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RATIONAL ANTIBIOTIC PHARMACOTHERAPY IN PEDIATRIC PRACTICE: A REVIEW OF EFFICACY, SAFETY, AND ANTIMICROBIAL RESISTANCE

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Abstract

Background: Antibiotics are among the most frequently prescribed medicines in children, yet a substantial share of this use is unnecessary, and antimicrobial resistance (AMR) has become one of the foremost global health threats. This article reviews the efficacy, safety, and resistance implications of antibiotic pharmacotherapy in pediatric practice, using atopic dermatitis as an illustrative model of the wider problem. Methods: A structured review of literature indexed in PubMed and Google Scholar (2003–2025) was undertaken, prioritizing systematic reviews, meta-analyses, and randomized controlled trials relevant to children. Results: The evidence indicates that antibiotics frequently confer limited clinical benefit where bacterial infection is not confirmed; a randomized trial in children found no meaningful benefit of oral or topical antibiotics for clinically infected eczema over standard care [1]. Bacterial colonization is nonetheless common — Staphylococcus aureus is present on the lesional skin of about 55% of children with atopic dermatitis [9] — and inappropriate antibiotic use drives resistance, including elevated fusidic-acid resistance in children [6]. Conclusion: Rational, evidence-based prescribing — reserving antibiotics for confirmed infection, minimizing duration, and prioritizing antimicrobial stewardship — is essential to protect children and to contain AMR.

Keywords

Antibiotics; pediatric pharmacotherapy; antimicrobial resistance; antimicrobial stewardship; drug safety; Staphylococcus aureus; rational drug use; atopic dermatitis.

INTRODUCTION

Antibiotics are among the most frequently prescribed medicines in pediatric practice, and for confirmed bacterial infection they remain irreplaceable. A considerable proportion of pediatric antibiotic use, however, is unnecessary, and its consequences extend well beyond the individual patient. Antimicrobial resistance (AMR) has become one of the foremost threats to global health, associated with an estimated 1.27 million directly attributable deaths in 2019 [7], and its containment has been placed among the

highest international priorities [14]. Children occupy a pivotal position in this problem: they are among the highest per-capita consumers of antibiotics, and prescribing patterns established early tend to persist into later care.

Rational pharmacotherapy — selecting a medicine that is genuinely indicated, effective, and safe, and using it for an appropriate duration — is therefore of particular importance in children. In the case of antibiotics, two questions lie at its heart: whether the drug confers real clinical benefit in a given situation, and what price, in terms of adverse effects and resistance, its use exacts. In everyday practice these questions are often blurred, and the mere presence of bacteria on the skin or mucosa is treated as sufficient justification for therapy.

This article reviews the current evidence on the efficacy, safety, and resistance implications of antibiotic pharmacotherapy in children, drawing on atopic dermatitis as a well-studied model of the wider problem, and seeks to distil a concise set of practical, evidence-based principles for rational prescribing.

LITERATURE REVIEW

Because the inappropriate use of antibiotics is the principal driver of resistance, and because children are among the highest per-capita consumers of these agents, pediatric prescribing occupies a central place in efforts to contain AMR [7, 14]. The core difficulty is not whether antibiotics act against susceptible bacteria, but whether they are genuinely required in a given clinical situation and at what long-term cost.

A recurring theme in the pediatric literature is that the clinical benefit of antibiotics is often smaller than assumed, particularly where bacterial infection has not been confirmed. Atopic dermatitis (AD) provides an instructive model. The lesional skin of children with AD is almost invariably colonized by Staphylococcus aureus, and this colonization has long been used to justify antibiotic therapy [5, 2]. Yet colonization is not the same as infection. A meta-analysis of 95 observational studies reported S. aureus carriage in 70% of lesional skin, 39% of non-lesional skin, and 62% of the nares of patients with AD, with the odds of carriage roughly twenty times higher than in controls and increasing with disease severity [12]. In pediatric populations specifically, a meta-analysis found colonization of about 55% on lesional skin and 56% in the nares, with methicillin-resistant S. aureus (MRSA) detected in 8.5% of skin and 11.6% of nasal samples [9].

Despite this high colonization, randomized evidence has repeatedly failed to demonstrate meaningful benefit from antibiotics in the absence of overt infection. A pragmatic, placebo-controlled randomized trial in children with clinically infected eczema found that neither oral flucloxacillin nor topical fusidic acid produced a clinically important improvement over standard emollient and topical-corticosteroid therapy [1]. A Cochrane systematic review of interventions to reduce S. aureus in eczema likewise found no reliable evidence that anti-staphylococcal measures benefit non-infected disease [3]. Parallel to this limited efficacy, inappropriate antibiotic use has been closely linked to the emergence of resistance in the very organisms it targets: topical fusidic acid, in particular, has been associated with high and rising rates of fusidic-acid-resistant S. aureus [8, 10, 11, 4], with resistance reported to be higher in children than in adults in a recent regional study [6]. Together, this literature frames the central pharmacological tension in pediatric practice: balancing genuine therapeutic need against the twin risks of adverse drug effects and resistance.

METHODOLOGY

This article is a structured narrative review. The peer-reviewed literature indexed in PubMed and Google Scholar was searched for the period 2003–2025 using combinations of the terms “antibiotic,” “antimicrobial resistance,” “pediatric,” “children,” “efficacy,” “safety,” “Staphylococcus aureus,” “fusidic acid,” and “rational drug use.” Priority was given to the highest available levels of evidence: systematic reviews, meta-analyses, and randomized controlled trials, supplemented by relevant observational studies and authoritative guidance. Studies were included if they reported on the efficacy, safety, or resistance implications of antibiotic use with relevance to children; non-peer-reviewed sources and studies without extractable quantitative or clinical data were excluded. Data were extracted and organized thematically under three domains — efficacy, colonization/microbiology, and resistance — and are summarized in Tables 1–3. Because this is a qualitative synthesis rather than a meta-analysis, results are reported descriptively, and every quantitative figure is attributed to its original source. No new patient-level data were generated; accordingly, ethical approval was not required.

RESULTS

Efficacy. The reviewed evidence consistently indicates that antibiotics offer limited benefit in pediatric inflammatory skin disease when overt bacterial infection is absent (Table 1). In the randomized trial by Francis and colleagues, the confidence intervals excluded a clinically meaningful advantage of antibiotics over standard care, and the authors concluded that most children with milder clinically infected eczema do not require antibiotics when appropriate topical therapy is provided [1]. The Cochrane review reached a concordant conclusion for non-infected disease [3].

Table 1. Evidence on the efficacy of antibiotics in pediatric eczema / inflammatory skin disease.

Study [ref]	Design / population	Key finding
Francis et al. (2017) [1]	Randomized, placebo-controlled trial; children with clinically infected eczema	No clinically important benefit of oral or topical antibiotics over standard care
George et al. (2019) [3]	Cochrane systematic review; eczema	No reliable evidence that anti-staphylococcal interventions benefit non-infected disease

Colonization and microbiology. S. aureus colonization is highly prevalent in pediatric AD, but its presence reflects the disease state rather than an indication for antibiotics in itself (Table 2). Colonization rates rise with disease severity and are markedly higher than in healthy children [12, 9].

Table 2. Staphylococcus aureus colonization in atopic dermatitis (selected syntheses).

Study [ref]	Population	Lesional	Nasal	MRSA
Totté et al. (2016) [12]	AD patients (95-study meta-analysis)	70%	62%	—
Sangaphunchai et al. (2023) [9]	Pediatric AD (meta-analysis)	55%	56%	8.5% skin / 11.6% nares

Resistance. Inappropriate antibiotic exposure — particularly repeated or prolonged topical use — is strongly associated with resistance (Table 3). Fusidic acid illustrates this clearly: baseline fusidic-acid resistance of 26% was observed among eczema patients carrying S. aureus [8], resistance reached as high as 78% among inpatients with atopic eczema, and 96% of patients carrying resistant strains had used a fusidic-acid-containing preparation in the preceding six months [10]. Prior topical use and the enriching effect of topical antimicrobials on resistant and multidrug-resistant strains have been confirmed in further studies [11, 4], and resistance has been reported to be higher in children (21%) than in adults (14%) [6].

Table 3. Fusidic-acid and topical-antibiotic resistance in S. aureus (selected studies).

Study [ref]	Setting / population	Key resistance finding
Ravenscroft et al. (2003) [8]	Atopic eczema	S. aureus in 76%; fusidic-acid resistance 26% at baseline
Shah & Mohanraj (2003) [10]	Dermatology patients	50% fusidic-acid resistant; up to 78% in inpatient atopic eczema; 96% had recent fusidic-acid use
Sule et al. (2007) [11]	Atopic eczema	Resistance associated with pattern of prior topical fusidic-acid use
Harkins et al. (2018) [4]	Pediatric AD	Topical antimicrobial use enriches for resistant S. aureus
Mian & Plant (2025) [6]	Regional study, UK	Fusidic-acid resistance higher in children (21%) than adults (14%)

Global context. At the population level, the cumulative effect of such inappropriate use is substantial: bacterial AMR was directly attributable to an estimated 1.27 million deaths worldwide in 2019 [7], underscoring that individual prescribing decisions aggregate into a global public-health outcome.

DISCUSSION

Taken together, these findings expose a persistent gap between the perceived and the demonstrated value of antibiotics in pediatric practice. The high prevalence of S. aureus colonization creates a strong intuitive pull toward antibiotic therapy, yet the randomized and systematic-review evidence indicates that, in the absence of overt infection, this

therapy adds little clinical benefit while contributing materially to resistance [1, 3]. The distinction between colonization and infection is therefore not merely academic; it is the pivotal clinical judgment on which rational prescribing depends.

The resistance data carry particular weight for pediatric care. The association between topical fusidic-acid use and fusidic-acid-resistant S. aureus — with resistance rising to 78% in some eczema inpatient populations and the great majority of carriers having recent exposure — demonstrates how quickly a convenient topical agent can lose its utility through overuse [10, 8, 11]. That resistance appears higher in children than adults [6] is especially concerning, because it suggests that patterns established early may compromise treatment options across a lifetime. From a safety perspective, unnecessary antibiotics also expose children to avoidable adverse effects and disrupt the developing microbiome, adding a further argument for restraint.

These observations align with international stewardship principles, which increasingly emphasize reserving antibiotics for confirmed infection, minimizing duration, and avoiding antibiotic monotherapy or prolonged topical courses [14]. In the specific case of AD, the mainstay of therapy — emollients, topical corticosteroids, and, where appropriate, calcineurin inhibitors — addresses the underlying inflammation and barrier dysfunction and often reduces bacterial burden indirectly, without the resistance cost of antibiotics.

This review has limitations. As a narrative rather than systematic review, its synthesis is selective and does not include a formal quality appraisal or quantitative pooling. Much of the illustrative evidence derives from AD and from a limited set of countries, with very little data from Central Asia; extrapolation to the broader pediatric setting and to the local Uzbek context should therefore be cautious. These gaps also point to a clear research priority: locally generated data on pediatric antibiotic use, efficacy, and resistance are needed to guide practice and policy.

CONCLUSION

Antibiotics remain indispensable for confirmed bacterial infection, but the pediatric evidence reviewed here shows that they are frequently used where their benefit is unproven and their resistance cost is real. Rational antibiotic pharmacotherapy in children rests on a small number of actionable principles: prescribe antibiotics only when bacterial infection is clinically evident or confirmed; use the shortest effective course; avoid prolonged or repeated topical antibiotics, particularly fusidic acid; treat the underlying condition (for example, with emollients and topical anti-inflammatory agents in atopic dermatitis) rather than the colonizing organism; and embed antimicrobial stewardship into everyday pediatric practice and undergraduate training. Because today’s students and junior clinicians will shape tomorrow’s prescribing, cultivating these habits early is both a clinical and a public-health imperative, and generating local evidence should be an early priority for the region.

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