Not in my backyard: a systematic review of clinicians’ knowledge and beliefs about antibiotic resistance

A. R. McCullough1*, J. Rathbone1, S. Parekh2, T. C. Hoffmann1 and C. B. Del Mar1

1Centre for Research in Evidence-Based Practice, Faculty of Health Sciences and Medicine, Bond University, Queensland 4229, Australia; 2Centre of National Research on Disability and Rehabilitation Medicine, Griffith Health Institute, Griffith University, Queensland 4131, Australia

*Corresponding author. Tel: +61-7-5595-5204; E-mail: amccullo@bond.edu.au

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Objectives: To systematically review clinicians’ knowledge and beliefs about the importance and causes of antibiotic resistance, and strategies to reduce resistance.

Methods: Four databases were searched (until July 2014), without restrictions on language, setting or study design. Fixed responses (from surveys) were grouped into categories. The proportion of participants who agreed with each category was expressed as median, percentage and IQR. Qualitative data were coded into emergent themes. Quantitative categories and qualitative themes were grouped into four overarching categories that emerged from the data.

Results: There were 57 included studies (38 quantitative, 14 qualitative, 5 mixed methods) of 11593 clinicians. Most clinicians (69%, IQR 63%–72%, n = 5 studies) had heard of antibiotic resistance and 98% (IQR 93%–99%, n = 5 studies) believed it was serious. The proportion who believed it was a problem for their practice (67%, IQR 65%–74%, n = 13 studies) was smaller than the proportion who believed it was a problem globally (89%, IQR 85%–97%, n = 5 studies) or nationally (92%, IQR 88%–95%, n = 21 studies). Most believed excessive antibiotic use (97%, IQR 91%–98%, n = 12 studies) and patient non-adherence (90%, IQR 82%–92%, n = 7 studies) caused resistance. Most knew of strategies to reduce resistance (e.g. clinician education, 90%, IQR 85%–96%, n = 7 studies). Qualitative findings support these data: they attributed responsibility for antibiotic resistance to patients, other countries and healthcare settings; resistance was considered a low priority and a distant consequence of antibiotic prescribing.

Conclusions: Clinicians believe antibiotic resistance is a serious problem, but think it is caused by others. This needs to be accommodated in interventions to reduce antibiotic resistance.

Introduction

The WHO recently described antibiotic resistance as a major ‘global security threat’ that could send healthcare into a ‘post-antibiotic era’.1 The problem is so serious that it is deemed to be as important as terrorism and climate change.1,2 Governments are developing national policies to minimize antibiotic resistance3–5 and international alliances to tackle the problem are evolving.6,7 Yet 23 000 people in the USA, 25 000 people in Europe and many more worldwide continue to die annually as a consequence of antibiotic resistance.4,8

Antibiotic use is the main driver of antibiotic resistance.9–11 Despite this, global antibiotic use grew by 36% between 2000 and 2010 to 73 billion units per year12 and antibiotics continue to be prescribed for conditions for which they confer little or no benefit.13–19 Antibiotic prescription usually involves an individual consultation between a patient and a clinician. Therefore, individual clinician prescribing behaviour is critical. Psychological theories illustrate that clinicians’ knowledge and beliefs influence this process.10,20

Specifically, disease knowledge, beliefs about the consequences of their prescribing decisions and perceived patients’ expectations influence decision making at clinical consultations.20–22

Numerous studies have assessed clinicians’ knowledge and beliefs about antibiotic resistance23–25 and several have shown that these influence prescribing behaviour.11,22,26 These studies have not been synthesized. A synthesis of these data is needed to help identify targets for future interventions to minimize antibiotic resistance. We sought to synthesize clinicians’ knowledge and beliefs about antibiotic resistance from quantitative and qualitative studies.

Methods

Protocol and registration

The review protocol was registered on the PROSPERO database (CRD42013005029) at http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42013005029. Ethics approval was not required.
Eligibility criteria
We sought primary studies that measured clinicians’ (any clinician including undergraduates, except veterinarians) knowledge or beliefs about antibiotic resistance with no restrictions on study design, language, setting or disease population. We excluded studies that did not measure knowledge or beliefs about antibiotic resistance as an outcome or had abstract-only data.

Search and information sources
We searched MEDLINE, EMBASE, PsycINFO and CINAHL (inception until the third week of July 2014). The MEDLINE search strategy was adapted for use in the other databases (Table S1, available as Supplementary data at JAC Online). Included search terms also targeted studies about the general public’s beliefs about antibiotic resistance; these data will be reported separately. We conducted forward and backward citation searches on all included articles using Web of Science and Scopus. We contacted authors of articles available in abstract-only form and key researchers in the field.

Study selection
Two reviewers (A. R. McC. or S. P. and J. R.) independently screened titles and abstracts and the full texts of potentially relevant articles. Conflicts were discussed and resolved between pairs of raters (A. R. McC. and J. R., S. P. and J. R.). Disagreements were resolved by a third reviewer (C. B. D. M. or T. C. H.).

Data extraction
Two reviewers (A. R. McC. or S. P. and J. R.) independently extracted data from all included studies. Studies published in languages other than English were translated using Google Translate and verified by translators. We contacted study authors to clarify data, when necessary. We extracted data on study design and participants (Table S2).

We extracted data relevant to assessing quality in surveys: survey method; sampling method; response rate; sample size; and description of participants. For knowledge and beliefs about antibiotic resistance outcomes, from quantitative studies, we extracted relevant fixed responses verbatim along with the proportion (%) of participants who responded affirmatively (e.g. yes or strongly agree/agree) (Table S3a–d). We aggregated positive Likert responses such as ‘strongly agree’ and ‘agree’ into a single category by taking the mean percentage across the categories. The proportion (%) of participants who responded ‘strongly disagree/disagree’ to two negatively phrased statements in a single study (e.g. ‘Antibiotic resistance is not a significant problem in my hospital/nationally’27) was extracted to allow aggregation with positive Likert responses. We extracted baseline outcome data in studies with more than one data collection time-point (such as clinical trials). If baseline data were not reported, we extracted post-intervention control group data for all relevant outcomes.

Figure 1. Summary of systematic review process.
One reviewer (A. R. McC.) extracted data verbatim from qualitative studies (including quotes) and surveys with free text responses directly into NVivo10.

Synthesis of results and summary measures

Quantitative data were synthesized by grouping together similar fixed responses into categories (Figure 1). Where two or more responses were available, we calculated the median, IQR and range of percentages of participants who agreed with each fixed response category. Initial categories were grouped into four overarching categories that emerged from the data: knowledge of antibiotic resistance; beliefs about the importance of antibiotic resistance; causes of antibiotic resistance; and strategies to minimize antibiotic resistance. We explored whether meta-analysis could be performed in a sub-group of studies posing similar questions about whether antibiotic resistance was a problem worldwide, nationally, locally or for the practice (data are shown in forest plots in Figure S1). Meta-analysis could not be performed due to high heterogeneity ($I^2$ between 95% and 98%) and wide confidence intervals. We explored heterogeneity by year of publication (<2011 and ≥2011; 2010 was the median publication year of included studies), setting (hospital, primary care and university) and development of country (developed or developing). Outcomes by gender and profession could not be determined as they were not consistently reported by group.

Qualitative synthesis involved four stages:

(i) Line-by-line coding into emergent themes. Where appropriate, these themes were given the same titles as those reported in the quantitative data.
(ii) Grouping of emergent themes under the four overarching categories described above.
(iii) Summarizing findings of each theme. Each theme was given an identifier, e.g. K1–4 for knowledge of antibiotic resistances themes 1–4.
(iv) Cross-referencing of quantitative categories and qualitative themes identified overlapping findings.

Results

Fifty-seven studies encompassing 11,593 clinicians were included (Figure 1; references for included studies are in the Supplementary data). Table S2 shows full study characteristics, which are summarized in Figure 2. Most studies were conducted in hospitals with physicians in North America or Europe. Females constituted <50% of clinicians in 22 (71%) studies.

Synthesis of quantitative data on knowledge and beliefs about antibiotic resistance

Clinicians’ knowledge and beliefs about the importance and causes of antibiotic resistance and strategies to minimize it are summarized in Figure 3(a–d); supporting data are in Table S3(a–d).

Most had heard of antibiotic resistance but few knew its correct prevalence or that it can last up to 12 months (Figure 3a). Most clinicians believed that antibiotic resistance was a serious problem that would get worse and the number of clinicians who believed it was a problem at the local, national or worldwide level was greater than the number who believed it was a problem at their practice level (Figure 3b).

High proportions of clinicians believed too much use of antibiotics, the use of broad-spectrum antibiotics and patient non-adherence caused resistance (Figure 3). The proportion of patients who believed antibiotic resistance to be a hospital-based problem was greater than the proportion who believed it to be a primary care problem (mainly studies with primary care clinicians; Figure 3c).

![Figure 2. Summary of characteristics of included studies.](https://academic.oup.com/jac/article-abstract/70/9/2465/722814)
Strategies with which the highest proportion of clinicians agreed were: reducing antibiotic use; educational interventions; local guidelines; and access to local antibiograms (Figure 3d). Two studies suggested that patient-focused strategies should be implemented; public campaigns and improving adherence.

There were no obvious trends in knowledge and beliefs by year, development stage or clinical setting (Table S3a–d).

**Synthesis of qualitative data on knowledge and beliefs about antibiotic resistance**

Knowledge and beliefs about the importance and causes of antibiotic resistance and strategies to minimize it from the qualitative synthesis are summarized in Figure 4(a–d). Tables S4–S7 report a complete description of themes, main findings and examples.

Qualitative synthesis findings were consistent with quantitative synthesis results as illustrated by the grey shading in Figure 4(a–d). Notable findings are summarized here. A number of clinicians did not believe antibiotic resistance was a serious problem (Figure 4b, I6) or believed it was outside of their control (I4). Clinicians did not believe antibiotic resistance was a problem for their practice and perceived it to be a greater problem for other countries and healthcare institutions (I1). They considered it to be a ‘theoretical’ problem, of lower priority compared with competing demands when prescribing antibiotics or instituting infection control procedures (I5). They believed antibiotic resistance was a distant consequence of antibiotic prescribing/infection control compared with the proximal consequences that inaction could have for their patient (I7). Six additional causes of resistance and five strategies were suggested (Figure 4c, C9–11, S10–S13,
S15). Additional strategies focused on changing doctor’s prescribing habits (S10), improved communication between clinicians (S11), delayed prescribing (S12), legislative changes (S13) and improving vaccination uptake (S15).

**Discussion**

In this systematic review of clinicians’ knowledge and beliefs about antibiotic resistance, we found that many clinicians had heard of antibiotic resistance; believed it was a serious problem; believed that using too many antibiotics was the main cause; and knew some of the evidence-based strategies to reduce it. But they also attributed blame for causing antibiotic resistance to other healthcare settings, professionals and patients; believed resistance was caused by short antibiotic durations, low dosages and patient non-adherence; and gave little focus to patient strategies. Knowledge gaps about antibiotic resistance prevalence and mechanism of action were evident.

Strengths of this review include our comprehensive search strategy, broad inclusion criteria and our contact of key authors.
**Figure 4.** Summary of qualitative synthesis of clinicians’ knowledge and beliefs about antibiotic resistance (n = 19 studies).

<table>
<thead>
<tr>
<th>ID</th>
<th>Theme</th>
<th>n</th>
</tr>
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<tbody>
<tr>
<td>K1</td>
<td>Have heard of antibiotic resistance</td>
<td>11</td>
</tr>
<tr>
<td>K2</td>
<td>Have not heard of antibiotic resistance</td>
<td>2</td>
</tr>
<tr>
<td>K3</td>
<td>Understanding of definition of antibiotic resistance</td>
<td>1</td>
</tr>
<tr>
<td>ID</td>
<td>Theme</td>
<td>n</td>
</tr>
<tr>
<td>11</td>
<td>Antibiotic resistance is a worldwide, national, local or practice problem</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>Antibiotic resistance is a serious problem</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>Antibiotic resistance will get worse</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Antibiotic resistance is out of my control</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Antibiotic resistance is not a priority</td>
<td>11</td>
</tr>
<tr>
<td>16</td>
<td>Antibiotic resistance is not a serious problem</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>Beliefs about the consequences of antibiotic resistance</td>
<td>9</td>
</tr>
</tbody>
</table>

Footnotes
ID = theme identifier code
n = number of studies contributing to each theme
Grey fill indicates theme was present in both quantitative and qualitative data

**Healthcare factors**

<table>
<thead>
<tr>
<th>ID</th>
<th>Theme</th>
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<tbody>
<tr>
<td>C1</td>
<td>Poor infection control</td>
<td>3</td>
</tr>
<tr>
<td>C2</td>
<td>“Inappropriate” antibiotic use</td>
<td>6</td>
</tr>
<tr>
<td>C3</td>
<td>Using too many antibiotics</td>
<td>4</td>
</tr>
<tr>
<td>C4</td>
<td>Broad-spectrum antibiotic use</td>
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</tr>
<tr>
<td>C5</td>
<td>Excessive antibiotic duration</td>
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<td>C6</td>
<td>Pharmaceutical representatives</td>
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<tr>
<td>C7</td>
<td>Lack of prescriber knowledge</td>
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</tr>
<tr>
<td>C8</td>
<td>Antibiotic resistance is a hospital or community problem</td>
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</tr>
<tr>
<td>C9</td>
<td>Antibiotic use</td>
<td>5</td>
</tr>
<tr>
<td>C10</td>
<td>Issuing antibiotics without prescription</td>
<td>3</td>
</tr>
<tr>
<td>C11</td>
<td>Lack of healthcare resources</td>
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**Patient factors**

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<tr>
<td>C12</td>
<td>Patient non-adherence to antibiotics</td>
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</tr>
<tr>
<td>C13</td>
<td>Self-medication with antibiotics</td>
<td>3</td>
</tr>
<tr>
<td>C14</td>
<td>Patient expectations</td>
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</tr>
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<td>C15</td>
<td>Delays seeking treatment</td>
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</tr>
<tr>
<td>C16</td>
<td>Antibiotics in domestic waste</td>
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<tr>
<td>C17</td>
<td>Consuming alcohol with antibiotics</td>
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**Livestock factors**

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<tbody>
<tr>
<td>C18</td>
<td>Overuse of antibiotics in animals</td>
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**Strategies to minimise resistance**

<table>
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<th>Theme</th>
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<tbody>
<tr>
<td>S1</td>
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<td>1</td>
</tr>
<tr>
<td>S2</td>
<td>Educational interventions</td>
<td>6</td>
</tr>
<tr>
<td>S3</td>
<td>Reduce antibiotic use</td>
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</tr>
<tr>
<td>S4</td>
<td>Local antibiotic guidelines</td>
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</tr>
<tr>
<td>S5</td>
<td>Access to local antibiograms</td>
<td>5</td>
</tr>
<tr>
<td>S6</td>
<td>New antibiotics</td>
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</tr>
<tr>
<td>S7</td>
<td>Better infection control</td>
<td>1</td>
</tr>
<tr>
<td>S8</td>
<td>Audit and feedback</td>
<td>2</td>
</tr>
<tr>
<td>S9</td>
<td>Access to diagnostic testing</td>
<td>1</td>
</tr>
<tr>
<td>S10</td>
<td>Change doctor’s prescribing habits</td>
<td>1</td>
</tr>
<tr>
<td>S11</td>
<td>Delayed prescribing</td>
<td>1</td>
</tr>
<tr>
<td>S12</td>
<td>Improved communication between clinicians</td>
<td>4</td>
</tr>
<tr>
<td>S13</td>
<td>Legislative changes</td>
<td>4</td>
</tr>
<tr>
<td>S14</td>
<td>Public education campaigns</td>
<td>4</td>
</tr>
<tr>
<td>S15</td>
<td>Increased vaccination uptake</td>
<td>1</td>
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</tbody>
</table>
in the field to identify unpublished studies and to clarify data. The inclusion of qualitative data added depth and understanding to the quantitative findings. Limitations include heterogeneous quantitative outcomes and variations in study size. Outcomes could not be meta-analysed due to this heterogeneity and because several fixed responses within a single category originated from the same study. This heterogeneity could not be explained by any of the variables explored due to the descriptive nature of the data. Included studies may have been subject to response bias, whereby participants provide socially desirable responses. The majority of response rates were moderate, low or very low, indicating that non-response bias was likely. The validity of the questions posed is not known and may have affected the responses obtained. Only one study allowed free text responses to questionnaires. Thus, questions from quantitative studies identify agreement with knowledge and beliefs that researchers thought were important.

Previous reviews have been much smaller in scope, only focused on factors influencing antibiotic prescribing, searched fewer databases or had language limitations, and two only included qualitative study designs. Similar to our review, they found that physicians attributed responsibility for antibiotic resistance to other clinicians.

Despite this review finding that clinicians are aware of antibiotic resistance, its primary cause and some of the evidence-based strategies to minimize it, the amount of antibiotics prescribed nevertheless continues to grow inappropriately. Several possible explanations arise from this study. The tendency for clinicians to blame others for the resistance crisis may be a diffusion of responsibility or a ‘tragedy of the commons’. Where everyone is responsible no one is really responsible. The more harmful the effect of a collective action (e.g. causing antibiotic resistance by prescribing antibiotics or poor infection control), the less responsibility individuals take for causing these effects. Social cognitive theory also explains why clinicians feel they are not responsible for antibiotic resistance. Antibiotic resistance is a distant and physically removed consequence of antibiotic prescribing, whereas patient distress and clinical deterioration are proximal and confronting consequences.

It is not known whether recent calls to action, occurring after the included studies were conducted, have changed clinicians’ beliefs about their role in the development of resistance. Some possibly important knowledge gaps were evident. Clinicians exhibited uncertainty about the duration of antibiotic resistance. Antibiotic resistance is reversible following antibiotic use, with rates of commensals exhibiting resistance decaying to low levels by 12 months. Many were also unaware of the prevalence of antibiotic resistance.

Most correctly believed antibiotic resistance is caused by excessive use of antibiotics, the use of broad-spectrum antibiotics and poor infection control. Many also believed ‘inappropriate’ antibiotic use, prolonged antibiotic duration and patient self-medication cause resistance—which is reasonable, as any antibiotic use can lead to resistance.

Most also attributed resistance to antibiotic underuse: doses that are too low, courses that are of too short duration, or patient non-adherence. Public health campaigns support this view, perhaps extrapolated from uncontrolled studies of resistance in tuberculosis before and after directly observed therapy. But the literature is less clear. Low-dose antibiotics may cause resistance to Streptococcus pneumoniae in children, but this is confounded by concurrent excessive duration of antibiotics. A Cochrane meta-analysis found the risk of treatment failure for acute otitis media at 1 month was higher with <7 days of antibiotics rather than >7 days (OR 1.34; 95% CI 1.15–1.55), an absolute risk increase of only 3%.

Amongst both qualitative and quantitative studies, antibiotic resistance was perceived as a hospital-based problem rather than a community problem. This is possibly because hospitals are where the effects of antibiotic resistance, such as severe and life-threatening infections, are felt, rather than in the community.

Evidence-based strategies to minimize resistance that clinicians knew about included educational interventions, local guidelines and antibiotic stewardship, reflecting the hospital-based setting of the majority of studies. Most proposed strategies were aimed at changing clinicians’ prescribing behaviour. Yet strategies are needed that also address patients’ behaviour. Two quantitative studies in this review suggested patient-focused strategies. One suggested improving adherence to antibiotics. The effect of improving adherence to antibiotics on resistance is not known: it could increase antibiotic exposure and potentially increase resistance. Another study suggested using public education campaigns; based on observational data, this has been effective in reducing antibiotic use in countries with high antibiotic usage. We found little awareness of other effective strategies involving both the patient and the clinician, such as delayed prescribing, written patient information or shared decision-making. These strategies cannot be implemented until clinicians are aware of them and develop the skills to deliver them. But equally concerning is our finding that clinicians attributed the problem to the actions of others, which may act as a barrier to the implementation of these effective strategies.

A key priority should be not only to increase awareness of these strategies, but also to develop interventions to change clinicians’ beliefs about their contribution to antibiotic resistance, to give them the skills to implement effective strategies and create a healthcare environment that supports this approach.

Conclusions
Clinicians believe antibiotic resistance is a serious problem, but think it is caused by others. They held contradictory beliefs about other causes of resistance and there was a lack of focus on patient-centred strategies to reduce resistance. This needs to be accommodated in any future interventions designed to reduce antibiotic resistance.

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Author contributions
All authors contributed to the study design, drafted the manuscript, gave final approval of the version to be published and are accountable for all aspects of the work. A. R. McC., S. P. and J. R. extracted the data. A. R. McC. analysed the data and designed the figures and tables. All authors, external and internal, had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication. The full dataset is available from the corresponding author at amcull@bond.edu.au.

Supplementary data
Figure S1 and Tables S1 to S7 are available as Supplementary data at JAC Online (http://jac.oxfordjournals.org/).

References