BMJ Open

Improving diagnostic antimicrobial stewardship in respiratory tract infections: a protocol for a scoping review investigating point-of-care testing programs in community pharmacy

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-068193
Article Type:	Protocol
Date Submitted by the Author:	11-Sep-2022
Complete List of Authors:	Saha, Sajal K.; Deakin University, School of Medicine; The University of Melbourne, Department of Infectious Diseases Promite, Shukla; RMIT University, School of Health and Biomedical Science Botheras, Carly L.; Deakin University, School of Medicine; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR) Manias, Elizabeth; Deakin University Faculty of Health, School of Nursing and Midwifery Mothobi, Nomvuyo; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR) Robinson, Suzanne; Deakin University, Deakin Health Economics, Institute for Health Transformation; Curtin University, EnAble Institute Athan, Eugene; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR); Deakin University Faculty of Health, School of Medicine
Keywords:	International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, INFECTIOUS DISEASES, Public health < INFECTIOUS DISEASES, PRIMARY CARE

Title:

Improving diagnostic antimicrobial stewardship in respiratory tract infections: a protocol for a scoping review investigating point-of-care testing programs in community pharmacy

Authors: Sajal K. Saha*[1,2], Shukla Promite[3], Carly L. Botheras[1,4], Elizabeth Manias[5], Nomvuyo Mothobi[4], Suzanne Robinson[6,7], and Eugene Athan[1,4]

Affiliations

[1]School of Medicine, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia

[2]National Centre for Antimicrobial Stewardship (NCAS), Department of Infectious Diseases, Melbourne Medical School, University of Melbourne, Melbourne, VIC 3000, Australia

[3]School of Health and Biomedical Science, RMIT University, Bundoora, VIC 3083, Australia

[4]Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR), Barwon Health, Geelong, VIC 3220, Australia

[5]School of Nursing and Midwifery, Centre for Quality and Patient Safety Research, Institute for Health Transformation, Deakin University, Geelong, Burwood VIC 3125 Australia

[6]Deakin Health Economics, Institute for Health Transformation, Deakin University, Geelong, VIC 3220, Australia

[7]EnAble Institute, Curtin University, WA 6102, Australia

Corresponding Author

Sajal K. Saha

School of Medicine, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia

Email: Sajal.saha@deakin.edu.au

Phone: +610452639559

Abstract

Introduction: Diagnostic uncertainty regarding the cause of respiratory tract infections (RTIs) multiplies the problem of unnecessary use of antibiotics and antimicrobial resistance in primary care. Point-of-care testing (POCT) programs have been recognised as a potential stewardship strategy to optimise antimicrobial use in primary care. There is a need for greater understanding of community pharmacy based POCT programs in reducing the unnecessary use of antimicrobials in patients with RTIs. This study aims to investigate the effectiveness, feasibility, and implementation challenges of POCT programs in community pharmacy to improve safe antimicrobial use in RTIs.

Methods: The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist and Arksey and O'Malley methodology framework guide this review. We will systematically review studies with either randomised controlled trial, non-randomised controlled trial, before-after study, observational study or pilot feasibility study designs. Medline, Emcare, PubMed, International Pharmaceutical Abstracts, Health Technology Assessment, Cochrane Central Register of Controlled Trials and Google Scholar databases will be used to search for articles. Three reviewers will independently screen, review, and select studies with POCT program involving community pharmacists for antimicrobial stewardship in RTIs. Data will undergo descriptive analysis using appropriate statistical methods. Consolidated Framework for Implementation Research will guide analysis and reporting regarding the factors influencing implementation of POCT programs in community pharmacy.

Ethics and dissemination: This review study does not require research ethics approval. We will present the review findings at the national and international conferences and seminars and publish in a peer-reviewed journal.

Keywords: Point-of-care testing program; diagnostic stewardship; antimicrobial stewardship; respiratory tract infections; community pharmacy

Word count: 3841

Strengths and limitations of this study

- This is the first review informing the breadth and quality of evidence regarding the point-of-care testing program in community pharmacies to avoid unnecessary use of antimicrobials in respiratory tract infections.
- This review may inform if point-of-care testing program in community pharmacy is effective, feasible and cost-effective to reduce inappropriate use of antimicrobials in patients with respiratory infection(s).
- The review may have potential implications to the expansion of community pharmacists' role in fostering antimicrobial stewardship in primary care.
- Including only English language article may have some chance of missing relevant studies.
- Heterogeneity and methodological quality of the studies may restrain analysis of few outcomes.

Introduction

Patients with symptoms of respiratory tract infections (RTIs) commonly visit their primary care clinicians including community pharmacists and are often treated with antibiotics unnecessarily. When RTIs are viral in origin, symptomatic treatment can produce the greatest benefits.[1] Evidence shows that general practitioners (GPs) prescribe antibiotic in RTIs at much higher than recommendations in the therapeutic guideline; acute rhinosinusitis (41% vs. 0.5–8%), acute otitis media (89% vs. 20–31%) and acute pharyngitis or sore throat (94% vs. 19–40%).[2] Diagnostic uncertainty regarding the cause of RTIs potentially contributes to the burden of inappropriate use of antibiotics and growing antimicrobial resistance in primary care.[3] Provision of point-of-care diagnostic tools and technologies have been recognised as promising antimicrobial stewardship programs to address diagnostic uncertainty and optimise antimicrobial use in RTIs. According to the World Health Organisation, diagnostic antimicrobial stewardship tools are clinical diagnostic tests that help to appropriately diagnose infectious diseases, surveillance of bacterial resistance, and enable taking decision of appropriate antimicrobial therapy.[4]

RTIs of bacterial origin can cause severe complications if there is a delayed diagnosis. One example of such RTIs is acute pharyngitis or sore throat which are potentially caused by group A streptococci. This infection can be severe, with a risk of late complications including scarlet fever, rheumatic fever in rare occasions and acute glomerulonephritis.[5] Early treatment with antimicrobials is associated with fewer complications.[6] Group A streptococci leads 700,000 worldwide deaths annually.[6-7] Interestingly, only around 20% of sore throat infections (ranges 5-15% in adult and 20-30% in children) are caused by group A streptococci. However, up to 70% of sore throat cases are treated with inappropriate antibiotics.[7-8] Limited capacity of primary care clinicians to detect specific causative organisms such as group A streptococci by point-of-care testing (POCT) is a challenge for appropriately treating acute pharyngitis cases and undertake rational antibiotic decisions.[8-9]

POCT can be defined as the "provision of a test when the result will be used to make a decision and to take appropriate action, which will lead to an improved health outcome".[10] The most important elements of POCT are getting rapid results and its communication to guide clinical decisions. Besides, POCT should guide follow-up action to impact patients' clinical management including referral, triage, and treatment decisions.[11-13] As POCT involves a process and mechanisms for screening and treatment decisions, it can be appropriately named as a POCT program. For normalisation, POCT programs need viable business models for sustainability and any program must fit with real-world clinical workflow and economic/incentive structures. The commonly used POCT programs for RTIs management include C-reactive protein (CRP) and Rapid Antigen Testing (RAT) program.

RATs can reliably identify bacteria like group A streptococci pharyngitis within five to fifteen min and facilitate justified medical decision-making and can allow clinicians to avoid inappropriate antibiotic choice and prevent complications.[6 14-15] Likewise, CRP testing programs can successfully differentiate bacterial RTIs from viral RTIs within five minutes.[16-18] CRP testing programs have been shown to be robust, reliable, and cost-effective in GP settings.[19-21] POCT programs have potential benefits in reducing unnecessary and inappropriate antibiotic use by supporting clinician's decisions for antimicrobial treatment and appropriate patient referral between GPs and pharmacists.[22-23]

Community pharmacists are well positioned in primary care to provide POCT screening and treatment services for patients seeking RTI treatment and efficiently refer patients to GPs who need further investigation for a sign of bacterial infection.[24] Community pharmacists have been undergoing an expansion of their scope of service and practices to address unmet needs of patient care, though this is mostly visible in developed countries.[25-26] POCT program could be an opportunity for community pharmacists to be better involved in the antimicrobial stewardship program for RTIs and to collaborate with GPs.

Evidence suggests that the adoption of CRP and RAT programs by community pharmacists can improve the selection of appropriate antibiotic treatment, reduce the use of health care resources, and enable health economic benefits.[16 23 27-28] A CRP testing program in UK community pharmacies showed potential in reducing unnecessary RTI-related GP visits.[29] Despite potential AMS benefits, the uptake of POCT program in the community pharmacies has been low worldwide. In most countries including in Australia, no POCT programs are utilised as standard practice in community pharmacy for patients seeking RTIs treatment. For lacking these programs and policy support, community pharmacists cannot scientifically judge which RTI patients should be referred to GPs or need just over the counter medicine for safe recovery. In an Australian nationwide survey, <15% of 613 surveyed community pharmacists used POCT programs in patients with any infections.[30]

To date, it remains unclear to what extent POCT programs are effective and feasible in the context of community pharmacy. The diversity of community pharmacies in terms of a business model, pharmacy practice regulatory policies, and rights for diagnostic use for patient safety, may influence POCT use by community pharmacists.[31] The clinical skills of community pharmacists and patients' receptiveness of POCT services from community pharmacy also matter to the provision of POCT program in routine pharmacy practices.[32] However, the diverse factors influencing implementation of POCT programs in community pharmacy for improving antimicrobial stewardship remain largely unknown.

Through searching PROSPERO, we found no systematic reviews related to POCT programs in community pharmacy. As the POCT program has gained global attention on antimicrobial resistance to

optimise antibiotic use in primary care, it is utmost important to comprehensively know if POCT programs in community pharmacy are effective, feasible, and implementable for antimicrobial stewardship. Considering the importance of diagnostic antimicrobial stewardship and expansion of the pharmacist's role in antimicrobial stewardship, this review study has been developed to provide synthesised evidence to help inform future diagnostic stewardship policy directions in the context of POCT program in community pharmacy for optimal antimicrobial use in RTIs.

Methods

We used Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[33] and Arksey and O'Malley's[34] seven component methodology framework to develop the review protocol and to conduct this scoping review. We chose a scoping review design as this review i) maps out the breadth of evidence in the literature on the topic of POCT testing program in community pharmacy, ii) aims not to confirm but investigate the effectiveness and feasibility of POCT testing program in community pharmacy, and iii) will inform future research directions to address evidence gaps. The seven components include: (1) identifying aims of the research; (2) review of sources of data, search strategies and study design to identify studies of interest; (3) selection of studies; (4) extraction of data; (5) quality assessment of the selected studies; (6) data collation and analysis of the outcome of interest and (7) proposing future direction of the topic of research. This study has been planned to conduct between 1 August 2022 to April 2023.

1. Identifying aims of the research

This scoping review focuses on the below aims.

1. To identify the breadth and scope of evidence assessing implementation of POCT in community pharmacy to optimise antimicrobial use.
2. To explore if POCT programs in community pharmacy is effective, feasible and cost-effective to optimise antimicrobial use in primary care.
3. To identify if evidence generated from published research is sufficient to inform policies supporting routine use of POCT program in community pharmacy for optimal antimicrobial use.
4. To investigate the reported implementation challenges and facilitators for using POCT program by community pharmacists in routine pharmacy practices.

2. Review of sources of data, search strategies and study design to identify studies of interest

Sources of data

We will conduct a systematic search in six medical databases to identify relevant studies. Databases include Medline, Emcare, PubMed, International Pharmaceutical abstracts, Health Technology

Assessment, Cochrane Central Register of Controlled Trials and Google Scholar. A uniform search strategy will be developed and applied to the defined databases. Databases will be accessed through the Deakin University library system.

Search strategy

The search strategy will follow the PICOT terminology: Population: [(community pharmac* OR community pharmacist* OR community pharmacy]; Intervention [point-of-care testing OR rapid antigen test OR C-reactive protein OR diagnostic test OR CRP OR RAT OR RADT*)]; Outcome [(Antibiotic* OR Antibiotics OR Antimicrobial* OR Antibiotic prescribing OR Antimicrobial prescribing OR antibiotic use OR Antimicrobial use OR Antimicrobial stewardship). This common search strategy will be applied to all the databases selected to search for articles. Study publication periods will be between Time: 01 Jan 2010- 31 Dec 2022. As POCT programs have been considered as potential antimicrobial stewardship programs in the national and international AMR action plan near around 2010, we believe that evidence will begin from that period.

Apart from the database search, snowballing strategies will be applied to identify any relevant studies from review articles. Manual searches will be performed in relevant pharmacy and health service journals, with a focus on journal publishing antimicrobial stewardship work, to reduce the chance of missing relevant articles. Examples of such journals include Research in Social and Administrative Pharmacy, International Journal of Clinical Pharmacy, Journal of Clinical Pharmacy, International Journal of Pharmacy Practice and Therapeutics, Journal of Pharmacy Practice and Research, European Journal of Hospital Pharmacy, Pharmaceutical Journal, Journal of American Pharmacist Association, Antibiotics, and Journal of Antimicrobial Chemotherapy. Utilising the auto alert system in individual databases until publication of this review, we will set an update of the literature search to minimise the risk of missing any potential articles.

Study design of the selected articles

The selected studies will consist of implementation studies and/ or feasibility studies with either RCTs, non-RCT design, observational study design (retrospective or prospective), cohort study design (retrospective or prospective) and pilot study design. Qualitative studies that assess perceptions of community pharmacists regarding POCT implementation for optimal antimicrobial use in community pharmacists will be included. The algorithm of the Effective Practice and Organisation of Care group (EPOC) EPOC criteria[35] will be utilised to determine the study design and to avoid any terminology that is ambiguous.

3. Selection of studies

All searched records either derived from electronic databases or manual snowballing will be merged to remove duplicate citations. Three reviewers (SKS, SP and CLB) will independently screen titles and abstracts and review full text using the following inclusion and exclusion criteria in the Covidence systematic review software. Articles will be excluded if it is clear from the title or abstract that the study does not meet inclusion criteria as stated below. Discrepancies will be resolved over discussion among the three reviewers. We will contact the authors if needed by email to obtain relevant articles or resolve any missing or unclear data or any clarification. We will use a PRISMA flow diagram to maintain transparency in the process of article selection and to record studies remain in each stage of selection with valid explanation.

Inclusion Criteria

Any study meeting all the following criteria will be included

1. **Population**: Only community pharmacists with any level of experience who have used POCT or shared views and experience of using POCT in community pharmacy for optimal use of antimicrobials.
2. **Intervention**: Any kind of POCT (e.g., CRP or RAT) that were used to diagnose RTIs with a purpose of optimising antimicrobial use. Studies will be considered for inclusion if they meet all the following conditions:
    - POCT programs were provided to patient or public by community pharmacist(s) to avoid unnecessary antimicrobial use in RTIs.
    - Investigated either a single POCT test or multiple POCT test services with a primary objective of reducing antimicrobial use or consumption in RTIs.
    - Evaluated either effectiveness, cost-effectiveness, feasibility, implementation, or receptiveness of POCT program by community pharmacists.
    - Applied any mode of POCT service delivery with charge or without charge of the patient or public.
    - Conducted the POCT program for any time frame or period.
3. **Settings**: Implementation of POCT program in community pharmacy or using GP-pharmacy practice agreements.
4. **Design**: Implementation study or feasibility study with either randomised controlled trial, non-randomised controlled trial, observational study (retrospective or prospective), cohort study (retrospective or prospective), or qualitative study that assesses feasibility of using POCT program, including implementation challenges and facilitators or community pharmacists' perceptions regarding POCT program for antimicrobial stewardship in RTIs.

5. **Outcome**: Studies assessing either effect, cost-effectiveness, feasibility, or implementation challenges and opportunities of using POCT program in community pharmacy for antimicrobial stewardship in RTIs.
6. **Country**: Studies conducted in any country.
7. **Time**: Studies conducted between January 2010 to 2022.
8. **Availability**: Full text articles are available.

Exclusion Criteria

1. Study published as editorial or case series or any conference abstracts which are not available as full text.
2. POCT test is delivered in setting other than community pharmacy
3. Articles not written in the English language.
4. Study involving patients with infections other than RTIs

4. Extraction of data

A data extraction template will be created and validated by data extractors (SKS, SP and CB) by pilot testing to ensure that it has captured all relevant information as needed for analysis, interpretation, and dissemination. Two authors will extract and interpret the data. We will use a template for intervention description and replication (TIDieR) checklist[36] to record POCT intervention details. Extracted data would include study demographics and general information (including study title, author, year, and publication details), objectives, study design, period of study, participants of the study, study settings, POCT services and its characteristics (types, delivery strategy, timing, provider and recipient characteristics, effect, feasibility, acceptability, sustainability), POCT intervention outcomes (effect, effect size, confidence interval (CI), odds ratio), recommendations and conclusions. The POCT intervention results will be meticulously and comprehensively extracted to make them statistically analysable. In the case of unclear or missing data or data presented in an unextractable form, we will contact the respective authors for clarification by email with a 2- week response time limit. If the author does not respond, the case will be described as uncontactable. We will group POCT programs based on infectious diseases for which they are using for, type of POCT programs, bacteria that POCT program is targeting for diagnosis, and country.

5. Assessing the quality of studies

SKS and CB will assess and grade the quality of study as high-, medium- or low- quality using evidence-based risk assessment tool specific to study design of randomised controlled trial or non-randomised controlled trial. This assessment will only occur if sufficient studies for meta-analysis are identified.

6. Data collation and analysis of the outcome of interest

We will use an evidence synthesis method[37] to map out existing evidence related to POCT use in community pharmacy for optimal antibiotic use in patient with infection(s). The results of the included articles will be tabulated and summarised in a table format for defined outcome measures. For effect measures, all the categorical variables (e.g., antimicrobial use) of the trials will be reported in the same unit with 95% confidence interval (CI). Continuous variables will be recorded with mean difference and 95% CI. If studies have adequate data for calculation, summary statistics will be recorded and analysed. Meta-analysis may be performed to determine the effect of POCT program if enough quality studies are found. SKS and CB will discuss, plan, and run the appropriate analysis of extracted data for desired outcomes. We will summarise and report each outcome of interest of this review.

7. Analysis of the outcomes of interest

We will analyse reported results using descriptive statistics and qualitative assessment

1. **Breadth and scope of evidence**: Number of selected studies based on outcome measures, study design, country, and if appropriate by quality of study, this will determine the breadth of evidence assessing implementation of POCT program in community pharmacy for optimal antimicrobial use in RTIs.
2. **Effect of POCT program**: Reduction of unnecessary or inappropriate antibiotic use governed by test result will be the measure of effectiveness of POCT programs. The other effect measures include i) total number of POCT tests received by patients, ii) proportion of positive POCT results that led to initiation of antibiotics, and iii) proportion of negative result that led to avoid antibiotic treatment. In addition, the frequency of false positives or false negatives and their effects on patients will be sought if reported. The complications from antibiotic prescription for false positive POCT test result and complications for not prescribing antibiotics for false negative results will also be descriptively measured if data suggests. Level of patient satisfaction with POCT services by pharmacist will also be measured from quantitative and qualitative data if available. Effect will also be measured by sub-groups based on the type of POCT program and study design (e.g., Randomised/nonrandomised controlled trial) given sufficient studies are available. Meta-analysis may be performed if there are adequate number of high and medium quality studies are available.
3. **Feasibility of POCT program**: Feasibility measures will be descriptively presented from the findings and conclusions of the selected studies. Clinical, operational, and economic feasibility will be explored from the selected studies. Feasibility data include simplicity, reliability, and accuracy of the test, whether the tests help pharmacists' clinical decision making, and barriers and facilitators to use POCT program in community pharmacy. The clinical outcomes that may be assessed if reported: 1) pharmacists' advice and rates of patient referral to GPs as a direct result of POCT; 2) patient outcomes (e.g., satisfaction, rate of infection recovery without

antimicrobials); and 3) associations between the POCT results and RTI outcomes. The operational outcomes include the rate of POCT service provision and uptake by patient, acceptability by consumers and potential of the POCT service for undertaking AMS.

4. **Cost-effectiveness of POCT program**: The incremental cost-effectiveness ratios of POCT per quality-adjusted-life-year (QALY) gained and per antimicrobial prescription avoided will be the measure of cost-effectiveness of the services. Cost-effectiveness measures will be calculated for a subgroup of studies based on type of POCT programs (e.g., CRP or RAT) as well. The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) guideline will be used when reviewing reporting the economic outcomes of the studies.[38]
5. **Implementation challenges, facilitators, and opportunities of the POCT program**: Data will be analysed using an implementation science framework, Consolidated Framework for Implementation Research (CFIR) to present reported implementation challenges and opportunities to inform design of future implementation study.[39] Factors influencing implementation of POCT programs in community pharmacies by inner and outer contexts[39] including at the level of individual community pharmacists will be extracted. The implications of the false negative and false positive cases and the safety factors considered to address those cases in community pharmacy will be extracted and analysed if reported in the eligible studies.

Subgroup analysis

We will undertake subgroup analysis for the outcomes of interest in this review if adequate data is available. Exploratory subgroup analysis could be performed by (1) POCT type such as CRP or RAT, (2) Type of RTIs, (3) country and (4) study design.

Patient and Public Involvement

None

Discussion

To the best of our knowledge, this is the first scoping review exploring the evidence of POCT program in community pharmacy for antimicrobial stewardship in RTIs. This study explores the effectiveness, feasibility and implementation challenges for POCT use by community pharmacists for optimal antimicrobial use in patients with RTIs in primary care. We anticipate that the findings will produce multiple benefits to antimicrobial stewardship researchers, stakeholders, and policymakers to make informed decisions about the provision of POCT program in community pharmacy as part of the primary care antimicrobial stewardship program.

First, this review will provide a global overview of the community pharmacy-based POCT program to avoid unnecessary antimicrobial use in RTIs, and the potential evidence gaps on the topic to inform practice and policy around the provision of routine POCT services in community pharmacy.

Second, evidence supports that there are several factors[40-41] influencing the implementation and provision of POCT programs to foster antimicrobial stewardship programs in primary care. However, the factors remain unknown in the context of community pharmacy and research in the area remains scant. Physician-pharmacist interprofessional issues, inter- and intra-country variation in pharmacy practices, policies and regulations for diagnostic use may interfere feasibility of using POCT program by community pharmacists. This review will present the global and country specific evidence regarding the effectiveness, feasibility, and implementation challenges of the POCT program for optimal antimicrobial use in RTIs.

Third, diagnostic stewardship has potential for improving doctor-pharmacist collaboration for antimicrobial stewardship in primary care. A general practitioner-pharmacist antimicrobial stewardship (GPPAS) model has highlighted implementation of POCT program utilising collaboration between general practitioners and community pharmacists to improve antimicrobial stewardship in Australian primary care.[42] Our review may provide evidence and progress in the field of general practitioner-community pharmacist collaborative implementation of the POCT program.

Fourth, our review could provide valuable insights for the future design of implementation trials on POCT program in community pharmacy. This review may be useful for antimicrobial stewardship funders to understand the importance of research funding for innovations in POCT programs in community pharmacy. Findings from a global lens will inform future needs of research, strategies and community pharmacy practice and policy changes in the provision of POCT program in community pharmacy for antimicrobial stewardship in RTIs in primary care.

Our study uses Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[33] and Arksey and O'Malley's[34] for methodological rigour of the study. We use seven databases for comprehensive search to get relevant articles around the world. The subject experts on antimicrobial stewardship, health economics, microbiologists, infectious disease physicians and pharmacists have been part of this multidisciplinary review team who will guide the analysis of data and interpretation of results. There is a limitation of this review. We will only include English language articles as no team members have been able to read in any other languages. This may lead to miss few relevant articles. Insufficient number of studies may restrain measuring and reporting few outcomes of interest in the review.

In summary, the progress in the field of diagnostic stewardship is central to address the growing burden of antimicrobial resistance caused by overuse of antimicrobials in RTIs in primary care. This review could have implications by informing primary care clinicians including pharmacists, researchers, and health policymakers about the strategic directions for future implementation of POCT program in community pharmacies at local or national scales to avoid unnecessary antimicrobial use in RTIs.

Ethics and dissemination

This scoping review does not need any formal ethical approval as no personal or primary data is being collected during this study. The findings will be presented at national and international conferences, scientific meetings and seminars, and published in a peer-reviewed journal.

Data Statement: All data will be extracted and analysed will be accessible on request from SKS.

Acknowledgements: The authors would like to express thanks to research team members of the CIIDIR for their valuable feedback on the draft of this review protocol.

Author Contributions: Review study was conceptualised and designed by SKS, SP and EA. SKS, SP and CB built the study design and developed search strategies. The data extraction, data analysis, data synthesis and statistical tests were designed by SKS, EM, NM, and SR. SKS has written the whole protocol and the manuscript. All authors reviewed and approved the manuscript for publication.

Funding: There is no specific funding for this review by material and technical support have been provided from the Faculty of Medicine of Deakin University, Australia.

Competing interests None declared.

Patient consent Not required.

Ethics approval Not required

References

1. Brink AJ, Van Wyk J, Moodley VM et al. The role of appropriate diagnostic testing in acute respiratory tract infections: An antibiotic stewardship strategy to minimise diagnostic uncertainty in primary care. *S Afr Med J* 2016;106(6):554-61.

2. McCullough AR, Pollack AJ, Plejdrup Hansen M et al. Antibiotics for acute respiratory infections in general practice: comparison of prescribing rates with guideline recommendations. *Med. J. Aust* 2017;207(2):65-9.
3. Walsh TL, Taffe K, Sacca N et al. Risk factors for unnecessary antibiotic prescribing for acute respiratory tract infections in primary care. *Mayo Clin Proc Innov Qual Outcomes* 2020;4(1):31-9.
4. WHO, 2016. Diagnostic stewardship: A guide to implementation in antimicrobial resistance surveillance sites. https://apps.who.int/iris/bitstream/handle/10665/251553/WHO-DGO-AMR-2016.3-eng.pdf?sequence=1&isAllowed=y

5. Hawker JI, Smith S, Smith GE et al. Trends in antibiotic prescribing in primary care for clinical syndromes subject to national recommendations to reduce antimicrobial resistance, UK 1995-2011: analysis of a large database of primary care consultations. *J Antimicrob Chemother* 2014; 69: 3423–30.
6. Little P, Stuart B, Hobbs FD et al. Antibiotic prescription strategies for acute sore throat: a prospective observational cohort study. *Lancet Infect Dis* 2014; 14: 213–9.
7. Papastergiou J, Trieu CR, Saltmarche D et al. Community pharmacist–directed point-of-care group A Streptococcus testing: evaluation of a Canadian program. *J Am Pharm Assoc* 2018;58(4):450-6.
8. Cohen-Poradosu R, Kasper DL, Infectious Disease Society of America. Group A streptococcus epidemiology and vaccine implications. *Clin Infect Dis* 2007;45(7):863e865.
9. Van Howe RS, Kusnier LP. Diagnosis and management of pharyngitis in a pediatric population based on cost-effectiveness and projected health outcomes. *Pediatrics* 2006;117(3):609e619.
10. Price CP, St. John A, Hicks JM Point-of-care testing. 2nd edition. Washington (D.C.): American Association for Clinical Chemistry. 2004
11. Price CP. Point of care testing. *BMJ* 2001; 322: 1285–1288.
12. Bissonnette L, Bergeron MG. Diagnosing infections–current and anticipated technologies for point-of-care diagnostics and home-based testing. *Clin Microbiol Infect* 2010; 16:1044–1053.
13. Boehme CC, Nicol MP, Nabeta P et al. Feasibility, diagnostic accuracy, and effectiveness of decentralised use of the Xpert MTB/RIF test for diagnosis of tuberculosis and multidrug resistance: a multicentre implementation study. *Lancet* 2011; 377:1495–1505.
14. ESCMID Sore Throat Guideline Group, Pelucchi C, Grigoryan L et al. Guideline for the management of acute sore throat. *Clin Microbiol Infect* 2012; 18:1–28. https://doi.org/10.1111/j.1469-0691.2012.03766.x
15. McIsaac WJ, Kellner JD, Aufricht P et al. Empirical validation of guidelines for the management of pharyngitis in children and adults. *JAMA* 2004; 291:1587–1595. https://doi.org/10.1001/jama.291.13.1587
16. Cooke J. C-Reactive Protein (CRP) as a point of care test (POCT) to assist in the management of patients presenting with symptoms of respiratory tract infection (RTI) - a new role for Community Pharmacists? *Pharm Manag* 2016; 32:25–29.
17. McCarthy PL, Frank AL, Ablow RC et al. Value of the C-reactive protein test in the differentiation of bacterial and viral pneumonia. *J Paed* 1978;92: 454–456.

18. Fujita I, Hamasaki Y, Miyazaki S. Differentiating between bacterial and viral infection by measuring both C-reactive protein and 2′ -5′ -oligoadenylate synthetase as inflammatory markers. *J Infect Chemother* 2002; 8:76–80.
19. Hughes A, Gwyn L, Harris S, Clark C. Evaluating point-of-care C-reactive protein testing in a general practice. *Clin Pharm* 2016; 8:309–318.
20. National Institute for Health and Care Excellence. Alere Afinion CRP for C-reactive protein testing in primary care. 2016 https://www.nice.org.uk/guidance/mib81/resources/alere-afinion-crp-for-creactive-protein-testing-in-primary-care-pdf-63499402887109 Accessed July 29, 2022.
21. Oppong R, Jit M, Smith RD, et al. Cost-effectiveness of point-of-care C-reactive protein testing to inform antibiotic prescribing decisions. *Br J Gen Pract* 2013;63: 465–471.
22. Martínez-González NA, Plate A, Jäger L, Senn O et al. The Role of Point-of-Care C-Reactive Protein Testing in Antibiotic Prescribing for Respiratory Tract Infections: A Survey among Swiss General Practitioners. *Antibiotics* 2022;11(5):543.
23. Klepser DG, Klepser ME, Dering-Anderson AM, Morse JA, Smith JK, Klepser SA. Community pharmacist–physician collaborative streptococcal pharyngitis management program. *J Am Pharm Assoc* 2016;56(3):323-9.
24. Saha SK, Kong DC, Mazza D et al. A systems thinking approach for antimicrobial stewardship in primary care. *Exp Rev Anti-infect Ther* 2022;20(6):819-27.
25. Tannenbaum C, Tsuyuki RT. The expanding scope of pharmacists' practice: implications for physicians. *CMAJ*. 2013; 185 (14): 1228-1232.
26. Framework for Implementation of Expanded Scope of Practice for Pharmacists. Alberta Health Services. Available at: http://www.albertahealthservices.ca/assets/Infofor/hp/if-hp-pharm-framework.pdf. Accessed August 01, 2022.
27. Hunter R. Cost-effectiveness of point-of-care C-reactive protein tests for respiratory tract infection in primary care in England. *Adv Ther* 2015; 32:69–85.
28. Wakeman M, Cork T, Watwood D. Point-of-care C-reactive protein testing in community pharmacy to deliver appropriate interventions in respiratory tract infections. *Clin Pharm* 2018;10(5):149-153. https://doi.org/10.1211/CP.2018.20204635
29. Cooke J, Butler C, Hopstaken R, et al. Narrative review of primary care point-of-care testing (POCT) and antibacterial use in respiratory tract infection (RTI). *BMJ Open Res* 2015;2: e000086. doi: 10.1136/bmjresp-2015-000086
30. Saha SK, Kong DC, Thursky K et al. Antimicrobial stewardship by Australian community pharmacists: Uptake, collaboration, challenges, and needs. *J Am Pharm Assoc* 2021;61(2):158-68.
31. Chalmers L, Czarniak P, Hughes J et al. Implementation factor mapping of a pilot study of point-of-care C-reactive protein testing for respiratory tract infections in community pharmacy. *Explor Res Clin and Soc Pharm* 2022:100147.

32. Czarniak P, Chalmers L, Hughes J et al. Point-of-care C-reactive protein testing service for respiratory tract infections in community pharmacy: a qualitative study of service uptake and experience of pharmacists. *Int J Clin Pharm* 2022;44(2):466-79.
33. Tricco AC, Lillie E, Zarin W et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169(7):467-73.
34. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19-32.
35. Rockers PC, Feigl AB, Røttingen JA et al. Study-design selection criteria in systematic reviews of effectiveness of health systems interventions and reforms: A meta-review. *Health Policy* 2012;104(3):206-14.
36. Hoffmann TC, Glasziou PP, Boutron I et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014; 348: g1687.
37. Carr S, Lhussier M, Forster N et al. An evidence synthesis of qualitative and quantitative research on component intervention techniques, effectiveness, cost-effectiveness, equity and acceptability of different versions of health-related lifestyle advisor role in improving health. *Health Technol. Assess* 2011;15(9):1-284.
38. Husereau D, Drummond M, Augustovski F et al. Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement: updated reporting guidance for health economic evaluations. Int J Technol Assess Health Care. 2022;38(1): e13
39. Damschroder LJ, Aron DC, Keith RE et al. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci* 2009;4(1):1-5.
40. Gallimore CE, Porter AL, Barnett SG et al. A state-level needs analysis of community pharmacy point-of-care testing. *J Am Pharm Assoc* 2021;61(3): e93-8.
41. Gubbins PO, Klepser ME, Dering-Anderson AM, Bauer KA, Darin KM, Klepser S, Matthias KR, Scarsi K. Point-of-care testing for infectious diseases: opportunities, barriers, and considerations in community pharmacy. *J Am Pharm Assoc* 2014;54(2):163-71.
42. Saha SK, Kong DC, Thursky K et al. A Novel GPPAS Model: Guiding the Implementation of Antimicrobial Stewardship in Primary Care Utilising Collaboration between General Practitioners and Community Pharmacists. *Antibiotics* 2022; 11(9); 1158

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4,5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N/A
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	7,8
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9,10
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	9,10
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	9

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	10
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	7
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	9
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	10,11
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9,10,11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	11
Limitations	20	Discuss the limitations of the scoping review process.	12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	12
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	13

Ref 33: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018; 169:467–473. doi: 10.7326/M18-0850.

BMJ Open

Improving diagnostic antimicrobial stewardship in respiratory tract infections: a protocol for a scoping review investigating point-of-care testing programs in community pharmacy

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-068193.R1
Article Type:	Protocol
Date Submitted by the Author:	10-Jan-2023
Complete List of Authors:	Saha, Sajal K.; Deakin University, School of Medicine; The University of Melbourne, Department of Infectious Diseases Promite, Shukla; RMIT University, School of Health and Biomedical Science Botheras, Carly L.; Deakin University, School of Medicine; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR) Manias, Elizabeth; Deakin University Faculty of Health, School of Nursing and Midwifery Mothobi, Nomvuyo; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR) Robinson, Suzanne; Deakin University, Deakin Health Economics, Institute for Health Transformation; Curtin University, EnAble Institute Athan, Eugene; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR); Deakin University Faculty of Health, School of Medicine
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Health services research, Respiratory medicine, Public health
Keywords:	International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, INFECTIOUS DISEASES, Public health < INFECTIOUS DISEASES, PRIMARY CARE

Title:

Improving diagnostic antimicrobial stewardship in respiratory tract infections: a protocol for a scoping review investigating point-of-care testing programs in community pharmacy

Authors: Sajal K. Saha*[1,2], Shukla Promite[3], Carly L. Botheras[1,4], Elizabeth Manias[5], Nomvuyo Mothobi[4], Suzanne Robinson[6,7], and Eugene Athan[1,4]

Affiliations

[1]School of Medicine, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia

[2]National Centre for Antimicrobial Stewardship (NCAS), Department of Infectious Diseases, Melbourne Medical School, University of Melbourne, Melbourne, VIC 3000, Australia

[3]School of Health and Biomedical Science, RMIT University, Bundoora, VIC 3083, Australia

[4]Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR), Barwon Health, Geelong, VIC 3220, Australia

[5]School of Nursing and Midwifery, Centre for Quality and Patient Safety Research, Institute for Health Transformation, Deakin University, Geelong, Burwood VIC 3125 Australia

[6]Deakin Health Economics, Institute for Health Transformation, Deakin University, Geelong, VIC 3220, Australia

[7]EnAble Institute, Curtin University, WA 6102, Australia

Corresponding Author

Sajal K. Saha

School of Medicine, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia

Email: Sajal.saha@deakin.edu.au

Phone: +610452639559

Abstract

Introduction: Diagnostic uncertainty regarding the cause of respiratory tract infections (RTIs) multiplies the problem of unnecessary use of antibiotics and antimicrobial resistance in primary care. Point-of-care testing (POCT) programs have been recognised as a potential stewardship strategy to optimise antimicrobial use in primary care. There is a need for greater understanding of community pharmacy based POCT programs in reducing the unnecessary use of antimicrobials in patients with RTIs. This review systematically maps out evidence around the effectiveness, feasibility, and implementation challenges of POCT programs in community pharmacy to improve safe antimicrobial use in RTIs.

Methods: The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist and Arksey and O'Malley methodology framework guide reporting of this review. We will systematically review studies with either randomised controlled trial, non-randomised controlled trial, before-after study, observational study or pilot feasibility study designs. Medline, Emcare, PubMed, Health Technology Assessment, Cochrane Central Register of Controlled Trials and Google Scholar databases will be used to search for articles. Three reviewers will independently screen, review, and select studies with POCT program involving community pharmacists for antimicrobial stewardship in RTIs. Summary statistics and random effects model if data permits will be used to summarise effectiveness, feasibility, and cost-effectiveness of POCT program. Consolidated Framework for Implementation Research will capture POCT implementation drivers.

Ethics and dissemination: This review study does not require research ethics approval. Findings will be disseminated through the national and international conferences and seminars and publications in peer-reviewed journal(s).

Keywords: Point-of-care testing program; diagnostic stewardship; antimicrobial stewardship; respiratory tract infections; community pharmacy

Word count: 3998

Strengths and limitations of this study

- This is the first scoping review protocol focuses the breadth of evidence regarding the effectiveness, feasibility and cost-effectiveness of implementing point-of-care testing program in community pharmacy to optimise antimicrobial use in patients with respiratory infection(s).
- The most current Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews tool guides systematic reporting of this review.
- The study could inform future implementation trial design and directed systematic reviews on point-of-care testing program in community pharmacy for antimicrobial stewardship.
- Including only English language article may have some chance of missing relevant studies.
- Limited and suboptimal quality study including heterogeneity may prevent generating rigid conclusions and recommendations.

Introduction

Patients with symptoms of respiratory tract infections (RTIs) commonly visit their primary care clinicians including community pharmacists and are often treated with antibiotics unnecessarily. When RTIs are viral in origin, symptomatic treatment can produce the greatest benefits.[1] Evidence shows that general practitioners (GPs) prescribe antibiotics in RTIs at much higher than recommendations in the therapeutic guideline; acute rhinosinusitis (41% vs. 0.5–8%), acute otitis media (89% vs. 20–31%) and acute pharyngitis or sore throat (94% vs. 19–40%).[2] Diagnostic uncertainty regarding the cause of RTIs potentially contributes to the burden of inappropriate use of antibiotics and growing antimicrobial resistance in primary care.[3] Provision of point-of-care diagnostic tools and technologies have been recognised as promising antimicrobial stewardship programs to address diagnostic uncertainty and optimise antimicrobial use in RTIs. According to the World Health Organisation, diagnostic antimicrobial stewardship tools are clinical diagnostic tests that help to appropriately diagnose infectious diseases, surveillance of bacterial resistance, and enable taking decision of appropriate antimicrobial therapy.[4]

RTIs of bacterial origin can cause severe complications if there is a delayed diagnosis. One example of such RTIs is acute pharyngitis or sore throat which are potentially caused by group A streptococci. This infection can be severe, with a risk of late complications including scarlet fever, rheumatic fever in rare occasions and acute glomerulonephritis.[5] Early treatment with antimicrobials is associated with fewer complications.[6] Group A streptococci leads 700,000 worldwide deaths annually.[6-7] Interestingly, only around 20% of sore throat infections (ranges 5-15% in adult and 20-30% in children) are caused by group A streptococci. However, up to 70% of sore throat cases are treated with inappropriate antibiotics.[7-8] Limited capacity of primary care clinicians to detect specific causative organisms such as group A streptococci by point-of-care testing (POCT) is a challenge for appropriately treating acute pharyngitis cases and undertake rational antibiotic decisions.[8-9]

POCT can be defined as the "provision of a test when the result will be used to make a decision and to take appropriate action, which will lead to an improved health outcome".[10] The most important elements of POCT are getting rapid results and its communication to guide clinical decisions. Besides, POCT should guide follow-up action to impact patients' clinical management including referral, triage, and treatment decisions.[11-13] As POCT involves a process and mechanisms for screening and treatment decisions, it can be appropriately named as a POCT program. For normalisation, POCT programs need viable business models for sustainability and any program must fit with real-world clinical workflow and economic/incentive structures. The commonly used POCT programs for RTIs management include C-reactive protein (CRP) and Rapid Antigen Testing (RAT) program.

RATs can reliably identify bacteria like group A streptococci pharyngitis within five to fifteen min and facilitate justified medical decision-making and can allow clinicians to avoid inappropriate antibiotic choice and prevent complications.[6 14-15] Likewise, CRP testing programs can successfully differentiate bacterial RTIs from viral RTIs within five minutes.[16-18] CRP testing programs have been shown to be robust, reliable, and cost-effective in GP settings.[19-21] POCT programs have potential benefits in reducing unnecessary and inappropriate antibiotic use by supporting clinician's decisions for antimicrobial treatment and appropriate patient referral between GPs and pharmacists.[22-23]

Community pharmacists are well positioned in primary care to provide POCT screening and treatment services for patients seeking RTI treatment and efficiently refer patients to GPs who need further investigation for a sign of bacterial infection.[24] Community pharmacists have been undergoing an expansion of their scope of service and practices to address unmet needs of patient care, though this is mostly visible in developed countries.[25-26] POCT program could be an opportunity for community pharmacists to be better involved in the antimicrobial stewardship program for RTIs and to collaborate with GPs.

Evidence suggests that the adoption of CRP and RAT programs by community pharmacists can improve the selection of appropriate antibiotic treatment, reduce the use of health care resources, and enable health economic benefits.[16 23 27-28] A CRP testing program in UK community pharmacies showed potential in reducing unnecessary RTI-related GP visits.[29] Despite potential AMS benefits, the uptake of POCT program in the community pharmacies has been low worldwide. In most countries including in Australia, no POCT programs are utilised as standard practice in community pharmacy for patients seeking RTIs treatment. For lacking these programs and policy support, community pharmacists cannot scientifically judge which RTI patients should be referred to GPs or need just over the counter medicine for safe recovery. In an Australian nationwide survey, <15% of 613 surveyed community pharmacists used POCT programs in patients with any infections.[30]

To date, it remains unclear to what extent POCT programs are effective and feasible in the context of community pharmacy. The diversity of community pharmacies in terms of a business model, pharmacy practice regulatory policies, and rights for diagnostic use for patient safety, may influence POCT use by community pharmacists.[31] The clinical skills of community pharmacists and patients' receptiveness of POCT services from community pharmacy also matter to the provision of POCT program in routine pharmacy practices.[32] However, the diverse factors influencing implementation of POCT programs in community pharmacy for improving antimicrobial stewardship remain largely unknown.

Through searching PROSPERO, we found no systematic reviews related to POCT programs in community pharmacy. As the POCT program has gained global attention on antimicrobial resistance to optimise antibiotic use in primary care, it is utmost important to comprehensively know if POCT programs in community pharmacy are effective, feasible, and implementable for antimicrobial stewardship. Considering the importance of diagnostic antimicrobial stewardship and expansion of the pharmacist's role in antimicrobial stewardship, this review study has been developed to provide synthesised evidence to help inform future diagnostic stewardship policy directions in the context of POCT program in community pharmacy for optimal antimicrobial use in RTIs.

Methods

We use Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[33] (Supplementary file 1) and Arksey and O'Malley's[34] seven component methodology framework to report this scoping review. We chose a scoping review design as this review i) maps out the breadth of evidence in the literature on the topic of POCT testing program in community pharmacy, ii) investigate evidence around the effectiveness and feasibility of POCT testing program in community pharmacy, and iii) will inform future research directions to address evidence gaps. The seven components include: (1) identifying aims of the research; (2) review of sources of data, search strategies and study design to identify studies of interest; (3) selection of studies; (4) extraction of data; (5) quality assessment of the selected studies; (6) data collation and analysis of the outcome of interest and (7) proposing future direction of the topic of research. This study has been planned to conduct between 1 August 2022 to April 2023.

1. Identifying aims of the research

This scoping review focuses on the below aims.

1. To identify the breadth and scope of evidence assessing implementation of POCT in community pharmacy to optimise antimicrobial use.
2. To map out evidence around effectiveness, feasibility and cost-effectiveness of POCT programs in community pharmacy to optimise antimicrobial use in primary care.
3. To understand the implementation challenges and opportunities for using POCT program by community pharmacists in routine pharmacy practices.
4. To identify if evidence generated from published research is sufficient to inform policies supporting routine use of POCT program in community pharmacy for optimal antimicrobial use.

2. Review of sources of data, search strategies and study design to identify studies of interest

Sources of data

We will conduct a systematic search in six medical databases to identify relevant studies. Databases include Medline, Emcare, PubMed, Health Technology Assessment, Cochrane Central Register of Controlled Trials and Google Scholar. A uniform search strategy will be developed and applied to the defined databases. Databases will be accessed through the Deakin University library system.

Search strategy

The search strategy will follow the PICOT terminology: Population: [(community pharmac* OR community pharmacist* OR community pharmacy]; Intervention [point-of-care testing OR rapid antigen test OR C-reactive protein OR diagnostic test OR CRP OR RAT OR RADT*)]; Outcome [(Antibiotic* OR Antibiotics OR Antimicrobial* OR Antibiotic prescribing OR Antimicrobial prescribing OR antibiotic use OR Antimicrobial use OR Antimicrobial stewardship). This common search strategy will be applied to all the databases selected to search for articles. Supplementary file 2 shows details of search strategy for all six databases. Study publication periods will be between Time: 01 Jan 2012- 31 Dec 2022. As POCT programs have been considered as potential antimicrobial stewardship programs in the national and international AMR action plan near around 2012, we believe that evidence will begin from that period.

Apart from the database search, snowballing strategies will be applied to identify any relevant studies from review articles. Manual searches will be performed in relevant pharmacy and health service journals, with a focus on journal publishing antimicrobial stewardship work, to reduce the chance of missing relevant articles. Examples of such journals include Research in Social and Administrative Pharmacy, International Journal of Clinical Pharmacy, Journal of Clinical Pharmacy, International Journal of Pharmacy Practice and Therapeutics, Journal of Pharmacy Practice and Research, European Journal of Hospital Pharmacy, Pharmaceutical Journal, Journal of American Pharmacist Association, Antibiotics, and Journal of Antimicrobial Chemotherapy. Utilising the auto alert system in individual databases until publication of this review, we will set an update of the literature search to minimise the risk of missing any potential articles.

Study design of the selected articles

The selected studies will consist of implementation studies and/ or feasibility studies with either RCTs, non-RCT design, observational study design (retrospective or prospective), cohort study design (retrospective or prospective) and pilot study design. Qualitative studies that assess perceptions of community pharmacists regarding POCT implementation for optimal antimicrobial use in community pharmacists will be included. The algorithm of the Effective Practice and Organisation of Care group (EPOC) EPOC criteria[35] will be utilised to determine the study design and to avoid any terminology that is ambiguous.

3. Selection of studies

All searched records either derived from electronic databases or manual snowballing will be merged to remove duplicate citations. Three reviewers (SKS, SP and CLB) will independently screen titles and abstracts and review full text using the following inclusion and exclusion criteria in the Covidence systematic review software. Articles will be excluded if it is clear from the title or abstract that the study does not meet inclusion criteria as stated below. Discrepancies will be resolved over discussion among the three reviewers. We will contact the authors if needed by email to obtain relevant articles or resolve any missing or unclear data or any clarification. We will use a PRISMA flow diagram to maintain transparency in the process of article selection and to record studies remain in each stage of selection with valid explanation.

Inclusion Criteria

Any study meeting all the following criteria will be included

1. **Population**: Only community pharmacists with any level of experience who have used POCT or shared views and experience of using POCT in community pharmacy for optimal use of antimicrobials.
2. **Intervention**: Any kind of POCT (e.g., CRP or RAT) that were used to diagnose RTIs with a purpose of optimising antimicrobial use. Studies will be considered for inclusion if they meet all the following conditions:
    - POCT programs were provided to patient or public by community pharmacist(s) to avoid unnecessary antimicrobial use in RTIs.
    - Investigated either a single POCT test or multiple POCT test services with a primary objective of reducing antimicrobial use or consumption in RTIs.
    - Evaluated either effectiveness, cost-effectiveness, feasibility, implementation, or receptiveness of POCT program by community pharmacists.
    - Applied any mode of POCT service delivery with charge or without charge of the patient or public.
    - Conducted the POCT program for any time frame or period.
3. **Settings**: Implementation of POCT program in community pharmacy or using GP-pharmacy practice agreements.
4. **Design**: Implementation study or feasibility study with either randomised controlled trial, non-randomised controlled trial, observational study (retrospective or prospective), cohort study (retrospective or prospective), or qualitative study that assesses feasibility of using POCT

program, including implementation challenges and facilitators or community pharmacists' perceptions regarding POCT program for antimicrobial stewardship in RTIs.

5. **Outcome**: Studies assessing either effect, cost-effectiveness, feasibility, or implementation challenges and opportunities of using POCT program in community pharmacy for antimicrobial stewardship in RTIs.
6. **Country**: Studies conducted in any country.
7. **Time**: Studies conducted between January 2012 to 2022.
8. **Availability**: Full text articles are available.

Exclusion Criteria

1. Study published as editorial or case series or any conference abstracts which are not available as full text.
2. POCT test is delivered in setting other than community pharmacy
3. Articles not written in the English language.
4. Study involving patients with infections other than RTIs

4. Extraction of data

A data extraction template will be created and piloted by data extractors (SKS, SP and CB). The process will confirm that the extraction form has captured all the relevant information required for analysis and reporting. The Extractors' feedback will be used to refine the form and finalise its usability and completeness. Duplicate data extraction will be occurred independently and any disagreements if remains will be addressed through discussion. The third reviewer will be approached if a consensus is not made. Two authors will extract and interpret the data. We will use a template for intervention description and replication (TIDieR) checklist[36] to record POCT intervention details. Extracted data would include study demographics and general information (including study title, author, year, and publication details), objectives, study design, period of study, participants of the study, study settings, POCT services and its characteristics (types, delivery strategy, timing, provider and recipient characteristics, effect, feasibility, acceptability, sustainability), POCT intervention outcomes (effect, effect size, confidence interval (CI), risk ratio), recommendations and conclusions. The POCT intervention results will be meticulously and comprehensively extracted to make them statistically analysable. In the case of unclear or missing data or data presented in an unextractable form, we will contact the respective authors for clarification by email with a 2- week response time limit. If the author does not respond, the case will be described as uncontactable. We will group POCT programs based on infectious diseases for which they are using for, type of POCT programs, bacteria that POCT program is targeting for diagnosis, and country.

5. Assessing the quality of studies

SKS and CB will assess and grade the quality of study as high-, medium- or low- quality using evidence-based risk assessment tool. We will use the Cochrane risk of bias tools involving six criteria[37] to assess the quality of RCTs and determine the internal validity of RCTs. The ROBINS-I risk assessment tools[38] will be used for non-randomised trials. This quality assessment will only occur if sufficient studies for meta-analysis are identified.

6. Data collation and analysis of the outcome of interest

We will use an evidence synthesis method[39] to map out existing evidence related to POCT use in community pharmacy for antimicrobial stewardship. Results of the included articles will be tabulated and summarised in table format for above defined outcome measures of effectiveness, feasibility, cost-effectiveness and implementation challenges. Descriptive summary of the results will be generated for each outcome measure and research questions. For effect measures, all the categorical variables (e.g., antimicrobial use) of the trials will be reported in the same unit with 95% confidence interval (CI). Continuous variables will be recorded with mean difference and 95% CI. Median and interquartile range would be a better descriptor if the primary sources of data did not check or report normality. If studies have adequate data for calculation, summary statistics will be recorded and analysed. Meta-analysis may be performed to determine the effect of POCT program if enough quality studies are found. Relative risk will be the measure of combined intervention effects. We will summarise and report each outcome of interest of this review.

Analysis of the outcomes of interest

We will summarise and analyse results reported in the selected studies using summary statistics including descriptive statistics.

1. **Breadth and scope of evidence**: Number of selected studies based on outcome measures, study design, country, and if appropriate by quality of study, this will determine the breadth of evidence assessing implementation of POCT program in community pharmacy for optimal antimicrobial use in RTIs.
2. **Effect of POCT program**: Reduction of unnecessary or inappropriate antibiotic use governed by test result will be the measure of effectiveness of POCT programs. The other effect measures could be i) total number of POCT tests received by patients, ii) proportion of positive POCT results that led to initiation of antibiotics, and iii) proportion of negative result that led to avoid antibiotic treatment. In addition, the frequency of false positives or false negatives and their effects on patients will be sought if reported. The complications from antibiotic prescription for false positive POCT test result and complications for not prescribing antibiotics for false negative results will also be descriptively measured if data suggests. Level of patient satisfaction with POCT services by pharmacist will also be measured from quantitative and

qualitative data if available. The hypotheses based on those secondary variables will considered exploratory hypotheses. Meta-analysis may be performed if there are adequate number of high and medium quality studies are available. Given adequate RCTs and meta-analysable data are available, a random effects model will be used to measure the pooled estimates of POCT intervention effect utilising OR and 95% CI. Forest plots, and I^2 statistics will measure across study heterogeneity. Subgroup analyses will determine the sources of heterogeneity [e.g., POCT strategies, implementation approaches, sample size, design, study quality].

3. **Feasibility of POCT program**: Feasibility measures will be descriptively presented from the findings and conclusions of the selected studies. Clinical, operational, and economic feasibility will be explored from the selected studies. Feasibility data include simplicity, reliability, and accuracy of the test, whether the tests help pharmacists' clinical decision making, and barriers and facilitators to use POCT program in community pharmacy. The clinical outcomes that may be assessed if reported: 1) pharmacists' advice and rates of patient referral to GPs as a direct result of POCT; 2) patient outcomes (e.g., satisfaction, rate of infection recovery without antimicrobials); and 3) associations between the POCT results and RTI outcomes. The operational outcomes include the rate of POCT service provision and uptake by patient, acceptability by consumers and potential of the POCT service for undertaking AMS. Descriptive statistics will be used to measure feasibility of the POCT program.
4. **Cost-effectiveness of POCT program**: The incremental cost-effectiveness ratios of POCT per quality-adjusted-life-year (QALY) gained and per antimicrobial prescription avoided will be the measure of cost-effectiveness of the services. Cost-effectiveness measures will be calculated for a subgroup of studies based on type of POCT programs (e.g., CRP or RAT) as well. The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) guideline will be used when reviewing reporting the economic outcomes of the studies.[40]
5. **Implementation challenges, facilitators, and opportunities of the POCT program**: Data will be analysed using an implementation science framework, Consolidated Framework for Implementation Research (CFIR) to present reported implementation challenges and opportunities to inform design of future implementation study.[41] Factors influencing implementation of POCT programs in community pharmacies by inner and outer contexts[41] will be extracted. The implications of the false negative and false positive cases and the safety factors considered to address those cases in community pharmacy will be extracted and analysed if reported in the eligible studies.

Subgroup analysis

We will undertake subgroup analysis for the outcomes of interest in this review if adequate data is available. Exploratory subgroup analysis could be performed by (1) POCT type such as CRP or RAT,

(2) Type of RTIs, (3) country and (4) study design, (5) the type and brand of the test, (6) sample employed if available nasopharyngeal or oropharyngeal.

Patient and Public Involvement

Patients or the public WERE involved in the design, or conduct, or reporting, or dissemination plans of our research

Discussion

To the best of our knowledge, this is the first scoping review exploring the evidence of POCT program in community pharmacy for antimicrobial stewardship in RTIs. This study explores the effectiveness, feasibility and implementation challenges for POCT use by community pharmacists for optimal antimicrobial use in patients with RTIs in primary care. We anticipate that the findings will produce multiple benefits to antimicrobial stewardship researchers, stakeholders, and policymakers to make informed decisions about the provision of POCT program in community pharmacy as part of the primary care antimicrobial stewardship program.

First, this review will provide a global overview of the community pharmacy-based POCT program to avoid unnecessary antimicrobial use in RTIs, and the potential evidence gaps on the topic to inform practice and policy around the provision of routine POCT services in community pharmacy.

Second, evidence supports that there are several factors[42-43] influencing the implementation and provision of POCT programs to foster antimicrobial stewardship programs in primary care. However, the factors remain unknown in the context of community pharmacy and research in the area remains scant. Physician-pharmacist interprofessional issues, inter- and intra-country variation in pharmacy practices, policies and regulations for diagnostic use may interfere feasibility of using POCT program by community pharmacists. This review will present the global and country specific evidence regarding the effectiveness, feasibility, and implementation challenges of the POCT program for optimal antimicrobial use in RTIs.

Third, diagnostic stewardship has potential for improving doctor-pharmacist collaboration for antimicrobial stewardship in primary care. A general practitioner-pharmacist antimicrobial stewardship (GPPAS) model has highlighted implementation of POCT program utilising collaboration between general practitioners and community pharmacists to improve antimicrobial stewardship in Australian primary care.[44] Our review may provide evidence and progress in the field of general practitioner-community pharmacist collaborative implementation of the POCT program.

Fourth, our review could provide valuable insights for the future design of implementation trials on POCT program in community pharmacy. This review may be useful for antimicrobial stewardship funders to understand the importance of research funding for innovations in POCT programs in community pharmacy. Findings from a global lens will inform future needs of research, strategies and community pharmacy practice and policy changes in the provision of POCT program in community pharmacy for antimicrobial stewardship in RTIs in primary care.

Our study uses Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[33] and Arksey and O'Malley's framework[34] for methodological rigour of the study. We use seven databases for comprehensive search to get relevant articles around the world. The subject experts on antimicrobial stewardship, health economics, microbiologists, infectious disease physicians and pharmacists have been part of this multidisciplinary review team who will guide the analysis of data and interpretation of results. There is a limitation of this review. We will only include English language articles as no team members have been able to read in any other languages. This may lead to miss few relevant articles. Insufficient number of studies may restrain measuring and reporting few outcomes of interest in the review.

In summary, the progress in the field of diagnostic stewardship is central to address the growing burden of antimicrobial resistance caused by overuse of antimicrobials in RTIs in primary care. This review could have implications by informing primary care clinicians including pharmacists, researchers, and health policymakers about the strategic directions for future implementation of POCT program in community pharmacies at local or national scales to avoid unnecessary antimicrobial use in RTIs.

Ethics and dissemination

This scoping review does not need any formal ethical approval as no personal or primary data is being collected during this study. The findings will be presented at national and international conferences, scientific meetings and seminars, and published in a peer-reviewed journal.

Data Statement: All data will be extracted and analysed will be accessible on request from SKS.

Acknowledgements: The authors would like to express thanks to research team members of the CIIDIR for their valuable feedback on the draft of this review protocol.

Author Contributions: Review study was conceptualised and designed by SKS, SP and EA. SKS, SP and CB developed search strategies. The data extraction, data analysis, data synthesis and statistical tests were designed by SKS, EM, NM, and SR. SKS has written the whole protocol and the manuscript. All authors reviewed and approved the manuscript for publication.

Funding: There is no specific funding for this review by material and technical support have been provided from the Faculty of Medicine of Deakin University, Australia.

Competing interests None declared.

Patient consent Not required.

Ethics approval Not required

References

1. Brink AJ, Van Wyk J, Moodley VM et al. The role of appropriate diagnostic testing in acute respiratory tract infections: An antibiotic stewardship strategy to minimise diagnostic uncertainty in primary care. *S Afr Med J* 2016;106(6):554-61.
2. McCullough AR, Pollack AJ, Plejdrup Hansen M et al. Antibiotics for acute respiratory infections in general practice: comparison of prescribing rates with guideline recommendations. *Med. J. Aust* 2017;207(2):65-9.
3. Walsh TL, Taffe K, Sacca N et al. Risk factors for unnecessary antibiotic prescribing for acute respiratory tract infections in primary care. *Mayo Clin Proc Innov Qual Outcomes* 2020;4(1):31-9.
4. WHO, 2016. Diagnostic stewardship: A guide to implementation in antimicrobial resistance surveillance sites. https://apps.who.int/iris/bitstream/handle/10665/251553/WHO-DGO-AMR-2016.3-eng.pdf?sequence=1&isAllowed=y
5. Hawker JI, Smith S, Smith GE et al. Trends in antibiotic prescribing in primary care for clinical syndromes subject to national recommendations to reduce antimicrobial resistance, UK 1995-2011: analysis of a large database of primary care consultations. *J Antimicrob Chemother* 2014; 69: 3423–30.
6. Little P, Stuart B, Hobbs FD et al. Antibiotic prescription strategies for acute sore throat: a prospective observational cohort study. *Lancet Infect Dis* 2014; 14: 213–9.
7. Papastergiou J, Trieu CR, Saltmarche D et al. Community pharmacist–directed point-of-care group A Streptococcus testing: evaluation of a Canadian program. *J Am Pharm Assoc* 2018;58(4):450-6.
8. Cohen-Poradosu R, Kasper DL, Infectious Disease Society of America. Group A streptococcus epidemiology and vaccine implications. *Clin Infect Dis* 2007;45(7):863e865.
9. Van Howe RS, Kusnier LP. Diagnosis and management of pharyngitis in a pediatric population based on cost-effectiveness and projected health outcomes. *Pediatrics* 2006;117(3):609e619.
10. Price CP, St. John A, Hicks JM Point-of-care testing. 2nd edition. Washington (D.C.): American Association for Clinical Chemistry. 2004
11. Price CP. Point of care testing. *BMJ* 2001; 322: 1285–1288.

12. Bissonnette L, Bergeron MG. Diagnosing infections–current and anticipated technologies for point-of-care diagnostics and home-based testing. *Clin Microbiol Infect* 2010; 16:1044–1053.
13. Boehme CC, Nicol MP, Nabeta P et al. Feasibility, diagnostic accuracy, and effectiveness of decentralised use of the Xpert MTB/RIF test for diagnosis of tuberculosis and multidrug resistance: a multicentre implementation study. *Lancet* 2011; 377:1495–1505.
14. ESCMID Sore Throat Guideline Group, Pelucchi C, Grigoryan L et al. Guideline for the management of acute sore throat. *Clin Microbiol Infect* 2012; 18:1–28. https://doi.org/10.1111/j.1469-0691.2012.03766.x
15. McIsaac WJ, Kellner JD, Aufricht P et al. Empirical validation of guidelines for the management of pharyngitis in children and adults. *JAMA* 2004; 291:1587–1595. https://doi.org/10.1001/jama.291.13.1587
16. Cooke J. C-Reactive Protein (CRP) as a point of care test (POCT) to assist in the management of patients presenting with symptoms of respiratory tract infection (RTI) - a new role for Community Pharmacists? *Pharm Manag* 2016; 32:25–29.
17. McCarthy PL, Frank AL, Ablow RC et al. Value of the C-reactive protein test in the differentiation of bacterial and viral pneumonia. *J Paed* 1978;92: 454–456.
18. Fujita I, Hamasaki Y, Miyazaki S. Differentiating between bacterial and viral infection by measuring both C-reactive protein and 2′ -5′ -oligoadenylate synthetase as inflammatory markers. *J Infect Chemother* 2002; 8:76–80.
19. Hughes A, Gwyn L, Harris S, Clark C. Evaluating point-of-care C-reactive protein testing in a general practice. *Clin Pharm* 2016; 8:309–318.
20. National Institute for Health and Care Excellence. Alere Afinion CRP for C-reactive protein testing in primary care. 2016 https://www.nice.org.uk/guidance/mib81/resources/alere-afinion-crp-for-creactive-protein-testing-in-primary-care-pdf-63499402887109 Accessed July 29, 2022.
21. Oppong R, Jit M, Smith RD, et al. Cost-effectiveness of point-of-care C-reactive protein testing to inform antibiotic prescribing decisions. *Br J Gen Pract* 2013;63: 465–471.
22. Martínez-González NA, Plate A, Jäger L, Senn O et al. The Role of Point-of-Care C-Reactive Protein Testing in Antibiotic Prescribing for Respiratory Tract Infections: A Survey among Swiss General Practitioners. *Antibiotics* 2022;11(5):543.
23. Klepser DG, Klepser ME, Dering-Anderson AM, Morse JA, Smith JK, Klepser SA. Community pharmacist–physician collaborative streptococcal pharyngitis management program. *J Am Pharm Assoc* 2016;56(3):323-9.
24. Saha SK, Kong DC, Mazza D et al. A systems thinking approach for antimicrobial stewardship in primary care. *Exp Rev Anti-infect Ther* 2022;20(6):819-27.
25. Tannenbaum C, Tsuyuki RT. The expanding scope of pharmacists' practice: implications for physicians. *CMAJ*. 2013; 185 (14): 1228-1232.
26. Framework for Implementation of Expanded Scope of Practice for Pharmacists. Alberta Health Services. Available at:

http://www.albertahealthservices.ca/assets/Infofor/hp/if-hp-pharm-framework.pdf. Accessed August 01, 2022.

27. Hunter R. Cost-effectiveness of point-of-care C-reactive protein tests for respiratory tract infection in primary care in England. *Adv Ther* 2015; 32:69–85.
28. Wakeman M, Cork T, Watwood D. Point-of-care C-reactive protein testing in community pharmacy to deliver appropriate interventions in respiratory tract infections. *Clin Pharm* 2018;10(5):149-153. https://doi.org/10.1211/CP.2018.20204635
29. Cooke J, Butler C, Hopstaken R, et al. Narrative review of primary care point-of-care testing (POCT) and antibacterial use in respiratory tract infection (RTI). *BMJ Open Res* 2015;2: e000086. doi: 10.1136/bmjresp-2015-000086
30. Saha SK, Kong DC, Thursky K et al. Antimicrobial stewardship by Australian community pharmacists: Uptake, collaboration, challenges, and needs. *J Am Pharm Assoc* 2021;61(2):158-68.
31. Chalmers L, Czarniak P, Hughes J et al. Implementation factor mapping of a pilot study of point-of-care C-reactive protein testing for respiratory tract infections in community pharmacy. *Explor Res Clin and Soc Pharm* 2022:100147.
32. Czarniak P, Chalmers L, Hughes J et al. Point-of-care C-reactive protein testing service for respiratory tract infections in community pharmacy: a qualitative study of service uptake and experience of pharmacists. *Int J Clin Pharm* 2022;44(2):466-79.
33. Tricco AC, Lillie E, Zarin W et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169(7):467-73.
34. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19-32.
35. Rockers PC, Feigl AB, Røttingen JA et al. Study-design selection criteria in systematic reviews of effectiveness of health systems interventions and reforms: A meta-review. *Health Policy* 2012;104(3):206-14.
36. Hoffmann TC, Glasziou PP, Boutron I et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014; 348: g1687.
37. Higgins, JPGreen, S. Cochrane Handbook for Systematic Reviews of Interventions: *The Cochrane Collaboration*. Chichester,UK: JohnWiley&Sons,2011.
38. Sterne JA, Herna´n MA, Reeves BC et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016; 355: i4919.
39. Carr S, Lhussier M, Forster N et al. An evidence synthesis of qualitative and quantitative research on component intervention techniques, effectiveness, cost-effectiveness, equity and acceptability of different versions of health-related lifestyle advisor role in improving health. *Health Technol. Assess* 2011;15(9):1-284.
40. Husereau D, Drummond M, Augustovski F et al. Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement: updated reporting guidance for health economic evaluations. Int J Technol Assess Health Care. 2022;38(1): e13

41. Damschroder LJ, Aron DC, Keith RE et al. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci* 2009;4(1):1-5.
42. Gallimore CE, Porter AL, Barnett SG et al. A state-level needs analysis of community pharmacy point-of-care testing. *J Am Pharm Assoc* 2021;61(3): e93-8.
43. Gubbins PO, Klepser ME, Dering-Anderson AM, Bauer KA, Darin KM, Klepser S, Matthias KR, Scarsi K. Point-of-care testing for infectious diseases: opportunities, barriers, and considerations in community pharmacy. *J Am Pharm Assoc* 2014;54(2):163-71.
44. Saha SK, Kong DC, Thursky K et al. A Novel GPPAS Model: Guiding the Implementation of Antimicrobial Stewardship in Primary Care Utilising Collaboration between General Practitioners and Community Pharmacists. *Antibiotics* 2022; 11(9); 1158

Supplementary File 1:

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4,5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N/A
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	7,8
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9,10
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	9,10
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	9

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	10
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	7
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	9
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	10,11
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9,10,11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	11
Limitations	20	Discuss the limitations of the scoping review process.	12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	12
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	13

Ref 33: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018; 169:467–473. doi: 10.7326/M18-0850.

Supplementary File 2: Search strategy

1. Medline:

(('community pharmacies' OR 'community pharmacist*' OR 'community'/exp OR community) AND ('pharmacy'/exp OR pharmacy) OR pharmac*) AND ('point-of-care testing'/exp OR 'point-of-care testing' OR 'point-of-care test' OR 'point of care test'/exp OR 'point of care test' OR 'rapid antigen test'/exp OR 'rapid antigen test' OR 'c-reactive protein'/exp OR 'c-reactive protein' OR 'diagnostic test'/exp OR 'diagnostic test' OR 'crp'/exp OR crp OR radt OR poct OR 'group a streptococcal' OR 'gas'/exp OR gas) AND ('antibiotic'/exp OR antibiotic OR 'antibiotics'/exp OR antibiotics OR 'antimicrobial'/expOR antimicrobial OR 'antimicrobials'/exp
OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use'/exp OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship'/exp OR 'antibiotic stewardship' OR 'antimicrobial stewardship'/exp OR 'antimicrobial stewardship') AND ('respiratory tract infection'/exp OR 'respiratory tract infection' OR rti OR rtis OR 'sore throat'/exp OR 'sore throat' OR 'pharyngitis'/exp OR pharyngitis OR 'cough'/exp OR cough OR 'sinusitis'/exp OR sinusitis OR 'cold'/exp OR cold OR 'pneumonia'/exp OR pneumonia OR 'tonsillitis'/exp OR tonsillitis OR 'bronchitis'/exp OR bronchitis OR 'bronchiolitis'/exp OR bronchiolitis OR 'throat infection'/exp OR 'throat infection' OR 'sinuses infection') AND ([article]/lim OR [article in press]/lim OR [conference abstract]/lim OR [conference paper]/lim OR [conference review]/lim OR [data papers]/lim OR [review]/lim OR [short survey]/lim OR [preprint]/lim) AND [embase]/lim AND [2012-2022]/py

2. Pubmed

Search: ('community pharmacies' OR 'community pharmacist' OR community pharmacy) AND ('point-of-care testing' OR 'point-of-care test' OR 'point of care test' OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR 'Group A streptococcal' OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship' OR 'antimicrobial stewardship') AND ('respiratory tract infection' OR RTI OR RTIs OR 'sore throat' OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR 'throat infection' OR 'sinuses infection' OR influenza) Filters: from 2010/1/1 - 2022/12/31
(("pharmacies"[MeSH Terms] OR "pharmacies"[All Fields] OR ("community"[All Fields] AND "pharmacies"[All Fields]) OR "community pharmacies"[All Fields] OR ("communal"[All Fields] OR "communalism"[All Fields] OR "communalities"[All Fields] OR "communality"[All Fields] OR "communally"[All Fields] OR "commune"[All Fields] OR "communes"[All Fields] OR "community s"[All Fields] OR "communitys"[All Fields] OR "residence characteristics"[MeSH Terms] OR ("residence"[All Fields] AND "characteristics"[All Fields]) OR "residence characteristics"[All Fields] OR "communities"[All Fields] OR "community"[All Fields]) OR ("pharmacies"[MeSH Terms] OR "pharmacies"[All Fields] OR ("community"[All Fields] AND "pharmacy"[All Fields]) OR "community pharmacy"[All Fields])) AND ("point of care testing"[MeSH Terms] OR ("point of care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point"[All Fields] AND "care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point of care testing"[MeSH Terms] OR ("point of care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point"[All Fields] AND "care"[All Fields] AND "test"[All Fields]) OR "point of care test"[All Fields]) OR ("point of care testing"[MeSH Terms] OR ("point of care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point"[All Fields] AND "care"[All Fields] AND "test"[All Fields]) OR "point of care test"[All Fields]) OR (("rapid"[All Fields] OR "rapidities"[All Fields] OR "rapidity"[All Fields] OR "rapidness"[All Fields]) AND ("antigen s"[All Fields] OR "antigene"[All Fields] OR

"antigenes"[All Fields] OR "antigenic"[All Fields] OR "antigenically"[All Fields] OR "antigenicities"[All Fields] OR "antigenicity"[All Fields] OR "antigenized"[All Fields] OR "antigens"[MeSH Terms] OR "antigens"[All Fields] OR "antigen"[All Fields]) AND ("research design"[MeSH Terms] OR ("research"[All Fields] AND "design"[All Fields]) OR "research design"[All Fields] OR "test"[All Fields])) OR ("c reactive protein"[MeSH Terms] OR ("c reactive"[All Fields] AND "protein"[All Fields]) OR "c reactive protein"[All Fields] OR "c reactive protein"[All Fields]) OR ("diagnostic tests, routine"[MeSH Terms] OR ("diagnostic"[All Fields] AND "tests"[All Fields] AND "routine"[All Fields]) OR "routine diagnostic tests"[All Fields] OR ("diagnostic"[All Fields] AND "test"[All Fields]) OR "diagnostic test"[All Fields]) OR ("curr res psychol"[Journal] OR "crp"[All Fields]) OR "RADT"[All Fields] OR "POCT"[All Fields] OR (group a[Author] AND ("streptococcus"[MeSH Terms] OR "streptococcus"[All Fields] OR "streptococcal"[All Fields])) OR ("gas"[All Fields] OR "gasoline"[MeSH Terms] OR "gasoline"[All Fields] OR "gasolines"[All Fields] OR "petrol"[All Fields] OR "petroleum"[MeSH Terms] OR "petroleum"[All Fields] OR "petroleums"[All Fields])) AND ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields] OR ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields]) OR ("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) OR ("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) OR (("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields]) AND ("prescribability"[All Fields] OR "prescribable"[All Fields] OR "prescribe"[All Fields] OR "prescribed"[All Fields] OR "prescriber"[All Fields] OR "prescriber s"[All Fields] OR "prescribers"[All Fields] OR "prescribes"[All Fields] OR "prescribing"[All Fields])) OR (("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) AND ("prescribability"[All Fields] OR "prescribable"[All Fields] OR "prescribe"[All Fields] OR "prescribed"[All Fields] OR "prescriber"[All Fields] OR "prescriber s"[All Fields] OR "prescribers"[All Fields] OR "prescribes"[All Fields] OR "prescribing"[All Fields])) OR ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields]) OR ("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) OR ("antimicrobial stewardship"[MeSH Terms] OR ("antimicrobial"[All Fields] AND "stewardship"[All Fields]) OR "antimicrobial stewardship"[All Fields] OR ("antibiotic"[All Fields] AND "stewardship"[All Fields]) OR "antibiotic stewardship"[All Fields]) OR ("antimicrobial stewardship"[MeSH Terms] OR ("antimicrobial"[All Fields] AND "stewardship"[All Fields]) OR "antimicrobial stewardship"[All Fields])) AND ("respiratory tract infections"[MeSH Terms] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infections"[All Fields]) OR "respiratory tract infections"[All Fields] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infection"[All Fields]) OR "respiratory tract infection"[All Fields] OR "RTI"[All Fields] OR "RTIs"[All Fields] OR ("pharyngitis"[MeSH Terms] OR "pharyngitis"[All Fields] OR ("sore"[All Fields] AND "throat"[All Fields]) OR "sore throat"[All Fields]) OR ("pharyngitis"[MeSH Terms] OR "pharyngitis"[All Fields] OR

"pharyngitides"[All Fields]) OR ("cough"[MeSH Terms] OR "cough"[All Fields] OR "coughing"[All Fields] OR "coughs"[All Fields] OR "coughed"[All Fields]) OR ("paranasal sinuses"[MeSH Terms] OR ("paranasal"[All Fields] AND "sinuses"[All Fields]) OR "paranasal sinuses"[All Fields] OR "sinuses"[All Fields] OR "sinusal"[All Fields] OR "sinuse"[All Fields] OR "sinusitis"[MeSH Terms] OR "sinusitis"[All Fields] OR "sinusitides"[All Fields]) OR ("common cold"[MeSH Terms] OR ("common"[All Fields] AND "cold"[All Fields]) OR "common cold"[All Fields] OR "cold"[All Fields] OR "cold temperature"[MeSH Terms] OR ("cold"[All Fields] AND "temperature"[All Fields]) OR "cold temperature"[All Fields]) OR ("pneumonia"[MeSH Terms] OR "pneumonia"[All Fields] OR "pneumonias"[All Fields] OR "pneumoniae"[All Fields] OR "pneumoniae s"[All Fields]) OR ("palatine tonsil"[MeSH Terms] OR ("palatine"[All Fields] AND "tonsil"[All Fields]) OR "palatine tonsil"[All Fields] OR "tonsil"[All Fields] OR "tonsils"[All Fields] OR "tonsilitis"[All Fields] OR "tonsillitis"[MeSH Terms] OR "tonsillitis"[All Fields] OR "tonsillitides"[All Fields] OR "tonsills"[All Fields]) OR ("bronchitis"[MeSH Terms] OR "bronchitis"[All Fields] OR "bronchitides"[All Fields]) OR ("bronchiolitis"[MeSH Terms] OR "bronchiolitis"[All Fields] OR "bronchiolitides"[All Fields]) OR ("pharyngitis"[MeSH Terms] OR "pharyngitis"[All Fields] OR ("throat"[All Fields] AND "infection"[All Fields]) OR "throat infection"[All Fields]) OR (("paranasal sinuses"[MeSH Terms] OR ("paranasal"[All Fields] AND "sinuses"[All Fields]) OR "paranasal sinuses"[All Fields] OR "sinuses"[All Fields] OR "sinusal"[All Fields] OR "sinuse"[All Fields] OR "sinusitis"[MeSH Terms] OR "sinusitis"[All Fields] OR "sinusitides"[All Fields]) AND ("infect"[All Fields] OR "infectability"[All Fields] OR "infectable"[All Fields] OR "infectant"[All Fields] OR "infectants"[All Fields] OR "infected"[All Fields] OR "infecteds"[All Fields] OR "infectibility"[All Fields] OR "infectible"[All Fields] OR "infecting"[All Fields] OR "infection s"[All Fields] OR "infections"[MeSH Terms] OR "infections"[All Fields] OR "infection"[All Fields] OR "infective"[All Fields] OR "infectiveness"[All Fields] OR "infectives"[All Fields] OR "infectivities"[All Fields] OR "infects"[All Fields] OR "pathogenicity"[MeSH Subheading] OR "pathogenicity"[All Fields] OR "infectivity"[All Fields])) OR ("influenza s"[All Fields] OR "influenza, human"[MeSH Terms] OR ("influenza"[All Fields] AND "human"[All Fields]) OR "human influenza"[All Fields] OR "influenza"[All Fields] OR "influenzas"[All Fields] OR "influenzae"[All Fields]))) AND (2010/1/1:2022/12/31[pdat])

3. **Emcare**

('community pharmacies' OR 'community pharmacist' OR community pharmacy) AND ('point-of-care testing' OR ‘point-of-care test’ OR ‘point of care test’ OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR ‘Group A streptococcal’ OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR ‘antibiotic stewardship’ OR ‘antimicrobial stewardship’) AND (‘respiratory tract infection’ OR RTI OR RTIs OR ‘sore throat’ OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsilitis OR bronchitis OR bronchiolitis OR ‘throat infection’ OR ‘sinuses infection’) {Including Related Terms}[2012-2022]

4. Cochrane Central Register of Controlled Trials

11 Trials matching ('community pharmacies' OR 'community pharmacist*' OR community pharmacy) AND ('point-of-care testing' OR ‘point-of-care test’ OR ‘point of care test’ OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR ‘Group A streptococcal’ OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR ‘antibiotic stewardship’ OR ‘antimicrobial stewardship’) AND (‘respiratory tract infection’ OR RTI OR RTIs OR ‘sore throat’ OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR ‘throat infection’ OR ‘sinuses infection’ OR influenza) in Title Abstract Keyword - with Publication Year from 2012 to 2022, in Trials (Word variations have been searched)
Cochrane Central Register of Controlled Trials
Issue 12 of 12, December 2022

5. Health Technology Assessment

(('community pharmacies' OR 'community pharmacist*' OR community pharmacy) AND ('point-of-care testing' OR 'point-of-care test' OR 'point of care test' OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR 'Group A streptococcal' OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship' OR 'antimicrobial stewardship') AND ('respiratory tract infection' OR RTI OR RTIs OR 'sore throat' OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR 'throat infection' OR 'sinuses infection' OR influenza)) FROM 2012 TO 2022

6. Google Scholar

('community pharmacies' OR 'community pharmacist*' OR community pharmacy) AND ('point-of-care testing' OR 'point-of-care test' OR 'point of care test' OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR 'Group A streptococcal' OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship' OR 'antimicrobial stewardship') AND ('respiratory tract infection' OR RTI OR RTIs OR 'sore throat' OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR 'throat infection' OR 'sinuses infection' OR influenza) 2012-2022.

First 250 articles coming from the search will be considered for screening titles and abstracts

BMJ Open

Improving diagnostic antimicrobial stewardship in respiratory tract infections: a protocol for a scoping review investigating point-of-care testing programs in community pharmacy

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2022-068193.R2
Article Type:	Protocol
Date Submitted by the Author:	01-Feb-2023
Complete List of Authors:	Saha, Sajal K.; Deakin University, School of Medicine; The University of Melbourne, Department of Infectious Diseases Promite, Shukla; RMIT University, School of Health and Biomedical Science Botheras, Carly L.; Deakin University, School of Medicine; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR) Manias, Elizabeth ; Monash University, School of Nursing and Midwifery, Faculty of Medicine, Nursing and Health Sciences; Deakin University, School of Nursing and Midwifery School of Nursing and Midwifery Mothobi, Nomvuyo; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR) Robinson, Suzanne; Deakin University, Deakin Health Economics, Institute for Health Transformation; Curtin University, EnAble Institute Athan, Eugene; Barwon Health, Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR); Deakin University Faculty of Health, School of Medicine
Primary Subject Heading:	Infectious diseases
Secondary Subject Heading:	Health services research, Respiratory medicine, Public health
Keywords:	International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, INFECTIOUS DISEASES, Public health < INFECTIOUS DISEASES, PRIMARY CARE

Title:

Improving diagnostic antimicrobial stewardship in respiratory tract infections: a protocol for a scoping review investigating point-of-care testing programs in community pharmacy

Authors: Sajal K. Saha*[1,2], Shukla Promite[3], Carly L. Botheras[1,4], Elizabeth Manias[5], Nomvuyo Mothobi[4], Suzanne Robinson[6,7], and Eugene Athan[1,4]

Affiliations

[1]School of Medicine, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia

[2]National Centre for Antimicrobial Stewardship (NCAS), Department of Infectious Diseases, Melbourne Medical School, University of Melbourne, Melbourne, VIC 3000, Australia

[3]School of Health and Biomedical Science, RMIT University, Bundoora, VIC 3083, Australia

[4]Centre for Innovation in Infectious Disease and Immunology Research (CIIDIR), Barwon Health, Geelong, VIC 3220, Australia

[5] School of Nursing and Midwifery, Faculty of Medicine, Nursing and Health Sciences, Monash University, Clayton, VIC 3800 Australia

[6]Deakin Health Economics, Institute for Health Transformation, Deakin University, Geelong, VIC 3220, Australia

[7]EnAble Institute, Curtin University, WA 6102, Australia

Corresponding Author

Sajal K. Saha

School of Medicine, Faculty of Health, Deakin University, Geelong, VIC 3220, Australia

Email: Sajal.saha@deakin.edu.au

Phone: +610452639559

Abstract

Introduction: Diagnostic uncertainty regarding the cause of respiratory tract infections (RTIs) multiplies the problem of unnecessary use of antibiotics and antimicrobial resistance in primary care. Point-of-care testing (POCT) programs have been recognised as a potential stewardship strategy to optimise antimicrobial use in primary care. There is a need for greater understanding of community pharmacy based POCT programs in reducing the unnecessary use of antimicrobials in patients with RTIs. This review systematically maps out evidence around the effectiveness, feasibility, and implementation challenges of POCT programs in community pharmacy to improve safe antimicrobial use in RTIs.

Methods: The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist and Arksey and O'Malley methodology framework guide reporting of this review. We will systematically review studies with either randomised controlled trial, non-randomised controlled trial, before-after study, observational study or pilot feasibility study designs. Medline, Emcare, PubMed, Health Technology Assessment, Cochrane Central Register of Controlled Trials and Google Scholar databases will be used to search for articles. Three reviewers will independently screen, review, and select studies with POCT program involving community pharmacists for antimicrobial stewardship in RTIs. Summary statistics and random effects model if data permits will be used to summarise effectiveness, feasibility, and cost-effectiveness of POCT program. Consolidated Framework for Implementation Research will capture POCT implementation drivers.

Ethics and dissemination: This review study does not require research ethics approval. Findings will be disseminated through the national and international conferences and seminars and publications in peer-reviewed journal(s).

Keywords: Point-of-care testing program; diagnostic stewardship; antimicrobial stewardship; respiratory tract infections; community pharmacy

Word count: 3841

Strengths and limitations of this study

- The most current Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews tool guides systematic reporting of this review.
- Limiting only English language article may have some chance of missing relevant studies.
- Limited number and suboptimal quality of studies may prevent generating rigid conclusions on the effectiveness and feasibility of implementing point-of-care testing program in community pharmacy to improve antimicrobial stewardship in respiratory tract infections.

Introduction

Patients with symptoms of respiratory tract infections (RTIs) commonly visit their primary care clinicians including community pharmacists and are often treated with antibiotics unnecessarily. When RTIs are viral in origin, symptomatic treatment can produce the greatest benefits.[1] Evidence shows that general practitioners (GPs) prescribe antibiotics in RTIs at much higher than recommendations in the therapeutic guideline; acute rhinosinusitis (41% vs. 0.5–8%), acute otitis media (89% vs. 20–31%) and acute pharyngitis or sore throat (94% vs. 19–40%).[2] Diagnostic uncertainty regarding the cause of RTIs potentially contributes to the burden of inappropriate use of antibiotics and growing antimicrobial resistance in primary care.[3] Provision of point-of-care diagnostic tools and technologies have been recognised as promising antimicrobial stewardship programs to address diagnostic uncertainty and optimise antimicrobial use in RTIs. According to the World Health Organisation, diagnostic antimicrobial stewardship tools are clinical diagnostic tests that help to appropriately diagnose infectious diseases, surveillance of bacterial resistance, and enable taking decision of appropriate antimicrobial therapy.[4]

RTIs of bacterial origin can cause severe complications if there is a delayed diagnosis. One example of such RTIs is acute pharyngitis or sore throat which are potentially caused by group A streptococci. This infection can be severe, with a risk of late complications including scarlet fever, rheumatic fever in rare occasions and acute glomerulonephritis.[5] Early treatment with antimicrobials is associated with fewer complications.[6] Group A streptococci leads 700,000 worldwide deaths annually.[6-7] Interestingly, only around 20% of sore throat infections (ranges 5-15% in adult and 20-30% in children) are caused by group A streptococci. However, up to 70% of sore throat cases are treated with inappropriate antibiotics.[7-8] Limited capacity of primary care clinicians to detect specific causative organisms such as group A streptococci by point-of-care testing (POCT) is a challenge for appropriately treating acute pharyngitis cases and undertake rational antibiotic decisions.[8-9]

POCT can be defined as the "provision of a test when the result will be used to make a decision and to take appropriate action, which will lead to an improved health outcome".[10] The most important elements of POCT are getting rapid results and its communication to guide clinical decisions. Besides, POCT should guide follow-up action to impact patients' clinical management including referral, triage, and treatment decisions.[11-13] As POCT involves a process and mechanisms for screening and treatment decisions, it can be appropriately named as a POCT program. For normalisation, POCT programs need viable business models for sustainability and any program must fit with real-world clinical workflow and economic/incentive structures. The commonly used POCT programs for RTIs management include C-reactive protein (CRP) and Rapid Antigen Testing (RAT) program.

RATs can reliably identify bacteria like group A streptococci pharyngitis within five to fifteen min and facilitate justified medical decision-making and can allow clinicians to avoid inappropriate antibiotic choice and prevent complications.[6 14-15] Likewise, CRP testing programs can successfully differentiate bacterial RTIs from viral RTIs within five minutes.[16-18] CRP testing programs have been shown to be robust, reliable, and cost-effective in GP settings.[19-21] POCT programs have potential benefits in reducing unnecessary and inappropriate antibiotic use by supporting clinician's decisions for antimicrobial treatment and appropriate patient referral between GPs and pharmacists.[22-23]

Community pharmacists are well positioned in primary care to provide POCT screening and treatment services for patients seeking RTI treatment and efficiently refer patients to GPs who need further investigation for a sign of bacterial infection.[24] Community pharmacists have been undergoing an expansion of their scope of service and practices to address unmet needs of patient care, though this is mostly visible in developed countries.[25-26] POCT program could be an opportunity for community pharmacists to be better involved in the antimicrobial stewardship program for RTIs and to collaborate with GPs.

Evidence suggests that the adoption of CRP and RAT programs by community pharmacists can improve the selection of appropriate antibiotic treatment, reduce the use of health care resources, and enable health economic benefits.[16 23 27-28] A CRP testing program in UK community pharmacies showed potential in reducing unnecessary RTI-related GP visits.[29] Despite potential AMS benefits, the uptake of POCT program in the community pharmacies has been low worldwide. In most countries including in Australia, no POCT programs are utilised as standard practice in community pharmacy for patients seeking RTIs treatment. For lacking these programs and policy support, community pharmacists cannot scientifically judge which RTI patients should be referred to GPs or need just over the counter medicine for safe recovery. In an Australian nationwide survey, <15% of 613 surveyed community pharmacists used POCT programs in patients with any infections.[30]

To date, it remains unclear to what extent POCT programs are effective and feasible in the context of community pharmacy. The diversity of community pharmacies in terms of a business model, pharmacy practice regulatory policies, and rights for diagnostic use for patient safety, may influence POCT use by community pharmacists.[31] The clinical skills of community pharmacists and patients' receptiveness of POCT services from community pharmacy also matter to the provision of POCT program in routine pharmacy practices.[32] However, the diverse factors influencing implementation of POCT programs in community pharmacy for improving antimicrobial stewardship remain largely unknown.

Through searching PROSPERO, we found no systematic reviews related to POCT programs in community pharmacy. As the POCT program has gained global attention on antimicrobial resistance to

optimise antibiotic use in primary care, it is utmost important to comprehensively know if POCT programs in community pharmacy are effective, feasible, and implementable for antimicrobial stewardship. Considering the importance of diagnostic antimicrobial stewardship and expansion of the pharmacist's role in antimicrobial stewardship, this review study has been developed to provide synthesised evidence to help inform future diagnostic stewardship policy directions in the context of POCT program in community pharmacy for optimal antimicrobial use in RTIs.

Methods

We use Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[33] (Supplementary file 1) and Arksey and O'Malley's[34] seven component methodology framework to report this scoping review. We chose a scoping review design as this review i) maps out the breadth of evidence in the literature on the topic of POCT testing program in community pharmacy, ii) investigate evidence around the effectiveness and feasibility of POCT testing program in community pharmacy, and iii) will inform future research directions to address evidence gaps. The seven components include: (1) identifying aims of the research; (2) review of sources of data, search strategies and study design to identify studies of interest; (3) selection of studies; (4) extraction of data; (5) quality assessment of the selected studies; (6) data collation and analysis of the outcome of interest and (7) proposing future direction of the topic of research. This study has been planned to conduct between 1 August 2022 to April 2023.

1. Identifying aims of the research

This scoping review focuses on the below aims.

1. To identify the breadth and scope of evidence assessing implementation of POCT in community pharmacy to optimise antimicrobial use.
2. To map out evidence around effectiveness, feasibility and cost-effectiveness of POCT programs in community pharmacy to optimise antimicrobial use in primary care.
3. To understand the implementation challenges and opportunities for using POCT program by community pharmacists in routine pharmacy practices.
4. To identify if evidence generated from published research is sufficient to inform policies supporting routine use of POCT program in community pharmacy for optimal antimicrobial use.

2. Review of sources of data, search strategies and study design to identify studies of interest

Sources of data

We will conduct a systematic search in six medical databases to identify relevant studies. Databases include Medline, Emcare, PubMed, Health Technology Assessment, Cochrane Central Register of Controlled Trials and Google Scholar. A uniform search strategy will be developed and applied to the defined databases. Databases will be accessed through the Deakin University library system.

Search strategy

The search strategy will follow the PICOT terminology: Population: [(community pharmac* OR community pharmacist* OR community pharmacy]; Intervention [point-of-care testing OR rapid antigen test OR C-reactive protein OR diagnostic test OR CRP OR RAT OR RADT*)]; Outcome [(Antibiotic* OR Antibiotics OR Antimicrobial* OR Antibiotic prescribing OR Antimicrobial prescribing OR antibiotic use OR Antimicrobial use OR Antimicrobial stewardship). This common search strategy will be applied to all the databases selected to search for articles. Supplementary file 2 shows details of search strategy for all six databases. Study publication periods will be between Time: 01 Jan 2012- 31 Dec 2022. As POCT programs have been considered as potential antimicrobial stewardship programs in the national and international AMR action plan near around 2012, we believe that evidence will begin from that period.

Apart from the database search, snowballing strategies will be applied to identify any relevant studies from review articles. Manual searches will be performed in relevant pharmacy and health service journals, with a focus on journal publishing antimicrobial stewardship work, to reduce the chance of missing relevant articles. Examples of such journals include Research in Social and Administrative Pharmacy, International Journal of Clinical Pharmacy, Journal of Clinical Pharmacy, International Journal of Pharmacy Practice and Therapeutics, Journal of Pharmacy Practice and Research, European Journal of Hospital Pharmacy, Pharmaceutical Journal, Journal of American Pharmacist Association, Antibiotics, and Journal of Antimicrobial Chemotherapy. Utilising the auto alert system in individual databases until publication of this review, we will set an update of the literature search to minimise the risk of missing any potential articles.

Study design of the selected articles

The selected studies will consist of implementation studies and/ or feasibility studies with either RCTs, non-RCT design, observational study design (retrospective or prospective), cohort study design (retrospective or prospective) and pilot study design. Qualitative studies that assess perceptions of community pharmacists regarding POCT implementation for optimal antimicrobial use in community pharmacists will be included. The algorithm of the Effective Practice and Organisation of Care group

(EPOC) EPOC criteria[35] will be utilised to determine the study design and to avoid any terminology that is ambiguous.

3. Selection of studies

All searched records either derived from electronic databases or manual snowballing will be merged to remove duplicate citations. Three reviewers (SKS, SP and CLB) will independently screen titles and abstracts and review full text using the following inclusion and exclusion criteria in the Covidence systematic review software. Articles will be excluded if it is clear from the title or abstract that the study does not meet inclusion criteria as stated below. Discrepancies will be resolved over discussion among the three reviewers. We will contact the authors if needed by email to obtain relevant articles or resolve any missing or unclear data or any clarification. We will use a PRISMA flow diagram to maintain transparency in the process of article selection and to record studies remain in each stage of selection with valid explanation.

Inclusion Criteria

Any study meeting all the following criteria will be included

1. **Population**: Only community pharmacists with any level of experience who have used POCT or shared views and experience of using POCT in community pharmacy for optimal use of antimicrobials.
2. **Intervention**: Any kind of POCT (e.g., CRP or RAT) that were used to diagnose RTIs with a purpose of optimising antimicrobial use. Studies will be considered for inclusion if they meet all the following conditions:
    - POCT programs were provided to patient or public by community pharmacist(s) to avoid unnecessary antimicrobial use in RTIs.
    - Investigated either a single POCT test or multiple POCT test services with a primary objective of reducing antimicrobial use or consumption in RTIs.
    - Evaluated either effectiveness, cost-effectiveness, feasibility, implementation, or receptiveness of POCT program by community pharmacists.
    - Applied any mode of POCT service delivery with charge or without charge of the patient or public.
    - Conducted the POCT program for any time frame or period.
3. **Settings**: Implementation of POCT program in community pharmacy or using GP-pharmacy practice agreements.

4. **Design**: Implementation study or feasibility study with either randomised controlled trial, non-randomised controlled trial, observational study (retrospective or prospective), cohort study (retrospective or prospective), or qualitative study that assesses feasibility of using POCT program, including implementation challenges and facilitators or community pharmacists' perceptions regarding POCT program for antimicrobial stewardship in RTIs.
5. **Outcome**: Studies assessing either effect, cost-effectiveness, feasibility, or implementation challenges and opportunities of using POCT program in community pharmacy for antimicrobial stewardship in RTIs.
6. **Country**: Studies conducted in any country.
7. **Time**: Studies conducted between January 2012 to 2022.
8. **Availability**: Full text articles are available.

Exclusion Criteria

1. Study published as editorial or case series or any conference abstracts which are not available as full text.
2. POCT test is delivered in setting other than community pharmacy
3. Articles not written in the English language.
4. Study involving patients with infections other than RTIs

4. Extraction of data

A data extraction template will be created and piloted by data extractors (SKS, SP and CB). The process will confirm that the extraction form has captured all the relevant information required for analysis and reporting. The Extractors' feedback will be used to refine the form and finalise its usability and completeness. Duplicate data extraction will be occurred independently and any disagreements if remains will be addressed through discussion. The third reviewer will be approached if a consensus is not made. Two authors will extract and interpret the data. We will use a template for intervention description and replication (TIDieR) checklist[36] to record POCT intervention details. Extracted data would include study demographics and general information (including study title, author, year, and publication details), objectives, study design, period of study, participants of the study, study settings, POCT services and its characteristics (types, delivery strategy, timing, provider and recipient characteristics, effect, feasibility, acceptability, sustainability), POCT intervention outcomes (effect, effect size, confidence interval (CI), risk ratio), recommendations and conclusions. The POCT intervention results will be meticulously and comprehensively extracted to make them statistically analysable. In the case of unclear or missing data or data presented in an unextractable form, we will contact the respective authors for clarification by email with a 2- week response time limit. If the author does not respond, the case will be described as uncontactable. We will group POCT programs based on

infectious diseases for which they are using for, type of POCT programs, bacteria that POCT program is targeting for diagnosis, and country.

5. Assessing the quality of studies

SKS and CB will assess and grade the quality of study as high-, medium- or low- quality using evidence-based risk assessment tool. We will use the Cochrane risk of bias tools involving six criteria[37] to assess the quality of RCTs and determine the internal validity of RCTs. The ROBINS-I risk assessment tools[38] will be used for non-randomised trials. This quality assessment will only occur if sufficient studies for meta-analysis are identified.

6. Data collation and analysis of the outcome of interest

We will use an evidence synthesis method[39] to map out existing evidence related to POCT use in community pharmacy for antimicrobial stewardship. Results of the included articles will be tabulated and summarised in table format for above defined outcome measures of effectiveness, feasibility, cost-effectiveness and implementation challenges. Descriptive summary of the results will be generated for each outcome measure and research questions. For effect measures, all the categorical variables (e.g., antimicrobial use) of the trials will be reported in the same unit with 95% confidence interval (CI). Continuous variables will be recorded with mean difference and 95% CI. Median and interquartile range would be a better descriptor if the primary sources of data did not check or report normality. If studies have adequate data for calculation, summary statistics will be recorded and analysed. Meta-analysis may be performed to determine the effect of POCT program if enough quality studies are found. Relative risk will be the measure of combined intervention effects. We will summarise and report each outcome of interest of this review.

Analysis of the outcomes of interest

We will summarise and analyse results reported in the selected studies using summary statistics including descriptive statistics.

1. **Breadth and scope of evidence**: Number of selected studies based on outcome measures, study design, country, and if appropriate by quality of study, this will determine the breadth of evidence assessing implementation of POCT program in community pharmacy for optimal antimicrobial use in RTIs.
2. **Effect of POCT program**: Reduction of unnecessary or inappropriate antibiotic use governed by test result will be the measure of effectiveness of POCT programs. The other effect measures could be i) total number of POCT tests received by patients, ii) proportion of positive POCT results that led to initiation of antibiotics, and iii) proportion of negative result that led to avoid antibiotic treatment. In addition, the frequency of false positives or false negatives and their

effects on patients will be sought if reported. The complications from antibiotic prescription for false positive POCT test result and complications for not prescribing antibiotics for false negative results will also be descriptively measured if data suggests. Level of patient satisfaction with POCT services by pharmacist will also be measured from quantitative and qualitative data if available. The hypotheses based on those secondary variables will considered exploratory hypotheses. Meta-analysis may be performed if there are adequate number of high and medium quality studies are available. Given adequate RCTs and meta-analysable data are available, a random effects model will be used to measure the pooled estimates of POCT intervention effect utilising OR and 95% CI. Forest plots, and I^2 statistics will measure across study heterogeneity. Subgroup analyses will determine the sources of heterogeneity [e.g., POCT strategies, implementation approaches, sample size, design, study quality].

3. **Feasibility of POCT program**: Feasibility measures will be descriptively presented from the findings and conclusions of the selected studies. Clinical, operational, and economic feasibility will be explored from the selected studies. Feasibility data include simplicity, reliability, and accuracy of the test, whether the tests help pharmacists' clinical decision making, and barriers and facilitators to use POCT program in community pharmacy. The clinical outcomes that may be assessed if reported: 1) pharmacists' advice and rates of patient referral to GPs as a direct result of POCT; 2) patient outcomes (e.g., satisfaction, rate of infection recovery without antimicrobials); and 3) associations between the POCT results and RTI outcomes. The operational outcomes include the rate of POCT service provision and uptake by patient, acceptability by consumers and potential of the POCT service for undertaking AMS. Descriptive statistics will be used to measure feasibility of the POCT program.
4. **Cost-effectiveness of POCT program**: The incremental cost-effectiveness ratios of POCT per quality-adjusted-life-year (QALY) gained and per antimicrobial prescription avoided will be the measure of cost-effectiveness of the services. Cost-effectiveness measures will be calculated for a subgroup of studies based on type of POCT programs (e.g., CRP or RAT) as well. The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) guideline will be used when reviewing reporting the economic outcomes of the studies.[40]
5. **Implementation challenges, facilitators, and opportunities of the POCT program**: Data will be analysed using an implementation science framework, Consolidated Framework for Implementation Research (CFIR) to present reported implementation challenges and opportunities to inform design of future implementation study.[41] Factors influencing implementation of POCT programs in community pharmacies by inner and outer contexts[41] will be extracted. The implications of the false negative and false positive cases and the safety factors considered to address those cases in community pharmacy will be extracted and analysed if reported in the eligible studies.

Subgroup analysis

We will undertake subgroup analysis for the outcomes of interest in this review if adequate data is available. Exploratory subgroup analysis could be performed by (1) POCT type such as CRP or RAT, (2) Type of RTIs, (3) country and (4) study design, (5) the type and brand of the test, (6) sample employed if available nasopharyngeal or oropharyngeal.

Patient and Public Involvement

Patients were not directly involved in our research but included studies for this review may include patient population.

Discussion

To the best of our knowledge, this is the first scoping review exploring the evidence of POCT program in community pharmacy for antimicrobial stewardship in RTIs. This study explores the effectiveness, feasibility and implementation challenges for POCT use by community pharmacists for optimal antimicrobial use in patients with RTIs in primary care. We anticipate that the findings will produce multiple benefits to antimicrobial stewardship researchers, stakeholders, and policymakers to make informed decisions about the provision of POCT program in community pharmacy as part of the primary care antimicrobial stewardship program.

First, this review will provide a global overview of the community pharmacy-based POCT program to avoid unnecessary antimicrobial use in RTIs, and the potential evidence gaps on the topic to inform practice and policy around the provision of routine POCT services in community pharmacy.

Second, evidence supports that there are several factors[42-43] influencing the implementation and provision of POCT programs to foster antimicrobial stewardship programs in primary care. However, the factors remain unknown in the context of community pharmacy and research in the area remains scant. Physician-pharmacist interprofessional issues, inter- and intra-country variation in pharmacy practices, policies and regulations for diagnostic use may interfere feasibility of using POCT program by community pharmacists. This review will present the global and country specific evidence regarding the effectiveness, feasibility, and implementation challenges of the POCT program for optimal antimicrobial use in RTIs.

Third, diagnostic stewardship has potential for improving doctor-pharmacist collaboration for antimicrobial stewardship in primary care. A general practitioner-pharmacist antimicrobial stewardship (GPPAS) model has highlighted implementation of POCT program utilising collaboration between

general practitioners and community pharmacists to improve antimicrobial stewardship in Australian primary care.[44] Our review may provide evidence and progress in the field of general practitioner-community pharmacist collaborative implementation of the POCT program.

Fourth, our review could provide valuable insights for the future design of implementation trials on POCT program in community pharmacy. This review may be useful for antimicrobial stewardship funders to understand the importance of research funding for innovations in POCT programs in community pharmacy. Findings from a global lens will inform future needs of research, strategies and community pharmacy practice and policy changes in the provision of POCT program in community pharmacy for antimicrobial stewardship in RTIs in primary care.

Our study uses Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[33] and Arksey and O'Malley's framework[34] for methodological rigour of the study. We use seven databases for comprehensive search to get relevant articles around the world. The subject experts on antimicrobial stewardship, health economics, microbiologists, infectious disease physicians and pharmacists have been part of this multidisciplinary review team who will guide the analysis of data and interpretation of results. There is a limitation of this review. We will only include English language articles as no team members have been able to read in any other languages. This may lead to miss few relevant articles. Insufficient number of studies may restrain measuring and reporting few outcomes of interest in the review.

In summary, the progress in the field of diagnostic stewardship is central to address the growing burden of antimicrobial resistance caused by overuse of antimicrobials in RTIs in primary care. This review could have implications by informing primary care clinicians including pharmacists, researchers, and health policymakers about the strategic directions for future implementation of POCT program in community pharmacies at local or national scales to avoid unnecessary antimicrobial use in RTIs.

Ethics and dissemination

This scoping review does not need any formal ethical approval as no personal or primary data is being collected during this study. The findings will be presented at national and international conferences, scientific meetings and seminars, and published in a peer-reviewed journal.

Data Statement: All data will be extracted and analysed will be accessible on request from SKS.

Acknowledgements: The authors would like to express thanks to research team members of the CIIDIR for their valuable feedback on the draft of this review protocol.

Author Contributions: Review study was conceptualised and designed by SKS, SP and EA. SKS, SP and CB developed search strategies. The data extraction, data analysis, data synthesis and statistical tests were designed by SKS, EM, NM, and SR. SKS has written the whole protocol and the manuscript. All authors reviewed and approved the manuscript for publication.

Funding: There is no specific funding for this review by material and technical support have been provided from the Faculty of Medicine of Deakin University, Australia.

Competing interests None declared.

Patient consent Not required.

Ethics approval Not required

References

1. Brink AJ, Van Wyk J, Moodley VM et al. The role of appropriate diagnostic testing in acute respiratory tract infections: An antibiotic stewardship strategy to minimise diagnostic uncertainty in primary care. *S Afr Med J* 2016;106(6):554-61.
2. McCullough AR, Pollack AJ, Plejdrup Hansen M et al. Antibiotics for acute respiratory infections in general practice: comparison of prescribing rates with guideline recommendations. *Med. J. Aust* 2017;207(2):65-9.
3. Walsh TL, Taffe K, Sacca N et al. Risk factors for unnecessary antibiotic prescribing for acute respiratory tract infections in primary care. *Mayo Clin Proc Innov Qual Outcomes* 2020;4(1):31-9.
4. WHO, 2016. Diagnostic stewardship: A guide to implementation in antimicrobial resistance surveillance sites. https://apps.who.int/iris/bitstream/handle/10665/251553/WHO-DGO-AMR-2016.3-eng.pdf?sequence=1&isAllowed=y
5. Hawker JI, Smith S, Smith GE et al. Trends in antibiotic prescribing in primary care for clinical syndromes subject to national recommendations to reduce antimicrobial resistance, UK 1995-2011: analysis of a large database of primary care consultations. *J Antimicrob Chemother* 2014; 69: 3423–30.
6. Little P, Stuart B, Hobbs FD et al. Antibiotic prescription strategies for acute sore throat: a prospective observational cohort study. *Lancet Infect Dis* 2014; 14: 213–9.
7. Papastergiou J, Trieu CR, Saltmarche D et al. Community pharmacist–directed point-of-care group A Streptococcus testing: evaluation of a Canadian program. *J Am Pharm Assoc* 2018;58(4):450-6.
8. Cohen-Poradosu R, Kasper DL, Infectious Disease Society of America. Group A streptococcus epidemiology and vaccine implications. *Clin Infect Dis* 2007;45(7):863e865.
9. Van Howe RS, Kusnier LP. Diagnosis and management of pharyngitis in a pediatric population based on cost-effectiveness and projected health outcomes. *Pediatrics* 2006;117(3):609e619.

10. Price CP, St. John A, Hicks JM Point-of-care testing. 2nd edition. Washington (D.C.): American Association for Clinical Chemistry. 2004
11. Price CP. Point of care testing. *BMJ* 2001; 322: 1285–1288.
12. Bissonnette L, Bergeron MG. Diagnosing infections–current and anticipated technologies for point-of-care diagnostics and home-based testing. *Clin Microbiol Infect* 2010; 16:1044–1053.
13. Boehme CC, Nicol MP, Nabeta P et al. Feasibility, diagnostic accuracy, and effectiveness of decentralised use of the Xpert MTB/RIF test for diagnosis of tuberculosis and multidrug resistance: a multicentre implementation study. *Lancet* 2011; 377:1495–1505.
14. ESCMID Sore Throat Guideline Group, Pelucchi C, Grigoryan L et al. Guideline for the management of acute sore throat. *Clin Microbiol Infect* 2012; 18:1–28. https://doi.org/10.1111/j.1469-0691.2012.03766.x
15. McIsaac WJ, Kellner JD, Aufricht P et al. Empirical validation of guidelines for the management of pharyngitis in children and adults. *JAMA* 2004; 291:1587–1595. https://doi.org/10.1001/jama.291.13.1587
16. Cooke J. C-Reactive Protein (CRP) as a point of care test (POCT) to assist in the management of patients presenting with symptoms of respiratory tract infection (RTI) - a new role for Community Pharmacists? *Pharm Manag* 2016; 32:25–29.
17. McCarthy PL, Frank AL, Ablow RC et al. Value of the C-reactive protein test in the differentiation of bacterial and viral pneumonia. *J Paed* 1978;92: 454–456.
18. Fujita I, Hamasaki Y, Miyazaki S. Differentiating between bacterial and viral infection by measuring both C-reactive protein and 2′ -5′ -oligoadenylate synthetase as inflammatory markers. *J Infect Chemother* 2002; 8:76–80.
19. Hughes A, Gwyn L, Harris S, Clark C. Evaluating point-of-care C-reactive protein testing in a general practice. *Clin Pharm* 2016; 8:309–318.
20. National Institute for Health and Care Excellence. Alere Afinion CRP for C-reactive protein testing in primary care. 2016 https://www.nice.org.uk/guidance/mib81/resources/alere-afinion-crp-for-creactive-protein-testing-in-primary-care-pdf-63499402887109 Accessed July 29, 2022.
21. Oppong R, Jit M, Smith RD, et al. Cost-effectiveness of point-of-care C-reactive protein testing to inform antibiotic prescribing decisions. *Br J Gen Pract* 2013;63: 465–471.
22. Martínez-González NA, Plate A, Jäger L, Senn O et al. The Role of Point-of-Care C-Reactive Protein Testing in Antibiotic Prescribing for Respiratory Tract Infections: A Survey among Swiss General Practitioners. *Antibiotics* 2022;11(5):543.
23. Klepser DG, Klepser ME, Dering-Anderson AM, Morse JA, Smith JK, Klepser SA. Community pharmacist–physician collaborative streptococcal pharyngitis management program. *J Am Pharm Assoc* 2016;56(3):323-9.
24. Saha SK, Kong DC, Mazza D et al. A systems thinking approach for antimicrobial stewardship in primary care. *Exp Rev Anti-infect Ther* 2022;20(6):819-27.

25. Tannenbaum C, Tsuyuki RT. The expanding scope of pharmacists' practice: implications for physicians. *CMAJ*. 2013; 185 (14): 1228-1232.
26. Framework for Implementation of Expanded Scope of Practice for Pharmacists. Alberta Health Services. Available at: http://www.albertahealthservices.ca/assets/Infofor/hp/if-hp-pharm-framework.pdf. Accessed August 01, 2022.
27. Hunter R. Cost-effectiveness of point-of-care C-reactive protein tests for respiratory tract infection in primary care in England. *Adv Ther* 2015; 32:69–85.
28. Wakeman M, Cork T, Watwood D. Point-of-care C-reactive protein testing in community pharmacy to deliver appropriate interventions in respiratory tract infections. *Clin Pharm* 2018;10(5):149-153. https://doi.org/10.1211/CP.2018.20204635
29. Cooke J, Butler C, Hopstaken R, et al. Narrative review of primary care point-of-care testing (POCT) and antibacterial use in respiratory tract infection (RTI). *BMJ Open Res* 2015;2: e000086. doi: 10.1136/bmjresp-2015-000086
30. Saha SK, Kong DC, Thursky K et al. Antimicrobial stewardship by Australian community pharmacists: Uptake, collaboration, challenges, and needs. *J Am Pharm Assoc* 2021;61(2):158-68.
31. Chalmers L, Czarniak P, Hughes J et al. Implementation factor mapping of a pilot study of point-of-care C-reactive protein testing for respiratory tract infections in community pharmacy. *Explor Res Clin and Soc Pharm* 2022:100147.
32. Czarniak P, Chalmers L, Hughes J et al. Point-of-care C-reactive protein testing service for respiratory tract infections in community pharmacy: a qualitative study of service uptake and experience of pharmacists. *Int J Clin Pharm* 2022;44(2):466-79.
33. Tricco AC, Lillie E, Zarin W et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med* 2018;169(7):467-73.
34. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19-32.
35. Rockers PC, Feigl AB, Røttingen JA et al. Study-design selection criteria in systematic reviews of effectiveness of health systems interventions and reforms: A meta-review. *Health Policy* 2012;104(3):206-14.
36. Hoffmann TC, Glasziou PP, Boutron I et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014; 348: g1687.
37. Higgins, JPGreen, S. Cochrane Handbook for Systematic Reviews of Interventions: *The Cochrane Collaboration*. Chichester,UK: JohnWiley&Sons,2011.
38. Sterne JA, Herna´n MA, Reeves BC et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016; 355: i4919.
39. Carr S, Lhussier M, Forster N et al. An evidence synthesis of qualitative and quantitative research on component intervention techniques, effectiveness, cost-effectiveness, equity and acceptability of different versions of health-related lifestyle advisor role in improving health. *Health Technol. Assess* 2011;15(9):1-284.

40. Husereau D, Drummond M, Augustovski F et al. Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement: updated reporting guidance for health economic evaluations. Int J Technol Assess Health Care. 2022;38(1): e13
41. Damschroder LJ, Aron DC, Keith RE et al. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci* 2009;4(1):1-5.
42. Gallimore CE, Porter AL, Barnett SG et al. A state-level needs analysis of community pharmacy point-of-care testing. *J Am Pharm Assoc* 2021;61(3): e93-8.
43. Gubbins PO, Klepser ME, Dering-Anderson AM, Bauer KA, Darin KM, Klepser S, Matthias KR, Scarsi K. Point-of-care testing for infectious diseases: opportunities, barriers, and considerations in community pharmacy. *J Am Pharm Assoc* 2014;54(2):163-71.
44. Saha SK, Kong DC, Thursky K et al. A Novel GPPAS Model: Guiding the Implementation of Antimicrobial Stewardship in Primary Care Utilising Collaboration between General Practitioners and Community Pharmacists. *Antibiotics* 2022; 11(9); 1158

Supplementary File 1:

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4,5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	6
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N/A
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	8
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	7
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	7,8
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	9,10
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	9,10
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	9

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	10
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	7
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	7
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	9
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	10,11
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9,10,11
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	11
Limitations	20	Discuss the limitations of the scoping review process.	12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	12
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	13

Ref 33: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018; 169:467–473. doi: 10.7326/M18-0850.

Supplementary File 2: Search strategy

1. Medline:

(('community pharmacies' OR 'community pharmacist*' OR 'community'/exp OR community) AND ('pharmacy'/exp OR pharmacy) OR pharmac*) AND ('point-of-care testing'/exp OR 'point-of-care testing' OR 'point-of-care test' OR 'point of care test'/exp OR 'point of care test' OR 'rapid antigen test'/exp OR 'rapid antigen test' OR 'c-reactive protein'/exp OR 'c-reactive protein' OR 'diagnostic test'/exp OR 'diagnostic test' OR 'crp'/exp OR crp OR radt OR poct OR 'group a streptococcal' OR 'gas'/exp OR gas) AND ('antibiotic'/exp OR antibiotic OR 'antibiotics'/exp OR antibiotics OR 'antimicrobial'/expOR antimicrobial OR 'antimicrobials'/exp
OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use'/exp OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship'/exp OR 'antibiotic stewardship' OR 'antimicrobial stewardship'/exp OR 'antimicrobial stewardship') AND ('respiratory tract infection'/exp OR 'respiratory tract infection' OR rti OR rtis OR 'sore throat'/exp OR 'sore throat' OR 'pharyngitis'/exp OR pharyngitis OR 'cough'/exp OR cough OR 'sinusitis'/exp OR sinusitis OR 'cold'/exp OR cold OR 'pneumonia'/exp OR pneumonia OR 'tonsillitis'/exp OR tonsillitis OR 'bronchitis'/exp OR bronchitis OR 'bronchiolitis'/exp OR bronchiolitis OR 'throat infection'/exp OR 'throat infection' OR 'sinuses infection') AND ([article]/lim OR [article in press]/lim OR [conference abstract]/lim OR [conference paper]/lim OR [conference review]/lim OR [data papers]/lim OR [review]/lim OR [short survey]/lim OR [preprint]/lim) AND [embase]/lim AND [2012-2022]/py

2. Pubmed

Search: ('community pharmacies' OR 'community pharmacist' OR community pharmacy) AND ('point-of-care testing' OR 'point-of-care test' OR 'point of care test' OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR 'Group A streptococcal' OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship' OR 'antimicrobial stewardship') AND ('respiratory tract infection' OR RTI OR RTIs OR 'sore throat' OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR 'throat infection' OR 'sinuses infection' OR influenza) Filters: from 2010/1/1 - 2022/12/31
(("pharmacies"[MeSH Terms] OR "pharmacies"[All Fields] OR ("community"[All Fields] AND "pharmacies"[All Fields]) OR "community pharmacies"[All Fields] OR ("communal"[All Fields] OR "communalism"[All Fields] OR "communalities"[All Fields] OR "communality"[All Fields] OR "communally"[All Fields] OR "commune"[All Fields] OR "communes"[All Fields] OR "community s"[All Fields] OR "communitys"[All Fields] OR "residence characteristics"[MeSH Terms] OR ("residence"[All Fields] AND "characteristics"[All Fields]) OR "residence characteristics"[All Fields] OR "communities"[All Fields] OR "community"[All Fields]) OR ("pharmacies"[MeSH Terms] OR "pharmacies"[All Fields] OR ("community"[All Fields] AND "pharmacy"[All Fields]) OR "community pharmacy"[All Fields])) AND ("point of care testing"[MeSH Terms] OR ("point of care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point"[All Fields] AND "care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point of care testing"[MeSH Terms] OR ("point of care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point"[All Fields] AND "care"[All Fields] AND "test"[All Fields]) OR "point of care test"[All Fields]) OR ("point of care testing"[MeSH Terms] OR ("point of care"[All Fields] AND "testing"[All Fields]) OR "point of care testing"[All Fields] OR ("point"[All Fields] AND "care"[All Fields] AND "test"[All Fields]) OR "point of care test"[All Fields]) OR (("rapid"[All Fields] OR "rapidities"[All Fields] OR "rapidity"[All Fields] OR "rapidness"[All Fields]) AND ("antigen s"[All Fields] OR "antigene"[All Fields] OR

"antigenes"[All Fields] OR "antigenic"[All Fields] OR "antigenically"[All Fields] OR "antigenicities"[All Fields] OR "antigenicity"[All Fields] OR "antigenized"[All Fields] OR "antigens"[MeSH Terms] OR "antigens"[All Fields] OR "antigen"[All Fields]) AND ("research design"[MeSH Terms] OR ("research"[All Fields] AND "design"[All Fields]) OR "research design"[All Fields] OR "test"[All Fields])) OR ("c reactive protein"[MeSH Terms] OR ("c reactive"[All Fields] AND "protein"[All Fields]) OR "c reactive protein"[All Fields] OR "c reactive protein"[All Fields]) OR ("diagnostic tests, routine"[MeSH Terms] OR ("diagnostic"[All Fields] AND "tests"[All Fields] AND "routine"[All Fields]) OR "routine diagnostic tests"[All Fields] OR ("diagnostic"[All Fields] AND "test"[All Fields]) OR "diagnostic test"[All Fields]) OR ("curr res psychol"[Journal] OR "crp"[All Fields]) OR "RADT"[All Fields] OR "POCT"[All Fields] OR (group a[Author] AND ("streptococcus"[MeSH Terms] OR "streptococcus"[All Fields] OR "streptococcal"[All Fields])) OR ("gas"[All Fields] OR "gasoline"[MeSH Terms] OR "gasoline"[All Fields] OR "gasolines"[All Fields] OR "petrol"[All Fields] OR "petroleum"[MeSH Terms] OR "petroleum"[All Fields] OR "petroleums"[All Fields])) AND ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields] OR ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields]) OR ("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) OR ("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) OR (("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields]) AND ("prescribability"[All Fields] OR "prescribable"[All Fields] OR "prescribe"[All Fields] OR "prescribed"[All Fields] OR "prescriber"[All Fields] OR "prescriber s"[All Fields] OR "prescribers"[All Fields] OR "prescribes"[All Fields] OR "prescribing"[All Fields])) OR (("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) AND ("prescribability"[All Fields] OR "prescribable"[All Fields] OR "prescribe"[All Fields] OR "prescribed"[All Fields] OR "prescriber"[All Fields] OR "prescriber s"[All Fields] OR "prescribers"[All Fields] OR "prescribes"[All Fields] OR "prescribing"[All Fields])) OR ("anti bacterial agents"[Pharmacological Action] OR "anti bacterial agents"[MeSH Terms] OR ("anti bacterial"[All Fields] AND "agents"[All Fields]) OR "anti bacterial agents"[All Fields] OR "antibiotic"[All Fields] OR "antibiotics"[All Fields] OR "antibiotic s"[All Fields] OR "antibiotical"[All Fields]) OR ("anti infective agents"[Pharmacological Action] OR "anti infective agents"[MeSH Terms] OR ("anti infective"[All Fields] AND "agents"[All Fields]) OR "anti infective agents"[All Fields] OR "antimicrobial"[All Fields] OR "antimicrobials"[All Fields] OR "antimicrobially"[All Fields]) OR ("antimicrobial stewardship"[MeSH Terms] OR ("antimicrobial"[All Fields] AND "stewardship"[All Fields]) OR "antimicrobial stewardship"[All Fields] OR ("antibiotic"[All Fields] AND "stewardship"[All Fields]) OR "antibiotic stewardship"[All Fields]) OR ("antimicrobial stewardship"[MeSH Terms] OR ("antimicrobial"[All Fields] AND "stewardship"[All Fields]) OR "antimicrobial stewardship"[All Fields])) AND ("respiratory tract infections"[MeSH Terms] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infections"[All Fields]) OR "respiratory tract infections"[All Fields] OR ("respiratory"[All Fields] AND "tract"[All Fields] AND "infection"[All Fields]) OR "respiratory tract infection"[All Fields] OR "RTI"[All Fields] OR "RTIs"[All Fields] OR ("pharyngitis"[MeSH Terms] OR "pharyngitis"[All Fields] OR ("sore"[All Fields] AND "throat"[All Fields]) OR "sore throat"[All Fields]) OR ("pharyngitis"[MeSH Terms] OR "pharyngitis"[All Fields] OR

"pharyngitides"[All Fields]) OR ("cough"[MeSH Terms] OR "cough"[All Fields] OR "coughing"[All Fields] OR "coughs"[All Fields] OR "coughed"[All Fields]) OR ("paranasal sinuses"[MeSH Terms] OR ("paranasal"[All Fields] AND "sinuses"[All Fields]) OR "paranasal sinuses"[All Fields] OR "sinuses"[All Fields] OR "sinusal"[All Fields] OR "sinuse"[All Fields] OR "sinusitis"[MeSH Terms] OR "sinusitis"[All Fields] OR "sinusitides"[All Fields]) OR ("common cold"[MeSH Terms] OR ("common"[All Fields] AND "cold"[All Fields]) OR "common cold"[All Fields] OR "cold"[All Fields] OR "cold temperature"[MeSH Terms] OR ("cold"[All Fields] AND "temperature"[All Fields]) OR "cold temperature"[All Fields]) OR ("pneumonia"[MeSH Terms] OR "pneumonia"[All Fields] OR "pneumonias"[All Fields] OR "pneumoniae"[All Fields] OR "pneumoniae s"[All Fields]) OR ("palatine tonsil"[MeSH Terms] OR ("palatine"[All Fields] AND "tonsil"[All Fields]) OR "palatine tonsil"[All Fields] OR "tonsil"[All Fields] OR "tonsils"[All Fields] OR "tonsilitis"[All Fields] OR "tonsillitis"[MeSH Terms] OR "tonsillitis"[All Fields] OR "tonsillitides"[All Fields] OR "tonsills"[All Fields]) OR ("bronchitis"[MeSH Terms] OR "bronchitis"[All Fields] OR "bronchitides"[All Fields]) OR ("bronchiolitis"[MeSH Terms] OR "bronchiolitis"[All Fields] OR "bronchiolitides"[All Fields]) OR ("pharyngitis"[MeSH Terms] OR "pharyngitis"[All Fields] OR ("throat"[All Fields] AND "infection"[All Fields]) OR "throat infection"[All Fields]) OR (("paranasal sinuses"[MeSH Terms] OR ("paranasal"[All Fields] AND "sinuses"[All Fields]) OR "paranasal sinuses"[All Fields] OR "sinuses"[All Fields] OR "sinusal"[All Fields] OR "sinuse"[All Fields] OR "sinusitis"[MeSH Terms] OR "sinusitis"[All Fields] OR "sinusitides"[All Fields]) AND ("infect"[All Fields] OR "infectability"[All Fields] OR "infectable"[All Fields] OR "infectant"[All Fields] OR "infectants"[All Fields] OR "infected"[All Fields] OR "infecteds"[All Fields] OR "infectibility"[All Fields] OR "infectible"[All Fields] OR "infecting"[All Fields] OR "infection s"[All Fields] OR "infections"[MeSH Terms] OR "infections"[All Fields] OR "infection"[All Fields] OR "infective"[All Fields] OR "infectiveness"[All Fields] OR "infectives"[All Fields] OR "infectivities"[All Fields] OR "infects"[All Fields] OR "pathogenicity"[MeSH Subheading] OR "pathogenicity"[All Fields] OR "infectivity"[All Fields])) OR ("influenza s"[All Fields] OR "influenza, human"[MeSH Terms] OR ("influenza"[All Fields] AND "human"[All Fields]) OR "human influenza"[All Fields] OR "influenza"[All Fields] OR "influenzas"[All Fields] OR "influenzae"[All Fields]))) AND (2010/1/1:2022/12/31[pdat])

3. **Emcare**

('community pharmacies' OR 'community pharmacist' OR community pharmacy) AND ('point-of-care testing' OR ‘point-of-care test’ OR ‘point of care test’ OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR ‘Group A streptococcal’ OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR ‘antibiotic stewardship’ OR ‘antimicrobial stewardship’) AND (‘respiratory tract infection’ OR RTI OR RTIs OR ‘sore throat’ OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsilitis OR bronchitis OR bronchiolitis OR ‘throat infection’ OR ‘sinuses infection’) {Including Related Terms}[2012-2022]

4. Cochrane Central Register of Controlled Trials

11 Trials matching ('community pharmacies' OR 'community pharmacist*' OR community pharmacy) AND ('point-of-care testing' OR ‘point-of-care test’ OR ‘point of care test’ OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR ‘Group A streptococcal’ OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR ‘antibiotic stewardship’ OR ‘antimicrobial stewardship’) AND (‘respiratory tract infection’ OR RTI OR RTIs OR ‘sore throat’ OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR ‘throat infection’ OR ‘sinuses infection’ OR influenza) in Title Abstract Keyword - with Publication Year from 2012 to 2022, in Trials (Word variations have been searched)
Cochrane Central Register of Controlled Trials
Issue 12 of 12, December 2022

5. Health Technology Assessment

(('community pharmacies' OR 'community pharmacist*' OR community pharmacy) AND ('point-of-care testing' OR 'point-of-care test' OR 'point of care test' OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR 'Group A streptococcal' OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship' OR 'antimicrobial stewardship') AND ('respiratory tract infection' OR RTI OR RTIs OR 'sore throat' OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR 'throat infection' OR 'sinuses infection' OR influenza)) FROM 2012 TO 2022

6. Google Scholar

('community pharmacies' OR 'community pharmacist*' OR community pharmacy) AND ('point-of-care testing' OR 'point-of-care test' OR 'point of care test' OR 'rapid antigen test' OR 'C-reactive protein' OR 'diagnostic test' OR CRP OR RADT OR POCT OR 'Group A streptococcal' OR GAS) AND (antibiotic OR antibiotics OR antimicrobial OR antimicrobials OR 'antibiotic prescribing' OR 'antimicrobial prescribing' OR 'antibiotic use' OR 'antimicrobial use' OR 'antibiotic stewardship' OR 'antimicrobial stewardship') AND ('respiratory tract infection' OR RTI OR RTIs OR 'sore throat' OR pharyngitis OR cough OR sinusitis OR cold OR pneumonia OR tonsillitis OR bronchitis OR bronchiolitis OR 'throat infection' OR 'sinuses infection' OR influenza) 2012-2022.

First 250 articles coming from the search will be considered for screening titles and abstracts