that antibiotic prescriptions comply with local guidance and query with the prescriber for those that do not.<br>10. Provide education and training in prudent antimicrobial use/AMR (using the antimicrobial resistance and stewardship competencies as a framework).<br>11. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR.<br>12. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>13. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change. | Psychological capability | Skills<br>Behavioral regulation | Training<br>Education | Instruction on how to perform the behavior<br>Self-monitoring of outcomes of behavior | Guidelines |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 14. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change.<br>15. Provide feedback to prescribers on patient safety incidents related to antimicrobial use, including hospital admissions for potentially avoidable life-threatening infections, infections with Clostridium difficile or adverse drug reactions, such as anaphylaxis.<br>16. Providers have a formulary in place for antibiotic prescribing. | | | | | |
| **NICE Infection Prevention and Control [QS61] [27]** | Patients<br>Prescribers<br>Providers<br>Commissioners | 1. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs.<br>2. Follow/adhere to local antibiotic formulary prescribers.<br>3. Prescribe an antibiotic only when there is clear clinical benefit.<br>4. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose.<br>5. Provide 'delayed/back-up' antibiotic strategy where appropriate.<br>6. Limit prescribing over the telephone to exceptional cases for self-limiting RTIs.<br>7. Provide education and training.<br>8. Commission, develop or implement interventions to support AMS.<br>9. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>10. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change.<br>11. Provide regular feedback on antimicrobials prescribing.<br>12. Providers have a formulary in place for prescribing.<br>13. Commissioners seek evidence/providers make evidence available for adherence to local or national guidance for antibiotic prescribing. | Psychological capability | Knowledge<br>Skills<br>Behavioral regulation | Education<br>Training<br>Enablement | Instruction on how to perform the behavior<br>Self-monitoring of the behavior<br>Action planning<br>Information about health consequences | Guidelines |
| **NHS England Quality Premium: 2016/17 Guidance for CCGs [49]** | Providers<br>Commissioners | 1. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>2. Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | Automatic motivation<br>Psychological capability | Reinforcement<br>Behavioral regulation | Incentivization<br>Education | Material reward<br>Feedback on the behavior | Fiscal measures |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| **NHS England Patient Safety Alert—addressing antimicrobial resistance through implementation of an antimicrobial stewardship program [47]** | Providers | 1. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR. | Physical opportunity | Environmental context and resources | Enablement | Adding objects to the environment | Communication/ marketing |
| | Commissioners | | Reflective motivation | Beliefs about consequences | Education | Information about health consequences | |
| **TARGET Antibiotics Toolkit (Treat Antibiotics Responsibly, Guidance, Education, Tools) [38]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Behavioral regulation | Education | Action planning | Service provision |
| | Prescribers | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Beliefs about consequences | Enablement | Adding objects to the environment | Guidelines |
| | Community pharmacists and pharmacy staff | 3. Use back-up prescriptions as directed by a suitably qualified healthcare professional (HCP). | Automatic motivation | Skills | Incentivization | Demonstration of the behavior | Communication and marketing |
| | Providers | 4. Take antibiotics as prescribed (do not save for later use or share with others) by a suitably qualified HCP. | Physical opportunity | Knowledge | Modeling | Feedback on the behavior | |
| | Commissioners | 5. Return unwanted antibiotics to the pharmacy. | Social opportunity | Environmental context and resources | Persuasion | Identification of self as role model | |
| | | 6. Follow/adhere to local antibiotic formulary—general behaviors | | Intention | Training | Information about health consequences | |
| | | 7. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | | Reinforcement | | Information about social environmental consequences | |
| | | 8. Give alternative, non-antibiotic self-care advice, where appropriate. | | Social influences | | Instruction on how to perform the behavior | |
| | | 9. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | | Social professional role and identity | | Reward (non material) | |
| | | 10. Provide safety netting advice whether or not the patient has been prescribed antibiotics (e.g., what to do if condition gets worse or side effects of medication). | | | | Self-monitoring of the behavior | |
| | | 11. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | | | | Credible source | |
| | | 12. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | | | | |
| | | 13. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | | | | |
| | | 14. Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice. | | | | | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 15. Undertake POCT in patients 18–65 years old presenting with acute cough/bronchitis in whom antibiotics are being considered.<br>16. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate.<br>17. Use/share written resources with the public when providing self-care advice for self-limiting RTIs.<br>18. Provide education and training in prudent antimicrobial use/AMR (using the antimicrobial resistance and stewardship competencies as a framework).<br>19. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR.<br>20. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR.<br>21. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>22. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change.<br>23. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change.<br>24. Providers have a formulary in place for antibiotic prescribing.<br>25. Commissioners seek evidence/providers make evidence available for adherence to local or national guidance for antibiotic prescribing.<br>26. Commissioners ensure information and resources are available for healthcare professionals to use during consultations with people seeking advice about managing self-limiting RTIs.<br>27. Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | | | | |
| **Treat Yourself Better [40]** | Patients | Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Reflective motivation<br>Social opportunity<br>Psychological capability | Intention<br>Knowledge<br>Skills<br>Social influences<br>Beliefs about consequences | Persuasion<br>Education<br>Training<br>Enablement | Credible source<br>Information about health consequences<br>Instruction on how to perform the behavior<br>Social comparison<br>Information about social and environmental consequences | Communication and marketing |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| **UK Chief Medical Officer letter to high prescribers of antibiotics [52]** | Prescribers | 1. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). | Psychological capability | Behavioral regulation | Persuasion | Social comparison | Communication/ marketing |
| | | 2. Give alternative, non-antibiotic self-care advice, where appropriate. Provide 'delayed/back-up' antibiotic strategy where appropriate. | Reflective motivation | Intention | Training | Credible source | |
| | | 3. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | Physical opportunity | Knowledge | Education | Instruction on how to perform the behavior | |
| | | 4. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | Environmental context and resources | Enablement | Adding objects to the environment | |
| | | | | Beliefs about consequences | | Behavioral substitution | |
| | | | | Optimism | | Feedback on the behavior | |
| | | | | | | Information about health consequences | |
| **Public Health England Fingertips platform [50]** | Commissioners | 1. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets. | Psychological capability | Behavioral regulation | Education | Feedback on the behavior | Service provision |
| | Providers | 2. Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | Reflective motivation | Intention | Enablement | Feedback on outcome(s) of behavior | |
| | | | | Knowledge | | Social comparison | |
| | | | | | | Information about health consequences | |
| **PrescQIPP Antimicrobial Stewardship [51]** | Prescribers | 1. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | Physical opportunity | Environmental context and resources | Enablement | Social support (practical) | Service provision |
| | Providers | 2. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support self-care. | Reflective motivation | Beliefs about consequences | Education | Information about social and environmental consequences | |
| | Commissioners | 3. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets. | Psychological capability | Skills | Training | Instruction on how to perform the behavior | |
| | | | Social opportunity | Behavioral regulation | Persuasion | Pros and cons | |
| | | | | Social influences | | Feedback on the behavior | |
| | | | | | | Feedback on outcome(s) of behavior | |
| | | | | | | Social comparison | |
| **UK Five Year Antimicrobial Resistance Strategy 2013 to 2018 [15]** | Prescribers | 1. Follow/adhere to local antibiotic formulary—general behaviors. | Reflective motivation | Beliefs about consequences | Education | Information about health consequences | Guidelines |
| | Providers | 2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | |
| | Commissioners | 3. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | Physical opportunity | Behavioral regulation | Enablement | Adding objects to the environment | |
| | | 4. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | Environmental context and resources | Coercion | Future punishment | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 5. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | Optimism | Persuasion | Identification of self as role model | |
| | | 6. Undertake POCT in patients 18–65 years old presenting with acute cough/bronchitis in whom antibiotics are being considered. | | Social professional role and identity | | | |
| | | 7. Provide education and training in prudent antimicrobial use/AMR (using the antimicrobial resistance and stewardship competencies as a framework). | | | | | |
| | | 8. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR | | | | | |
| | | 9. Commissioners seek evidence/providers make evidence available for adherence to local or national guidance for antibiotic prescribing. | | | | | |
| **NHS website advice on common cold [55]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Training | Information about health consequences | Service provision |
| | | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Intention | Education | Instruction on how to perform the behavior | |
| | | | | | Persuasion | Credible source | |
| **NICE Antimicrobial stewardship: changing risk-related behaviors in the general population [NG63] [23]** | Prescribers | 1. Give alternative, non-antibiotic self-care advice, where appropriate. | Psychological capability | Knowledge | Education | Instruction on how to perform the behavior | Guidelines |
| | Community pharmacists and pharmacy staff | 2. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | Social opportunity | Social influences | Training | Social support practical | |
| | Providers | 3. Provide safety netting advice whether or not the patient has been prescribed antibiotics (e.g., what to do if condition gets worse or side effects of medication). | | Behavioral regulation | Enablement | Self-monitoring of behavior | |
| | Commissioners | 4. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | | | Action planning | |
| | | 5. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | | | | Feedback on outcome(s) of behavior | |
| | | 6. Use/share written resources with the public when providing self-care advice for self-limiting RTIs. | | | | | |
| | | 7. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR. | | | | | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 8. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support self-care. | | | | | |
| | | 9. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change. | | | | | |
| | | 10. Commissioners ensure information and resources are available for healthcare professionals to use during consultations with people seeking advice about managing self-limiting RTIs. | | | | | |
| | | 11. Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | | | | | |
| **Center for Pharmacy Postgraduate Education distance course: Antibacterial resistance—a global threat to public health: the role of the pharmacy team [56]** | Community pharmacists and pharmacy staff<br>Prescribers | 1. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | Psychological capability | Skills | Training | Instruction on how to perform the behavior | Guidelines |
| | | 2. Use/share written resources with the public when providing self-care advice for self-limiting RTIs. | | | | Behavioral practice/ rehearsal | |
| | | 3. When giving an antibiotic prescription for a self-limiting RTI, inform the patients of the dose and duration or to take their antibiotics exactly as prescribed. | | | | | |
| | | 4. Check that antibiotic prescriptions comply with local guidance and query with the prescriber for those that do not. | | | | | |
| | | 5. Accept and dispose appropriately of returned antibiotics. | | | | | |
| | | 6. Follow/adhere to local antibiotic formulary—general behaviors. | | | | | |
| | | 7. Prescribe an antibiotic only when there is clear clinical benefit. | | | | | |
| | | 8. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | | | | | |
| | | 9. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | | | | | |
| | | 10. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | | | | |
| | | 11. Limit prescribing over the telephone to exceptional cases for self-limiting RTIs. | | | | | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| **UK Clinical Pharmacy Association/Royal Pharmaceutical Society—professional practice curriculum [57]** | Prescribers | Follow/adhere to local antibiotic formulary–general behaviors. | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Guidelines |
| **FeverPAIN [58]** | Prescribers | Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | Psychological capability<br>Reflective motivation | Knowledge<br>Beliefs about consequences | Enablement<br>Education | Adding objects to the environment<br>Information about health consequences | Service provision |
| **Public health England Managing Common Infections Guidance [28]** | Prescribers | 1. Follow/adhere to local antibiotic formulary—general behaviors.<br>2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat).<br>3. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose.<br>4. Provide 'delayed/back-up' antibiotic strategy where appropriate.<br>5. Undertake POCT in patients 18–65 years old presenting with acute cough/bronchitis in whom antibiotics are being considered.<br>6. Limit prescribing over the telephone to exceptional cases for self-limiting RTIs. | Reflective motivation | Intention<br>Knowledge | Training<br>Persuasion | Instruction on how to perform the behavior<br>Credible source | Guidelines |
| **NICE Respiratory tract infections (self-limiting): prescribing antibiotics [CG69] [59]** | Patients<br>Prescribers | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation.<br>2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition.<br>3. Give alternative, non-antibiotic self-care advice, where appropriate.<br>4. Provide 'delayed/back-up' antibiotic strategy where appropriate. | Psychological capability | Knowledge<br>Skills | Training<br>Enablement | Instruction on how to perform the behavior<br>Social support practical | Guidelines |
| **NICE Antimicrobial Stewardship [QS121] [29]** | Prescribers<br>Providers<br>Commissioners | 1. Follow/adhere to local antibiotic formulary—general behaviors.<br>2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat).<br>3. Give alternative, non-antibiotic self-care advice, where appropriate. Provide 'delayed/back-up' antibiotic strategy where appropriate. | Physical opportunity<br>Psychological capability<br>Reflective motivation | Behavioral regulation<br>Beliefs about consequences<br>Environmental context and resources | Education<br>Enablement<br>Training | Feedback on behavior<br>Self-monitoring of behavior<br>Goal setting (behavior) | Guidelines |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 4. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | Goals | Environmental restructuring | Information about health consequences | |
| | | 5. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | Knowledge | Persuasion | Instruction on how to perform the behavior | |
| | | 6. Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice. | | | | Restructuring the physical environment | |
| | | 7. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR | | | | Action planning | |
| | | 8. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support self-care. | | | | | |
| | | 9. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets. | | | | | |
| | | 10. Promote current national guidelines, or promote/develop local guidelines on antimicrobial prescribing among all prescribers, providing updates if the guidelines change. | | | | | |
| | | 11. Commissioners seek evidence/providers make evidence available for adherence to local or national guidance for antibiotic prescribing. | | | | | |
| | | 12. Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | | | | | |
| **Self Care Forum: Factsheet 7 (Cough in Adults); Factsheet 12 (Common Cold) [60]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Skills | Training | Instruction on how to perform the behavior | Service provision |
| | | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | | Knowledge | Education | Information about health consequences | |
| **Managing Acute Respiratory Tract Infections (MARTI) e-learning [45]** | Prescribers | 3. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). | Automatic motivation | Reinforcement | Coercion | Action planning | |
| | | 4. Give alternative, non-antibiotic self-care advice, where appropriate. | Reflective motivation | Knowledge | Education | Credible source | |
| | | 5. Provide safety netting advice whether or not the patient has been prescribed antibiotics (e.g., what to do if condition gets worse or side effects of medication). | Physical opportunity | Social professional role and identity | Enablement | Demonstration of the behavior | |
| | | 6. Provide 'delayed/back-up' antibiotic strategy where appropriate. | Psychological capability | Beliefs about consequences | Incentivization | Feedback on outcome(s) of behavior | |
| | | 7. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | | Skills | Persuasion | Framing/reframing | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 8. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | | Environmental context and resources | Training | Future punishment | |
| | | 9. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | | | Identification of self as role model | |
| | | 10. Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice. | | | | Information about health consequences | |
| | | | | | | Information about social environmental consequences<br>Instruction on how to perform the behavior<br>Non-specific reward<br>Problem solving<br>Salience of consequences<br>Self-monitoring of outcome(s) of the behavior | |
| **Stemming the Tide of Antibiotic Resistance (STAR) e-learning [44]** | Prescribers | 1. Follow/adhere to local antibiotic formulary—general behaviors. | Psychological capability | Skills | Training | Demonstration of the behavior | Service provision |
| | | 2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). | Reflective motivation | Intention | Persuasion | Credible source | |
| | | 3. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | Social opportunity | Beliefs about consequences | Modeling | Information about health consequences | |
| | | | Automatic motivation | Social influences<br>Reinforcement | Incentivization | Behavioral practice/rehearsal<br>Instruction on how to perform the behavior<br>Information about social and environmental consequences<br>Non-specific reward | |
| **Open Prescribing.net [61]** | Providers<br>Commissioners | Monitor antibiotic prescribing in relation to local and national resistance patterns or targets. | Psychological capability | Knowledge | Education<br>Enablement | Feedback on the behavior<br>Feedback on the outcome of behavior<br>Adding objects to the environment | Service provision |
| **CENTOR [62]** | Prescribers | 1. Follow/adhere to local antibiotic formulary—general behaviors | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Service provision |
| | | 2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). | | | | | |
| | | 3. Document, in patients records, clinical diagnosis (including symptoms) if prescribing an immediate or back up antimicrobial and/or giving self-care advice. | | | | | |
| | | 4. Undertake POCT in patients 18–65 years old presenting with acute cough/bronchitis in whom antibiotics are being considered. | | | | | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| **Health Education England 'Antimicrobial Resistance: A Guide for GPs' [63]** | Prescribers | 1. Follow/adhere to local antibiotic formulary—general behaviors. | Psychological capability | Knowledge | Education | Information about health consequences | Communication and marketing |
| | | 2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | Reflective motivation | Intention | Enablement | Social support (practical) | |
| | | 3. Give alternative, non-antibiotic self-care advice, where appropriate. | Automatic motivation | Emotion | Persuasion | Credible source | |
| | | 4. Use/share written self-care resources/leaflets when issuing self-care advice for symptoms of self-limiting RTIs. | | Environmental context and resources | Training | Adding objects to the environment | |
| | | 5. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | Skills | Coercion | Future punishment | |
| | | | | Social professional role and identity | | Identification of self as role model | |
| | | | | | | Instruction on how to perform the behavior | |
| **Public Health England Keep Antibiotics Working campaign [48]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Education | Credible source | Communication and marketing |
| | Providers | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Beliefs about consequences | Training | Information about health consequences | |
| | Commissioners | 3. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR. | Automatic motivation | Emotion | Enablement | Information about social and environmental consequences | |
| | | | Physical opportunity | Environmental context and resources | Persuasion | Instruction on how to perform the behavior | |
| | | | | Intention | | Social support (practical) | |
| **NICE Sinusitis (acute): antimicrobial prescribing [NG79] [24]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Skills | Training | Instruction on how to perform the behavior | Guidelines |
| | Prescribers | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Physical capability | Knowledge | Education | Information about health consequences | |
| | | 3. Use back-up prescriptions as directed by a suitably qualified healthcare professional (HCP). | Reflective motivation | Memory attention and decision making | Enablement | Action planning | |
| | | 4. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | | Beliefs about consequences | | Pharmacological support | |
| | | 5. Give alternative, non-antibiotic self-care advice, where appropriate. | | | | | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | 6. Provide safety netting advice. | | | | | |
| | | 7. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | | | | | |
| | | 8. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | | | | |
| **NICE Sore throat (acute): antimicrobial prescribing [NG84] [26]** | Prescribers | 1. Follow/adhere to local antibiotic formulary—general behaviors | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Guidelines |
| | | 2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). | | Memory attention and decision making | Education | Information about health consequences | |
| | | 3. Give alternative, non-antibiotic self-care advice, where appropriate. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | | Enablement | Action planning | |
| | | 4. Provide safety netting advice | | | | | |
| | | 5. When an antibiotic is indicated prescribe the narrowest spectrum antibiotic possible, for the right duration, at the right dose. | | | | | |
| | | 6. Explain the prescribing decision to the patient, including where appropriate, the benefits and harms of antibiotics. | | | | | |
| | | 7. Provide 'delayed/back-up' antibiotic strategy where appropriate. | | | | | |
| **Department of Health & Social Care 'Take Care not Antibiotics' videos [64]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Communication and marketing |
| | | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | | Skills | Education | Information about health consequences | |
| | | | | | Enablement | Action planning | |
| **Patient.info webpages on colds, sore throats, antibiotics, bronchitis and sinusitis [65]** | Patients | 3. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Education | Information about health consequences | Service provision |
| | | 4. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Intention | Training | Instruction on how to perform the behavior | |
| | | 5. Use back-up prescriptions as directed by a suitably qualified healthcare professional (HCP). | | | | | |
| | | 6. Take antibiotics as prescribed (do not save for later use or share with others) by a suitably qualified HCP. | | | Persuasion | Credible source | |
| **Health Education England 'Awareness of Antimicrobial Resistance (AMR) Animation' [66]** | Patients | Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Beliefs about consequences | Persuasion | Salience of consequences | Communication and marketing |
| | | | Psychological capability | Knowledge | Education | Information about health consequences Identification of self as role model | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| **Self Care Forum: Self Care Week [53]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Education | Information about health consequences | Communication and marketing |
| | Providers | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | | Skills | Training | Instruction on how to perform the behavior | |
| | Commissioners | 3. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support self-care. | | Memory attention and decision making | Enablement | Social support (practical) | |
| | | | | | | Prompts/cues | |
| **theLearning pharmacy.com [42]** | Community pharmacists and pharmacy staff | 1. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Service provision |
| | | 2. Use/share written resources with the public when providing self-care advice for self-limiting RTIs. | Physical opportunity | Environmental context and resources | Enablement | Adding objects to the environment | |
| | | 3. Check that antibiotic prescriptions comply with local guidance and query with the prescriber for those that do not. | | Skills | | Behavioral practice/ rehearsal | |
| **Public Health England 'Beat the Bugs' course [46]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Education | Salience of consequences | Service provision |
| | | 2. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | Reflective motivation | Behavioral regulation | Enablement | Information about health consequences | |
| | | 3. Take antibiotics as prescribed (do not save for later use or share with others) by a suitably qualified HCP. | Automatic motivation | Beliefs about consequences | Training | Action-planning | |
| | | 4. Return unwanted antibiotics to the pharmacy. | | Reinforcement | Incentivization | Instruction on how to perform the behavior | |
| | | | | Skills | Persuasion | Behavioral practice/ rehearsal | |
| | | | | | | Non-specific reward | |
| **Royal Pharmaceutical Society: Antimicrobial Stewardship Quick Reference Guide [31]** | Community pharmacists and pharmacy staff | 1. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | Reflective motivation | Social professional role and identity | Persuasion | Identification of self as role model | Service provision |
| | | 2. When giving an antibiotic prescription for a self-limiting RTI, inform the patients of the dose and duration or to take their antibiotics exactly as prescribed. | Psychological capability | Beliefs about capabilities | Training | Focus on past success | |
| | | 3. Check that antibiotic prescriptions comply with local guidance and query with the prescriber for those that do not. | Physical opportunity | Knowledge | Enablement | Instruction on how to perform the behavior | |

**Table A1.** *Cont.*

| | | | Mechanism of Action | | Intervention Content | | |
|---|---|---|---|---|---|---|---|
| **Intervention** | **Target Group** | **Behavior** | **COM-B** | **TDF** | **Intervention Type** | **BCT** | **Policy Option** |
| | | | | Environmental context and resources | | Adding objects to the environment | |
| **Royal College of Nursing (RCN) and Infection Prevention Society (IPS) Infection Prevention and Control Commissioning Toolkit [43]** | Providers<br>Commissioners | 1. Commissioners seek evidence/providers make evidence available for adherence to local or national guidance for antibiotic prescribing.<br>2. Commission, develop or implement interventions (e.g., guidance, services, programs, or campaigns) to support AMS/tackle AMR.<br>3. Monitor antibiotic prescribing in relation to local and national resistance patterns or targets.<br>4. Providers have a formulary in place for antibiotic prescribing. | Psychological capability | Knowledge | Training | Instruction on how to perform the behavior | Guidelines |
| **British Society for Antimicrobial Chemotherapy: Antibiotic Action [39]** | Patients | 1. Self-care and/or obtain pharmacy advice for signs and symptoms of self-limiting respiratory tract infections prior to, or instead of, a primary care consultation. | Psychological capability | Knowledge | Education | Information about health consequences | Service provision |
| | Prescribers | 2. Prescribe an antibiotic only when there is likely to be clear clinical benefit, (using fever PAIN or CENTOR for sore throat). OR Do not issue an immediate prescription for an antimicrobial to a patient who is likely to have a self-limiting condition. | Reflective motivation | Social professional role and identity | Persuasion | Identification of self as role model | |
| | Community pharmacists and pharmacy staff | 3. Provide self-care advice for patients with symptoms of self-limiting RTIs, instead of, following or prior to referral to a primary care clinician, giving safety netting advice where appropriate. | Physical opportunity | Environmental context and resources | Enablement | Adding objects to the environment | |
| | Providers | 4. Reduce antibiotic prescribing/antimicrobial resistance—general behaviors. | | | | | |
| | Commissioners | 5. Do not request antibiotics at primary care consultations for symptoms of self-limiting RTIs. | | | | | |
| | | 6. Take antibiotics as prescribed (do not save for later use or share with others) by a suitably qualified HCP. | | | | | |

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