

**Supplementary Table 1:** Summary of key characteristics of papers (n=5)

<b>Citation</b>	<b>Country</b>	<b>Sample</b>	<b>Study design</b>	<b>Clinical population</b>	<b>Intervention</b>	<b>Outcomes</b>
Eefje et al (2015)	UK	37 GPs	Qualitative study, focus groups	Children, fever	n/a	<p>“An important factor driving uncertainty for them as GPs was the low incidence of serious bacterial infections (...) They experienced that (diagnostic) uncertainty leads to extra careful management decisions and in turn to more antibiotic prescriptions”</p>
Williams et al (2018)	UK	15 GPs, 15 nurse prescribers (NPs)	Qualitative study, interviews	General population, RTIs	n/a	<p>“Peer discussion and education played an important role in supporting treatment decisions, as prescribers had the opportunity to discuss alternative prescribing techniques as well as to validate their own prescribing decisions.”</p> <p>“Inconsistent prescribing approaches between prescribers were repeatedly reported as a barrier to negotiating care management decision”</p>

Citation	Country	Sample	Study design	Clinical population	Intervention	Outcomes
						<p>“Nurse prescribers were more likely to work to protocol (...) this protocol meant their decisions were made based on the facts before them and supported by local and national guidelines. GPs reported they would often prescribe differently from the guidelines and base their prescribing decisions on ‘gut feeling’”</p> <p>“Audit, feedback and/or supervision were reported to be very important in OOH prescribing”</p>
Colliers et al (2018)	Belgium	17 GPs, 1 manager, 5 pharmacists	Qualitative study, interviews	General population, all conditions	n/a	<p>“Several interviewees suggested to make a specific GPC guideline on antibiotic prescribing. GPs like the fact they can hide behind a decision that was made not by themselves, but for example by the GPC board”</p> <p>“There is a difference in how they deal with these guidelines.</p>

Citation	Country	Sample	Study design	Clinical population	Intervention	Outcomes
						Some use them actively and will check them regularly while working with patients. Others claim they know what is in there, and they do not need to check anymore. Some stick to their own antibiotic preferences, although they know their choice is not guideline-recommended.”
de Bont et al (2018)	Netherlands	3,518 GPs	Randomised controlled trial	Children, fever	Booklet	<p>“The booklet was used in only 3,407 (28.5%) of the encounters (...). Antibiotic prescribing did not differ significantly between centers in which family physicians had access to the booklet and control centers”.</p> <p>“Children in the group with booklet access were less likely than usual care counterparts to receive a prescription for any medication including nonantibiotic medications”</p>
Dyrkorn et al (2016)	Norway	53 GPs	Randomised controlled trial	General population, all conditions	Peer education programme	“There were no significant differences between the intervention and control groups in total prescription rates

Citation	Country	Sample	Study design	Clinical population	Intervention	Outcomes
						neither at baseline or in the intervention period. The intervention group showed a better adherence to national guidelines after the intervention”.

**Supplementary Table 2:** Qualitative meta synthesis of clinical recommendations covered by clinical guidelines (n=46) and training materials (n=8)

Mechanisms				
Theme	Sub-theme	Recommended in:	Recommended since:	Recommended by:
Spectrum	1.1. Broad if critically ill / life threatening	UK	2017	PHE
	1.2. Broad if narrow not effective	UK	2015	NICE
	1.3. Switch from broad to narrow after test results	UK, International	2015-2018	PHE, Up to Date
	1.4. Narrow	UK, International	2014-2018	PHE, NICE, Target Toolkit, PresQIPP
Prescription strategy	2.1. No prescription	UK	2015	NICE
	2.2. No prescription should be provided to children under 3 months old	International	2018	Dynamed Plus
	2.3. No prophylaxis prescription	UK	2007	NICE

<b>Mechanisms</b>				
<b>Theme</b>	<b>Sub-theme</b>	<b>Recommended in:</b>	<b>Recommended since:</b>	<b>Recommended by:</b>
	2.4. Immediate prescription if meningitis risk	UK, International	2018	NICE, Up to Date
	2.5. Intravenous if life-threatening	UK	2013-2017	NICE
	2.6. Prescription if sepsis risk	UK, International	2015-2018	PHE, NICE, Up to Date, BSAC
	2.7. Prescription if symptoms of pneumonia	International	2017	Dynamed Plus
	2.8. Prescription if clear infection	UK	2013-2018	PHE, NICE
	2.9. Prescription if acute presentation	UK, International	2013-2018	PHE, NICE, Up to Date, BSAC
	2.10. Topical prescription for moderate presentation	International	2018	Up to Date
	2.11. Delayed prescription if case condition worsens in next few days/ weeks'	UK, International	2017-2018	NICE, Up to Date
	2.12. Delayed prescription if diagnosis uncertain	UK	2014-2018	NICE, Target Toolkit
	2.13. Delayed prescription if not critically ill	UK	2018	NHS
	2.14. Refer to specialised care if recurrent presentations	UK	2018	NICE
	2.15. Telephone prescription in limited situations	UK	2017	PHE
	2.16. Prophylaxis if recurrent presentations	UK, International	2018	NICE, Up to Date
	2.17. Infection control	UK, International	2015-2018	PHE, NICE, Up to Date
Communication with patients	3.1. Discussion about treatment plan	UK		Healthcare CPD

<b>Mechanisms</b>				
<b>Theme</b>	<b>Sub-theme</b>	<b>Recommended in:</b>	<b>Recommended since:</b>	<b>Recommended by:</b>
	3.2. Information on antibiotics consequences	UK, International	2015-2019	NICE, Target Toolkit, Wellcome Trust, NHS, Up to Date
	3.3. Information on self-limiting conditions	UK, International	2014-2019	PHE, NICE, Target Toolkit, NHS, Up to Date, BSAC, Healthcare CPD
	3.4. Provide leaflets about condition and/or antibiotic prescribing	UK	2014-2018	Target Toolkit, NHS
	3.5. Tailored information/care plan	UK	2017-2018	NICE, Royal College of Paramedics
	3.6. Managing patient/carer expectations	UK	2008-2018	NICE, Target Toolkit, Healthcare CPD
	3.7 Frame antimicrobial resistance as undermining modern medicine	UK	Unknown	Wellcome Trust
	3.8 Explain the fundamentals of antibiotic resistance succinctly	UK	Unknown	Wellcome Trust
	3.9 Emphasise antibiotic resistance as a universal issue	UK	Unknown	Wellcome Trust
	3.10 Focus on immediate action (“here and now”)	UK	Unknown	Wellcome Trust
	3.11 Encourage immediate action	UK	Unknown	Wellcome Trust
Treatment duration	4.1. Short-course	UK, International	2014-2018	NICE, PresQIPP
Clinical benchmarking	5.1. Understanding of local prescribing patterns	UK	2013-2018	PHE, NICE, Target Toolkit, Royal College of Paramedics, BSAC

<b>Mechanisms</b>				
<b>Theme</b>	<b>Sub-theme</b>	<b>Recommended in:</b>	<b>Recommended since:</b>	<b>Recommended by:</b>
	5.2. Understanding of prescribers' own prescribing patterns	UK	2013-2018	Target Toolkit, Wellcome Trust, Healthcare CPD
Decision-making	6.1. Use aid-decision / symptom checklist tools	UK	2018	NICE, Target Toolkit, Royal College of Paramedics, NHS
	6.2. Prescription after clinical history	UK, International	2015-2019	PHE, NICE, Target Toolkit, Up to Date
	6.3. Prescription after test results	UK, International	2007-2018	PHE, NICE, Up to Date, BSAC
	6.4. Review after test results	UK, International	2014-2019	PHE, NICE, Dynamed Plus, Up to Date, BSAC
	6.5. Review prophylaxis after 3 months	UK	2018	NICE
	6.6. Review repeated prescriptions after 6 months	UK	2015	NICE
	6.7. Test if recurrent presentations	UK	2015-2019	NICE
	6.8. Full sepsis evaluation if fever	International	2018	Up to Date

Note: NICE (The National Institute for Health and Care Excellence, [www.nice.org.uk/](http://www.nice.org.uk/)); PHE (Public Health England, [www.gov.uk/government/organisations/public-health-england](http://www.gov.uk/government/organisations/public-health-england)); BSAC (British Society for Antimicrobial Chemotherapy, [www.bsac.org.uk/](http://www.bsac.org.uk/)); Dynamed Plus ([www.dynamed.com/](http://www.dynamed.com/)); Up to Date ([www.uptodate.com/home](http://www.uptodate.com/home)); Healthcare CPD ([www.healthcarecpd.com/](http://www.healthcarecpd.com/)); NHS (National Health Service, [www.nhs.uk/](http://www.nhs.uk/)); PresQIPP ([www.prescqipp.info/](http://www.prescqipp.info/)); Target Toolkit ([www.rcgp.org.uk/TARGETantibiotics](http://www.rcgp.org.uk/TARGETantibiotics)); Wellcome Trust ([www.wellcome.org](http://www.wellcome.org)); Royal College of Paramedics ([www.collegeofparamedics.co.uk/](http://www.collegeofparamedics.co.uk/)).

**Supplementary Table 3:** Search strategy for peer-reviewed papers in electronic databases

1. exp *Anti-Bacterial Agents/ad, dt, st, sd, tu, ut [Administration & Dosage, Drug Therapy, Standards, Supply & Distribution, Therapeutic Use, Utilization]
2. antibiotic.mp.
3. antibacterial.mp.
4. antimicrobial.mp.
5. out-of-hours.mp.
6. (urgent and emergency care).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
7. after-hours.mp.
8. (accident and emergency service).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]
9. exp After-Hours Care/ or exp Emergency Medical Services/
10. professional training.mp.
11. professional development.mp.
12. professional skills.mp.
13. continuing professional development.mp.
14. exp Education, Medical/
15. exp Education, Nursing/
16. prescription guidelines.mp.



17. guidance on prescribing.mp.
18. guidance for dispensing.mp.
19. good practice in prescribing.mp.
20. exp Drug Prescriptions/
21. exp Practice Guidelines as Topic/
22. exp Drug Utilization/
23. exp Practice Patterns, Physicians'/
24. exp Guideline Adherence/
25. 1 or 2 or 3 or 4
26. 5 or 6 or 7 or 8 or 9
27. 10 or 11 or 12 or 13 or 14 or 15
28. 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
29. 25 and 26 and 27 and 28

Note: In non-electronic databases, search was conducted by typing “antibiotic OR antimicrobial OR antibacterial” in all websites used.

**Supplementary Table 4** – List of clinical guidelines and training materials selected for review by organisation / database

<b>Title of document</b>	<b>Organisation / Database</b>
XprESS multi sinus dilation system for treating chronic sinusitis (MTG30)	Clinical Key (published by NICE)
Antimicrobial stewardship	Clinical Key (published by NICE)
Antibiotics for pediatric outpatients with community-acquired pneumonia	Dynamed Plus
ANTIBIOTICS AND INFECTION CONTROL leaflet	Pharmaceutical Services Negotiating Committee
Evaluation and management of suspected sepsis and septic shock in adults	Up to Date

Treatment and prevention of bacterial sepsis in the preterm infant (<34 weeks gestation)	Up to Date
Treatment of bronchiectasis in adults	Up to Date
Septic shock in children: Rapid recognition and initial resuscitation (first hour)	Up to Date
Urinary tract infections in adults	Clinical Key (published by NICE)
Diagnosis of urinary tract infections	PHE
Advisory Committee on Antimicrobial Prescribing, Resistance and Healthcare Associated Infection (APRHAI)	PHE
Management and treatment of common infections	PHE
Antimicrobial prescribing and stewardship competencies	PHE
Start Smart - Then Focus Antimicrobial Stewardship Toolkit for English Hospitals	PHE
SHOW MUCH DO YOU KNOW? Principles of antimicrobial prescribing	PHE
Approach to rational antibiotic use in the outpatient setting	Dynamed Plus
Fever in under 5s: assessment and initial management	NICE
Bronchiolitis in children: diagnosis and management	NICE
Pneumonia in adults: diagnosis and management	NICE
Sepsis	NICE
Otitis media (acute): antimicrobial prescribing	NICE
Sore throat (acute): antimicrobial prescribing	NICE
Urinary tract infection in under 16s: diagnosis and management	NICE
Sepsis: recognition, diagnosis and early management	NICE
Pneumonia in adults	NICE
Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use	NICE
Antibiotic Awareness Key Messages 2017	Pharmaceutical Services Negotiating Committee (published by NICE)
Antimicrobial stewardship: prescribing antibiotics	PrescQIPP (published by NICE)
Sinusitis (acute): antimicrobial prescribing	PrescQIPP (published by NICE)

Practical Guide TO ANTIMICROBIAL STEWARDSHIP In hOSPITALS	PrescQIPP
Urinary tract infection (recurrent): antimicrobial prescribing	PrescQIPP (published by NICE)
Pyelonephritis (acute): antimicrobial prescribing	PrescQIPP (published by NICE)
Tackling antimicrobial resistance: educational priorities	Royal College of Paramedics
Respiratory tract infections (selflimiting): prescribing antibiotics	Target (Published by NICE)
Febrile infant (younger than 90 days of age): Management	Up to date
Recurrent urinary tract infection in women	Up to date
Antimicrobial stewardship in outpatient settings	Up to Date
Antimicrobial stewardship in hospital settings	Up to date
Acute otitis media in children: Treatment	Up to Date
Management and outcome of sepsis in term and late preterm infants	Up to Date
Upper respiratory tract infections: Considerations in adolescent and adult athletes	Up to Date
Acute otitis media in children: Prevention of recurrence	Up to Date
External otitis: Treatment	Up to Date
Four diagnostic strategies for better-targeted antibiotic use	Wellcome Trust
Antimicrobial Stewardship: A competency-based approach	WHO
TARGET Antibiotic Training Modules	Target Toolkit
TARGET antibiotic presentation core slides	Target Toolkit
Antibiotic Resistance in Primary Care	RCGP
STAR: Stemming the Tide of Antibiotic Resistance	BSAC
Antimicrobial Stewardship	Centre for Pharmacy and Postgraduate Education
NECS eLearning: antibiotic prescribing and antimicrobial stewardship in primary care	NESC
Scottish Reduction in Antimicrobial Prescribing (ScRAP)	NHS Education for Scotland