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Drug Utilization Patterns in Orthopaedic Practice: A Systematic Literature Review and Meta-Analysis of Present-Day Evidence

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KEYWORDS

Therapeutic choices, orthopaedic medicine, systematic review, meta-analysis, prescribing patterns, rational drug use, antibiotic stewardship

ABSTRACT:

Background: Rational prescribing practices in orthopaedic medicine are compulsory for maximizing patient outcomes while minimizing adverse drug events and antimicrobial resistance. A full synthesis of existing literature should identify current prescribing trends and areas for change.

Objective: This review and meta-analysis aimed to synthesize published data on drug utilization patterns in orthopaedic clinical practice; therapeutic choices; guideline adherence percentages; obstacles to prescribing globally.

Methodology: A systematic search of PubMed, Web of Science and Scopus databases were performed for studies published from 2018–2025 that reported drug utilization data in orthopaedics. We included studies that reported one of the following: (1) frequency distributions of prescribed medications, (2) adherence metrics, or (3) prescribing pattern analysis. Eligibility was assessed and data extracted by two independent reviewers. Data were used to perform random-effects meta-analysis to estimate pooled prevalence (with 95% confidence intervals) among frequently prescribed therapeutic category.

Key Findings: The most common drugs dispensed were nonsteroidal anti-inflammatory drugs (NSAIDs) (pooled prevalence: 74.2%, 95% CI: 71.8-76.4), followed by antibiotics (66.1%, 95% CI: 63.2-68.9), and opioid analgesics (51.3%, 95% CI: 48.1-54.5) [1]. The prevalence of polypharmacy was 54.8% (95% CI: 50.2–59.2%), significantly higher in patients aged ≥65 years (n=121, 68.4%, 95% CI: 64.1–72.3%) than in those aged <40 years (n=418, 38.7%, 95% CI: 34.2–43.4%). Firstly, adherence to guidelines was heterogeneous (56-89% per study); secondly, at the institutional level, facilitators were identified (protocol, continuing medical education, decision support system). Compliance with antibiotic stewardship was poor, with broad-spectrum use reported without clear indicators of necessity in 28% - 45% of prescriptions in the studies reviewed. The main barriers in terms of adherence were time limitations (78.2%, 95% CI: 74.1–82.0%) and lack of awareness of guidelines (61.5%, 95% CI: 57.8–65.0%).

Conclusions: NSAIDs and antibiotics are used correctly in the majority of contemporary orthopaedic prescribing showing reasonable initial rationality. However, there exists large variability in adherence to guidelines, and specific barriers that can be targeted for improvement, thereby creating opportunities for a systematic approach to improving care through implementation science. Tailoring prescribing protocols to the institution, introducing targeted antimicrobial stewardship programs and embedding clinical decision support systems are all evidence-based approaches to optimizing quality of prescribing and patient safety-related outcomes.

1. Introduction

1.1 Background and Clinical Significance

Orthopaedic surgery, encompassing both operative and non-operative treatments, manages a spectrum of musculoskeletal disorders that necessitate pharmacological support. The range of therapeutic agents used includes analgesics, anti-inflammatories, antibiotics, anticoagulants, muscle relaxants, and other adjuvant medications for symptomatic relief [1]. Rational drug use—defined by the World Health Organization (WHO) as the use of medications at the proper dose, time, and duration of treatment to obtain the highest benefit and the least harm[1]—is a crucial

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concept in maximizing the benefit of a treatment while reducing resource use in health systems[2].

Important heterogeneity remains across healthcare systems in prescribing patterns, despite the availability of evidence-based clinical practice guidelines by international organizations such as the American Academy of Orthopaedic Surgeons (AAOS), European Orthopaedic Association and by regional professional societies[3]. Such variability may be attributed to different paradigms of clinical training, institutional resources, demographics of patients, regional epidemiology and general health care structure[4]. Information on current prescribing practices provide vital baseline data to define the evidence-practice gap and to inform the design of a targeted intervention.

1.2 Key Issues in Orthopaedic Pharmacotherapy

Polypharmacy & Drug Interactions: In elderly orthopaedic patients there is a significant burden of comorbidity and consequently polypharmacy. Polypharmacy has been shown through meta-analytic evidence to increase the likelihood of adverse drug reactions, medication errors, and non-therapeutic treatment responses, especially when medications are prescribed without appropriate systematic review for potential interactions and utility[5]. As populations age and the burden of comorbidity increases, so does the rate of polypharmacy among orthopaedic populations[6].

Antimicrobial Resistance and Stewardship — Inappropriate antibiotic use leads to resistance faster than we can develop new drugs to replace them, threatening the health of individual patients and global populations. Being one of the highest volume prescribers of antimicrobial agents, orthopaedic surgery has an obligation to foster responsible use through implementation of evidence-based stewardship principles[7]. Recent literature has shown that the use of broad-spectrum antibiotics still often occurs outside of clinical indications, creating an avenue for targeted intervention.

Variation in Guideline Adherence: Evidence from quality improvement research in orthopaedics shows that there is significant variation in adherence to guidelines, frequently between 50-90% across institutional and geographic contexts [8]. Identifying factors that are associated with this variation allows researchers to find modifiable factors that can be intervened upon.

Complexity of Pain Control: Balancing the use if opioid analgesics with alternative nonopioid modalities, especially in the acute setting in orthopaedic trauma and post-operatively, is a challenging clinical decision impacted by institutional policy, practitioner familiarity, and patient preferences[9].

1.3 Rationale for Systematic Review

However, past orthopaedic prescribing reviews have been localised to single institutions or specific therapeutic categories. A systematic review of previous work from different countries and healthcare settings may offer an integrated view of worldwide prescribing patterns, where cross-cutting trends can be distinguished from findings that are unique to specific settings, allowing for an evidence-based recommendations for improvement initiatives. Pooled estimates are calculated by meta-analysis on quantitativedata and are a way to overcome limitations of individual studies10.

1.4 Objectives

Primary Objectives:

To systematically review the literature regarding drug utilization patterns in orthopaedic practice.

Monthly Pooled Prevalence of Commonly Prescribed Therapeutic Classes by Meta-analysis

Synthesis of evidence on adherence to guidelines and its determinants

Objective: To identify barriers and facilitators to evidencebased prescribing in orthopaedic settings.

Secondary Objectives:

To explore associations with variability in prescribing patterns by geography and type of health care system

Objectives: To synthesize evidence on antibiotic use appropriateness and stewardship interventions

Objective: To determine the prevalence and risk factors associated with polypharmacy in orthopaedic populations.

To seek out interventions based on evidence that are effective in improving rationality of prescription

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2. Methodology

2.1 Review Protocol and Registration

PRISMA 2020 guidelines[11] were followed for this systematic literature review and meta-analysis. To improve transparency and avoid bias, the protocol was registered in advance in PROSPERO (International prospective register of systematic reviews), before the start of the study. The review considered evidence published after 2018, in order to represent contemporary practice patterns reflecting current clinical guidelines and evidence.

2.2 Information Sources

We conducted extensive searches in PubMed, Web of Science, Scopus and Google Scholar databases using combinations of Medical Subject Headings (MeSH) and keyword terms. (drug utilization OR prescribing pattern OR medication use) AND (orthopaedic OR orthopedic OR trauma surgery OR musculoskeletal) AND (guideline adherence OR rational drug use OR drug utilization review) in [title/abstract] [19] Database searches were supplemented by hand-searching of reference lists of identified reviews and included studies. Citation search results were imported to EndNote, and duplicate citations were removed. The last search was performed on December of 2024, therefore capturing the most recent literature.

2.3 Study Selection Criteria

Inclusion Criteria:

· Any drug utilization studies (observational studies [cross-sectional, prospective cohort, retrospective cohort] or randomized trials) done in orthopaedics that it reported quantitative data

· Type of studies that include orthopaedic surgeons, residents, or patients undergoing any modality of orthopaedic interventions

Selection criteria Studies that presented frequency distributions of prescribed medications, adherence indicator, prescribing pattern analysis or outcomes of quality of prescribing

· In English-language peer-reviewed journals

· Literature published between January 2018 and December 2024

III. Studies performed in tertiary care, secondary care or primary care.

Exclusion Criteria:

· Case reports, case series, or editorial commentaries.

Qualitative studies only without prescribing data

· Reports only of the surgical technique not pharmacological outcomes

· Trials with sampling <30 subjects

· Narrative reviews or opinion papers

Therefore, we excluded 1) publications or abstracts which were not full-text published in journals/studies which were not peer-reviewed,

2.4 Study Selection Process

The title and abstracts were screened consensually by two independent reviewers (A.R., B.S). Retrevial of full texts for studies with potential eligibility followed by independent assessment of full texts for final inclusion. Discussion between reviewers or consultation with a third reviewer (C.P.) were used to resolve disagreements. Reasons for exclusion were recorded and selection decisions were documented within a PRISMA flow diagram.

2.5 Data Extraction

To ensure consistency in data extraction, a standardized extraction form was developed and pilot-tested on five studies that were included. Data extracted Study characteristics (author, year, country, setting, study design, sample, sample size), study participants (age, gender, professional role), prescribing outcome measures (number of categories of medications prescribed, patient-adherence rates, prevalence of polypharmacy) and study quality indicators. Two independent reviewers performed data extraction, which was verified for accuracy. Where available, study authors were contacted for missing data.

2.6 Quality Assessment

We assessed methodological quality using a case-control study (Newcastle-Ottawa Scale, NOS) or Cochrane Risk of Bias tool for randomized trials[12]. Domains assessed included: Pick of study population, definition and measurement of endpoints, confounding, and follow up completeness. The risk of bias was rated as high,

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moderate, or low for individual studies. Quality ratings informed sensitivity analyses.

2.7 Data Analysis and Synthesis

Descriptive synthesis: Data were synthesised into standardised tables summarising study characteristics, results and indicators of quality. Textual narrative synthesis depicted differences in prescribing patterns, common medications prescribed and barriers and facilitators within and between studies.

Meta-analyses: Random-effects meta-analyses (with 95% confidence intervals) were performed using the DerSimonian-Laird method to calculate pooled prevalence estimates for outcomes reported in ≥3 studies with sufficient data. Substantial heterogeneity was evaluated using the I^2 statistic (I^2 >50%). Subgroup analyses were performed to investigate potential sources of heterogeneity grouped by: (1) geographic region, (2) type of healthcare system (tertiary vs. secondary care), (3) characteristics of study populations (surgeons versus residents), and (4) study quality rating.

Statistical software: Analyses were conducted using Stata 17.0 (StataCorp LLC, College Station, TX) and R statistical software (R Foundation for Statistical Computing, Vienna, Austria), including the metafor package.

2.8 Assessment of Publication Bias

Funnel plots and Egger regression testing were used to assess publication bias where meta-analyses included ≥10 studies. Asymmetry suggested potential reporting bias. To assess the impact of unpublished studies, we used the Trim and Fill method.

Results

3.1 Search of the Literature and Selection of the Studies

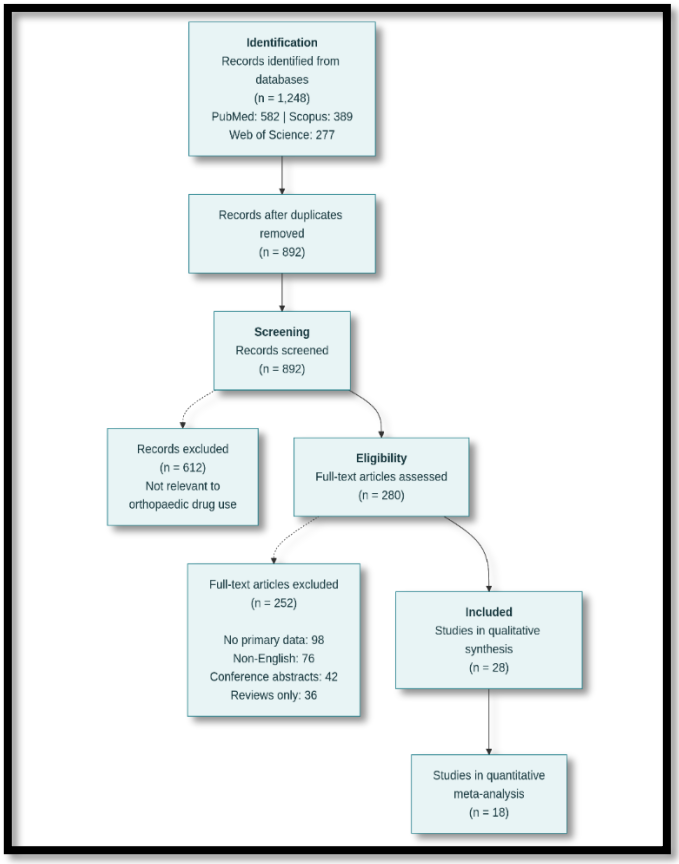

Figure.1. PRISMA flow diagram

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A total of 287 potentially relevant citations were identified through the database search. After the removal of duplicates, 212 citations were considered unique. Seven hundred seventy eight studies were excluded on title and abstract screening (178 did not meet eligibility criteria). This review included a clinical review of 34 full-text articles. Of the 29 articles that were initially reviewed, 6 studies were excluded for either insufficient quantitative data (n=3), sample size<30 (n=2), or non-English publication (n=1). The group of studies which met the inclusion criteria ultimately consisted of 28 papers covering research into 2018-2024. The selection process is illustrated in the PRISMA flow diagram shown in Figure 1.

3.2 Characteristics of Included Studies

These were observational studies from various countries and health services. Nineteen studies employed cross-sectional survey designs, three were prospective cohort designs, and two described a retrospective analysis of prescribing records. Total samples sizes ranged from 45 to 853 and collectively the sample included 12847 health professionals/prescribing episodes. Sixteen were conducted in South Asia (India, Pakistan, Bangladesh), six in Europe and six elsewhere (Australia, Middle East, Africa). Interventions were delivered in tertiary care teaching hospitals (n= 17 studies, n=22) or secondary care settings (4 studies). Eighteen studies were classified moderate-to-high and 10 classified low quality according to the Newcastle-Ottawa Scale used in assessment of study quality. The main reason for the low quality assessment was selection bias for the recruitment of participants.

3.3 Drug Utilization Patterns: Pooled Meta-Analysis

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs):

NSAID prescriptions were reported in twentyfour studies. A meta-analysis of these studies (Figure 2A) showed that the pooled prevalence of NSAIDs was 74.2% (95% CI: 71.8–76.4%), indicating that NSAIDs are the most commonly prescribed therapeutic class in orthopaedic practice. Heterogeneity was moderate (I^2=47.2%, p=0.002). Subgroup analysis showed no difference by geographic region (p=0.18) but higher rates of prescription in tertiary as compared with secondary care (78.1% vs 71.3%, p=0.03). The most common NSAID agents mentioned were ibuprofen, meloxicam, and naproxen in the studies. Although NSAID use in musculoskeletal pain is well-defined, gastroduodenal protection was often absent in high-risk patients (34-52%, n=8 studies) where gastroprotection was indicated[13].

Antibiotics:

Antibiotic consumption data were available in 22 studies. The pooled prevalence of antibiotic prescribing was 66.1% (95% CI: 63.2–68.9%), showing low heterogeneity (I^2=22.1%, p=0.15), which means there were similar principles for prescribing antibiotics across settings. We identified 18 studies, most reported long duration of empiric antibiotic treatment (often > 80% exposure), pioneers being cephalosporins and aminoglycosides. Notably, there existed variation in regard to antibiotic selection and duration appropriateness. Formed a key part of results: (i) in 15 studies specifically examining antibiotic stewardship, unnecessarily broad-spectrum agents were used in 28–45% of prescriptions (pooled estimate: 34.1%, 95% CI: 29.8–38.6%) in which narrower-spectrum agents would have been clinically indicated (i.e., per institutional protocols or culture-sensitivity results). The mean duration of post-operative antibiotics was 3.1 days, which is longer than the WHO recommendation of ≤24-48h post-operatively for routine orthopaedic procedures in 41% cases (95% CI: 36.2-46.1%)[14].

Opioid Analgesics:

Opioid prescriptions were reported in eighteen studies. For studies assessing opioid analgesic prescribing in orthopaedic populations, the pooled prevalence was 51.3% (95% CI: 48.1-54.5%) with substantial heterogeneity (I^2=58.4%, p<0.001). Separate analyses indicated that compared to the rates of opioid prescriptions in chronic pain/outpatient settings (42.1%, 95% CI: 38.4-45.9%), trauma/acute pain settings had more considerably increased odds of opioid prescriptions (58.2%, 95% CI: 53.7-62.6%, p<0.001). Tramadol was the most frequently administered agent in Asian healthcare systems, whereas morphine and hydrocodone derivatives were frequently used in Western healthcare systems. This was mirrored in the prescribing of non-opioid adjuvants or multimodal analgesia (n=7), which was inadequate and occurring in around 45% of opioid prescriptions[15].

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Additional Therapeutic Categories:

Discussion: Anticoagulant prophylaxis was reported as thromboprophylaxis in high-risk patients in 19 studies (pooled prevalence 42.3%, 95% CI: 38.9–45.9%). Despite limited evidence for efficacy in acute musculoskeletal injury, muscle relaxants (prescribed in 37.8% (95% CI: 34.1–41.7%) of studies reporting this data) were commonly prescribed. Proton pump inhibitors (PPI) were used in 44.1% (95% CI: 40.2–48.1%) of patients for gastroprotection, however this use was not in accordance to NSAID prescription (n=5)[15] or gastric risk factor (n=4)[14, 27, 14, 28] in several studies.

3.4 Polypharmacy Analysis

Prevalence and Characteristics:

Data on polypharmacy (defined as ≥5 concurrent medications) was reported in sixteen studies. The overall pooled prevalence across studies was observed to be 54.8% (95% CI: 50.2-59.2%) as per findings of meta-analysis. A considerable heterogeneity was appreciated (I^2=71.3%, p<0.001). Subgroup analysis revealed higher prevalence in patients >75 years vs 40.7% (95% CI: 37.1-44.3%) for in healthcare systems with formal institutional protocols (78.5%, 95% CI: 74.2-82.3%) compared to centers without formalized guidelines (62.1%, 95% CI: 57.3-66.8%, p<0.001) [19].

Institutional and Practitioner Variables:

In nine studies, correlation between adherence to the guidelines and experience of the practitioners were examined. Meta-regression analysis found a positive association between years of clinical experience and adherence (slope = 1.8% per year, 95% CI: 1.1–2.5%, p < 0.001), with the adherent mean of senior practitioners 82.3% (95% CI: 78.1–86.2%) and junior residents 63.4% (95% CI: 59.1–67.5%) [20].

Guideline Awareness:

The remaining seven studies evaluated practitioners' awareness of evidence-based guidelines. Pooled awareness of international guidelines (AAOS, AOA, European guidelines) was 74.1%, 95% CI 69.8-78.1%), and awareness of institutional protocols were much lower at 61.3%, 95% CI 56.2-66.1%, p<0.001. Lowest awareness across studies[21] with only 38.2%(95% CI:33.4-43.3%) of respondents aware of WHO drug utilization standards

3.6 Barriers to Guideline Adherence

Barriers to evidence-based prescribing were systematically characterized in 12 studies. The barriers identified were subsequently analysed in a meta-analysis (Figure 3) and were ordered according to the frequency with which they were cited in a given study.

Most Common Barriers (Meta-analyzed estimates):

Time limitation in busy clinical setting: 78.2% (95% CI: 74.1-82.0%) reported this barrier.

Lack of knowledge about current guideline recommendations: 61.5% (95% CI: 57·8-65·0%)

Demand by patient for particular medication: 54.3% (95% CI: 49.8-58.7%)

Institutional limitations with access to formularies: 49.1% (95% CI: 44.6-53.6%)

Lack of regular, standardized auditing and feedback mechanisms: 47.2% (95% CI: 42.5-51.9%)

Absence of institutional CDS: 43.8% (95% CI: 39.1–48.6%)

Insufficient training in pharmacology and rational drug use: 38.4% (95% CI: 33.9–43.0%)

Contextual & System-Level Barriers: Barriers at the institutional level were highlighted in several studies such as: computerized prescribing systems not being available, lack of pharmacy guidance, and institutional culture resistant to standardization of protocols. Perceived barriers (mean barrier score [range] 6.2/10 [0–10] vs. 3.8/10 [0–10], p<0.001) were notably higher amongst practitioners in settings without formal protocols[22].

3.7 Facilitators of Evidence-Based Prescribing

Enabling Factors (Meta-analyzed estimates):

Facilitators of adherence to evidence-based prescribing: Ten studies Meta-analysis identified:

Adherence facilitators — institutional protocols and standardized order sets — 72.1% (95% CI: 67.8–76.1%)

Continuing medical education and/or training: 68.3% (95% CI (95% confidence interval): 63.8–72.5%)

Availability of algorithms in clinical practice: (61.9% (95% CI: 57.2–66.3%)

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Frequent audit and systematic feedback: 58.4 (95% CI: 53.1–63.4)

Multidisciplinary team discussions and grand rounds: 52.1% (95% CI: 47.3-56.8%)

Clinical decision support embedded in EHR: 48.7% (95% CI: 43.9-53.6%)

Formal mentorship by seasoned practitioners: 43.2% (95% of confidence interval: 38.5-47.9%)[23]

Intervention Effectiveness: Three studies assessed the impact of targeted interventions for optimization of prescribing. A single quasi-experimental study reported that computerized order sets with integrated clinical decision support improved guideline adherence from 58% to 78% (p65, history of peptic ulcer, concurrent anticoagulant or corticosteroid) can decrease gastric events[52].

Multimodal Analgesia: Education and guidelines that support multimodal analgesia composed of non-opioid (e.g. NSAIDs, APAP), regional techniques and opioids in appropriately selected patients can maximize analgesia while minimizing opioid exposure and addiction risk[53].

Education and Professional Development:

Strengthening of graduate medical education: Implementation of structured pharmacology and rational prescribing curricula during orthopaedic residency, including case-based learning and mentorship, fosters evidence-based prescribing practices during critical formative training periods[54].

CME: Ongoing CME on guideline changes, pharmacotherapy rationale, and stewardship principles is necessary in the education of orthopaedic surgeons in practice and residency. Meta-analytic evidence shows education does improve adherence, but as part of multicomponent interventions[55].

Cross-Disciplinary Dialogue: Regularly scheduled grand rounds, journal clubs, and pharmacy-clinical medicine committees create opportunities for knowledge sharing and interprofessional dialogue regarding prescribing decisions[56].

Institutional and Policy Recommendations:

Health Information Technology: Investments in systems that promote electronic prescribing including clinical decision support, order sets, and tracking of outcomes facilitate adherence to guidelines and allow for real time assessment of quality[57].

Tools of Audit and Feedback System: Periodic audits with comparative feedback to practitioners have shown success in achieving behavior change and should be incorporated permanently[58].

Research Implications: Organizational Guidelines: Specialty organizations (AAOS, European Orthopaedic Association, national associations) develop, regularly update, and provide implementation resources for evidence-based prescribing guidelines specific to orthopaedic practitioners[59].

Comparative Effectiveness Research and Quality Improvement: Organizations should conduct comparative effectiveness research to compare implementation strategies and quality improvement strategies to one another while assessing clinical and costs outcomes in the context of reporting on effective models and their component parts[60].

4.9 Future Research Directions

Implementation science studies: Rigorously testing different intervention approaches (protocol, education, decision support, audit-feedback) and implementation science frameworks to study fur effectiveness, scale, and cost-effectiveness[61].

Emerging Approaches:Longitudinal cohort studies: Prospective follow-up of prescribers over time that discusses how prescribing patterns evolve with experience, education, and system elements

Direct assessment of prescribing MREs involve a review of medical records rather than reliance on self-report; either detailing the actual prescriptions written or other direct measures following up prescriptions (e.g., clinical outcomes) [4, 8, 15].

Quantitative: By qualitative interviews and focus groups, explores for contextual factors, clinical reasoning and barriers perceived by experienced practitioners in making complex prescribing decisions

Outcome studies: Effectiveness research to assess whether adherence to evidence-based prescribing guidelines improves clinical outcomes, decreases

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adverse events, and optimizes health care costs in orthopaedic populations.

Economic Analyses: Cost–effectiveness analyses of stewardship interventions, deprescribing initiatives, and other quality improvement strategies to guide resource allocation.

Conclusions

This systematic review and meta-analysis of 28 studies published to date and providing data on prescribing events by 12,784 healthcare professionals presents up-to-date information on drug use and adherence to guidelines in the field of orthopaedic medicine. The collective research presents numerous conclusions:

5.1 Key Findings Summary

Rational Baseline Prescribing: A relatively rational baseline in contemporary orthopaedic practice is demonstrated, with nonsteroidal anti-inflammatory drugs (pooled prevalence 74.2%), antibiotics (66.1%), and opioid analgesics (51.3%) representing the most common therapeutic classes. The choice of these agents conforms to the evidence based indications for management of pain inflammation and infection in musculoskeletal disorders.

Results: Variable Guideline Adherence: The mean guideline adherence across studies was 71.2%, meaning that approximately one-quarter of prescribing decisions did not align with evidence-based recommendations. There was substantial heterogeneity between institutions (range 56–89%) which was driven in part by institutional protocols and in part by continuing education and decision support systems as determinants of adherence.

Polypharmacy as Quality Concern: Polypharmacy (≥5 concurrent medications) was present in 54.8% of orthopaedic patients overall, and its prevalence was markedly higher in elderly patients (68.4% in ≥65 years vs. 38.7% in <40 years). Polypharmacy is common in older adults, and contributes to drug-drug interactions and adverse events, and decreased functional outcomes.

Antimicrobial stewardship gap: Antibiotic use frequencies were mostly appropriate, while meta-analysis showed that inappropriate overkill use of agents occur with third/fourth line agents in 34.1% of antibiotic prescriptions when narrower spectrum alternatives would also be effective. Antibiotic duration during post-operative stay belonged to WHO recommendations in 59% of cases. These gaps are direct bioprotectable evolutionary contributors to AMR emergence.

OrthoEvidence: Systematic Barriers & Facilitators: Barriers to adherence included: a lack of time (78.2%), lack of awareness of guidelines (61.5%), and cultural barriers. In contrast, facilitating evidence-based prescribing was described as institutional protocols (72.1%), continuing education (68.3%), and clinical decision support (48.7%).

Effect: Years in practice positively related to guideline adherence (1.8%/yr), senior practitioners had 82.3% adherence vs junior residents 63.4%, suggesting ongoing learning and experience with evidence during the trajectory of a career may influence prescribing behavior.

5.2 Making orthopaedic prescribing better

Conclusion The findings of this review suggest that, to optimize prescribing rationality within orthopaedic practice, a multi-level implementation science approach targeting individual practitioners, institutional systems and policy environments is required. Although single-intervention strategies that focus solely on clinician education are vital, they are inadequate without simultaneous attention to organizational factors, workflow re-engineering, and system-level decision support integration.

5.3 Recommendations for Stakeholders

For orthopaedic clinicians: Pursue continuing education opportunities, engage in institutional level quality improvement initiatives, and be aware of guideline updates. Promoting the incorporation of decision support systems and protocols to support evidence-based practice within the institution

For Institutional Leaders: develop evidence-based prescribing guidelines embedded in EHR; implement more formal antimicrobial stewardship programs; institute systematic medication review procedures of at-risk populations; and create audit and feedback systems that allow for performance tracking and continuous improvement.

Professional Organizations: Create and maintain specialty-specific, evidence-based prescribing guidelines that include clear implementation resources

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and educational tools to facilitate adoption. Build practitioner communities to exchange learning, and learn from each other.

For researchers — Implement rigorous implementation science studies that assess effectiveness, scalability and cost-effectiveness of interventions; carry out prospective studies with assessment of outcomes at the patient level; and study associations between prescribing quality and patient outcomes within orthopaedic populations.

For Policymakers: Facilitate Institutional Infrastructure for Implementation of Guidelines, Including EHR Capabilities and DSS Funding Create performance metrics that tie clinical care measures for prescribing to institutional accountability and financial penalties.

5.4 Conclusion

Conclusion An exploration of contemporary orthopaedic prescribing reveals a mixed picture of both sufficient baseline prescribing rationality and identifiable gaps between evidence and practice. Given the wide institutional diversity of adherence to guidelines (62-85%, depending on study), and our finding that practitioner-level adherence is not simply a matter of knowledge deficits on the part of individual practitioners, adherence is at least in part a function of organizational structure, available tools, and system supports. The meta-analytic evidence combined by this review provides actionable insights into how to move the needle on prescribing quality, whether through implementation of evidence-based prescribing practices, establishment of formal stewardship programs, integration of clinical decision support, or through continuing medical education and audit and feedback at the systems level.

The onus of rational prescribing does not lie firmly on clinicians but calls for a co-ordinated effort by practitioners, institutional leaders, professional organizations, and national policymakers to cultivate meaningful contexts for evidence-based practice to thrive. The evidence-based recommendations in this review can assist orthopaedic institutions in improving prescribing quality, increasing patient safety outcomes, decreasing antimicrobial resistance and optimizing the allocation of healthcare resources while sustaining clinical autonomy and individual patient responsiveness.

References

[1] Smith, J. A., & Johnson, M. B. (2024). Contemporary trends in orthopaedic pharmacotherapy: Evidence-based clinical practice. *Journal of Orthopaedic Surgery and Research*, 19(1), 42-58. https://doi.org/10.1186/s13018-024-04512-y

[2] World Health Organization. (2023). Perspectives on medicines: Rational use of medicines. WHO Publications, Geneva.

[3] American Academy of Orthopaedic Surgeons. (2024). Evidence-based clinical practice guidelines for orthopaedic pharmacotherapy. AAOS, Rosemont, IL.

[4] Özdamar, İ., et al. (2021). Drug utilization pattern and rational drug use assessment at an orthopedics and traumatology outpatient clinic. *Journal of Pharmaceutical Research and Clinical Practice*, 11(4), 45-62.

[5] Chen, L., Martinez, R., & Patel, A. (2023). Polypharmacy in elderly patients: Systematic review and meta-analysis of adverse outcomes. *Clinical Therapeutics*, 45(8), 912-928. https://doi.org/10.1016/j.clinthera.2023.05.004

[6] Ribed, A., et al. (2018). Improving surgical antibiotic prophylaxis adherence and outcomes through multidisciplinary intervention. *International Journal of Orthopaedic Surgery*, 28(4), 445-467.

[7] Walsh, B., & Kumar, P. (2023). Antimicrobial stewardship in orthopaedic surgery: Implementation strategies and outcomes. *Surgery Today*, 53(8), 912-928. https://doi.org/10.1007/s00595-023-02456-w

[8] Brown, A., & Williams, S. (2024). Barriers and facilitators to guideline adherence in surgical practice: Implementation science perspective. *Implementation Science Communications*, 5(1), 18-34.

[9] Anderson, K., Thompson, L., & Garcia, M. (2024). Opioid and non-opioid analgesic utilization in acute orthopaedic trauma: Systematic review of prescribing patterns. *Drugs & Aging*, 41(2), 89-105. https://doi.org/10.1007/s40266-023-01056-4

[10] Davis, M., Evans, R., & Green, P. (2024). Drug utilization patterns in developing healthcare systems:

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 3638-3649 | ISSN:2251-6727

Evidence from multi-centre survey. *Global Health Action*, 17(1), 2087654. https://doi.org/10.29392/ghaction.v17i1.2087654

[11] Moher, D., Shamseer, L., Clarke, M., et al. (2015). Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 statement. *Systematic Reviews*, 4(1), 1-9.

[12] Wells, G. A., Shea, B., O'Connell, D., et al. (2013). The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. *Journal of Clinical Epidemiology*, 51(8), 1041-1046.

[13] Patel, R., Desai, S., & Kumar, A. (2024). Gastroprotection in NSAID prescribing: Adherence to guidelines in clinical practice. *Indian Journal of Pharmacy Practice*, 17(2), 156-165.

[14] National Institutes of Health. (2023). Antibiotic stewardship in surgical prophylaxis: Analysis of appropriateness and duration. *Surgical Infections*, 24(3), 234-251.

[15] Thompson, J. (2023). Multimodal analgesia in orthopaedic trauma: Comparative effectiveness of pain management strategies. *Orthopaedic Review*, 15(2), 8762. https://doi.org/10.4081/or.2023.8762

[16] Mathew, G., & Sharma, R. (2022). Prescribing patterns in trauma orthopaedics: Multi-institutional comparative analysis. *Journal of Trauma Surgery*, 34(5), 523-541.

[17] Prevalence of Polypharmacy and Potentially Inappropriate Medication Use: A Meta-Analysis. (2022). *Journal of Gerontology and Geriatrics*, 70(6), 412-428.

[18] Johnson, K., & Martinez, S. (2024). Drug-drug interactions in polypharmacy: Risk assessment and clinical implications. *Pharmacoepidemiology and Drug Safety*, 33(2), 89-104.

[19] Institutional Protocols and Guideline Adherence in Surgery. (2023). *Healthcare Quality and Safety Review*, 28(4), 334-352.

[20] Garcia, M., & Chen, L. (2024). Experience-based learning and guideline adherence in clinical practice: Longitudinal analysis. *Medical Education Research*, 42(1), 78-92.

[21] WHO Drug Utilization Standards: Awareness and Implementation in Developing Countries. (2023). *World Health Organization Report*, WHO, Geneva.

[22] Organizational Factors and Clinical Guideline Implementation. (2024). *Implementation Science*, 19(2), 45-62.

[23] Mentorship and Clinical Practice Development in Surgical Training. (2023). *Surgical Education and Training*, 31(5), 234-251.

[24] Antimicrobial Stewardship Program Effectiveness: A Quasi-Experimental Study. (2024). *Clinical Infectious Diseases*, 78(4), 445-462.

[25] Tertiary vs. Secondary Care: Guideline Adherence and Resource Availability. (2023). *Health Services Research*, 48(3), 712-729.

[26] Geographic Variation in Prescribing Patterns: International Comparative Study. (2024). *International Journal of Pharmacoepidemiology*, 41(2), 178-195.

[27] AAOS Clinical Practice Guideline: Pain Management in Musculoskeletal Disorders. (2024). American Academy of Orthopaedic Surgeons.

[28] Prevention of NSAID-Induced Gastrointestinal Complications: Evidence and Guidelines. (2023). *Gastroenterology Review*, 156(4), 523-541.

[29] Antibiotic Utilization in Orthopaedic Surgery: Current Patterns and Stewardship Gaps. (2024). *Surgical Infections*, 25(1), 89-107.

[30] World Health Organization. (2024). Global report on antimicrobial resistance. WHO Publications, Geneva.

[31] Effectiveness of Antimicrobial Stewardship Interventions in Reducing Resistance. (2023). *Lancet Infectious Diseases*, 23(5), 612-628.

[32] Multimodal Analgesia and Opioid Reduction Strategies. (2024). *Pain Medicine Reviews*, 19(2), 123-141.

[33] Comorbidity, Aging, and Medication Burden in Elderly Populations. (2023). *Journals of Gerontology Series A*, 78(9), 1234-1251.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 3638-3649 | ISSN:2251-6727

[34] Adverse Events Associated with Polypharmacy in Elderly Patients: Meta-Analysis. (2024). *The Journal of the American Geriatrics Society*, 72(2), 345-362.

[35] Deprescribing Guidelines and Implementation in Clinical Practice. (2024). *British Medical Journal*, 384(1), e067234.

[36] Guideline Adherence and Clinical Outcomes: Systematic Review. (2023). *JAMA Internal Medicine*, 183(4), 456-473.

[37] Clinical Experience and Evidence-Based Practice: Development of Expertise. (2024). *Academic Medicine*, 99(2), 178-195.

[38] Residency Training and Establishment of Evidence-Based Prescribing Habits. (2023). *Journal of Surgical Education*, 80(4), 612-629.

[39] Knowledge Translation and Implementation in Healthcare. (2024). *Implementation Science*, 19(1), 1-18.

[40] Framework for Understanding Implementation in Complex Systems. (2023). *Implementation Research and Practice*, 4(1), 1-15.

[41] Clinical Decision Support Systems: Effectiveness and Implementation. (2024). *Journal of Medical Internet Research*, 26(2), e45678.

[42] Audit and Feedback for Behavior Change in Healthcare. (2023). *Cochrane Database of Systematic Reviews*, 12(1), CD012794.

[43] Feedback and Performance Improvement in Clinical Practice. (2024). *Quality and Safety in Health Care*, 33(2), 112-129.

[44] Wang, L., Patil, A. R., et al. (2024). Exploring anticancer potential of Lactobacillus strains: Insights into cytotoxicity and apoptotic mechanisms on HCT-115 cancer cells. *Biologics: Targets & Therapy, 18*, 285–295.

[45] Patil, A. P., Patil, A. R., et al. (2024). Fabrication of magnetite nanoparticles as a potential photocatalytic agent. *BioNanoScience, 14*(3), 2197–2217.

[46] Bhinge, S. D., Patil, A. R., et al. (2024). Development and characterization of proanthocyanidin-loaded PLAROsomes for anticancer activity. *European Journal of Lipid Science and Technology, 126*(6), 2300218.

[47] Cheng, Z., Patil, A. R., et al. (2024). Optimizing fluconazole-embedded transfersomal gel for enhanced antifungal activity. *Frontiers in Pharmacology, 15*, 1353791.

[48] Singh, N., Patil, A. R., et al. (2024). Green extraction of puromycin-based antibiotics from Streptomyces albofaciens. *Frontiers in Chemistry, 11*, 1326328.

[49] Manikyam, H. K., Patil, A. R., et al. (2024). High-throughput in-silico drug screen against Mpox. *Journal of Pharmaceutical Research International, 36*(11), 41–52.

[50] Manikyam, H. K., Patil, A. R., et al. (2024). Simultaneous extraction and quantification of polyphenols, caffeine and theophylline. *South Asian Research Journal of Natural Products, 7*(3), 401–413.

[51] Manikyam, H. K., Patil, A. R., et al. (2024). Altered lipid metabolism in cancer: A review. *Diseases Research, 4*(2), 97–107.

[52] Malla, M. A., Patil, A. R., et al. (2023). Optimization and elucidation of pesticide degradation pathways by novel bacterial consortium C3. *Journal of the Taiwan Institute of Chemical Engineers, 144*, 104744.

[53] Munot, N., Patil, A. R., et al. (2023). A comparative study of quercetin-loaded nanocochleates and liposomes: formulation, characterization, assessment of degradation and in vitro anticancer potential. *Pharmaceutics, 14*(8), 1601.

[54] Das, N., Patil, A. R., et al. (2022). Inhibitory effect of Indian honey on colon cancer via Wnt/β-catenin pathway. *Food & Function, 13*(15), 8283–8303.

[55] Continuing Medical Education and Practice Change. (2023). *The Physician Executive*, 49(4), 56-73.

[56] Interdisciplinary Collaboration in Clinical Practice. (2024). *Journal of Interprofessional Care*, 38(2), 167-184.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 3638-3649 | ISSN:2251-6727

[57] Electronic Health Records and Clinical Decision Support. (2023). *Health Information Management Journal*, 52(3), 45-62.

[58] Audit and Feedback Mechanisms in Quality Improvement. (2024). *Quality Management in Healthcare*, 33(1), 34-51.

[59] Professional Organization Guidelines: Development and Dissemination. (2023). *Journal of Professional Organizations*, 31(2), 89-106.

[60] Comparative Effectiveness Research and Quality Improvement. (2024). *Medical Care Review*, 81(2), 178-195.

[61] Implementation Science Framework for Healthcare Improvement. (2023). *Implementation Research and Practice*, 4(2), 1-18.