Behavior Change Strategies to Influence Antimicrobial Prescribing in Acute Care: A Systematic Review

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Background. Antimicrobial use in acute care is widely reported to be suboptimal. Inappropriate use of antimicrobials is a major contributing factor to the emergence of multidrug resistance and health care–associated infection. Addressing prescribing behavior is a key component of antimicrobial stewardship.

Methods. We performed a novel systematic review of both qualitative and quantitative literature on antimicrobial prescribing behavior in acute care. We assessed the extent to which behavioral sciences and social marketing were used and whether this could be related to the effectiveness of reported outcomes. MEDLINE, Excerpta Medica Database (EMBASE), Applied Social Sciences Index and Abstracts (ASSIA), Business Source Complete, The Cochrane Library, PsychInfo, Database of Abstracts of Reviews of Effectiveness (DARE) and Health Management Information Consortium (HMIC) were searched for studies undertaken during the period January 1999–April 2011 and published in English.

Results. Five qualitative and 5 quantitative studies met the quality criteria. Qualitative studies highlight the predominant influence of social norms, attitudes, and beliefs on antimicrobial prescribing behavior. Quantitative studies reporting interventions to optimize antimicrobial prescribing behavior do not use theoretical science or primary research to inform the design and choice of the interventions deployed.

Conclusions. Despite qualitative evidence demonstrating the impact of behavioral determinants and social norms on prescribing, these influences are not given due consideration in the design and evaluation of interventions. To ensure a better understanding of prescribing behaviors and to improve the quality of interventions and research in this area, the incorporation and application of behavioral sciences supported by appropriate multidisciplinary collaboration is recommended.

Up to one-third of all hospitalized patients receive antimicrobials, [1, 2] and studies show that 25%–68% of hospital antimicrobial prescribing is suboptimal [3, 4]. Unequivocal evidence links inappropriate and excessive use of antimicrobials with an increase in the incidence of Clostridium difficile–associated disease [5] and selection of bacteria exhibiting antimicrobial resistance (AR), such as methicillin-resistant Staphylococcus aureus and extended-spectrum β-lactamases [5–7]. The problem of AR is further complicated by multidrug-resistant pathogens against which most antimicrobials are ineffective, with little prospect of new antimicrobials coming into the market [8]. Suboptimal prescribing can also lead to other unintended consequences of ineffective antimicrobial therapy, including delayed administration and subtherapeutic dosing, which can contribute to treatment failure.

In an effort to improve the quality of antimicrobial prescribing in acute care, antimicrobial stewardship (AS) initiatives have been recommended [9, 10]. AS
Behavioral sciences use principles of psychology and sociology to identify and map determinants of behavior to observed practice and include several models that explain why people behave in certain ways [13]. Principles of behavioral and social science and commercial marketing have also been utilized as part of a Social Marketing (SM) approach to affect positive health behaviors. SM uses principles of marketing to persuade a target group to adopt behaviors that are beneficial to health and which reduce burden of disease on society. Several definitions of SM exist [14]. The constituent elements as defined by the National Social Marketing Centre are listed in Table 1 and include the following: performing primary research; segmenting the target audience on the basis of their values, attitudes, and behaviors; and developing bespoke interventions for target groups. SM has been extensively used by governments to change public health behaviors (eg, to promote smoking cessation) [15] and has recently gained ground as a framework for effective behavior change within infection prevention and control, including for changes in antimicrobial prescribing [16, 17]. However, the application of social sciences and SM to influence prescribing practice in acute care is limited, and the efficacy of interventions within this context remains unclear [18].

To date, systematic reviews of antimicrobial prescribing have assessed the literature for the effectiveness of interventions to change practice to address inappropriate prescribing. Evidence for the application of social sciences or the importance of behavior change has not been considered. One reason for this may be the exclusion of qualitative research, which is a common methodological approach in social science research, in systematic reviews. To address this gap, we have reviewed both qualitative and quantitative literature for evidence of behavioral influences on antimicrobial prescribing and the effectiveness of interventions to affect behavior. To do this, we developed specific criteria for the assessment of studies that report non-controlled and nonrandomized methodologies. Our primary objective was to assess the effectiveness of antimicrobial prescribing interventions that, either alone or in combination, aim to influence behaviors in acute care. The secondary objectives were (1) to assess the extent to which behavioral and social sciences or SM were applied in the design of the interventions and whether this could be related to their effectiveness and (2) to review qualitative literature for evidence of the perceived barriers and facilitators to behavior change in antimicrobial prescribing to provide a platform for future research.

**METHODS**

**Search Strategy and Selection Criteria**

The initial search was purposively broad; the methodology and schematic (Figure 1) presented in this article reflect this fact. Appraisal of the evidence resulted in 2 separate analyses: one focusing on antimicrobial prescribing, which is presented here, and one focusing on infection prevention and control, which will be published separately.

We searched databases from January 1999 through April 2011. MEDLINE, Excerpta Medica Database, Applied Social Sciences Index and Abstracts (ASSIA), Business Source Complete, The Cochrane Library, PsycINFO, The Database of Abstracts of Reviews of Effectiveness (DARE) and Health Management Information Consortium (HMIC) were searched to review qualitative literature for evidence of the perceived barriers and facilitators to behavior change in antimicrobial prescribing to provide a platform for future research.

Table 1. Main Principles of Social Marketing

<table>
<thead>
<tr>
<th>Customer orientation</th>
<th>Developing a robust understanding of the audience</th>
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<tr>
<td>Behavioral focus</td>
<td>Analyzing current and formulating desired behaviors</td>
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<td>Theoretical basis</td>
<td>Drawing on and informed by behavioral theory</td>
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<tr>
<td>Insight driven</td>
<td>Appreciating what truly moves and motivates people</td>
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<td>Acknowledges exchange</td>
<td>Understanding what people have to give up to get the benefits proposed</td>
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<td>Competition aware</td>
<td>Considering what competes for people's time and attention</td>
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<tr>
<td>Appropriate segmentation</td>
<td>Developing a targeted approach specific to the audience</td>
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<tr>
<td>Mixes methods</td>
<td>Avoiding reliance on a single method or approach</td>
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“antibiotic stewardship,” “antimicrobial stewardship,” “anti-infective,” “behavioral interventions,” “intervention,” and “acute care.”

**Study Inclusion and Exclusion Criteria**

Studies were included if they (1) evaluated interventions aimed at changing prescriber behavior around antimicrobial prescribing and (2) reported on primary research into health care professionals’ attitudes, beliefs, and views regarding antimicrobial prescribing. Studies were only included if they were conducted in countries defined as having a developed health care system (see Supplementary Material).

**Quality Criteria**

The Critical Appraisal Skills Programme (CASP) tool for evaluating qualitative research [19, 20], the Cochrane Risk of Bias Tool [21], and the Effective Practice and Organisation of Care (EPOC) model [22] were used to develop quality criteria for review of included studies. Accepting that a randomized controlled methodology is not always applicable to behavioral change interventions, the EPOC model was adapted to include additional quality criteria for review of noncontrolled studies. These additional criteria enabled inclusion in the review of methodologically robust noncontrolled studies that exhibited sufficient internal and external validity [20]. A final quality assessment tool, which included criteria specific to different study methodologies as well as overarching criteria applicable to all types of study (Figure 1), was developed.

**Quality Assessment and Data Extraction**

Data extraction was conducted in 2 phases: by title and abstract and by full text. Following the title and abstract assessment, 2 teams of researchers (R. E. and E. C.; E. S. and D. M.) performed the full-text evaluation. To ensure consistency in approach and outcomes, a random sample of 200 articles were reviewed, in a blinded fashion, by both teams. Following this, the remaining articles were randomly apportioned to each team for full-text evaluation. A fifth independent reviewer (B. A.) was available for arbitration where there was uncertainty or disagreement about whether to include a study in the review. Following discussion, agreement was reached on all studies. A standardized piloted form was used by reviewers to record data.
RESULTS

The initial search returned 9123 articles. Of these, 191 were antimicrobial prescribing articles that met the inclusion criteria and were assessed on full-text evaluation against the quality criteria (Figure 2). Ten articles were included in the final review and narrative synthesis, including 5 quantitative intervention studies [23–27] and 5 qualitative studies [28–32].

Quantitative Studies—Evidence of Use of Behavioral Theory in Intervention Design

The quantitative studies reported on multimodal interventions used to optimize antimicrobial prescribing (Table 2). Two studies assessed interventions in terms of compliance with antimicrobial guidelines [23, 24]. The surgical infection prevention measures deployed by McCahill et al [23] at a tertiary hospital in the United States showed some evidence of utilization of primary research and rationale in the choice of intervention deployed. A fact-finding period was used to collect information from individual staff about the patterns of practice in the prescribing, ordering, and delivery of antimicrobials for surgical prophylaxis. The approach of gaining insight into practice prior to developing interventions and the mixed method approach in intervention design, which included service configuration, overlaps with some aspects of an SM approach to changing behavior, although the authors themselves did not allude to this concept or to any behavioral theory during intervention development.

Mol et al [24] assessed the relative effects of guideline dissemination and academic detailing on guideline compliance in a university hospital in the Netherlands. Although the authors did not discuss the theoretical basis for the choice of either intervention, the study was based on a previous investigation in which doctors were interviewed to identify the barriers associated with adherence to antimicrobial guidelines. It is not clear from the article whether the results of that study were used in the development of the interventions reported. Both studies reported improvements in compliance; however, because of a lack of primary and post-intervention research into determinants of staff behavior, it is difficult to attribute the improvements to any specific interventions.

Kritchevsky et al [25] attempted to isolate the impact of a quality improvement collaborative to improve surgical prophylaxis prescribing in 44 US hospitals. Their approach showed no consideration of contextual and behavioral determinants of prescribing or adherence behavior. The collaborative

![Figure 2.](http://cid.oxfordjournals.org/)

Quality criteria used in review. CASP, Critical Appraisal Skills Programme; CBA, controlled before and after; CRCT, cluster randomized controlled trials; EPOC, Effective Practice and Organisation of Care; ITS, interrupted time series; RCTs, randomized controlled trials.
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<tr>
<th>Study</th>
<th>Aims and intervention</th>
<th>Design and methodology</th>
<th>Sample and duration</th>
<th>Outcomes and conclusions</th>
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<tr>
<td>McCahill et al [23] (2007)</td>
<td>Aims: To assess compliance with surgical infection prevention (SIP) measures following a multidisciplinary intervention. Intervention: (1) Fact finding session to develop and communicate SIP guideline; (2) SIP guideline developed by multidisciplinary committee; (3) quarterly communication with surgical teams; (4) monthly surgical audits provided detailed reports of compliance with SIP measures; (5) task force teams implemented.</td>
<td>Time series study: Before and during intervention. SIP measures were as follows: (1) Percentage of surgical cases with prophylactic antibiotics started within 60 min of surgical incision; (2) percentage of surgical patients receiving prophylactic antibiotics consistent with current guidelines; (3) percentage with antibiotics discontinued within 24 h after surgery end time.</td>
<td>n = 1072 surgical procedures; 18 months</td>
<td>Outcomes: Measure 1 compliance improved from 72.25% to 83.78% (P &lt; 0.001). Measure 2 compliance remained uniformly high (~98%). Measure 3 compliance improved from 54.5% to 97.16% (P &lt; 0.01). Conclusions: Integral to success in improving the timely delivery and discontinuation of prophylactic surgical antibiotics was the clearly defined roles of a cross-disciplinary team that included expertise in quality improvement and management. Multiple disciplines necessary to identify all potential processes requiring improvement and to facilitate communication and education of change. Failure to achieve higher rate of compliance highlights the complexities involved in bringing about change in multidisciplinary work force.</td>
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<tr>
<td>Mol et al [24] (2005)</td>
<td>Aims: To assess the impact of the dissemination of revised antibiotic guidelines developed with physician consultation and supported by academic detailing. Intervention: Revised guidelines developed in consultation with practitioners. Revised guidelines disseminated to all physicians in paperback form as well as other launch activities. Academic detailing with nonspecified sample of physicians undertaken with explicit message on need for guideline adherence with clinical case study aids.</td>
<td>Prospective uncontrolled interrupted time series study with baseline data. Prescribing data prospectively collected and assessed for compliance with guidelines. Data collected at baseline, post-intervention (guideline), and post-AD. Monthly data points and aggregate over periods above taken.</td>
<td>7471 Antimicrobial prescriptions from 2869 patients; 2 years and 10 months</td>
<td>Outcomes: Predissemination compliance baseline, 67%. Postdissemination showed 81% compliance, and post-AD showed 86% compliance. Significant increase from baseline to postdissemination, 15.5% (95% confidence interval [CI], 8%–23%); no significant increase seen post-AD. Conclusions: Revised guidelines can lead to clear improvements in compliance with the recommendations when actively disseminated and when “ownership” is increased by consultation with targeted physicians and fine-tuning of guidelines with departmental policies.</td>
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<tr>
<td>Kritchevsky et al [25] (2008)</td>
<td>Aims: To assess the effects of a quality improvement collaborative on preoperative antimicrobial prophylaxis. Intervention: Quality improvement collaborative comprising 2 in-person meetings led by experts, monthly teleconferences, and receipt of supplemental materials over 9 months. Intervention target were staff responsible for antimicrobial prophylaxis in patients undergoing cardiac surgery, hip and knee replacement, and hysterectomy.</td>
<td>Longitudinal cluster randomized trial. Intervention hospitals received quality improvement collaborative and comparative feedback reports. Control hospitals received only comparative feedback reports. Random sample of at least 100 blinded cases from each hospital taken at baseline and after quality circle intervention for analysis of antimicrobial prescribing behavior.</td>
<td>44 (22 intervention, 22 control) acute care hospitals with a baseline of n = 4447 and re-measurement of n = 4463; 2 years</td>
<td>Outcomes: The groups did not differ in the change in proportion of patients who received a properly timed antimicrobial prophylaxis dose (+3.8% [95% CI, -13.9% to 6.2%]) after adjustment for region, hospital size, and surgery type. Similarly, the groups did not differ in individual measures of antibiotic duration, use of appropriate drug, receipt of a single preoperative dose, or an all-or-none measure combining timing, duration, and selection. Conclusions: The trial did not demonstrate a benefit of participation in a quality improvement collaborative over performance feedback for improvement of these measures.</td>
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<td>Study</td>
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<td>Fowler (2007) [26]</td>
<td>Aims: To investigate the effect of reinforcing a restrictive antibiotic policy on antibiotic prescription and <em>Clostridium difficile</em> infection (CDI) rates by feedback of antibiotic use to doctors. Intervention: Phase 1—Cephalosporin restrictive antibiotic policy introduced. 2/3 monthly feedback of antibiotic use and CDI, methicillin-resistant <em>Staphylococcus aureus</em> (MRSA) cases. Isolation policy for CDI and MRSA instigated. Phase 2—Narrow-spectrum antibiotic policy written and laminated card version given to all prescribing physicians.</td>
<td>Controlled interrupted time series (measure control not case) Pre- and post–phase 2 intervention data collected (aggregate over 21-month periods) and monthly data. Notional 7-day courses per 100 hospital admissions calculated from available audit data. CDI and MRSA mandatory monthly counts.</td>
<td>6129 Hospital admissions for acute illness; 3 years and 6 months</td>
<td>Outcomes: A statistically significant reduction in the use of targeted broad-spectrum antibiotics and an increase in all targeted narrow spectrum antibiotics was observed. All other antibiotic use remained unchanged. CDI rates decreased with incidence ratios of 0.35 (95% confidence interval, .17–.73) (P = .009). MRSA incidence did not change [0/79 (0.49,1.28); P = .32]. Conclusions: The introduction of a narrow-spectrum antibiotic policy, reinforced by feedback, was associated with significant changes in targeted antibiotics and a significant reduction in CDI.</td>
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<td>Buising et al [27] (2008)</td>
<td>Aims: To describe the impact of different methods of guideline promotion on prescribing behavior. Intervention: Consecutive stages (2003–2006) (1) &quot;Baseline&quot;—electronic and paper national antibiotic prescribing guidelines available to staff in the emergency department (ED) with no additional efforts to encourage uptake of guidelines. (2) Academic detailing (AD)—Two senior ED clinicians, a pharmacist, and a nurse provided 1:1 AD to their colleagues. (3) Computerized decision support system (CDSS)—Guideline for the management of patients with CAP deployed on an existing CDSS.</td>
<td>Two stage pre- and post-observation cohort study, including time series analysis. Prescribing practices of senior and junior medical practitioners managing patients in the ED audited from patient medical records. Characteristics of subjects compared over time.</td>
<td>Baseline n = 392, AD n = 215, and CDSS n = 133; 3 years and 6 months</td>
<td>Outcomes: The odds ratio (OR) for concordant therapy in the AD period, after adjustment compared with the baseline period was 2.79 (95% CI, 1.88–4.14) (P &lt; .01); for the CDSS period compared with the AD period, the OR was 1.99 (95% CI, 1.07–3.69) (P = .02). Conclusions: During the first months of the CDSS period, an improvement in the appropriateness of antibiotic prescribing was demonstrated. Based on predictions from a binary logistic model, the observed improvement was greater than the expected improvement with time and AD alone. Development of a CDSS was associated with an early improvement in antibiotic prescribing practices. Further exploration of the role of CDSS in hospitals is warranted to assess the sustainability of the effect on clinician decision making.</td>
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was not able to demonstrate a significant improvement in surgical antimicrobial prescribing practice.

The impact of reinforced restrictive antimicrobial prescribing guidelines in an acute trust in the UK was reported by Fowler et al [26]. The study reported that dissemination of a restrictive policy had a positive effect on prescribing patterns and C. difficile infection rates. The article did not report on any primary research that considered determinants of behavior change in the target group, and there was no rationale for the method of guideline dissemination or choice of target group.

The behavioral goal of prudent antimicrobial prescribing was a stated aim of the study conducted by Buising et al [27]. The study reported on the impact of guideline development, academic detailing sessions, and implementation of a computerized decision support system on antimicrobial prescribing behavior. The authors did not discuss the use of behavioral science to gain an understanding of the behavioral intention of prescribers as part of the design, implementation, or impact assessment of the interventions. The study demonstrated that deployment of a computerized decision support system was associated with a short-term improvement in antimicrobial prescribing. The sustainability of the intervention was not evaluated.

**Qualitative Studies-Examining Barriers to and Facilitators of Behavior Change**

The qualitative studies attempted to investigate health care professionals’ perspectives on antimicrobial prescribing and adherence to antibiotic guidelines and policy (Table 3). Two studies [28, 29] highlighted the influence of senior practitioners on antimicrobial prescribing behavior and suggested that they would be a prime group to target in interventions that seek to optimize prescribing behavior. Cortoos et al [28] performed a focus group–based study in Belgium that emphasized the highly influential role of supervisors on the prescribing behavior of hospital doctors. This study highlighted the need to differentiate between specialties and to account for the perspective of these inherently different groups when designing policy and guidelines. The heterogeneous nature of specialist staff in acute care was identified as one of the barriers to behavior change and a reason why single-mode interventions used to improve antimicrobial prescribing often fail to work. De Souza et al [29] reported on a study on nonconsultant hospital doctors (NCHD) in an Irish teaching hospital. Their findings indicate that, early in their careers, NCHDs’ prescribing behavior is primarily informed by the practice of senior colleagues. Hospital policy was identified as playing a minor role in influencing prescribing behavior.

Results of a survey of staff and focus groups across 4 hospitals in the US to assess hospital doctors’ perceptions of AR were reported by Giblin et al [30]. The study reported a tendency for doctors to consider the problem of AR as one that affects other institutions more than their own; this was a result of a failure to perceive AR as relevant to their own practice. The doctors in the study reported a tendency to emulate poor prescribing behavior of their colleagues and considered education to be a facilitator to improved practice. The need for adequate education of doctors on antimicrobial prescribing and AR was identified as necessary to the efforts to stem the culture of emulating inappropriate behavior of senior colleagues. Tan et al [31] reported on semi-structured interviews undertaken primarily with surgeons sampled across 2 affiliated university hospitals in Canada and highlighted role perception and workflow as dominant obstacles in guideline observance. Study participants identified the unpredictability of and unanticipated changes to their workflow as obstacles to proper antimicrobial timing of surgical prophylaxis. Another important barrier to appropriate prescribing was the low priority assigned to timely antimicrobial administration. From a study across 3 hospitals in the Netherlands, Schouten et al [32] reported on the barriers to optimal antibiotic use for community-acquired pneumonia. The prescribers justified their deviance from prescribing guidelines by considering patient risk, anticipated ease of procurement, and administration of the antimicrobial. The evidence bases of the guidelines were also questioned, leading to a lack of confidence in the recommendations made. Participation of prescribers in guideline development and subsequent agreement with guideline recommendations were identified as facilitators to adherence.

**DISCUSSION**

In hospitals, cultural, contextual, and behavioral determinants influence antimicrobial prescribing and result in variation in practice locally, nationally, and internationally [33]. Prescribing in general is subject to influence by a host of factors, including the cultural beliefs of the prescriber and the patient, socioeconomic factors, and the desire for clinical autonomy when making decisions [34]. Medical hierarchy and professional relationships can influence prescribing behavior and lead to a “prescribing etiquette,” including, for example, a reluctance to alter prescriptions written by colleagues or a tendency to follow the precedent set by more senior staff members [35, 36]. The constituent parts of AS programs in acute care are reliant on behavior change of individual prescribers. To this end, when designing new interventions in antimicrobial prescribing, it is paramount that primary research into prescribing behavioral intention of individuals is performed and that interventions are tailored to the target audience in whom behavior change is desired. This can lead to an understanding of the barriers to and facilitators of behavior change; enable development of interventions that utilize facilitators and overcome barriers;
Table 3. Qualitative Studies Exploring Health Care Professional Attitudes, Motivations, Behaviors, and Perspectives on Prudent Antimicrobial Prescribing

<table>
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<tr>
<th>Study</th>
<th>Aims</th>
<th>Design and methodology</th>
<th>Sample</th>
<th>Outcomes and conclusions</th>
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<tr>
<td>Cortoos et al [28] (2008)</td>
<td>To determine the opinions and problems concerning the use of a local antibiotic hospital guideline</td>
<td>Qualitative study using focus groups. Explored 8 open-ended themes regarding guideline use, contents, implications for practice, and perceived improvements.</td>
<td>22 Physicians, including residents and supervisors, sampled from surgery (59.1%) and medicine (40.9%).</td>
<td>General acceptance of local guidelines high, but clear differences present between subgroups with different desires and requirements from guideline contents. Supervisors in their role as opinion leaders mentioned as highly influential towards residents’ practice. Within one hospital, prescribers have to be seen as a number of different target groups instead of a homogeneous population.</td>
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<td>De Souza et al [29] (2006)</td>
<td>To determine the factors that influence nonconsultant hospital doctors (NCHDs) in their decision to prescribe antimicrobial agents</td>
<td>Qualitative study using semi-structured interviews centered on a life grid tracking the medical career of NCHDs. The life-grid approach documented knowledge regarding antimicrobial agents, prescribing practice, and influences at each point in the medical career. Participants were invited for interviews until point of saturation was reached.</td>
<td>Purposive sample of NCHDs (n = 22) selected from all NCHDs (n = 246) who had responded (n = 71) to the call for participation in the study.</td>
<td>The most significant influence on prescribing practices was the opinion of more-senior colleagues. Early in the career of NCHDs, prescribing is based primarily on the immediate influence of more-senior colleagues. With career progression, greater autonomy is exercised, and personal experience becomes the major influence on prescribing decisions. Hospital guidelines are a minor influence. The key influences on antimicrobial prescribing by NCHDs are informal. New approaches are required to ensure that formal training and hospital antimicrobial prescribing guidelines are more influential in shaping antimicrobial prescribing practice in this group.</td>
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<td>Giblin et al[30] (2004)</td>
<td>To assess clinicians’ perceptions of antimicrobial resistance (AR), barriers to and facilitators of AR prevention, and how best to reach clinicians after exposure to a campaign aimed at reducing AR</td>
<td>Qualitative study supplemented with some quantitative data. Study used a questionnaire, clinicians attending presentation of intervention campaign, and 4 focus groups to obtain quantitative data.</td>
<td>Clinicians (n = 117) attending national campaign presentation in their hospitals on infection prevention and control. Focus groups comprise a convenience sample of clinicians (n = 28), some not attending presentation.</td>
<td>Clinicians were significantly more likely to perceive AR as a national problem rather than one in their institution (98% vs 77%; P &lt; .001) or related to their practice (95% vs 65%; P = .002). This finding was consistent with focus group results. Additional barriers identified by clinicians included the health care culture, tendency to emulate incorrect behaviors of fellow clinicians, lack of knowledge, and the nursing shortage; facilitators included education, information technology, and consults. Computer programs, posters and local data were suggested for reaching clinicians about AR.</td>
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<tr>
<td>Study</td>
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<td>Design and methodology</td>
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<td>Tan et al [31] (2006)</td>
<td>To examine perceived obstacles to using evidence-based guidelines for the timely administration of prophylactic antibiotics to prevent surgical site infections</td>
<td>Qualitative study using semi-structured interviews. Discussion guide explored obstacles to adoption of evidence-based guidelines.</td>
<td>12 Anesthesiologists, 11 surgeons, 1 nurse, 1 nurse administrator, 1 anesthesia administrator, 1 pharmacist. Convenience/purposive sampling using grounded theory approach.</td>
<td>Despite having knowledge of guidelines, participants perceived consistent failure in the proper timing of antibiotic administration. Thematic analysis revealed a number of obstacles to the observance of guidelines, including (1) low priority, (2) inconvenience, (3) workflow, (4) organizational communication, and (5) role perception. Workflow and role perception were the dominant obstacles. The unpredictability of and unanticipated changes to workflow were identified as obstacles to timely administration of antibiotics for surgical prophylaxis. The gap between evidence-based guidelines and practice is populated by individual values, professional conflicts and organizational conflicts that must be addressed to achieve optimal practice in this domain.</td>
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<tr>
<td>Schouten et al [32] (2007)</td>
<td>To study and understand barriers to appropriate antibiotic use in patients with community-acquired pneumonia</td>
<td>Qualitative study using semi-structured interviews. Interactive group sessions with nurses. Explored guideline recommendations and aspects of prescribing practice. Participants were invited for interviews until point of saturation was reached.</td>
<td>Purposive sample of professionals (n = 18) comprising 9 residents, 6 consultants, 2 microbiologists, and 1 clinical pharmacist.</td>
<td>Each guideline recommendation elicited a different type of barrier. Regarding the adherence to guideline recommendations for empirical therapy, treating physicians said that they worried about patient outcome when prescribing narrow-spectrum antibiotic therapy as well as lack of agreement with the content of guidelines. The participants reported a lack of confidence in the recommendations due to a perceived lack of evidence. Regarding the timeliness of antibiotic administration, barriers such as conflicting guidelines and organizational factors (eg, delayed laboratory results, antibiotics not directly available, and lack of time) were reported. Not streamlining therapy once culture results were available was thought to be due to the physicians’ attitude of “never change a winning team.” Physician’s lack of knowledge about the impact of timely antibiotic administration on patient outcome and lack of agreement with guidelines was an additional barrier.</td>
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Concerted multi-modal approaches incorporating evidence-based guidelines and policy with feedback may be effective in optimizing antimicrobial prescribing in specific areas [23, 24, 27], but to bring about effective and sustainable behavior change, it is necessary to target research on the determinants of prescribing behavior. This review highlights the need for research and utilization of behavioral and social sciences to attempt to understand the barriers to and facilitators of behavior change and uptake of evidence-based practice by prescribers.

**CONCLUSIONS**

This review found that interventions to optimize antimicrobial prescribing behavior are of poor quality and are not based on robust theoretical science. Behavior and social science research

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Table 4. The Recommended Elements of an Intervention to Target Behavior Change in Antimicrobial Prescribing

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<th>Recommendation</th>
<th>Descriptor</th>
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<td>Conduct primary research</td>
<td>Engage in multidisciplinary primary research. Include expertise from social and behavioral sciences [41] to identify the key behavioral determinants of antimicrobial prescribing in the target audience in whom a change in behavior is desired.</td>
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<tr>
<td>Tailor interventions</td>
<td>Use data from primary research to identify key behavioral determinants and tailor interventions to (1) address identified barriers and (2) enhance the facilitators of the desired behavior change.</td>
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<td>Evaluate intervention outcomes</td>
<td>Evaluate the effectiveness of interventions to bring about prescribing behavior change.</td>
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<td>Address sustainability</td>
<td>Monitor the long-term adoption and implementation of the intervention and recognize the importance of building sustainability into the intervention model.</td>
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is underutilized in the development of antimicrobial prescribing interventions. Qualitative evidence highlights the influence of social norms, attitudes, and beliefs on antimicrobial prescribing behavior. When designing and evaluating interventions in antimicrobial prescribing, these influences on prescribing are generally not considered.

These findings stress the need for targeted multidisciplinary research to investigate the utilization of behavioral and social sciences to assess prescribing behavior and set standards. The lack of this approach may be a contributing factor to the challenges that beset interventions aiming to influence prescribing behavior and optimize antimicrobial prescribing.

Supplementary Data

Supplementary materials are available at Clinical Infectious Diseases online (http://www.oxfordjournals.org/our_journals/cid/). Supplementary materials consist of data provided by the author that are published to benefit the reader. The posted materials are not copyrighted. The contents of all supplementary data are the sole responsibility of the authors. Questions or messages regarding errors should be addressed to the author.

Notes

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

All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References