

BMJ Open Outcomes to evaluate care for adults with acute dental pain and infection: a systematic narrative review

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ABSTRACT

Objective To identify outcomes reported in peer-reviewed literature for evaluating the care of adults with acute dental pain or infection.

Design

Systematic narrative review.

Setting/participants Primary research studies published in peer-reviewed literature and reporting care for adults with acute dental pain or infection across healthcare settings. Reports not in English language were excluded.

Study selection Seven databases (CINAHL Plus, Dentistry and Oral Sciences Source, EMBASE, MEDLINE, PsycINFO, Scopus, Web of Science) were searched from inception to December 2020. Risk of bias assessment used the Critical Appraisal Skills Programme checklist for randomised controlled trials and Quality Assessment Tool for Studies of Diverse Design for other study types.

Outcomes Narrative synthesis included all outcomes of care for adults with acute dental pain or infection. Excluded were outcomes about pain management to facilitate treatment, prophylaxis of postsurgical pain/infection or traumatic injuries.

Results Searches identified 19 438 records, and 27 studies (dating from 1993 to 2020) were selected for inclusion. Across dental, pharmacy, hospital emergency and rural clinic settings, the studies were undertaken in high-income (n=20) and low/middle-income (n=7) countries. Two clinical outcome categories were identified: signs and symptoms of pain/infection and complications following treatment (including adverse drug reactions and reattendance for the same problem). Patient-reported outcomes included satisfaction with the care. Data collection methods included patient diaries, interviews and in-person reviews.

Discussion A heterogeneous range of study types and qualities were included: one study, published in 1947, was excluded only due to lacking outcome details. Studies from dentistry reported just clinical outcomes; across wider healthcare more outcomes were included.

Conclusions A combination of clinical and patient-reported outcomes are recommended to evaluate care for adults with acute dental pain or infection. Further research is recommended to develop core outcomes aligned with the international consensus on oral health outcomes.

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INTRODUCTION

Acute dental pain has a significant impact on quality of life.^{1 2} Timely intervention for the

Strengths and limitations of this study

- The first systematic review to examine outcome measures of care for adults with acute dental pain or infection across healthcare settings.
- The outcomes will be important for evaluating new dental antibiotic and opioid stewardship interventions, as these drugs are frequently overprescribed for adults with acute dental pain and infection, exacerbated by the COVID-19 pandemic.
- Studies about paediatric patients, studies about the postoperative management of pain, studies about local anaesthesia to facilitate dental treatment, studies about traumatic injuries and papers not in English language were excluded due to key differences in clinical management.
- Two independent reviewers extracted data and two different reviewers assessed the quality using either the Critical Appraisal Skills Programme (for the randomised controlled trials) or the Quality Assessment Tool for Studies with Diverse Designs.
- Reporting based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines, with searches of seven major electronic databases from their inception to December 2020.

relief of dental pain and infection is essential to prevent worsening of ill health and reduce the risk of potentially life-threatening complications, such as sepsis, airway occlusion or analgesic overdose.^{3 4} Failure of initial treatment to relieve dental pain and infection can result in patient reattending for further treatment, including to emergency medical care.⁵ Thus, ensuring high-quality care for people with acute dental problems is critical for both patient safety and service efficiency. Outcomes to evaluate the care provided for people with acute dental pain and/or infection are important.

Evidence-based clinical guidelines can improve the provision of quality healthcare and patient outcomes.⁶ Guidelines for treating acute dental pain and infection are generally based on the principle that operative dental procedures (such as removal of

a tooth or its pulp) are indicated to address the cause and prevent symptoms recurring.⁷ Drugs such as analgesics and antibiotics have a limited role in dentistry and should usually only be used in addition to dental procedures.^{8,9} Suboptimal treatment of dental pain and infection with drug prescriptions instead of dental procedures is common, including by general medical practitioners and in emergency departments.^{10–12} The contribution of dentistry to global efforts to tackle antibiotic resistance¹³ and opioid substance misuse disorder has been highlighted, with a call for the profession to improve its approach to stewardship of these drugs.^{7,14,15}

While a plethora of drug trials for the treatment of dental pain or infection have been published, there is little research on patient outcomes following urgent dental care for acute dental pain or infection.⁵ A rise in the number of trials to evaluate dental antibiotic stewardship and opioid stewardship interventions is anticipated, with a focus on optimising care and judicious use of medicines for adults (where more than 90% of dental prescribing occurs).¹⁶ To evaluate the effectiveness of these sorts of interventions and to enable improvements in the quality of urgent dental care, this study aimed to identify outcomes from the peer-reviewed literature for evaluating care for adults with acute dental pain and/or infection.

Objectives

The research question was ‘What measures in the published literature have been employed to evaluate the outcome of care for adults with acute dental pain and/or infection?’

METHODS

Patient and public involvement

A coproduction team designed and delivered this systematic narrative review. Experts by experience (patients) of urgent dental care and/or complications of dental antibiotics (CC and CP) and academic dental professionals (LT, SH and WT) were involved in all stages of this study, from refining the research question and search terms which had been drafted by WT through to disseminating the results. Through discussion between the members of the coproduction team, involvement with each step of the review was allocated according to the skills they wished to develop and the time they had available to contribute at the relevant stages. Individual contributions are indicated in the following sections.

Eligibility criteria

Primary research studies published in peer-reviewed journals were included if they reported outcomes of care for adults (aged over 18 years) treated for acute dental pain and/or infection with advice, prescriptions, or interventions (such as dental extraction). There was no restriction on the year of dissemination.

Studies which included care for children or for people with other oral or dental conditions (such as cervicofacial infections treated as hospital inpatients or postsurgical pain control) were excluded. Studies of urgent dental care for traumatic injuries were excluded as this is a markedly different population and the subject of a separate study.¹⁷ Reports which did not include the outcomes of care provided (or details of how those outcomes were measured) were also excluded, such as studies about the efficacy of local anaesthesia to facilitate the provision of dental procedures at point of care. Primary research studies not published in peer reviewed journals (such as conference abstracts, case studies and other grey literature) were excluded as the research was seeking tried and tested outcomes for use in clinical trials. Studies not in the English language were excluded due to lack of translation facilities. Full details of the inclusion/exclusion criteria are detailed in online supplemental table 1.

Population groups identified for subgroup analysis during the synthesis phase were dental vs other health-care settings, and high-income versus low-income and middle-income countries (LMICs).

Information sources

On 29 November 2020, seven databases were searched from their earliest dates: CINAHL Plus, Dentistry and Oral Sciences Source, Ovid EMBASE, Ovid Medline, PyscINFO, Scopus and Web of Science.

Search strategy

The search strategy used to identify relevant papers from the database searches was developed in consultation with an information specialist at the University of Manchester. It consisted of ‘population’ AND ‘intervention’ terms. Population terms were: (Acute* OR Urgent OR Unschedule* OR Emergenc*) AND (Dental* OR Odontogenic OR Dentoalveolar) AND (Pain OR Toothache OR Pulpitis OR Infection OR Swell* OR Abscess OR Pericoronitis OR Osteitis OR Socket OR Periodontitis OR Implantitis OR Ulcer* OR Stomatitis). Intervention terms were: Patient Care OR Dental Care OR Procedure OR Treat* OR Endodont* OR Exodont* OR Extract* OR Extirpat* OR Incis* OR Drain* OR Debrid* OR Irrigat* OR Prescri* OR Antibiotic* OR Antimicrob* OR Antiseptic OR Analgesi* OR Advice OR Refer*. Full details of the search terms and limits employed with each database are detailed in online supplemental table 2).

Limits included: ‘human’ as animal and laboratory studies were not eligible for the review, and ‘English language’ as justified in the ‘eligibility criteria’ section. There were no limits on the date of included studies.

Selection process

Titles and abstracts from the database searches (undertaken by WT) were transferred into Endnote V.X9 where duplicates were removed (by WT) and the title/abstracts were screened (independently by WT and SH) for potential inclusion. Full texts of all shortlisted studies were

assessed for eligibility (independently by WT and LT). Where necessary, corresponding authors were contacted to confirm whether the included population met our inclusion criteria. Disagreements at each stage of the process were resolved through discussion between the screeners.

Data collection process

The characteristics (study type, objective and population) and outcomes, data source (patient-reported, clinician observed or administrative system) and data collection instrument were collected from each report by two reviewers (LT and SH) working independently. Disagreements at each stage of the process were resolved through discussion between the reviewers.

Data items: outcomes and other variables

All outcomes relating to the outcomes of care provided to adults with acute dental pain or infection were sought, together with details about the sources of data and timescales between urgent dental treatment received by the participants and completion of data collection. In addition, specific details about the types of studies (eg, randomised controlled trial (RCT) or questionnaire study) and population were sought, including age range of patients, type of healthcare setting (such as dental clinic or pharmacy), country in which the study took place, and whether a high-income or LMIC (based on World Bank definitions).¹⁸ Details about study type, patient age, healthcare setting and country for each included study are provided in [table 1](#), details about which countries were LMICs are highlighted (in bold) in [table 2](#). There was no restriction on time frames for the outcomes and where missing data was identified this was recorded in the results tables. Where necessary, corresponding authors were contacted to provide details relating to the data items sought (such as the age of participants).

Quality assessment

The shortlisted studies were assessed using the Critical Appraisal Skills Programme (CASP) Checklist for RCTs.¹⁹ For studies which used a design not valid for an RCT (as assessed via the CASP RCT checklist), the Quality Assessment Tool for Studies with Diverse Design (QATSDD) was used.²⁰ Quality assessment of all studies was undertaken by WT, with 30% of studies (selected at random from across the CASP and QATSDD sets) independently assessed by CP. Discrepancies in relation to each element of the assessment framework were resolved through discussion between the assessors and, where differences were just one point, the scores were averaged.

Synthesis methods

All studies which had been selected for inclusion and which had passed the quality assessment were eligible for inclusion in synthesis. Outcome data collected were initially categorised by WT based on a framework advocated for antimicrobial stewardship interventions²¹ as the outcomes identified in this study were

intended to be employed in trials of stewardship interventions. All authors of the paper discussed and agreed adjustments to the category titles, which aligned the language with that used in a recently published international consensus of oral health outcomes.²²

The tabular structure displays a summary of outcomes for each study, using the structure identified. [Table 2](#) presents clinical outcomes ('signs/symptoms of dental pain or infection' and 'complications or harm') and patient-reported outcomes ('satisfaction with the outcome of care' and 'other') for each study with details of how the outcome was measured (such as numeric pain scale). Sources of data employed in each study and the timescales between treatment provided to participants and completion of data collection are presented in [table 3](#).

RESULTS

Study selection

Of the 19 438 records identified from database searches, 27 studies were selected for inclusion (see [figure 1](#)). One study, published in 1947, was excluded as it was impossible to tell how the outcomes had been measured.²³ Another study²⁴ which may look like it should be included was excluded as it reported secondary analysis of data collected in other studies.^{25 26}

Study characteristics

The included studies dated between 1993 and 2020 and encompassed a heterogeneous range of designs, from RCTs to questionnaire surveys. Most studies (n=23) took place in dental settings, one was in a hospital emergency department, another in a rural community healthcare clinic and a third was in community pharmacy; the setting for one study was unclear. The earliest 14 studies all took place in high income countries (during the period 1993–2012). Of the 13 studies which took place between 2013 and 2020, seven were based in LMICs (Brazil, Egypt, India, Tanzania and Turkey). Further characteristics of the included studies, including their objectives, are presented in [table 1](#).

Quality assessment

Following application of the inclusion/exclusion criteria, 11 studies were quality assessed using the CASP framework for RCTs (see online supplemental table 3) and 16 using the QATSDD tool (see online supplemental table 4). Many of the studies assessed using the QATSDD criteria scored poorly, for example, due to failure to justify the sample size or provision of a rationale for the analytic method used, and few studies covered the QATSDD criterion about patients being involvement in the study design.

Results of individual studies

The outcomes recorded in each individual study are presented in [table 2](#), including details about how they were measured. Two categories of clinical outcomes and one of patient-report outcomes were identified. Clinical

Table 1 Characteristics of included studies

Study	Study type	Objective	Population* (patient age, setting, country)
Fazakerley <i>et al</i> , 1993 ⁴⁶	Comparative double-blind trial.	To evaluate the efficacy of cephadrine, amoxicillin and phenoxymethylpenicillin in the treatment of dentoalveolar infections.	18–65 years. University dental clinic, UK.
Gibson <i>et al</i> , 1993 ⁴⁷	Prospective survey.	To investigate the success of treatment in resolving the chief complaint of pain and to determine the compliance with further dental care for the original dental problem.	18 years or older. University dental clinic, Canada.
Fouad <i>et al</i> , 1996 ⁴⁸	Double-blind, placebo-controlled clinical trial.	To examine the effect of penicillin on the reduction of symptoms and the course of recovery of the localised acute apical abscess after emergency endodontic treatment.	18 years or older. University dental clinic, USA.
Penniston and Hargreaves, 1996 ⁴⁹	Prospective, randomised, double-blind, placebo-controlled clinical trial.	To compare the analgesic efficacy of ketorolac tromethamine following intraoral periapical infiltration injection or intramuscular injection of the drug.	18–65 years. University dental clinic, USA.
Adriaenssen, 1998 ⁵⁰	Open, randomised, multicentre comparative study.	Comparison of the efficacy, safety and tolerability of azithromycin and co-amoxiclav in the treatment of acute periapical abscesses.	18–75 years. Dental practices, Belgium
Doroschak <i>et al</i> , 1999 ⁵¹	Randomised, double-blind, placebo-controlled study.	To determine if a combination of a Non-Steroidal Anti-Inflammatory Drug (NSAID) and an opioid provide greater pain relief than either drug alone.	18–65 years. University dental clinic, US
Gallatin <i>et al</i> , 2000 ⁵²	Prospective, double-blind, randomised study.	To evaluate pain reduction in untreated irreversible pulpitis using an intraosseous injection of Depo-Medrol.	18 years or older. University dental clinic, USA.
Houck <i>et al</i> , 2000 ²⁵	Prospective, randomised blinded study.	To evaluate postoperative pain and swelling after performing a trephination procedure in symptomatic necrotic teeth with radiolucencies.	Adults*. University dental clinic, USA.
Nagle <i>et al</i> , 2000 ⁵³	Prospective, randomised, double-blind study.	To determine the effect of penicillin on pain in untreated teeth diagnosed with irreversible pulpitis.	Adults*. University dental clinic, USA.
Henry <i>et al</i> , 2001 ²⁶	Prospective, randomised, double-blind, placebo-controlled study.	To determine the effect of penicillin on postoperative pain and swelling in symptomatic necrotic teeth.	18 years or older. University dental clinic, USA.
Hersh <i>et al</i> , 2003 ⁵⁴	Randomised, double-blind, placebo-controlled clinical trial.	Efficacy and safety of a benzocaine intraoral patch in patients presenting with spontaneous toothache pain	18–65 years. University dental clinic, USA.
Runyon <i>et al</i> , 2004 ⁵⁵	Prospective, randomised, double-blind, placebo-controlled trial.	To determine if penicillin is necessary or beneficial in the treatment of undifferentiated dental pain without overt infection.	18 years or older. Emergency department, USA.
Campanelli <i>et al</i> , 2008 ⁵⁶	Clinical study.	To record the objective and subjective systemic signs of emergency patients presenting with pulp necrosis and localised acute apical abscess.	18 years or older. University dental clinic, USA.
Cohen <i>et al</i> , 2009 ²⁸	Cross-sectional survey.	The pharmacist's role in managing toothache pain from the perspective of the patient.	21 years or older. Community pharmacy, USA.
Wilson <i>et al</i> , 2013 ²⁷	Retrospective questionnaire survey.	To record the levels of patient satisfaction with oral urgent treatment and to highlight areas for improvement in both training and service provision.	18 years or older. Rural community clinic*, Tanzania
Sethi <i>et al</i> , 2014 ⁵⁷	Randomised clinical trial.	To compare and evaluate the effect of an oral dose of 100 mg tapentadol, 400 mg etodolac or 10 mg ketorolac as a pretreatment analgesic for the prevention and control of postoperative endodontic pain in patients with irreversible pulpitis.	18–60 years. Dental college clinic, India.
Pavithra <i>et al</i> , 2015 ⁵⁸	Randomised double blind trial.	To compare and evaluate analgesic effectiveness of Ibuprofen and Aceclofenac in management of acute irreversible pulpitis.	20–50 years. Dental college clinic, India.
Bultema <i>et al</i> , 2016 ⁵⁹	Prospective, double-blind randomised trial.	To compare liposomal bupivacaine versus bupivacaine for pain control in untreated, symptomatic irreversible pulpitis.	18 years or older. University dental clinic, USA.

Continued

Table 1 Continued

Study	Study type	Objective	Population* (patient age, setting, country)
Sebastian <i>et al</i> , 2016 ⁶⁰	Prospective, randomised study.	To compare debridement vs no debridement on postoperative pain in emergency patients with symptomatic pulpal necrosis, and apical radiolucency.	18 years or older. University dental clinic, USA.
Santini <i>et al</i> , 2017 ⁶¹	Double-blind, controlled parallel design.	To compare the overall analgesic effectiveness of two combinations of opioid and non-opioid analgesics for acute periradicular abscess.	Over 18 years. Dental hospital, Brazil
Taggar <i>et al</i> , 2017 ⁶²	Randomised, double-masked, controlled, parallel-group trial.	To compare the analgesic effect of a single dose of ibuprofen sodium dihydrate with that of a comparable dose of ibuprofen acid in endodontic pain patients presenting with moderate to severe pain.	18–60 years. (Setting unclear), USA.
Aaron and Steier, 2018 ⁶³	Single-centre prospective clinical Study.	To determine if dentists are successful in reducing pain caused by acute apical abscess in a National Health Service emergency setting and if different treatment strategies result in different levels of pain reduction.	20–68 years. Primary care dental clinic, UK.
Beus <i>et al</i> , 2018 ²⁹	Prospective, randomised, single-blind study.	To compare the postoperative course of incision and drain with drain placement versus mock incision and drainage procedure with mock drain placement after endodontic debridement in swollen emergency patients.	18 years or older. University dental clinic, USA.
Eren <i>et al</i> , 2018 ⁶⁴	Single-blinded, single-centre, randomised controlled trial.	To evaluate three emergency procedures for their ability to alleviate clinical symptoms associated with symptomatic teeth having signs of (at least) partial irreversible pulpitis.	18–60 years. University dental clinic, Turkey.
Wolf <i>et al</i> , 2019 ⁶⁵	Prospective randomised study.	To compare the outcomes of two emergency treatment procedures to alleviate pain from localised symptomatic apical periodontitis.	18 years or older. University dental clinic, Sweden.
Al-Rawhani <i>et al</i> , 2020 ⁶⁶	Randomised placebo-controlled double-blind trial.	To evaluate the effect of preoperative administration of a single, oral dose of 50 mg diclofenac on postoperative pain in patients with symptomatic irreversible pulpitis.	18 years or older. University dental clinic, Egypt.
da Silva <i>et al</i> , 2020 ⁶⁷	Double-blind, randomised clinical trial.	To compare the acetaminophen administration efficacy or its combination with codeine for pain control in acute apical abscesses cases.	18 years or older. University dental clinic, Brazil.

*Where not specified in the paper, authors were contacted to confirm participants were all aged >18 years and care was for only people with acute dental pain or infection.

outcomes included: 'signs and symptoms of dental pain/infection', and 'complications or other harm' resulting from treatment or disease progression. Patient-reported outcomes included patient satisfaction with the outcome of care.

As also shown in table 2, various approaches were used for measuring the clinical outcomes, including unidimensional pain scales (such as a Visual Analogue Scale (VAS) or category pain scale), amount of rescue medication taken, and the presence of absence of various signs and symptoms such as swelling, trismus or fever. Complications were assessed by recording whether unplanned visits had been required or whether the patient had experienced symptoms of drug allergy or other adverse effects (such as gastrointestinal symptoms and headaches).

Details about data sources for the outcomes and duration of data collection in each study are presented in table 3. Most of the outcomes were reported by patients (n=20) through diaries, questionnaires or interviews. A minority of studies (n=7) employed clinical observations from in person monitoring or review during or after their treatment appointment. None of the studies used a combination of patient-reported and clinician observed data. No studies employed data from healthcare administrative

systems. Data collection in most studies took place over less than a week (n=17). In six studies, the duration of data collection was 1 week, and two of the remaining four studies data collection completed 1 year after the participant received urgent dental treatment.

Results of syntheses

Pain was the most commonly reported sign/symptom (see table 2), including unstimulated/spontaneous pain (n=24), pain stimulated by percussion, chewing or thermal stimulus (n=7) or the need for additional pain relief through use of rescue medication (n=14). Complications or other harm related to the treatment provided included adverse outcomes (such as drug allergy or nausea) and progression of the acute dental condition requiring unplanned visits for additional treatment. Patient satisfaction was only recorded in studies in non-dental healthcare settings^{27 28} and only one dental study included patient-reported outcomes.²⁹

Comparing results between high-income countries and LMICs found just one difference in the outcomes reported: none of the studies undertaken in LMICs reported on swelling as a sign of infection, compared with 35% (n=7/20) of studies undertaken in high-income

Table 2 Outcome measures employed in each included study

	Signs/symptoms of dental pain or infection					Complications or harm		Patient-reported outcomes		
	Pain intensity – unstimulated	Pain intensity – stimulated	Pain Reduction	Rescue pain relief taken	Swelling	Other signs/symptoms	Adverse drug reaction	Unplanned visits	Satisfaction	Other
Fazakerley <i>et al</i> , 1993 ⁴⁶	VAS				Numeric scale	Temperature, Lymphadenopathy				
Gibson <i>et al</i> , 1993 ⁴⁷	Yes/no			Yes/No				Yes/No		
Fouad <i>et al</i> , 1996 ⁴⁸	VAS			Amount	Category scale	Fever, Trismus or Swallowing difficulty	Allergy GI Tract	Yes/No		
Penniston and Hargreaves, 1996 ⁴⁹	VAS, HP-VAS and Category Scale						Injection pain			
Adriaenssen, 1998 ⁵⁰	Category scale	Category scale			Yes/No	Gingival redness, Bone loss	Headache			
Doroschak <i>et al</i> , 1999 ⁵¹	VAS, HP-VAS and Category Scale						GI tract Headache Euphoria Sedation			
Gallatin <i>et al</i> , 2000 ⁵²	Category scale	Category scale		Amount						
Houck <i>et al</i> , 2000 ²⁵	Numeric scale	Numeric scale		Amount & type	Numeric scale					
Nagle <i>et al</i> , 2000 ⁵³	Numeric scale	Numeric scale		Amount						
Henry <i>et al</i> , 2001 ²⁶	Numeric scale	Numeric scale		Amount and type	Numeric scale					
Hersh <i>et al</i> , 2003 ⁵⁴			Verbal pain relief scale							
Runyon <i>et al</i> , 2004 ^{55*}	VAS				Yes/No	Temperature, Purulence, Trismus				
Campanelli <i>et al</i> , 2008 ⁵⁶	VAS					Malaise				
Cohen <i>et al</i> , 2009 ^{28*}									Category scale	
Wilson <i>et al</i> , 2013 ^{27*}			Category scale						Category scale	Cost of care
Sethi <i>et al</i> , 2014 ⁵⁷	VAS						GI Tract Dizziness Headache Heartburn			

Continued

Table 2 Continued

	Signs/symptoms of dental pain or infection				Complications or harm			Patient-reported outcomes	
	Pain intensity—unstimulated	Pain intensity—stimulated	Pain Reduction	Rescue pain relief taken	Swelling	Other signs/symptoms	Adverse drug reaction	Unplanned visits	Satisfaction Other
Pavithra <i>et al</i> , 2015 ⁵⁸	VAS								
Bultema <i>et al</i> , 2016 ⁵⁹	VAS			Delayed prescription			Numbness	Yes/No	
Sebastian <i>et al</i> , HP-VAS 2016 ⁶⁰				Delayed prescription					
Santini <i>et al</i> , 2017 ⁶¹	VAS			Yes/No			GI Tract Dizziness Drowsiness Headache		
Taggar <i>et al</i> , 2017 ⁶²	VAS								
Aaron and Steier, 2018 ⁶³	Modified pain quality assessment scale								
Beus <i>et al</i> , 2018 ²⁹	HP-VAS								Patient perception: 'feeling better'
Eren <i>et al</i> , 2018 ⁶⁴	VAS								
Wolf <i>et al</i> , 2019 ⁶⁵	Numeric scale								
Al-Rawhani <i>et al</i> , 2020 ⁶⁶	HP-VAS								
da Silva <i>et al</i> , 2020 ⁶⁷	VAS								

*Study undertaken in non-dental setting.
GI, gastrointestinal; HP-VAS, Heft Parker Visual Analogue Scale.

Table 3 Data sources and data collection periods

	Patient reported		Clinician observed	
	Patient diary	Questionnaires or interviews	In-person review	In-person monitoring
Fazakerley <i>et al</i> , 1993 ⁴⁶			5 days	
Gibson <i>et al</i> , 1993 ⁴⁷		2 days		
Fouad <i>et al</i> , 1996 ⁴⁸	3 days			
Penniston and Hargreaves, 1996 ⁴⁹	6 hours			
Adriaenssen, 1998 ⁵⁰			10 days	
Doroschak <i>et al</i> , 1999 ⁵¹	1 day			
Gallatin <i>et al</i> , 2000 ⁵²	1 week			
Houck <i>et al</i> , 2000 ²⁵	1 week			
Nagle <i>et al</i> , 2000 ⁵³	1 week			
Henry <i>et al</i> , 2001 ²⁶	1 week			
Hersh <i>et al</i> , 2003 ⁵⁴				90 min
Runyon <i>et al</i> , 2004 ⁵⁵			1 week	
Campanelli <i>et al</i> , 2008 ⁵⁶			2 weeks	
Cohen <i>et al</i> , 2009 ²⁸		1 year		
Wilson <i>et al</i>, 2013²⁷		1 year*		
Sethi <i>et al</i>, 2014⁵⁷	1 day			
Pavithra <i>et al</i>, 2015⁵⁸		45 min		
Bultema <i>et al</i> , 2016 ⁵⁹	3 days			
Sebastian <i>et al</i> , 2016 ⁶⁰	5 days			
Santini <i>et al</i> 2017⁶¹	3 days			
Taggar <i>et al</i> , 2017 ⁶²				1 hour
Aaron <i>et al</i> , 2018 ⁶³		1 day		
Beus <i>et al</i> , 2018 ²⁹	4 days			
Eren <i>et al</i>, 2018⁶⁴	1 week			
Wolf <i>et al</i> , 2019 ⁶⁵		5 days		
Al-Rawhani <i>et al</i>, 2020⁶⁶	2 days			
da Silva <i>et al</i>, 2020⁶⁷	3 days			

Studies highlighted in bold are those undertaken in LMICs.

*Where not specified in the paper, authors were contacted to confirm the timescales.

LMICs, low-income and middle-income countries.

countries. There was also one difference found in data sources for the outcomes: none of the LMIC-based studies recorded clinician observed outcomes compared with 30% (n=6/20) of studies in high-income countries. No differences were found in data collection periods.

DISCUSSION

A diverse range of measures were identified to assess the outcomes of care for adults presenting with acute dental pain and/or infection across a range of healthcare settings in high income and LMICs. Most were clinical outcomes, such as signs and symptoms of pain and infection and complications or other harms following treatment (such as drug allergy). Patient-reported outcomes relating to satisfaction were only used in studies from

non-dental settings. The range of outcomes and data collection periods were similar between high income countries and LMICs. Just one key difference was noted in their assessment: none of the LMIC studies reported clinician-observed data. This is the first study to focus comprehensively on outcomes relating to acute dental conditions and a lack of consensus in outcomes reported across the studies was found.

Due to the heterogeneous range of studies identified for inclusion, a systematic narrative review was selected to enable synthesis of the results. This type of review is, however, more subjective, and open to potential bias than conventional systematic reviews. Core outcome sets (COS) can improve consistency in reporting and maximise the value derivable from studies.³⁰ Further research

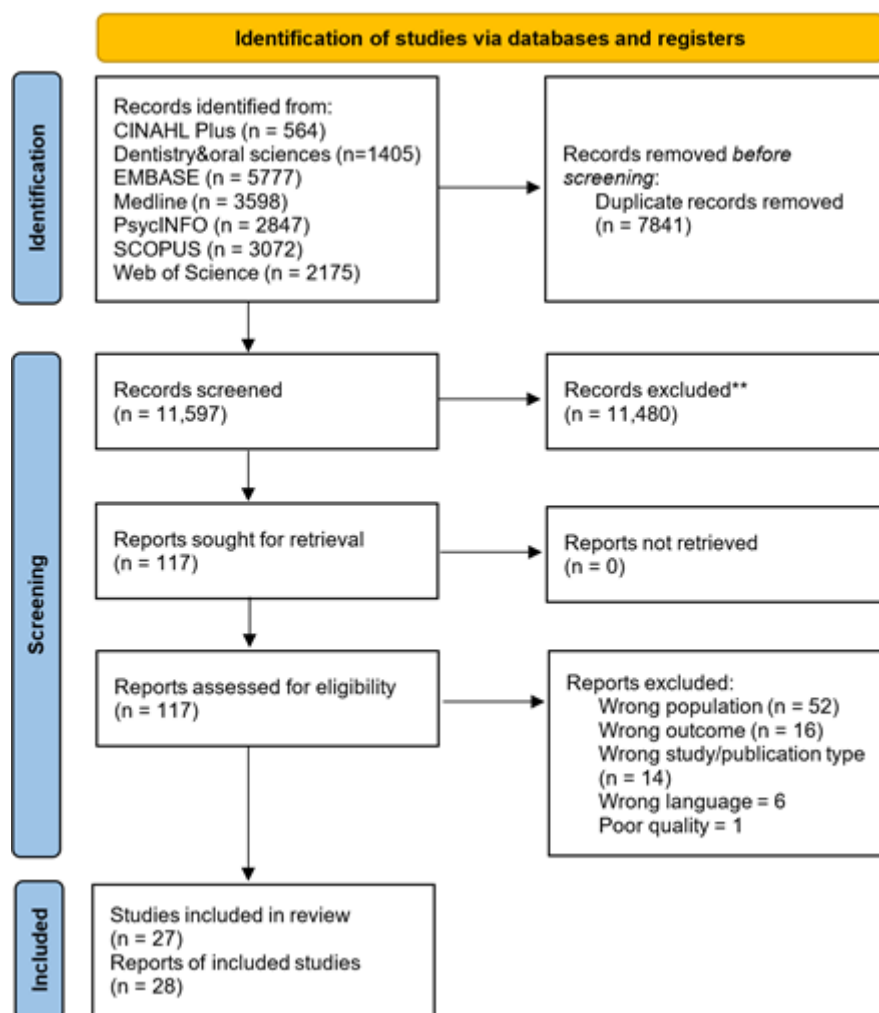


Figure 1 PRISMA flow chart detailing selection of the included studies. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

is indicated to develop a COS relating to the care of people presenting with acute dental pain or infection across healthcare settings internationally. Given the high rates of inappropriate antibiotic prescribing for people with acute dental conditions^{16 31} and the increasing recognition of the important contribution dentistry can make to global efforts to tackle antibiotic resistance,⁷ this COS will be particularly important.

Measuring what matters to patients has been recognised as central to improving patient care and service delivery, with patients needing to be involved in decisions about what to measure.³² For this reason, experts by experience of urgent dental care were key members of our coproduction team, including when devising the review's search strategy. Funding to reimburse their time for participating in the length process of a systematic review was welcomed by the experts by experience.

The range of healthcare settings included in this review (dental clinics, pharmacies, hospital emergency departments and community clinics) mean the findings of this study are widely generalisable and can be easily translated to different healthcare settings around the world. Even though limited to English language, studies from a

wide range of countries were included, across both high-income countries and LMICs. Six papers were excluded due to language (including 50% in Japanese) which may have introduced additional outcomes and differences in cultural practices.

Restricting this paper to published studies relating to adults from the peer-reviewed literature means that additional measures in the grey literature may have been missed as well as meaning that it fails to conform completely to the new Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines for systematic reviews which were published during the course of our study.³³ The authors decided additional searches of the grey literature would not, however, meet the research questions or their intention to identify outcomes which had been successfully tried and tested. Studies including children were excluded from this review as the outcomes (especially patient-reported outcomes) are materially different.³⁴ Further, the trials for which these outcomes will be used by the authors relate to dental antibiotic stewardship and opioid stewardship for adult patients, which is the patient group where most overprescribing of these drugs occurs.^{35 36}

The importance of valid, reliable and feasible measures for improving the quality of oral healthcare, including patient-reported outcomes and experience measures has been recognised.³⁷ In 2020, an international consensus of patient-centred outcomes to measure adult oral health (focusing on caries and periodontal disease) was published and highlighted that multiple measures are required to capture the effect of oral health on the individual patient.²² Where possible, we have adopted the terminology from this adult oral health standard set of outcomes when presenting our findings, such as ‘complications or other harm resulting from treatment or disease progression’ and ‘unplanned visits.’ However, while our findings cover some of the same territory, there are important differences in the detail especially relating to timescales. For example, there is no mention of ‘infection’ in the oral health outcomes and ‘dental pain’ covers only the frequency of pain in the last 6 months and ‘complications’ within 30 days, whereas our study found that these outcomes were measured in hours and days for people with acute dental conditions. Quality of life indicators such as the ability to eat, sleep, speak or carry out usual work activities at home and in the workplace (productivity) are outcomes from the standard oral health set which could be useful for studies of the outcome of care for people with acute dental pain and/or infection but which were not employed in any of the studies within our review.²²

Primary medical care and to a lesser extent primary dental care have been recent targets of global efforts to tackle antibiotic resistance through stewardship programmes by reducing unnecessary and inappropriate prescribing.^{38–39} A hybrid umbrella/systematic review of measures to evaluate the effectiveness of antibiotic stewardship programmes, in primary medical and dental care respectively, found similar outcomes to this present review, including drug allergy, re-consultation rates and patient satisfaction.⁴⁰ Notably, the study about antibiotic stewardship measures found dental studies focused only on antibiotic use and the authors concluded that a range of metrics encompassing the wider measures employed in studies of medical care, including patient-reported outcomes, should also be utilised in dentistry. Our findings reiterate this idea that a diverse range of outcomes should be used to evaluate care for people with acute dental conditions. Clinical outcomes such as signs and symptoms of pain and infection, and complications (including unplanned dental visits) should be employed in future studies, together with patient-reported measures such as satisfaction with the outcome of care.

Most studies in the review used unidimensional pain scales which are recognised to work well for acute pain: VAS, Heft-Parker scale, numeric rating scale and category pain scale.³⁴ Interestingly, none used the unidimensional pain scales based on images: Faces Pain Scale or Wong-Baker Faces Pain Scale.³⁴ Unsurprisingly none used the McGill Pain Scale or other multidimensional scales which are recognised to be more useful for chronic than acute

pain.³⁴ Future research to compare the utility of pain scales based on images with the other unidimensional pain scales for use in urgent dental care settings would be useful.

Dental antibiotic and opioid prescribing are recent priorities for clinicians and policymakers around the world, with overprescribing identified as a problem driving the development and spread of antibiotic resistance⁷ and substance misuse disorder,⁴¹ respectively. Prescribing rates and choices varying between countries, and solutions to tackle the problem of overprescribing need to be tailored to the local context.^{14,42} A recent pilot trial of a clinical decision prescribing tool and targeted education to improve dental antibiotic and opioid prescribing in Australia demonstrated a 41% reduction in antibiotic usage and 59% reduction in opioids.¹⁶ Clinical trials of antibiotic and opioid stewardship interventions are also planned in the UK⁴³ and USA.⁴⁴ Further research to develop a set of core outcomes for studies relating to the care of adults with acute dental pain and infection would be useful in the evaluation of stewardship interventions, to enable direct comparisons between stewardship interventions internationally.⁴⁵

Standardising the reporting of metrics will facilitate improvements in the quality of care for people with acute dental pain and/or infection. The outcomes identified in this study (both clinical and patient reported) should form the basis on which to build international consensus on a COS as these measures will be useful in research, clinical and public health settings. Future research should be directed towards development and utilisation of this outcome set across healthcare settings where people with acute dental pain and infection present for treatment.

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Supplemental Material

Table S1 – Inclusion/Exclusion Criteria

Inclusion criteria:

- Population:
 - Adults presenting with acute dental pain and/or infection
 - Any healthcare setting or service (not limited to dentistry)
- Intervention
 - Any care provided for the relief of acute dental pain or treatment of acute dental infection, including operative and pharmacological treatment and other non-pharmacological approaches (including advice only or referral to other services).
- Outcome
 - All outcomes measured and reported by the study which are related to the relief of acute dental pain or treatment of acute dental infection.
- Study/publication type
 - Primary research reported in peer reviewed journals
 - English language only

Exclusion criteria:

- Population
 - Animal studies
 - In-vitro / lab-based studies
 - People under the age of 18 years
 - People with other oral or dental conditions (eg emergency dental conditions such as cervico-facial infections requiring hospitalisation, dental trauma or haemorrhage following an extraction; oral cancer; or chronic conditions such as chronic facial pain, TMD or trigeminal neuralgia)
 - People attending for routine preventative care
 - People attending for postoperative pain following routine/scheduled dental care eg removal of third molars
 - People with unusual medical conditions eg glucose-6-dehydrogenase deficiency
 - Papers which include both adults and children
 - Papers which include non-acute as well as acute conditions
 - Paper which included non-dental as well as dental conditions
- Intervention
 - Approaches outside of conventional guidelines eg holistic or complementary therapies including acupuncture
- Outcomes
 - Outcomes which are not related to the relief of acute dental pain or treatment of acute dental infection.
 - Outcomes relating to local anaesthesia to enable treatment
- Study/publication type:
 - Systematic review
 - Guidelines and guideline development
 - Trial Protocol
 - Opinion piece/Commentary/Review articles/Case Reports/Letters
 - Qualitative studies
 - Studies if updates had subsequently been published
 - Manuscript not in English (e.g. abstract in English but not the rest)
 - No abstract available – or only an abstract available

Table S2 – Search terms for each database

Database	Population search terms	Boolean Operator	Intervention search terms	Limitations employed
CINAHL Plus (EBSCO Host)	((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or Implantitis or Ulcer* or Stomatitis))	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*)	English Language Academic Journals
Dentistry and Oral Science Sources (EBSCO Host)	((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or Implantitis or Ulcer* or Stomatitis))	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*)	English Language Academic Journals
EMBASE (Ovid Online)	((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or	English Language Human

	Implantitis or Ulcer* or Stomatitis)).mp		Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*).mp	
Medline (Ovid Online)	((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or Implantitis or Ulcer* or Stomatitis)).mp	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*).mp	English Language Human
PsychINFO (Ovid Online)	((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or Implantitis or Ulcer* or Stomatitis)).mp	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*).mp	English Language Human
Scopus	Search within article title, abstract, key words: '((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*)	Published Articles English Language Human

	Implantitis or Ulcer* or Stomatitis))’			
Web of Science	((Acute* or Urgent or Unschedul* or Emergenc*) AND (Dent* or Odontogenic or Dentoalveolar) AND (Pain or Toothache or Pulpitis or Infection or Swell* or Abscess or Pericoronitis or Osteitis or Socket or Periodontitis or Implantitis or Ulcer* or Stomatitis))	AND	(Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer* or Patient Care or Dental Care or Procedure or Treat* or Endodont* or Exodont* or Extract* or Extirpat* or Incis* or Drain* or Debrid* or Irrigat* or Prescri* or Antibiotic* or Antimicrob* or Antiseptic or Analgesi* or Advice or Refer*)	Articles English Language

Table S3 – Quality assessment of the studies using Critical Appraisal Skills Programme (CASP) Checklist for Randomised Controlled Trials

	a) Is the basic study design valid for an RCT?			b) Was the study methodologically sound?				c) What are the results?			d) Will the results help?		Overall Include?
	1. Clear research question?	2. Randomisation?	3. All participants accounted for?	4a. Participants blinded?	4b. Investigators blinded?	4c. Analysts blinded?	5. Study groups similar at the start?	6. Same treatment for each group?	7. Comprehensive reporting?	8. Benefits vs harms/costs?	9. Locally applicable?	10. Better than existing care?	
Fazakerley et al, 1993	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes
Fouad et al, 1996	Yes	Yes	Yes	Yes	Yes	Can't tell	Can't tell	Yes	Yes	Yes	Yes	Can't tell	Yes
Houck et al, 2000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nagle et al, 2000	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pavithra et al, 2015	Yes	Yes	Yes	Yes	Yes	No	Can't tell	Yes	No	Yes	Yes	Yes	Yes
Santini et al, 2017	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Can't tell	Can't tell	No	Can't tell	Yes
Beus et al, 2018	Yes	Yes	Yes	Yes	No	Can't tell	Yes	Yes	No	Yes	Yes	Can't tell	Yes
Eren et al, 2018	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wolf et al, 2019	Yes	Yes	Yes	Can't tell	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Al-Rawhani et al, 2020	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Yes
da Silva et al, 2020	Yes	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table S3 – Quality assessment of studies which were not randomised controlled trials, using the Quality Assessment Tool for Studies with Diverse Designs (QATSDD)

	Explicit theoretical framework	Aims in main report	Setting described	Sample size considered	Sample of reasonable size	Data collection method	Choice of data collection tool(s)	Detailed recruitment data	Measuring tool assessed	Question and method fit - data collection	Question and method fit - analysis	Analysis method selected	Users involved in design	Strength/limitation discussion	Total (% of maximum)
Scoring: 0 = No mention; 1=very slightly covered; 2=Moderately covered; 3=Completely covered. Where independent reviewer scores differed, averages are provided.															
Gibson et al, 1993	0	2	2	0	3	2	1	2	0	3	2	1	1	2	21 (53%)
Nusstein et al, 2002	1	3	2	0	0	3	2	3	1	2	3	1	0	1	22 (55%)
Campanelli et al, 2008	0	2	3	0	1	3	0	3	1	3	3	1	0	1	21 (53%)
Cohen et al, 2009	3	3	3	1	2	3	3	3	1	3	3	3	3	2	36 (90%)
Wilson et al, 2013	0	1	3	0	1	1	3	2	1	2	2	1	3	3	23 (58%)
Aaron et al, 2018	0	3	3	3	3	3	1	0	0	3	2	1	0	2	24 (60%)
Penniston et al, 1996	0	2	3	3	1	2	0	2.5	0	3	3	1	0	0	20.5 (51%)
Adriaenssen et al, 1998	2	1	3	3	3	2	1	2	0	1	2	0	0	0	20 (50%)
Doroschak et al, 1999	3	3	3	2	1	3	3	2.5	2	3	3	1	0	2	31.5 (79%)
Gallatin et al, 2000	3	3	1	0	1	3	1	3	0	3	2	1	0	1	22 (55%)
Henry et al, 2001	3	3	1	0	1.5	2.5	0	3	0	3	2	1	0	2	22 (55%)
Hersh et al, 2003	3	3	3	0	3	2	3	3	0	3	3	2	0	2	30 (75%)
Runyon et al, 2004	3	3	2	3	3	3	1	3	0	3	3	2	0	3	32 (80%)
Sethi et al, 2014	1	3	1	2	3	3	3	3	0	3	3	2	0	1	28 (70%)
Bultema et al, 2016	3	3	1	0	3	2	2	3	0	3	3	1	0	2	26 (65%)
Sebastian et al, 2016	2	3	1	0	3	2	1	3	0	2	2	1	0	1	21 (53%)
Taggar et al, 2017	3	3	1	1	3	3	1	3	0	2	2	1	0	3	26 (65%)