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The Role of Inhaled Corticosteroids in Preventing Hospital Attendance and Improving Clinical Outcomes in Children with Recurrent Croup: A Systematic Review

Dean Robinson

dean.robinson4@nhs.net

University College London Hospitals NHS Foundation Trust

Agamemnon Pericleous

University College London Hospitals NHS Foundation Trust

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Abstract

Purpose:

Recurrent croup is a common cause of repeated healthcare utilisation in children. Although corticosteroids are widely used in acute croup, their role in reducing hospital attendance and improving outcomes in recurrent croup remains unclear.

Methods:

A systematic literature search was conducted across major medical databases. Studies were selected using predefined PICO-based inclusion and exclusion criteria and a PRISMA-guided screening process. Studies evaluating inhaled or systemic corticosteroids in children with recurrent croup were included. Primary outcomes were hospital admission and re-attendance rates. Secondary outcomes included croup severity scores, symptom improvement, and adverse effects.

Results:

Of 432 records identified, eight studies met the inclusion criteria, comprising six randomised controlled trials and two observational studies. Inhaled steroid use was associated with reduced hospital admission rates and improved clinical outcomes compared with placebo. Improvements in croup severity scores and symptom burden were observed with both inhaled and systemic corticosteroids. Systemic corticosteroids were associated with lower admission and re-admission rates than placebo and inhaled treatments. Among inhaled therapies, budesonide was associated with lower re-admission rates than dexamethasone.

Conclusion:

High-quality evidence from randomised controlled trials and systematic reviews supports the use of corticosteroids in acute croup, demonstrating consistent benefits across multiple clinically relevant outcomes. In contrast, evidence for recurrent croup remains limited and is predominantly observational. While inhaled steroids appear to reduce admissions and improve symptom severity, their role in preventing recurrent croup remains investigational. Further prospective studies are required to establish the optimal corticosteroid regimen and define the role of early home-based inhaled therapy.

What is known – What is new

What is known: Corticosteroids are established in acute croup, but recurrent croup is less well understood, with heterogeneous evidence for inhaled corticosteroids [ICS] as preventative therapy.

What is new: ICS were associated with reduced admissions, improved severity scores and symptom improvement; limited data suggest systemic corticosteroids may reduce admission/re-admission more than ICS.

Introduction

Croup is one of the most common causes of upper airway obstruction in young children, accounting for a substantial proportion of paediatric emergency department attendances and hospital admissions worldwide [1][2]. Characterised by inspiratory stridor, a barking cough and varying degrees of respiratory distress, croup is most commonly caused by a viral infection and typically affects children between 6 months and 3 years of age [2]. Although most episodes are self-limiting, moderate and severe disease may require medical intervention, resulting in significant healthcare utilisation and parental anxiety [1][2].

Corticosteroids are well established as the cornerstone of acute croup management [3]. Numerous randomised controlled trials and systematic reviews have demonstrated that corticosteroid treatment improves croup severity scores, reduces the need for additional interventions, shortens hospital stay and decreases rates of hospital admission and return healthcare visits [3][4][5]. Consequently, corticosteroids, particularly dexamethasone, are recommended in national and international clinical guidelines for children presenting with acute croup regardless of initial disease severity [2][6].

In contrast, recurrent croup remains less well understood. Although definitions vary, recurrent croup is generally characterised by two or more episodes of croup requiring medical assessment or treatment [7][8]. Recurrent presentations may significantly affect quality of life for children and their families and contribute disproportionately to healthcare utilisation through repeated emergency department attendances, hospital admissions and repeated courses of corticosteroids [7][8]. Increasing recognition of recurrent croup as a distinct clinical entity has prompted interest in preventative treatment strategies rather than management of individual acute episodes alone [7].

Inhaled corticosteroids [ICS] represent one potential preventative therapy. The clinical overlap between recurrent croup and airway hyperreactivity has led to the hypothesis that recurrent croup may represent an inflammatory airway disorder in a subset of children, providing a biological rationale for the use of inhaled corticosteroids as preventative therapy [9][10][11][12]. Their anti-inflammatory effects, established safety profile in paediatric respiratory disease and ease of home administration have led to increasing clinical interest in their use at the onset of upper respiratory tract symptoms or as prophylactic treatment in children with recurrent croup [8]. However, unlike acute croup, the evidence supporting ICS in recurrent disease is limited, heterogeneous and has not been comprehensively studied [8]. Existing studies differ considerably in patient populations, definitions of recurrent croup, corticosteroid preparations, treatment regimens and reported outcomes, making it difficult to draw firm conclusions regarding effectiveness [8].

A systematic evaluation of the available evidence is therefore needed to inform clinical practice and identify priorities for future research. This systematic review aims to evaluate the effectiveness of

inhaled corticosteroids in children with recurrent croup, with particular emphasis on their ability to reduce hospital admissions and re-attendance. Secondary objectives are to assess their effects on croup severity, symptom improvement and adverse events, while comparing outcomes with systemic corticosteroids where comparative evidence exists.

Methods

Protocol and Registration

A written review protocol, specifying the objectives, eligibility criteria, and planned methods, was developed prior to the commencement of the literature search. The protocol was not registered on a public registry such as PROSPERO.

Search Strategy

A systematic literature search was conducted to identify studies evaluating the use of ICS in children with recurrent croup using a PICO framework as a guide. The search was designed and carried out with the support of the library and information service team at the Royal College of Surgeons of England. The following electronic databases were searched: OVID MEDLINE, Embase, the Cochrane Central Register of Controlled Trials [CENTRAL] and The Cochrane Database of Systematic Reviews [CDSR]. The search was run on the 1st April 2026 and covered publications within the 30 years preceding the search date. The full search strategies are outlined in the Supplementary material, Tables 1–3.

The search was limited to studies involving children. Reference lists of included studies and relevant reviews were hand-searched to identify any additional eligible studies.

Eligibility Criteria

Studies were included and excluded according to pre-specified criteria, developed prior to the literature search and applied consistently by two reviewers.

Inclusion criteria:

- Children aged 0–18 years
- Diagnosis of croup
- Studies must include children with recurrent croup, defined as > = 2 isolated croup episodes in their lifetime
- Use of any inhaled corticosteroid, including nebulised and metered-dose inhaler formulations
- A comparator of placebo, systemic corticosteroids, or no treatment
- Studies reporting on at least one of the following outcomes: frequency of croup episodes, severity of episodes, hospital admissions/emergency department visits, adverse effects, or quality-of-life

measures
- Study designs: randomised controlled trials, cohort studies, case-control studies, observational studies, and case series

Exclusion criteria:

- Adult participants
- Alternative diagnoses to croup
- Studies using systemic corticosteroids only, with no ICS arm
- Studies with mixed interventions in which the effect of ICS could not be separated from other treatments
- Case reports
- Narrative reviews
- Grey literature

Study Selection

The initial search identified 414 records across all the databases. A further 18 were identified via hand-searches of initially identified studies, giving a total of 432 studies. After removal of duplicates, 397 records remained for title and abstract screening. Zotero reference manager tool was used to upload all identified articles. Two reviewers independently screened all titles and abstracts against the pre-specified eligibility criteria, and the full texts of potentially eligible articles were then independently assessed for inclusion by both reviewers using Rayyan as the systematic review tool. Assessors agreed on 95% of the 397 articles reviewed. Disagreements were resolved by discussion and a subsequent final decision made and recorded on Rayyan.

Of the 397 records identified, eight studies met the inclusion criteria and were included in the final review: six randomised controlled trials and two observational studies. The study selection process is summarised in the PRISMA flow diagram [Figure 1].

Data Extraction

Data were extracted using a standardised data extraction form, capturing study design, population characteristics, intervention and comparator details and outcomes relating to symptom changes, admissions, severity scoring and the need for further medical attention. Data was categorised into ICS, Systemic corticosteroids and placebo/no treatment. Any adverse events were also recorded.

Risk of Bias Assessment

The Cochrane Risk of Bias 2 [RoB 2] tool for randomised controlled trials and the ROBINS-I tool for observational studies were used to assess for bias in all eight studies.

Overall, the six RCTs demonstrated low to moderate risk of bias, while both observational studies were at moderate risk owing to retrospective study design and potential selection bias.

Data Synthesis

For dichotomous outcomes — including hospital admission rates, reattendance rates, readmission rates, and rates of symptom improvement — relative risk [RR] and corresponding p-values were calculated using two-proportion z-tests to compare intervention and comparator groups across studies. Where sufficient homogeneous data were available, a meta-analysis was performed for changes in croup severity scores using JASP software. Given the variation in study designs, populations, and outcome measures across the included studies, remaining outcomes were synthesised narratively.

Reporting

This review was conducted and is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] guidelines.

Results

Study characteristics

The included studies were published between 1994 and 2023 and were conducted in Australia, Italy, Turkey and the United States. Sample sizes ranged from 57 to 198 participants with a total of 786 children. Considerable heterogeneity existed between studies in terms of study design, patient populations, definitions of recurrent croup, corticosteroid preparation, route of administration and comparator groups.

Five studies evaluated nebulised budesonide, one evaluated dexamethasone and 2 did not specify which particular steroid was used in the nebuliser. Dosage ranged from 2-4mg for budesonide. Comparator groups included placebo, oral or intramuscular corticosteroids and no corticosteroid treatment. Outcomes reported varied across studies, with hospital admission, symptom improvement, re-attendance rates and croup severity scores being the most frequently reported. See Table 1 for more detailed study characteristics.

Primary outcomes

Hospital admission

Evidence regarding hospital admission was reported in five RCTs. Compared with placebo [65.6%], inhaled corticosteroids were associated with reduced hospital admission rates [25.3%] [Two proportion z-test] [$p < 0.001$]. However, studies directly comparing inhaled and systemic corticosteroids

demonstrated lower admission rates in children receiving systemic treatment [10%] [Two-proportion z-test] [$p < 0.001$].

Re-attendance & readmission

Re-attendance outcomes were measured in all of the studies included. Readmission rates were evaluated in all 6 RCTs. There was no significant difference in reattendance rates between the ICS group, systemic treatment group and placebo/no treatment group. Systemic corticosteroid [2.92%] use was associated with reduced readmission rates compared to ICS [8.84%] [Two proportion z-test] [$p = 0.041$] and placebo [11.4%] [Two-proportion z-test] [$p = 0.008$]. Among inhaled corticosteroid regimens, nebulised budesonide [2.54%] was associated with lower re-admission rates than nebulised dexamethasone [22.22%] [Two-proportion z-test] [$p < 0.001$].

Secondary outcomes

Symptom improvement

Most studies demonstrated improved symptom resolution following corticosteroid treatment. Compared with placebo [42.86%], inhaled corticosteroids [75.13%] resulted in greater symptom improvement and a higher proportion of children achieving clinically significant improvement [Two-proportion z-test] [$p < 0.001$]. However, symptom improvement was generally comparable between inhaled and systemic corticosteroids. The rates of children which experienced worsening of their condition following ICS [13.99%] and systemic treatment [17.39%] was comparable between both groups.

Croup severity scores

Severity scores were reported using a variety of assessment tools, most commonly the Westley Croup Score. Studies comparing inhaled corticosteroids with placebo consistently demonstrated greater reductions in croup severity following inhaled corticosteroid treatment [Figure 2]. Studies directly comparing inhaled and systemic corticosteroids found no consistent differences in severity score improvement [Figure 3].

Additional treatment and adverse events

Requirement for rescue treatment was infrequently reported. Where assessed, nebulised adrenaline remained the most common additional intervention. Adverse events were uncommon, with no major treatment-related complications reported in any included study. Reporting of adverse effects was inconsistent across studies, precluding formal comparison.

Summary of findings

Overall, inhaled corticosteroids demonstrated clinical benefit compared with placebo, with improvements in symptom resolution, croup severity scores and hospital admission outcomes. However, when directly compared with systemic corticosteroids, inhaled corticosteroids did not demonstrate superiority for reducing admissions or re-attendance. The available evidence for recurrent croup remained limited, with substantial clinical and methodological heterogeneity between studies. See [figure 4] for an overview of the primary and secondary outcomes.

Discussion

This systematic review demonstrates that corticosteroids are associated with improved clinical outcomes in children with recurrent croup, with ICS showing benefit compared with placebo for hospital admission, symptom improvement and croup severity scores. However, the evidence base for recurrent croup remains limited and heterogeneous [7][8]. In direct comparisons, systemic corticosteroids were associated with lower admission and re-admission rates than ICS, while nebulised budesonide appeared more effective than nebulised dexamethasone in reducing re-admission [13]. These findings suggest that although ICS may have a role in the management of recurrent croup, their optimal use and position relative to systemic corticosteroids remain uncertain.

The reduction in hospital admission associated with ICS compared with placebo is clinically relevant. Recurrent croup can result in repeated emergency department presentations, disruption to families and repeated exposure to systemic corticosteroids [7][8]. The potential for an inhaled treatment to reduce hospital attendance, particularly when administered at home at the onset of symptoms, is therefore attractive. The observed improvement in croup severity scores and symptom resolution provides further support for a clinically meaningful treatment effect. However, the available studies varied considerably in their definitions of recurrent croup, treatment regimens and outcome assessment, limiting the certainty with which these findings can be generalised [8].

The apparent greater effectiveness of systemic corticosteroids for reducing admission and re-admission compared with ICS is also important. Corticosteroids administered systemically have an established role in acute croup because of their rapid and sustained anti-inflammatory effects [3–5]. Our findings suggest that this established treatment remains important for children presenting with more significant acute symptoms, even where ICS are being considered as a preventative or early intervention strategy. However, direct comparisons between systemic and inhaled corticosteroids were limited, and differences in route, dose, timing of administration and disease severity may have influenced the observed treatment effects. It is therefore not possible to conclude that systemic corticosteroids are intrinsically superior to ICS for all children with recurrent croup.

Among inhaled therapies, nebulised budesonide was associated with a substantially lower re-admission rate than nebulised dexamethasone. This finding is of potential clinical interest but should be interpreted cautiously as the number of studies contributing to this comparison was small. In addition, the clinical significance of differences between individual inhaled corticosteroid preparations remains uncertain.

Further adequately powered comparative trials are required before one inhaled corticosteroid can be recommended preferentially.

The improvement in croup severity scores with ICS compared with placebo provides additional evidence of efficacy. Severity scores, most commonly the Westley Croup Score, are useful measures of clinical response but were not consistently reported across studies and were assessed at different time points [14]. The meta-analyses therefore provide evidence of an overall improvement, but the heterogeneity between studies limits direct comparison of the magnitude of benefit. Importantly, when ICS were compared directly with systemic corticosteroids, there was no consistent difference in severity score improvement, suggesting that ICS may provide comparable short-term symptomatic benefit in selected children despite differences in hospital utilisation outcomes.

The potential role of ICS in recurrent croup may extend beyond treatment of individual acute episodes. The pathophysiology of recurrent croup is incompletely understood, and recurrent episodes may represent a heterogeneous group of conditions rather than repeated uncomplicated viral croup. Proposed associations include airway hyperreactivity, atopy [9–12], gastro-oesophageal reflux [15] and underlying airway abnormalities [16]. The observation that ICS may reduce symptom severity and hospital attendance raises the possibility that airway inflammation contributes to recurrent symptoms in at least a subset of children. Early administration of ICS at the onset of upper respiratory tract symptoms could therefore represent a pragmatic preventative strategy [8]. However, the current evidence is insufficient to establish whether this approach prevents recurrent episodes themselves or primarily reduces the severity of individual acute episodes.

A potential advantage of early home-based ICS therapy is the opportunity to intervene before progression to more severe symptoms requiring hospital assessment [8]. This may be particularly valuable for children with predictable recurrent episodes and families who have experienced repeated emergency presentations. Nevertheless, the evidence identified in this review does not yet establish the optimal timing, dose or duration of ICS therapy, nor whether treatment should be administered routinely or only at the onset of symptoms. These questions are particularly important given the different regimens used across the included studies.

The safety findings are reassuring, with no major treatment-related adverse events reported. This is broadly consistent with the wider paediatric literature, in which recommended doses of ICS have generally been associated with a favourable safety profile, although dose-related effects on growth velocity have been observed in some studies of long-term use for other respiratory conditions [17][18]. However, adverse event reporting was inconsistent, and the relatively small evidence base limits the ability to identify uncommon or longer-term complications. This is particularly relevant if ICS are used repeatedly over prolonged periods in young children. Future studies should therefore incorporate systematic reporting of adverse events, treatment exposure and cumulative corticosteroid dose.

Strengths and limitations

The principal strength of this review is the systematic assessment of the available evidence specifically relating to corticosteroid treatment in recurrent croup, an area in which clinical practice is evolving despite limited evidence. The inclusion of both randomised and observational evidence enabled a broader assessment of clinically relevant outcomes, including hospital utilisation and symptom severity.

There are several limitations. First, only eight studies met the inclusion criteria, and the majority of evidence was derived from randomised controlled trials evaluating relatively short-term outcomes. Second, there was substantial clinical and methodological heterogeneity between studies, including differences in the definition of recurrent croup, patient characteristics, corticosteroid preparation and dose, route and timing of administration, comparator treatment and outcome assessment. This limits the ability to directly compare findings across studies. Third, several clinically relevant outcomes, particularly quality of life, time to symptom resolution and adverse effects, were inconsistently reported. Finally, the available evidence may be subject to publication and reporting bias, particularly given the relatively small number of studies.

Implications for clinical practice and research

High-quality evidence from randomised controlled trials and systematic reviews has established corticosteroids as effective treatment for acute croup, with consistent benefits across clinically relevant outcomes. In contrast, evidence specifically addressing recurrent croup remains limited. Our findings suggest that ICS may reduce hospital admission and improve symptoms compared with placebo, but systemic corticosteroids may provide greater protection against admission and re-admission. The potential benefit of nebulised budesonide compared with nebulised dexamethasone warrants further investigation.

Future research should focus on well-designed, adequately powered prospective trials specifically recruiting children with recurrent croup. Studies should use a consistent definition of recurrent croup and standardised severity and outcome measures. In particular, randomised trials evaluating early home administration of ICS at the onset of upper respiratory tract symptoms should assess hospital attendance, admission, re-attendance, symptom severity, time to resolution, quality of life and adverse effects. Comparisons between different ICS preparations and doses would also help establish the optimal treatment regimen.

Conclusion

ICS appear to have clinical benefit in children with recurrent croup, particularly in reducing hospital admission and improving symptom severity compared with placebo. However, systemic corticosteroids may be more effective in reducing admission and re-admission, and the evidence supporting preventative ICS therapy remains limited. While ICS are well established in the acute management of croup, their role in preventing recurrent croup remains investigational. Further high-quality prospective studies are required to determine whether early home-based ICS therapy can safely and effectively reduce recurrent hospital presentations.

Figures and Tables

Table 1
Study characteristics of included articles. ICS= Inhaled corticosteroids. IM= intramuscular.

Study	Year	Country	Study design	Sample size	Nebulised ICS agent	Comparators
Sowa 2023	2023	USA	Retrospective observational	126	Not specified	No treatment
Arslan 2009	2009	Turkey	Observational	57	Not specified	No treatment
Geelhoed 2005	2005	Australia	RCT	72	Budesonide	Oral steroids
Klassen 1998	1998	Canada	RCT	198	Budesonide	Oral steroids alone and ICS with oral steroids
Geelhoed 1995	1995	Australia	RCT	80	Budesonide	Oral steroids and placebo
Johnson 1998	1998	Canada	RCT	144	Budesonide	IM steroids and placebo
Johnson 1996	1996	Canada	RCT	55	Dexamethasone	Placebo
Klassen 1994	1994	Canada	RCT	54	Budesonide	Placebo

Abbreviations

ICS
Inhaled corticosteroids
PICO
Population, intervention, comparison, outcomes
PRISMA
Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Declarations

Ethical approval

was not required for this systematic review, as it involved the analysis of previously published data and did not involve human participants or access to identifiable patient data.

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Competing interests

No authors have any competing interests to declare for this research publication.

Author Contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was written by D.R. and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability

All data supporting the findings of this study are available upon request.

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Figures

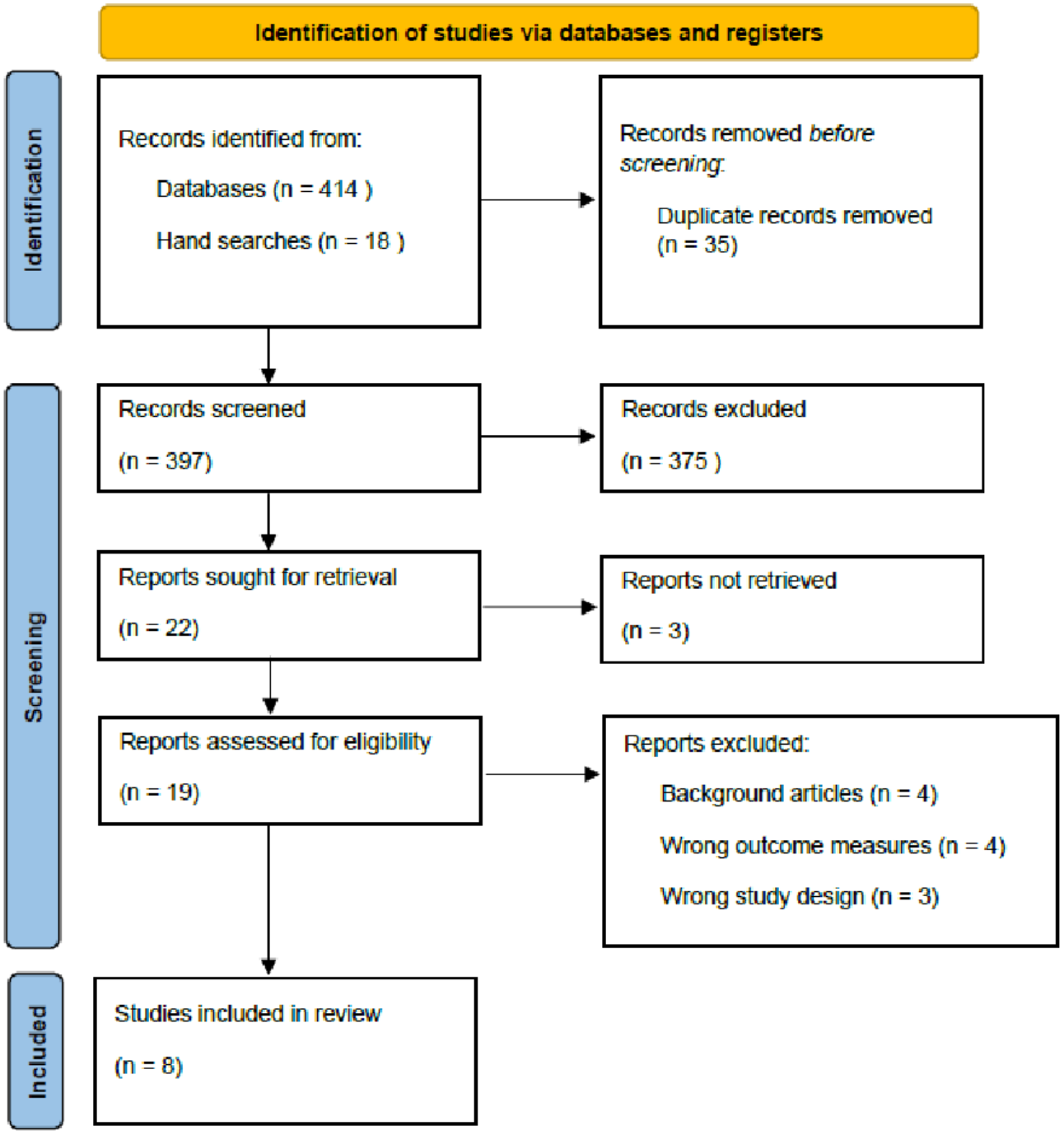


Figure 1

PRISMA 2020 flow diagram outlining the screening process for potential articles for inclusion in this systematic review.

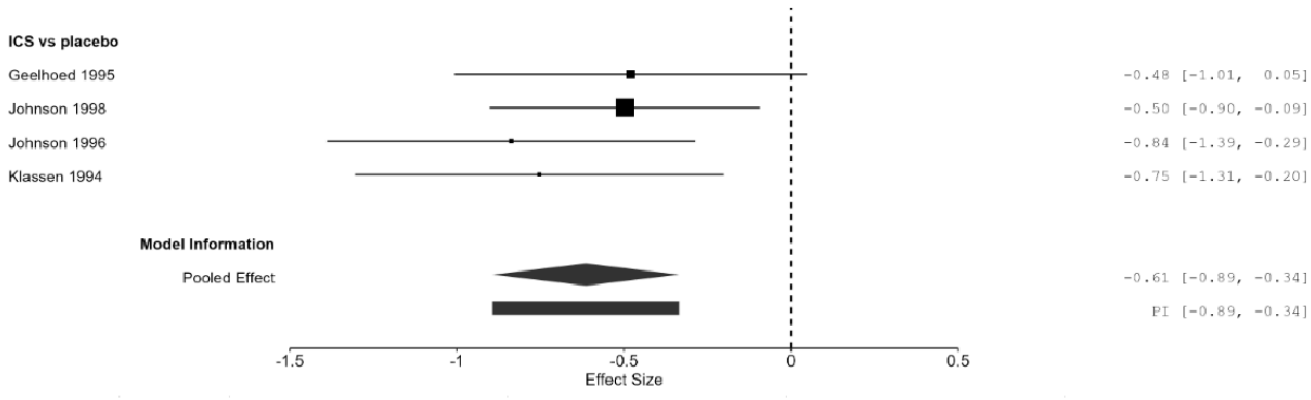


Figure 2

Forest plot showing the effect of inhaled corticosteroids against placebo at reducing croup severity scores. ICS= inhaled corticosteroids. Pooled effect= 0.006.

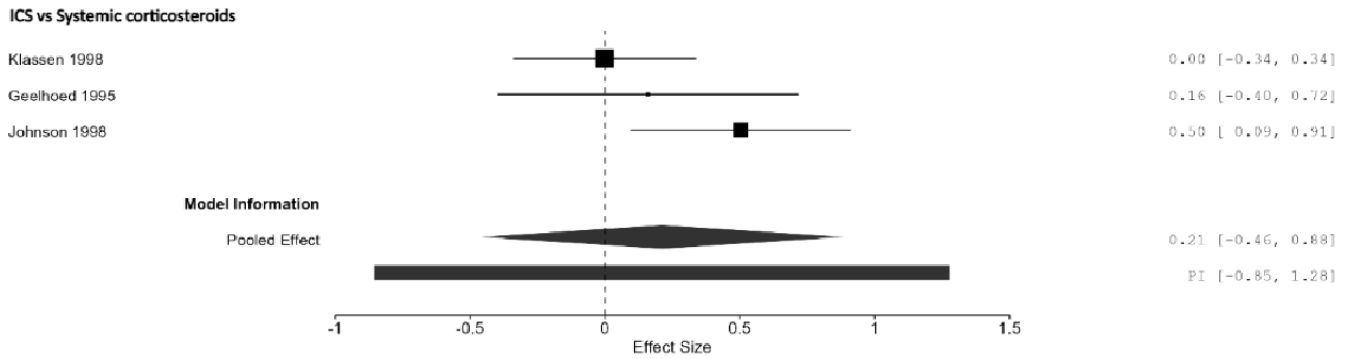


Figure 3

Forest plot showing the effect of inhaled corticosteroids against systemic corticosteroids on reducing croup severity scores. ICS= inhaled corticosteroids. Pooled effect= 0.307.

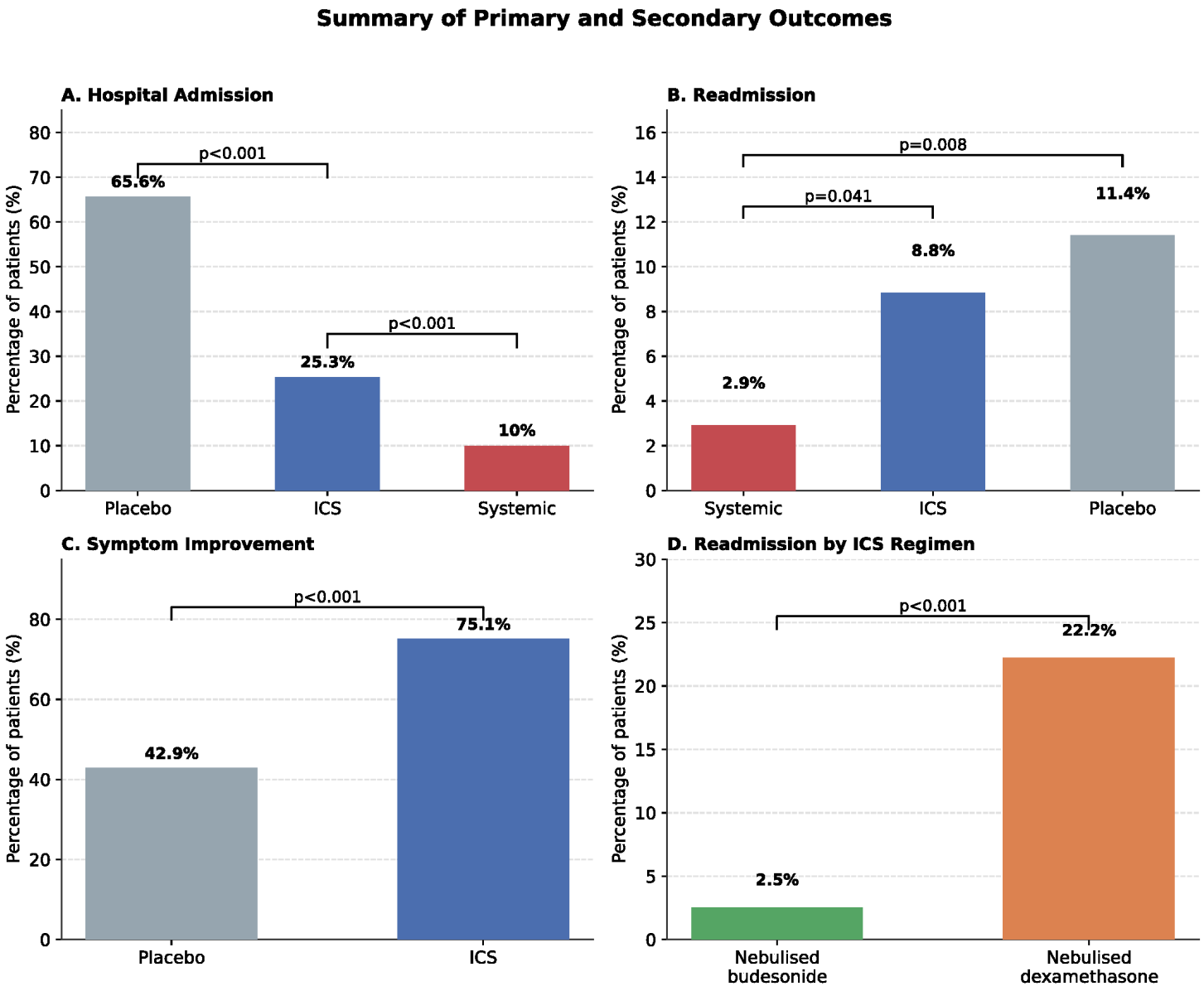


Figure 4

Bar charts showing the main results from the primary and secondary outcomes. ICS= inhaled corticosteroids.

Supplementary Files

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- Supplementarymaterial.pdf