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Postprint: Development of a Public Education Framework for Pediatric Antimicrobial Use Post-Discharge

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Abstract

Background: The issue of irrational antibiotic use by children and their parents following hospital discharge is prominent. Providing children and parents with correct antibiotic medication guidance and popular science education constitutes an important measure for improving parental awareness and promoting rational antibiotic use. However, no standardized popular science guidelines currently exist to direct the development of pediatric antibiotic popular science resources.

Objective: To develop a discharge popular science standard for pediatric antibiotics, providing a reference for the normative production of pediatric antibiotic popular science resources and guiding parents in the rational use of antibiotics after hospital discharge.

Methods: From December 2024 to February 2025, a scoping systematic review of discharge popular science content for pediatric antibiotics was conducted through literature research, with thematic synthesis employed to integrate the literature content. Based on the scoping systematic review results, a draft questionnaire for the pediatric antibiotic discharge popular science framework was developed. In March 2025, clinical experts specializing in pediatric infection, pediatric popular science, and pediatric medication education were selected to complete a Delphi expert consultation via “Wenjuanxing” for questionnaire distribution and collection. Based on experts’ importance ratings for each item [mean score ≥ 4 points and coefficient of variation (CV) $\leq 25\%$], consensus determination was performed, and framework indicators were finalized to construct the pediatric antibiotic discharge popular science framework.

Results: A total of 7,886 articles were initially retrieved, with 55 articles ultimately included after screening. Nineteen descriptive themes (secondary indicators) and four analytical themes (primary indicators) were summarized through

thematic synthesis. A total of 35 questionnaires were distributed, and 21 were returned. The importance ratings from 21 experts for the 19 secondary indicators and 4 primary indicators revealed that all indicator importance scores ranged from 4-5 points, with CV \$ 25%, and intraclass correlation coefficient (ICC) = 0.52 (95%CI = 0.18-0.76, P = 0.003), indicating good expert consistency and achieved consensus. Based on the expert consultation results for the draft indicators, a pediatric antibiotic discharge popular science framework was finally established, comprising 4 primary indicators (basic knowledge, medication methods, adverse reactions, behavioral habits) and 19 secondary indicators (antibiotic definition, antibiotic classification, concept differentiation, disease cognition, etc.).

Conclusion: The pediatric antibiotic discharge popular science framework constructed in this study demonstrates high scientific rigor and reliability, and can provide an important reference for developing pediatric antibiotic discharge popular science resources and guiding parents in the rational use of antibiotics.

Full Text

Construction of a Scientific Popularization Framework for Antimicrobial Drugs for Children Discharged from Hospital

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Abstract

Background The problem of irrational use of antimicrobial drugs by parents of children after hospital discharge is particularly prominent. Providing correct guidance and popular science education on antimicrobial use to children and their parents represents an important measure to improve parental awareness and promote rational use. However, there is currently no standardized scientific popularization framework to guide the development of pediatric antimicrobial education resources.

Objective To formulate a scientific popularization standard for pediatric antimicrobial drugs upon discharge, providing reference for standardized resource development and guiding parents in rational antimicrobial use after discharge.

Methods From December 2024 to February 2025, we conducted a systematic scoping review of literature on pediatric antimicrobial scientific popularization at discharge using thematic synthesis to integrate findings. Based on these results, we developed a preliminary questionnaire for a pediatric antimicrobial scientific popularization framework. In March 2025, clinical experts specializing in pediatric infections, pediatric science popularization, and pediatric medication education were selected to complete Delphi expert consultations through the “Wenjuanxing” platform. Consensus was determined when items received mean importance scores ≥ 4 and coefficient of variation (CV) $\leq 25\%$. The framework indicators were finalized based on expert consultation to construct the pediatric antimicrobial scientific popularization framework for discharge.

Results A total of 7,886 articles were initially retrieved, with 55 articles ultimately included after screening. Thematic synthesis identified 19 descriptive themes (secondary indicators) and 4 analytical themes (primary indicators). We distributed 35 questionnaires and received 21 completed responses. The 21 experts rated all 19 secondary and 4 primary indicators with importance scores of 4–5 and CV $\leq 25\%$. The intraclass correlation coefficient (ICC) was 0.52 (95%CI=0.18–0.76, $P=0.003$), indicating moderate agreement and consensus achievement. Based on expert consultation results, we established a final framework comprising 4 primary indicators (basic knowledge, medication methods, adverse reactions, and behavioral habits) and 19 secondary indicators (antibiotic definitions, classification, concept differentiation, disease awareness, etc.).

Conclusion The constructed framework demonstrates high scientific validity and reliability. It provides an important reference for developing pediatric antimicrobial scientific popularization materials at discharge and guiding parents in rational antimicrobial use.

Keywords Anti-bacterial agents; Child; Patient discharge; Science popularization framework; Thematic synthesis; Delphi technique

Children are a high-risk population for infectious diseases, and antimicrobial drugs are among the most commonly used medications in pediatrics. However, irrational use of antimicrobials among children after hospital discharge remains a significant problem. Multiple national surveys conducted between 2016–2019 revealed a severe bacterial resistance situation among Chinese children, closely linked to antimicrobial overuse [1-2]. Scientific popularization and education provide correct guidance on antimicrobial use to children and parents, representing an important strategy to improve parental awareness and promote rational use. The Chinese government attaches great importance to antimicrobial education for children. The 2022 National Action Plan to Combat Microbial Resistance (2022–2025) [3] emphasizes extensive science education in primary and secondary schools to foster early concepts of infection prevention and rational antimicrobial use. The 2023 Notice on Strengthening Clinical Medication Management for Children [4] explicitly requires monitoring of pediatric anti-

crobial use and enhanced guidance and education for parents regarding common problems during and after medication use. The Action Plan for Rational Use of Antimicrobials in Chinese Children (2023–2025) [5] also calls for strengthened public education on antimicrobial indications and harms of overuse to reduce blind self-medication.

Despite these policies, studies consistently show that parental knowledge about antimicrobials is generally inadequate, with various irrational behaviors including self-medication, non-indicated use, non-adherence to medical advice, and disregard for bacterial resistance [6–8]. One study investigating parental demand for antimicrobial knowledge identified nine categories of concerns, including basic antimicrobial 常识, dosage, precautions, and indications [9]. However, no standardized scientific popularization framework currently guides the development of pediatric antimicrobial education resources. Therefore, this study aims to establish a pediatric antimicrobial scientific popularization standard to guide parents in rational antimicrobial use after discharge.

Methods

Literature Search Strategy and Inclusion Criteria We applied the PCC (Population, Concept, Context) principle [10–11] to establish inclusion criteria: (1) **Population (P)**: children, parents or guardians, and discharged patients; (2) **Concept (C)**: pediatric antimicrobial scientific popularization standards or materials, parental antimicrobial awareness and education needs, and irrational antimicrobial use after discharge; (3) **Context (C)**: outpatient/emergency departments, post-discharge settings, community pharmacies, and home environments.

Exclusion criteria included: (1) duplicate publications; (2) literature with incomplete original data or questionnaire structures; (3) unavailable full texts; (4) conference papers and dissertations.

We systematically searched China National Knowledge Infrastructure (CNKI), Wanfang Data, VIP Database, Chinese Biomedical Literature Service System, PubMed, National Public Service Platform for Standards, National Standards Library, CNKI Standards Database, International Organization for Standardization, American National Standards Institute, European Standards, and American Society of Health-system Pharmacists. Supplementary searches were conducted on Baidu and Bing. The search timeframe spanned from database inception to August 2024. Chinese search terms included: antimicrobial drugs, antibiotics, rational drug use, usage patterns, discharge, parents, children, science popularization, education, and knowledge-attitude-practice. English terms included: Anti-Bacterial Agents, Patient Discharge, Inappropriate Prescribing, Parents, Child, and Health Education.

Data Extraction and Integration From December 2024 to February 2025, we extracted basic study information (first author, publication year, country),

background environment, research objectives, population characteristics (study population type, child age, parent age), survey methods, research content items, and influencing factors. We employed thematic synthesis using a “three-level interpretation” approach [12-13], utilizing the DeepSeek platform to initially categorize extracted content items into descriptive themes (secondary indicators), which were then further synthesized into analytical themes (primary indicators). Two researchers independently performed this integration, exchanged opinions, and reached consensus.

Expert Consultation Expert Selection: We selected clinical experts from pediatric departments and general hospital pediatrics across China’s eastern, central, and western regions. Experts were required to: (1) specialize in pediatric infections, pediatric science popularization, or pediatric medication education; (2) include physicians, nurses, and pharmacists.

Questionnaire Design: Based on scoping review results, we developed a preliminary questionnaire covering: (1) expert demographic information; (2) evaluation of primary indicators (4 items) regarding familiarity, importance, relevance, and judgment basis; (3) evaluation of secondary indicators (19 items) on the same dimensions. All ratings used a 5-point Likert scale.

Consultation Process: In March 2025, we distributed questionnaires via “Wenjuanxing” and employed a modified Delphi method [14]. After the first round, items with mean importance scores ≤ 4 and CV $\geq 25\%$ were considered to have reached consensus and excluded from subsequent rounds. Items not meeting these criteria were revised based on expert feedback.

Statistical Analysis: We used Excel 365 and SPSS 25.0 for statistical analysis. Questionnaire recovery rate (R) indicated expert engagement (R $60\pm 8\%$), with scores ≥ 4 (out of 5) considered highly important. ICC and CV evaluated consensus (ICC 0.60 or CV 25% indicated good consistency) [15-16]. Expert authority coefficient (Cr) reflected reliability (Cr 0.70 indicated high authority) [17], calculated from familiarity (Ca) and judgment basis (Cs). Cronbach’s α evaluated reliability (α 0.80 indicated good reliability). Item-level (I-CVI) and scale-level (S-CVI) content validity indices evaluated validity (I-CVI 0.78 and S-CVI 0.90 indicated good validity) [18-19]. The significance level was set at $\alpha=0.05$.

Results

Literature Search Results The initial search yielded 7,886 articles. After removing duplicates ($n=1,370$), 6,516 articles remained. Title and abstract screening excluded 6,431 articles, leaving 85 for full-text review. After full-text screening, 55 articles were included [Figure 1: see original paper] (see Appendix Table 1 for basic information).

Framework Indicators from Thematic Synthesis From the 55 included articles, we extracted 691 content items and identified 19 descriptive themes (secondary indicators), ultimately synthesizing 4 analytical themes (primary indicators) to form the preliminary pediatric antimicrobial scientific popularization framework.

Expert Consultation Results Questionnaire Recovery: We distributed 35 questionnaires and received 21 completed responses (recovery rate R=60%).

Expert Characteristics: The 21 responding experts came from pediatric departments across China, including Beijing Children's Hospital (eastern region), Hunan Children's Hospital (central region), and West China Second University Hospital, West China Hospital, and Kunming Children's Hospital (western region). Departments represented included pediatric infectious diseases, respiratory medicine, otolaryngology, neurology, emergency pediatrics, general pediatrics, and pharmacy (Table 1).

Importance Scoring and Consensus: All 19 secondary and 4 primary indicators received importance scores of 4–5. All indicators had CV $\leq 25\%$, with ICC=0.52 (95%CI=0.18–0.76, P=0.003), indicating moderate agreement and achieved consensus without requiring subsequent rounds. Detailed scoring is presented in Table 2.

Expert Authority Coefficient: Expert Cr scores ranged from 0.8–1.0 for all indicators, demonstrating high authority. Specific Ca, Cs, and Cr scores are detailed in Table 2.

Questionnaire Reliability and Validity: Cronbach's α was 0.94, indicating excellent reliability. Two indicators (route of administration, medication tendency) had I-CVI<0.78, while all others exceeded 0.78, demonstrating good item-level content validity. S-CVI was 0.87, indicating acceptable overall content validity.

Final Framework Determination: Through thematic synthesis and expert consultation, we established the final pediatric antimicrobial scientific popularization framework for discharge [Figure 2: see original paper].

Discussion

Parents exhibit numerous misconceptions and irrational behaviors regarding pediatric antimicrobial use. Common issues include non-indicated use, unauthorized dosage or duration adjustments, and self-medication, often stemming from inadequate professional knowledge. Parents frequently confuse antimicrobial classifications, mechanisms of action, or principles for bacterial versus viral infections [20-22]. These misconceptions not only affect treatment efficacy but also contribute to adverse drug reactions and resistant strain transmission [23].

Our study identified four primary dimensions—basic knowledge, medication methods, adverse reactions, and behavioral habits—as critical entry points for

education. The basic knowledge dimension addresses common confusions between antimicrobials, anti-inflammatory drugs, antipyretics, and cold medicines. The medication methods dimension covers dosage errors and insufficient treatment courses. The adverse reactions dimension includes both common and other adverse effects and their management. The behavioral habits dimension targets problems such as self-medication and demanding prescriptions from physicians.

Science education represents a crucial strategy for improving parental antimicrobial use behaviors. The 2021–2030 National Program for Child Development in China [24] emphasizes strengthening health education for children and utilizing expert databases to guide guardians toward rational medication concepts. Systematic knowledge dissemination through science popularization effectively corrects misconceptions and reduces antimicrobial misuse [25]. Our framework covers four comprehensive dimensions that address parental needs: basic knowledge (definitions, classification, concept differentiation, disease awareness), medication methods and adverse reactions (addressing parents' primary concerns [9] with detailed guidance on indications, dosage, drug interactions, timing changes, and adverse effect management), and behavioral habits (focusing on discharge/home use issues like self-medication, physician communication, medication tendencies, and proper storage).

Clinical pharmacists play an irreplaceable role in pediatric antimicrobial education. Their pharmaceutical and medical expertise enables effective dissemination of rational medication knowledge, improving parental understanding and promoting appropriate use. Education is a core pharmacist responsibility, delivered through verbal counseling, online/offline materials, and lectures [29]. Using our framework, our team will develop authoritative content based on drug labels, guidelines, and national formularies for clinical education. This process enhances both public knowledge and pharmacist professional competence, ultimately optimizing therapeutic outcomes [30-32].

This study has several limitations. First, the limited number of experts may result in an incomplete framework, and similar professional backgrounds might create a “highly consistent” subjective bias. Future research should expand expert sources and include parental surveys for greater diversity. Second, regional variations in culture, economic development, and medical resources require further validation of the framework's applicability. Third, the framework awaits empirical research; future studies will evaluate the actual effectiveness of educational materials based on this framework. Fourth, the limited number of included articles and potential heterogeneity in sample size, quality, and methodology prevented weighting of framework themes.

Conclusion

Through literature thematic synthesis and expert consultation, we constructed a pediatric antimicrobial scientific popularization framework for discharge comprising 4 primary indicators (basic knowledge, medication methods, adverse

reactions, behavioral habits) and 19 secondary indicators. Expert consultation showed all indicators received importance scores ≥ 4 with CV $\leq 25\%$ and $Cr > 0.8$, demonstrating high importance and scientific validity. The questionnaire showed excellent reliability (Cronbach's $\alpha=0.94$) and good validity (most I-CVI > 0.78 , S-CVI=0.87). This framework provides clear standards and practical guidance for pediatric antimicrobial education and serves as an important basis for healthcare institutions to guide parents in rational antimicrobial use.

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Author Contributions: MA Linling contributed to study design, literature screening, systematic review, and framework development; WANG Qiqiong and NI Xiaofeng participated in protocol design and questionnaire development; SHI Yuqing and WEN Yan developed questionnaires and contacted experts; PAN Xiangcheng oversaw the project, performed data analysis, and reviewed the manuscript.

Conflict of Interest: None declared.

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Appendix Table 1: Basic Information of Included Studies

Study	Country	Setting	Descriptive Theme Classification*
Dai et al. [1]	China	Community	A, C, D, E, J, L, M, N, P, Q
Li et al. [2]	China	Community	B, C, E, F, J, L, N, O, P, Q, R
Zhang et al. [3]	China	Outpatient	C, E, F, G, H, I, J, K, L, M, N, O, P, S
Liu et al. [4]	China	Outpatient	B, C, E, F, G, H, J, K, L, R
Chen et al. [5]	China	Outpatient	C, E, H, J, L, M, O, P, Q
Yu et al. [6]	China	Community	E, F, G, H, J, M, O, P, Q, R
Hai et al. [7]	China	Community	E, G, J, M, N, O, P, Q, R
Li et al. [8]	China	Community	C, E, H, L, R
Chen et al. [9]	China	Outpatient	C, D, E, G, H, I, J, K, L, M, N, O, R
Yu et al. [10]	China	Community	C, E, F, G, H, J, K, L, M, N, O, P, Q, R, S
Wang et al. [11]	China	Community	E, H, I, N, O, P, R
Peng et al. [12]	China	Outpatient	E, F, G, J, K, N, Q, R
Zhang et al. [13]	China	Inpatient	B, E, G, H, M, P
Zhang et al. [14]	China	Outpatient	C, E, H, J, L, M, O, P, Q
Gao et al. [15]	China	Community	E, G, J, M, N, O, P, Q, R
Wang et al. [16]	China	Community	C, E, F, H, I, J, M, N, O, R, S
Yang et al. [17]	China	Outpatient	M, P, Q
Zhang et al. [18]	China	Community	A, E, F, G, I, J, K, L, L, N, O, Q, R, S
Tang et al. [19]	China	Outpatient	E, G, H, I, J, L, M, N, O, P

Study	Country	Setting	Descriptive Theme Classification*
Luo et al. [20]	China	Outpatient	C, E, F, I, J, L, M, N, O, P, Q, R
Liu et al. [21]	China	Outpatient	D, E, F, H, J, M, O, P
Ding et al. [22]	China	Community	E, G, H, N, O, P, Q, R
Li et al. [23]	China	Outpatient	C, D, N, P, R
Cui et al. [24]	China	Outpatient	E, G, L, N
Alkhaldi et al. [25]	Jordan	Community	B, C, E, F, G, H, J, L, L, O
Lecky et al. [26]	UK	Community	E, G, M, N, O, P, Q
Wang et al. [27]	China	Outpatient	E, H, I, N, O, P, R
Zhang et al. [28]	China	Outpatient	C, E, H, L, R
Yu et al. [29]	China	Rural community	C, D, E, M, N, O
Francis et al. [30]	UK	Outpatient	D, E, M, N, O
Wang et al. [31]	China	Outpatient	A, N, Q, R
Zeng et al. [32]	China	Outpatient	C, D, N, P, R
Liao et al. [33]	China	Community	E, G, L, N
Yang et al. [34]	China	Outpatient	B, E, F, H, I, J, M, N, O, R, S
Wun et al. [35]	Hong Kong	Community	E, Q
Maor et al. [36]	Israel	Outpatient	A, E, J, M
Panagakou et al. [37]	Greece	Outpatient	C, E, G, L, L, L, M, N, O, P, Q
Fan et al. [38]	China	Outpatient	E, G, H, M, O, P, Q
Yang et al. [39]	China	Rural community	C, D, O, P, R
Schnell et al. [40]	USA	Outpatient	E, F, G, J, L, N
Li et al. [41]	China	Outpatient	A, E, L, O
Liu et al. [42]	China	Outpatient	C, E, F, G, H, J, L, N
Dong et al. [43]	China	Outpatient	D, E, I, M
Zong et al. [44]	China	Outpatient	A, D, E, N
Huang et al. [45]	USA	Community	A, D, E, J, M, R
Croft et al. [46]	USA	Community	C, E
Cho et al. [47]	South Korea	Outpatient	E, F, G, J, L, N
Parimi et al. [48]	Trinidad	Outpatient	E, L, M, N, O, P, Q, R
Vinker et al. [49]	Israel	Outpatient	C, D, E, M, N, O, P, Q
Belongia et al. [50]	USA	Community	A, E, L, O
Trepka et al. [51]	USA	Community	D, E, M, N, O
Bauchner et al. [52]	USA	Outpatient	D, E, M, N
Collett et al. [53]	USA	Outpatient	A, E, L, O
Wang et al. [54]	USA	Hospital discharge	B, E, F, G, M
Hu et al. [55]	China	Outpatient	E, J, L

Descriptive theme classification: A-Antibiotic definition, B-Antibiotic classification, C-Concept differentiation, D-Disease awareness, E-Indications, F-Dosage and frequency, G-Route of administration, H-Combination therapy, I-Timing of change, J-Timing of discontinuation, K-Dietary effects, L-Common adverse reactions and management, M-Other adverse reactions, N-Doctor-patient communication, O-Medication tendency, P-Self-medication, Q-Self-purchasing, R-Drug

storage, S-Reading drug labels.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv — Machine translation. Verify with original.