



REVIEWS

Strategic Pharmaceutical Procurement for Surgical Care in Public Hospitals: A Scoping Review of Health System Architecture and Payment Reforms

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Keywords

Strategic Purchasing • Pharmaceutical Procurement • Procurement Models • Hospital Purchasing • Payment Reforms • Bundled Payments • Health Financing • Public Hospitals

Summary

Background. Rising surgical expenditures challenge the financial sustainability of public health systems. Pharmaceutical procurement is an important component of surgical care, but procurement choices are shaped by financing, governance, pricing policy, and provider-payment incentives. This scoping review mapped pharmaceutical procurement strategies used in public hospital surgical care and examined how health system architecture and payment reforms influence their design and implementation.

Methods. We conducted a scoping review following PRISMA-ScR and a prospectively registered protocol. PubMed, Scopus, and Web of Science were searched for English-language literature published from 1 January 2018 through 31 December 2025 using a Population-Concept-Context framework. Forty-three sources were included after duplicate removal, title/abstract screening, and full-text assessment. Procurement mechanisms, pricing and reimbursement levers, provider-payment arrangements, health system context, and reported outcomes were charted and synthesized narratively.

Results. Two broad and overlapping patterns were identified. Centralized and pooled procurement approaches, including

national or regional tendering and group purchasing, remain the dominant mechanisms for obtaining price and volume advantages. Value-oriented procurement is less mature and is typically enabled by broader payment reforms rather than functioning as a payment model itself. In particular, bundled and episode-based payments can shift hospital incentives from minimizing pharmaceutical acquisition prices toward managing total episode cost and outcomes. The evidence base is concentrated in high-income settings, and direct evidence linking bundled payment to selection of surgical pharmaceuticals remains limited.

Conclusion. Strategic pharmaceutical procurement is context-dependent and should be aligned with health system governance, pharmaceutical pricing policy, and provider-payment incentives. The evidence supports an adaptive approach in which high-volume, substitutable products are suited to competitive or pooled procurement, whereas higher-cost or outcome-sensitive products may require value assessment, negotiated agreements, and stronger clinical-data infrastructure. These conclusions should be interpreted cautiously because the evidence is heterogeneous and predominantly descriptive.

Introduction

Globally, healthcare expenditures are increasing at an unsustainable rate, placing substantial pressure on public finances [1]. The hospital sector accounts for the largest share of these expenditures and represents approximately 31% of national health spending in a high-cost country such as the United States [2]. Within the hospital setting, costs associated with surgical care are a major contributor to resource utilization. Common inpatient surgical procedures such as knee and hip arthroplasty, cesarean section, cholecystectomy, and coronary artery bypass grafting are performed at high volumes and are inherently resource-intensive [3]. One important yet often underestimated component of these costs is pharmaceutical expenditure, which encompasses a wide range of medications essential to the preoperative phase of care, including anesthetic agents, prophylactic antibiotics, anticoagulants, analgesics, and other specialty pharmaceuticals [4].

Public hospitals, which constitute the backbone of service delivery in many national health systems, are at the forefront of efforts to manage these rising costs while maintaining or improving the quality of care [5]. In this context, the methods used to purchase or procure pharmaceuticals are not merely administrative functions; rather, they represent critical strategic levers for achieving efficiency and value [6]. However, the procurement strategies available to a public hospital are not determined in isolation. They are path-dependent and heavily influenced by the institutional architecture of the national health system [7]. The financing mechanisms (*e.g.*, general taxation versus social health insurance), provider payment models (*e.g.*, FSS versus bundled payments), and governance structures (*e.g.*, centralized versus decentralized) of a health system create a unique set of incentives and constraints that determine which procurement models are feasible and effective [8]. For example, the procurement approach adopted in a centrally funded single-payer system such as the

United Kingdom's National Health Service is inherently different from that of a fragmented, multi-payer social health insurance system such as Germany's [9].

An important observation from the outset is the profound interdependence between the methods used to reimburse healthcare providers for surgical services and the approaches employed to procure essential inputs, such as pharmaceuticals. In traditional FFS systems, where hospitals are reimbursed separately for each service and episode of care, the prevailing financial incentive is to minimize the unit cost of each input. Such an environment naturally favors procurement strategies such as competitive tendering, in which the primary objective is to secure the lowest possible price for each vial, tablet, or pharmaceutical product [7].

However, the global transition toward value-based healthcare has introduced Alternative Payment Models (APMs) such as bundled and episode-based payments, which provide a single comprehensive payment for an entire episode of care. Under these arrangements, hospitals assume financial responsibility for the total cost of the care episode [10]. This fundamentally alters the procurement calculus. The incentive shifts from minimizing the cost of individual inputs to minimizing the total cost of the entire episode of care. Consequently, a medication with a higher acquisition cost that results in fewer complications, shorter lengths of stay, or lower readmission rates may become the most economically rational choice, even though it would appear less attractive under a conventional FFS framework [11].

Although extensive literature evaluates the clinical and financial effects of alternative payment models, their implications for pharmaceutical procurement have not been synthesized consistently. The present review therefore treats procurement mechanisms, pharmaceutical pricing/reimbursement levers, and provider-payment models as analytically distinct but interacting domains. This distinction is important because a bundled payment does not itself purchase a medicine; instead, it changes the financial incentives under which hospitals make procurement and formulary decisions. The review maps the available evidence, identifies dominant procurement patterns, and examines where payment reform may create conditions for more value-oriented purchasing.

The primary objective of this review is to identify, map, and synthesize the literature on pharmaceutical procurement strategies relevant to common surgical procedures in public hospitals. The secondary objectives are to:

- Categorize the identified procurement strategies into a coherent typology (e.g., volume-based models emphasizing economies of scale versus value-based models focusing on clinical outcomes).
- Analyze the relationship between a country's overarching health system architecture (classified by financing and delivery structures) and the specific pharmaceutical purchasing strategies employed.
- Identify critical knowledge gaps within the current literature to inform future research agendas for

policymakers, hospital administrators, and health services researchers.

- Propose the core components of an evidence-based strategic purchasing model that is adaptable across diverse health system contexts.

Conceptual Framework for Analyzing Pharmaceutical Procurement

DEFINING STRATEGIC PURCHASING IN SURGICAL CARE

In health economics, strategic purchasing extends beyond the administrative act of procurement. It is a proactive, evidence-informed process through which purchasers seek to maximize health-system value for available resources [12]. For surgical pharmaceuticals, this requires attention to acquisition price, quality, supply continuity, downstream clinical outcomes, and total episode cost. To avoid conceptual overlap, this review distinguishes three interacting layers: (1) direct procurement mechanisms used to acquire medicines; (2) pricing and reimbursement levers that influence the net price or coverage conditions of medicines; and (3) provider-payment mechanisms that alter hospital incentives but are not procurement mechanisms themselves.

Direct volume-based procurement mechanisms: These strategies aggregate demand or competition to reduce unit prices and improve purchasing leverage. Key examples include:

- Tendering: A formal procedure where suppliers are invited to bid for a contract to supply specific goods. This can be open (accessible to all qualified suppliers) or restricted (invitation-only) [13].
- GPOs: Entities that aggregate the purchasing volume of multiple member institutions (e.g., a network of hospitals) to negotiate discounts from manufacturers and distributors that individual members could not secure independently [14].
- Direct value-oriented procurement mechanisms: These approaches link purchasing or contractual terms more explicitly to expected value, uncertainty, or observed performance. A key example is:
 - Outcome- or performance-linked purchasing: Contracts may condition price, rebate, reimbursement, or continued coverage on predefined clinical, utilization, or economic outcomes. Such arrangements are most relevant for high-cost products when uncertainty about real-world value is substantial [16].
- Risk-sharing and managed-entry agreements: These are negotiated arrangements between purchasers/payers and manufacturers that may include financial rebates, expenditure caps, price-volume terms, or performance-based conditions. Financial agreements should be distinguished from true outcome-based agreements because the former can lower net prices without requiring outcome measurement [56–58].
- Provider-payment mechanisms (enabling

environment): Bundled and episode-based payments are not pharmaceutical procurement models. They are provider-payment arrangements that make hospitals or provider organizations financially accountable for a defined episode of care. By exposing providers to total episode cost, these models can change formulary and procurement incentives, including the willingness to select a higher-acquisition-cost medicine when it plausibly reduces complications, length of stay, or readmissions. CMS BPCI Advanced, launched in 2018, is a prominent example of this incentive structure; however, direct evidence on medication-level selection effects remains limited [59, 60].

- **Pricing, reimbursement, and regulatory levers:** These system-level mechanisms shape the prices and conditions under which procurement occurs. They include external and internal reference pricing, health technology assessment and value-based pricing, formulary management, direct price negotiation, tendering, pooled procurement, and confidential discounts or rebates. WHO guidance emphasizes that external reference pricing is commonly combined with negotiation and depends on reliable price information, while OECD analyses note that confidential rebates can create a gap between list and net prices and complicate international price comparisons [56–58]. These levers should therefore be interpreted as part of the policy environment surrounding procurement rather than as interchangeable procurement models.

HEALTH SYSTEM TYPOLOGY AND PATH DEPENDENCY

The procurement strategies available to a hospital or purchasing agency are not formulated in a vacuum; they are heavily influenced by the overarching architecture of the national health system. Based on established health

policy frameworks [7], these systems can be broadly categorized according to their primary financing and service delivery arrangements (Tab. I).

A country's health system classification is not merely a descriptive label. It reflects a deep institutional architecture that has evolved over decades. This structure creates a "path dependency", making certain policy choices including those related to procurement more natural or feasible than others. For instance, a system funded by a single government entity through general taxation possesses an inherent capacity for centralized, single-payer purchasing. Conversely, a system funded by hundreds of quasi-private sickness funds lacks this centralized capability but may offer a more fertile, competitive environment for innovative, value-based contracting between payers and providers. Recognizing this institutional path dependency is critical for understanding why specific procurement models succeed or fail in different global contexts.

METHODS

This scoping review followed a predefined protocol and was reported in accordance with PRISMA-ScR. The protocol was prospectively registered on the Open Science Framework (OSF) to support transparency and reproducibility [20, 23]. The review question and eligibility criteria were structured using the Population-Concept-Context (PCC) framework in line with Joanna Briggs Institute guidance. The three PCC components were:

- **Population:** The review included studies focusing on public or publicly funded hospitals. Studies exclusively examining pharmaceutical procurement in private, for-profit hospital systems were excluded to maintain a strict focus on the public sector context.
- **Concept:** The core concept was pharmaceutical

Tab. I. Characteristics of National Health System Models.

Health System Domain	Beveridge Model (e.g., UK, Spain)	Bismarck Model (e.g., Germany, France)	National Health Insurance (e.g., Canada, South Korea)	Out-of-Pocket Model (e.g., Many low- and middle-income countries (LMICs))
Financing	General taxation. Government acts as the single payer [9, 18].	Mandatory payroll contributions to non-profit "sickness funds" [18, 19].	Government-run insurance program with universal premiums. Single payer [18, 19].	Direct patient payments at the point of care. Minimal risk pooling [18, 19].
Service Delivery	Predominantly public institutions. Many physicians are government employees [9, 19].	Mix of public and private (often non-profit) providers [18, 19].	Predominantly private sector providers funded by public insurance [19].	Mix of public, private, and informal providers [18].
Access Level	Universal access as a right of citizenship [19].	Universal access guaranteed, but tied to employment or fund membership [19].	Universal access guaranteed for contributing citizens [19].	Access strictly dependent on individual ability to pay [19].
Key Implication for Purchasing	High potential for centralized monopsony power and national tendering [7].	Decentralized purchasing creating a fragmented market. Fosters GPO development [7].	Single-payer insurer holds strong price negotiation leverage, but provider purchasing remains fragmented [19].	Highly fragmented, price-sensitive purchasing at the provider or patient level [7].

Note: The "Key Implication for Purchasing" row represents the authors' synthesis of how financing and governance arrangements may shape purchasing options; it is not a direct quotation from the cited sources.

procurement or purchasing in relation to strategic, financial, or policy mechanisms. Eligible concepts included competitive tendering, pooled procurement and GPOs, outcome- or performance-linked purchasing, risk-sharing/managed-entry agreements, reference-pricing and negotiation policies, formulary management, and the influence of provider-payment reforms on procurement decisions. Studies concerned only with physical logistics (*e.g.*, warehousing or distribution) without a purchasing, pricing, financing, or formulary component were excluded.

- **Context:** The context was common inpatient surgical care in public or publicly funded hospitals, including orthopedic, cardiovascular, general surgical, and obstetric/gynecologic procedures. Outpatient-only, primary-care, and long-term-care settings were excluded unless the evidence directly informed an inpatient surgical episode or public-hospital procurement decision.

Publications from 1 January 2018 through 31 December 2025 were eligible. The start date was selected deliberately because 2018 marks an important period in the expansion of contemporary episode-based payment reform, including the launch of CMS BPCI Advanced, while subsequent years saw renewed international guidance on pharmaceutical pricing and procurement, including the 2020 WHO guideline on country pharmaceutical pricing policies [56, 59]. Restricting the review to this period was intended to capture current procurement and payment architectures rather than provide a historical review. Only English-language literature was included. Eligible peer-reviewed quantitative, qualitative, mixed-methods, economic-modeling, and review designs were considered, together with predefined grey literature from WHO, OECD, and the World Bank. Commentaries, editorials, and letters were excluded.

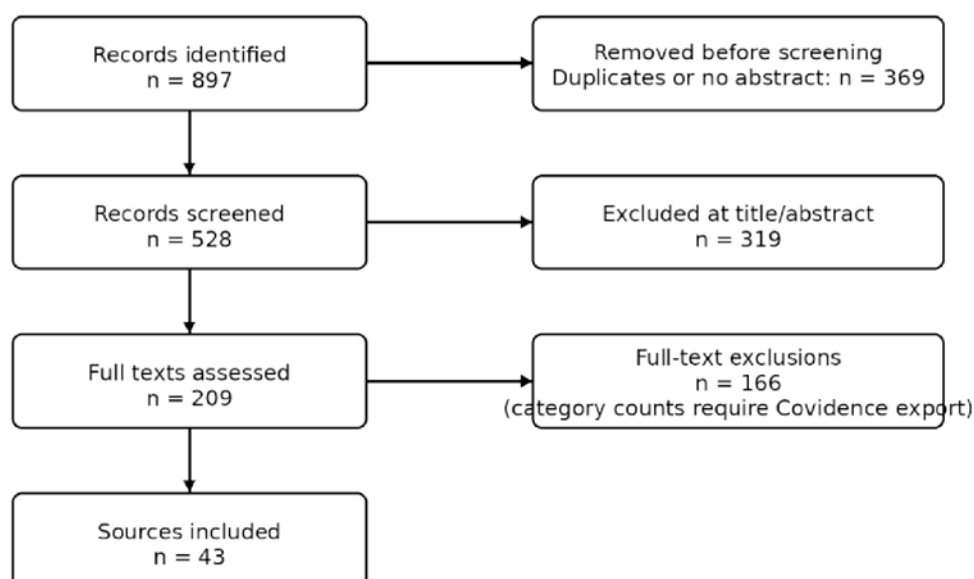
To address PRISMA-ScR Item 8, the search was developed iteratively around three domains: pharmaceutical procurement/purchasing, surgical or perioperative care, and health-system/payment architecture. Controlled vocabulary and free-text terms were adapted to the syntax of PubMed, Scopus, and Web of Science. Backward and forward citation tracking was also performed for included full-text sources. The complete database-specific search syntax, field tags, and restrictions is provided in Supplementary Appendix, Table S1. Because database interfaces use different field conventions, equivalent concepts were translated rather than copied verbatim across platforms.

All identified citations were imported into Covidence. The study flow comprised 897 records identified; 369 records were removed before title/abstract screening because of duplication or absence of an abstract, leaving 528 records for title/abstract screening. Of these, 319 were excluded at the first screening stage and 209 full texts were assessed for eligibility. A further 166 full-text records were excluded, leaving 43 sources in the final synthesis (Fig. 1). Detailed full-text exclusion categories should be reported from the Covidence audit trail in the final submission package.

Phase 1 (Title and Abstract Screening): Two reviewers independently screened each unique record against the predefined eligibility criteria. Records judged potentially eligible by either reviewer progressed to full-text assessment.

Phase 2 (Full-Text Screening): The same two reviewers independently assessed retrieved full texts for final inclusion. Where prioritization or relevance-ranking functions were used within the review software, these were used only to order screening workflow and did not determine eligibility. Inclusion and exclusion decisions remained reviewer-based.

Fig. 1. PRISMA-ScR flow diagram of study selection.



Tab. II. Data Charting Framework.

Category	Extracted Variable	Description and Rationale
Publication Details	Author, Year, Country of Origin	Provides fundamental bibliographic data and enables the geographical mapping of the evidence base.
Health System Context	Primary Health System Typology	Classifies the country's health system based on financing models (e.g., Beveridge, Bismarck, National Health Insurance). Acts as the primary variable for comparative analysis.
Study Characteristics	Study Design, Aims/Objectives	Identifies the nature of the evidence (e.g., policy analysis, economic modeling, case study) to evaluate the methodological strength of the literature.
Population	Type of Hospital	Verifies that the study setting aligns with public/publicly funded hospitals (eligibility criterion).
Surgical Context	Surgical Procedure/Specialty	Identifies specific surgical procedures discussed (e.g., orthopedics, cardiology) to distinguish generic procurement models from procedure-specific ones.
Procurement Model	Primary Strategy Implemented	Conceptually categorizes the direct purchasing strategy (e.g., tendering, pooled/GPO procurement, outcome-linked contracting) and separately records payment mechanisms that influence procurement incentives.
Model Specifics	Key Mechanisms and Levers	Extracts implementation specifics such as negotiation processes, pricing/rebate conditions, performance metrics, risk-sharing provisions, and links to provider-payment arrangements.
Outcomes	Stated Objectives and Reported Results	Captures the intended goals of the procurement model (e.g., cost containment) and any reported impacts on cost, access, or quality

Disagreements at either stage were resolved through discussion and, when required, adjudication by a third reviewer. A formal inter-rater agreement statistic (e.g., Cohen's kappa) was not reported in the available review records; accordingly, no agreement coefficient is claimed here. Reasons for full-text exclusion were documented in the review-management workflow and should be exported by category for the final PRISMA-ScR reporting package (Tab. S2).

A standardized data charting form was collaboratively developed by the research team to guide the extraction of relevant information (Tab. S3). To ensure clarity, consistency, and comprehensiveness, the form was pilot-tested on a purposive sample of five included articles and subsequently refined prior to full data extraction [22]. This structured approach ensured that the unstructured information within the selected articles was transformed into a cohesive, synthesized dataset directly aligned with the review's objectives [23]. Table II outlines the data charting framework utilized.

Methodological quality and confidence: No formal risk-of-bias tool was prespecified because the purpose was evidence mapping rather than pooled effect estimation. During synthesis, however, the research team considered study design, directness to surgical pharmaceutical procurement, and whether findings were empirical, modeled, or policy-descriptive when interpreting confidence in conclusions.

Results

Forty-three sources were included in the final synthesis. The evidence base was heterogeneous and was concentrated in high-income settings, especially North America and Europe, with a smaller cluster

from the Asia-Pacific region and limited representation from LMICs. Study designs were predominantly policy analyses, descriptive case studies, economic or simulation models, and observational evaluations, with fewer systematic or scoping reviews. Orthopedic and cardiovascular surgical pathways were among the most frequently discussed procedure areas. Because the available manuscript dataset did not retain a complete study-level extraction table, exact country-, design-, procedure-, and procurement-model counts should be populated from the original charting/Covidence export in Supplementary Table S3 before resubmission.

SYNTHESIS OF PROCUREMENT MODELS

The synthesis was organized using the revised conceptual framework: direct procurement mechanisms (volume-based and value-oriented), pricing/reimbursement levers, and provider-payment mechanisms that create incentives for procurement behavior. Table III maps these domains across major health-system archetypes. This structure also operationalizes path dependency by asking which purchasing mechanisms are institutionally feasible given the concentration of purchasing authority, payer fragmentation, and provider financial risk.

The synthesis of the charted data was organized thematically around a typology of procurement models, as presented in Table I, followed by a comparative cross-system analysis based on the major health system archetypes.

1. The Dominance of Volume-Based Procurement: Tendering and Group Purchasing
2. The Emergence of Value-Oriented Procurement and Payment-Enabled Incentives

A growing segment of the literature, particularly from the United States and Europe, describes movement toward value-oriented contracting and more explicit

Tab. III. Matrix of Procurement and Payment-Incentive Domains Across Health System Archetypes.

Mechanism / Incentive Domain	Beveridge Systems	Bismarck Systems	NHI / Hybrid Systems
National/Centralized Tendering	Dominant procurement mechanism enabled by centralized purchasing authority and monopsony power.	Less common due to fragmented payer structures; limited regional initiatives exist.	Used by national insurers to establish reimbursement prices and negotiate with manufacturers.
GPOs	Limited use because centralized procurement often fulfills this function.	Widely used by hospitals to aggregate demand and strengthen bargaining power.	Predominant in private provider markets, particularly in the United States.
Value-oriented / performance-linked purchasing	Emerging through centrally driven pilot initiatives.	Limited implementation; being explored by individual sickness funds.	Major area of innovation led by public payers such as Medicare.
Bundled or episode-based payment (provider-payment incentive; not a procurement mechanism)	Selective use within broader payment-reform initiatives; potential to create incentives for total-cost-of-care procurement.	Piloted by selected insurers/provider networks; effect on pharmaceutical procurement depends on how financial accountability is delegated.	Prominent in U.S. public-payment innovation (e.g., BPCI Advanced); direct medication-level procurement effects remain incompletely documented.

consideration of total care costs and outcomes. This should not be interpreted as a wholesale “paradigm shift”: volume-based approaches remain dominant in many settings, while value-oriented approaches are heterogeneous, selective, and often experimental.

Provider value-based payment programs can alter the economic environment in which procurement decisions are made by linking hospital revenue to quality and efficiency. Direct pharmaceutical value-oriented mechanisms, by contrast, include performance-linked rebates, risk-sharing agreements, and negotiated managed-entry arrangements. Maintaining this distinction prevents provider payment from being misclassified as procurement.

Bundled and episode-based payments illustrate the interaction between provider payment and procurement. Under CMS BPCI Advanced, participants were accountable for total Medicare expenditures and quality over defined clinical episodes, including many surgical episodes and Part B drugs [59]. Evaluations have reported Medicare savings for surgical episode groups while generally maintaining measured quality, although the savings have largely been attributed to broader care redesign and post-acute utilization rather than demonstrated medication-specific substitution [60]. Thus, bundled payment provides a plausible incentive for value-conscious pharmaceutical selection, but direct empirical evidence linking the model to specific perioperative medicine choices remains an important gap.

HOW HEALTH SYSTEM ARCHITECTURE SHAPES PHARMACEUTICAL PROCUREMENT

When the synthesized evidence is mapped onto major health system archetypes, distinct patterns emerge that underscore the powerful influence of health system architecture on PPSs. These findings are summarized in Table III.

BEVERIDGE MODEL

The literature relating to Beveridge-type health systems, such as that of the United Kingdom, highlights the advantages of centralized procurement. The single-payer structure facilitates national-level negotiations and tendering processes, generating substantial monopsony purchasing power that can be leveraged to reduce pharmaceutical prices [13]. Evidence suggests that centralized tendering constitutes the dominant procurement mechanism in these systems, reflecting the institutional capacity of a unified purchaser to coordinate procurement activities across the healthcare sector [26]. The implementation of value-based procurement approaches appears to remain at a relatively early and experimental stage, often driven by centrally coordinated policy initiatives designed to align resource allocation with quality and outcome objectives [29].

BISMARCK MODEL

In countries operating under Bismarck-style social health insurance systems, such as Germany and France, the procurement landscape is considerably more fragmented. The evidence points to a hybrid model in which statutory health insurance funds play a central role in price negotiations and reimbursement decisions, while hospitals frequently rely on GPOs to strengthen their purchasing power for products that fall outside centralized reimbursement arrangements [32]. Consequently, procurement strategies in these systems tend to combine elements of centralized negotiation with decentralized purchasing mechanisms, reflecting the pluralistic nature of their financing and governance structures.

NATIONAL HEALTH INSURANCE AND HYBRID SYSTEMS

The United States, as the most prominent example of a hybrid health system, demonstrates the broadest spectrum of pharmaceutical procurement models. Public

Tab. IV. Key Themes and Supporting Evidence Identified Across the Included Studies.

Key Theme	Supporting Evidence from Included Studies	Representative References
Centralized procurement reduces pharmaceutical prices and improves affordability	Multiple large-scale procurement programs reported sustained reductions in pharmaceutical expenditures and improved access to medicines.	[33-38]
Data-driven supply chain management improves efficiency and inventory performance	Studies employing AI, machine learning, and optimization approaches consistently reported improvements in forecasting, inventory control, and cost reduction.	[39-45]
Strong governance and regulatory coordination are critical success factors	Comparative and case studies identified governance quality as a key determinant of procurement effectiveness.	[38, 46-52]
Procurement models require adaptation to local institutional and market conditions	Systematic reviews and comparative analyses reported variable outcomes depending on legal, technical, and market environments.	[38, 47]
Implementation challenges may undermine procurement reforms	Empirical studies documented risks related to supply shortages, stakeholder resistance, and system integration barriers.	[48, 49, 53-55]
Performance-based financing and public-private collaboration may strengthen procurement outcomes	Evidence from several settings suggested positive effects when procurement reforms were linked to performance incentives and collaborative governance arrangements.	[51, 52]
Centralized purchasing: quantitative example	Brazilian centralized rituximab purchasing achieved discounts close to 70% of the reference price and was estimated to save BRL 81.6 million (13.8%) versus a modeled hospital-purchasing scenario; the example is not surgery-specific and is presented to illustrate scale effects rather than provide a pooled estimate.	[26]
Bundled payment: episode-level evidence	CMS BPCI Advanced evaluations reported savings for surgical clinical episodes with quality generally maintained; published evaluation summaries attribute much of the savings to care redesign and post-acute utilization, while direct medication-selection effects remain insufficiently reported.	[59, 60]
Pricing opacity / reference pricing	WHO and OECD sources indicate that external reference pricing is often combined with negotiation and that confidential discounts/rebates can cause public list prices to differ materially from net transaction prices, complicating cross-country comparisons.	[56-58]

payers, particularly Medicare, serve as major drivers of value-based healthcare innovation and have pioneered bundled payment initiatives and VBP programs that are extensively documented in the literature [29]. At the same time, the country's large and highly fragmented hospital sector relies heavily on powerful GPOs to achieve economies of scale and manage pharmaceutical expenditures [27]. This dual dynamic makes the United States a particularly rich source of evidence regarding the coexistence of multiple procurement strategies operating simultaneously within a single health system. The findings suggest that hybrid systems may provide fertile ground for procurement innovation by enabling the coexistence of both market-based and policy-driven approaches to pharmaceutical purchasing (Tab. IV).

Discussion

INTERPRETATION OF THE MAIN FINDINGS

The findings of this scoping review suggest that PPSs for common surgical procedures in public hospitals cannot be understood as isolated managerial decisions;

rather, they are deeply embedded within the broader institutional, financing, and governance arrangements of health systems. Across the reviewed evidence, two parallel procurement paradigms emerged. The first is a volume-based paradigm, in which centralized tendering and GPOs remain the dominant and most widely documented mechanisms for controlling pharmaceutical expenditures through economies of scale and enhanced bargaining power. The second is a value-based paradigm, driven largely by provider-payment reforms, where procurement decisions increasingly consider the contribution of pharmaceuticals to overall episode-of-care costs and patient outcomes rather than acquisition price alone.

The comparative analysis further demonstrated that the feasibility and effectiveness of procurement strategies are strongly conditioned by health system architecture. In Beveridge-type systems, centralized governance structures facilitate national procurement mechanisms and generate substantial monopsony purchasing power that can be leveraged to reduce pharmaceutical prices. In Bismarck systems, fragmented financing arrangements encourage collective purchasing arrangements such as

GPOs to compensate for dispersed bargaining power. Hybrid and National Health Insurance systems exhibit the greatest diversity of procurement approaches, reflecting the coexistence of centralized payment reforms and decentralized purchasing mechanisms. These findings support the view that procurement strategies are path-dependent and cannot be transferred uncritically across health system contexts.

A particularly important finding is the interaction between provider-payment reform and procurement incentives. Provider-payment mechanisms such as bundled payments should not be treated as procurement models; rather, they determine who bears financial risk and therefore alter the objective function facing hospitals. Under FFS, procurement may remain focused on acquisition price when downstream costs are separately reimbursed. Under episode-based accountability, hospitals have stronger incentives to consider whether a medicine affects complications, length of stay, readmissions, and other episode costs. The evidence supports this incentive pathway conceptually and at the episode level, but medication-specific causal evidence remains limited.

CROSS-CUTTING THEMES EMERGING FROM THE EVIDENCE

Several recurring themes were consistently identified across the reviewed literature.

First, centralized and aggregated procurement mechanisms were commonly associated with lower pharmaceutical prices or expenditures, although effect size varied by market structure, product competition, and governance. A concrete example outside a narrowly surgical setting is Brazil's centralized rituximab purchasing program, which reported discounts close to 70% of the reference price and estimated savings of BRL 81.6 million compared with a hypothetical hospital-purchasing scenario [26]. Such estimates illustrate potential scale effects but should not be generalized directly to perioperative medicines or other health systems.

Second, data-driven supply chain management approaches including advanced forecasting systems, optimization algorithms, and digital inventory management tools were repeatedly linked to improvements in operational efficiency and reductions in stockouts and supply disruptions. These findings highlight the growing importance of analytics and digital infrastructure as enabling components of strategic procurement.

Third, pricing and reimbursement mechanisms interact with procurement and can materially alter the net price paid. External reference pricing may anchor negotiations, but confidential rebates and discounts can make public list prices poor proxies for transaction prices. This opacity is particularly important for cross-country comparisons and may limit the transferability of apparent price advantages [56-58].

Fourth, governance quality emerged as a critical determinant of procurement performance. Successful procurement initiatives were generally characterized by

strong regulatory oversight, transparent accountability mechanisms, effective stakeholder coordination, and clear implementation frameworks. Conversely, weak governance structures were frequently associated with implementation challenges and reduced effectiveness.

Fifth, the evidence emphasized the importance of continuous monitoring, stakeholder engagement, and performance-based incentives in sustaining procurement improvements over time. Procurement reforms should therefore be viewed as ongoing organizational processes rather than one-time policy interventions.

Despite these positive findings, implementation challenges remain substantial. Several studies reported persistent risks of supply shortages, stakeholder resistance, market concentration, and operational difficulties associated with large-scale procurement reforms. These findings suggest that procurement strategies must be adapted to local institutional, regulatory, and market conditions rather than being adopted as universal solutions.

KNOWLEDGE GAPS AND FUTURE RESEARCH PRIORITIES

This scoping review identified several important gaps in existing literature.

First, there is a notable absence of comparative effectiveness research directly evaluating alternative procurement models for the same pharmaceutical products and surgical procedures within comparable health system contexts. Most studies focus on a single procurement strategy in isolation, limiting the ability to determine which approaches perform best under specific circumstances.

Second, the geographical distribution of evidence remains heavily concentrated in high-income countries, particularly those in North America and Europe. Evidence from LMICs remains limited, despite the fact that these settings often face the most significant challenges related to affordability, supply security, and procurement capacity.

Third, while value-oriented procurement and provider-payment reforms are frequently discussed together, empirical evidence on their distinct and joint effects remains scarce. In particular, direct evidence connecting bundled payment exposure to medication selection, utilization, or pharmaceutical spending within surgical episodes is limited. Longitudinal evaluations should distinguish changes in drug acquisition, formulary choice, downstream utilization, patient outcomes, and total episode cost.

Fourth, a substantial implementation gap exists between high-level policy discussions surrounding payment reforms and the operational realities of hospital pharmacy and procurement departments. More research is needed to understand how procurement practices evolve in response to changing reimbursement structures and organizational incentives.

Finally, a particularly important gap concerns the limited integration of procurement and provider-payment research. Most studies examine procurement

mechanisms and payment reforms as separate policy domains, despite growing evidence that their interaction may substantially influence pharmaceutical utilization, hospital decision-making, and episode-level costs. Future research should explicitly investigate these interdependencies and their implications for strategic purchasing.

TOWARDS A HYBRID STRATEGIC PHARMACEUTICAL PROCUREMENT FRAMEWORK

The synthesized evidence suggests that no single procurement model is capable of simultaneously achieving all policy objectives related to cost containment, quality improvement, supply security, and value creation. Consequently, a truly strategic approach to pharmaceutical procurement should be adaptive, context-sensitive, and capable of integrating multiple procurement mechanisms.

Based on the evidence reviewed, this study proposes an evidence-informed framework consisting of four interrelated components: (1) procurement stratification, (2) data and analytical infrastructure, (3) integrated governance and clinical engagement, and (4) contextual adaptation to health system architecture.

1. Procurement Stratification Rather Than Uniform Purchasing

The proposed framework rejects a one-size-fits-all approach to pharmaceutical procurement and instead advocates for the classification of pharmaceuticals according to their economic and clinical characteristics. For generic and high-volume products, such as standard anesthetic agents, generic antibiotics, and intravenous solutions, the primary objective should be cost minimization. In these cases, volume-based procurement mechanisms - including transparent national or regional tenders in centralized systems and participation in large, efficient GPOs in fragmented systems - represent the most effective strategies for maximizing economies of scale and reducing acquisition costs. In contrast, for high-cost, high-impact pharmaceuticals, such as advanced anticoagulants that reduce hospital length of stay or innovative hemostatic agents that prevent serious bleeding complications, the primary objective should be value optimization. In such circumstances, value-based procurement mechanisms are more appropriate. These may include risk-sharing agreements with manufacturers or, more effectively, the integration of pharmaceutical decision-making within bundled payment arrangements for the entire surgical episode, where higher acquisition costs may be justified by reductions in total episode-of-care expenditures.

Minimum requirements for resource-constrained settings

For LMIC and resource-constrained settings, implementation should begin with a minimum viable procurement architecture rather than assuming high-income data capacity. The minimum institutional requirements are a legally authorized purchasing

entity or pooled mechanism; transparent tender and conflict-of-interest rules; a basic formulary with clinical stewardship; routine capture of purchase price, volume, supplier, stockout, expiry, and lead-time data; and a governance forum linking procurement, pharmacy, finance, and clinical leadership. Outcome-linked contracts should be introduced only where patient-level utilization and outcome data can be linked reliably to costs. Where such infrastructure is absent, transparent competitive procurement, pooled purchasing, framework agreements, supplier diversification, and simple performance dashboards may offer greater value than complex risk-sharing contracts.

2. Data and Analytical Infrastructure

Strategic pharmaceutical procurement is not feasible without robust data systems. Public hospitals and health systems should invest in information infrastructures capable of tracking not only pharmaceutical acquisition costs but also the relationships between pharmaceutical utilization, patient outcomes, episode-level expenditures, readmission rates, and supply chain performance. Such data are essential for evaluating value and constitute a prerequisite for meaningful participation in value-based procurement arrangements.

3. Integrated Governance and Clinical Engagement

Strategic procurement cannot function as an isolated responsibility of pharmacy or procurement departments. Instead, it requires an integrated governance structure that brings together hospital administrators, financial managers, pharmacists, surgeons, anesthesiologists, and other relevant stakeholders. This collaborative body should be responsible for evidence-informed decision-making, including the evaluation of the overall cost-benefit profile of new pharmaceutical products and their contribution to clinical and economic outcomes.

4. Adaptation to Health System Context

The proposed framework should be regarded as adaptive rather than prescriptive. Consistent with the principle of path dependency, procurement strategies must be aligned with the institutional characteristics of the surrounding health system.

In Beveridge-type systems, efforts should focus on strengthening the analytical capabilities of centralized procurement agencies to incorporate value-based criteria into purchasing decisions for high-impact pharmaceuticals.

In Bismarck-type systems, emphasis should be placed on strengthening the governance capacity of GPOs and enabling collaboration between hospitals and sickness funds to pilot bundled payment and value-based procurement initiatives.

In hybrid and National Health Insurance systems, procurement strategies should be closely aligned with the incentives generated by public payer programs, particularly bundled payment and VBP initiatives, to ensure consistency between reimbursement mechanisms and procurement objectives.

LIMITATIONS

This review should be interpreted in light of several methodological limitations. First, as a scoping review, it was designed to map concepts and evidence rather than estimate pooled effectiveness; no formal risk-of-bias appraisal was prespecified. Confidence in the findings is therefore constrained by the predominance of descriptive policy analyses, case studies, economic models, and heterogeneous observational evidence. Second, the search was limited to three bibliographic databases, English-language sources, and a 2018-2025 publication window, which may have omitted relevant earlier or non-English evidence. Third, the evidence base is geographically concentrated in high-income settings, so the proposed framework should not be assumed to transfer directly to LMICs without adaptation. Fourth, several cited procurement studies address pharmaceuticals broadly rather than perioperative medicines specifically, limiting directness. Finally, policy and payment arrangements evolve rapidly; findings represent the evidence available through the stated search period.

POLICY, PRACTICE, AND RESEARCH IMPLICATIONS

The findings of this review have direct implications for key stakeholders.

IMPLICATIONS FOR POLICYMAKERS

Payment reforms and procurement policies should be developed in parallel. Policymakers should establish interoperable purchasing and claims data, common definitions for episode cost, transparent tender and rebate governance, and explicit rules for when value-based or risk-sharing agreements are justified. A practical minimum dashboard should include acquisition price and net price where available, supplier concentration, contract compliance, stockout days, emergency purchases, wastage/expiry, medicine utilization per procedure, length of stay, readmissions, complications, and total episode cost. Policy pilots should specify a comparator and evaluation period before scale-up.

IMPLICATIONS FOR HOSPITAL MANAGERS

Hospital managers should move from unit-price-only purchasing toward segmented category management. High-volume substitutable products can be managed through competitive tendering, pooled purchasing, and supplier-performance monitoring; high-cost or outcome-sensitive medicines require multidisciplinary review

of total-cost and clinical evidence. Hospitals should invest first in spend analytics, formulary analytics, procedure-level utilization data, supplier performance metrics, and linkage of pharmacy data with length-of-stay, complication, and readmission outcomes. A standing procurement governance committee should include procurement, pharmacy, finance, surgery, anesthesiology, quality, and – where relevant – payer representatives, with documented conflict-of-interest management and predefined escalation rules.

IMPLICATIONS FOR RESEARCHERS

The gaps identified in this review highlight several priorities for future research. There is a pressing need for:

Empirical comparative-effectiveness studies directly comparing the total costs and quality outcomes of volume-based versus value-based procurement strategies for specific surgical procedures. Also, In-depth case studies and implementation science research from LMICs to better understand the unique challenges and potential solutions associated with pharmaceutical procurement in resource-constrained settings. Longitudinal studies evaluating the long-term effects of different procurement models on patient outcomes, health equity, and pharmaceutical innovation.

In summary, although strategic pharmaceutical procurement models have demonstrated considerable benefits, continued research and context-specific adaptation remain essential to maximize their effectiveness and sustainability within public hospital settings.

FUTURE STUDIES

Future studies should focus on adapting strategic pharmaceutical procurement models to diverse health system contexts, integrating advanced analytical approaches, and evaluating their long-term impacts on health outcomes and system sustainability. Key research priorities identified in this review are summarized in Table V.

Conclusion

This scoping review mapped international evidence on strategic pharmaceutical procurement relevant to common surgical care in public hospitals through a comparative health-systems lens. The findings indicate

Tab. V. Key Research Questions for Advancing Strategic Pharmaceutical Procurement Models.

Research Question	Rationale
How can strategic pharmaceutical procurement models be adapted for LMICs?	Identifying context-specific barriers and enabling factors is essential to ensure effectiveness and sustainability.
What are the long-term effects of centralized procurement on surgical outcomes and health system resilience?	Longitudinal studies are needed to evaluate impacts beyond costs and availability, including patient outcomes.
How can advanced data analytics and artificial intelligence be integrated into pharmaceutical procurement models in public hospitals?	Technological innovations may further optimize efficiency, reduce shortages, and improve decision-making.

that procurement mechanisms are strongly conditioned by financing, governance, pricing policy, and the allocation of provider financial risk. Volume-based approaches remain the most established mechanisms for high-volume and substitutable medicines, while value-oriented purchasing is emerging selectively and requires stronger data and governance capacity. Provider-payment reforms such as bundled payments should be understood as incentive mechanisms that may support value-conscious procurement rather than as procurement models themselves. The most defensible path forward is therefore an adaptive hybrid framework that segments medicines by market and clinical characteristics, combines transparent procurement with appropriate pricing levers, and aligns hospital purchasing decisions with episode-level incentives where the necessary data infrastructure exists. Because the evidence is heterogeneous and concentrated in high-income settings, implementation should be piloted, measured, and adapted to local institutional capacity.

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Ethics approval and consent to participate

The Research Ethics Committee of the Iran University of Medical Sciences provided the ethical approval for this study (IR.IUMS.REC.1402.920) previously. All methods were performed in accordance with the relevant guidelines and regulations such as Declarations of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Funding

Not applicable.

Competing interests Statement

The authors declare that they have no competing interests.

Authors' contributions

DC, IMA, and MM contributed to the conception and design of the study. HP, DC conducted the search, and IMA was co-moderator. DC, IMA, MM, and HP conducted screening and selecting the final studies, which SR discussed regularly. DC, IMA, and MM wrote the initial draft and contributed to manuscript revisions. DC, IMA, and MM performed a search of the literature. DC, IMA, HP, and MM editing All authors read and confirmed the final manuscript.

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Supplementary Materials

Tab. S1. Database-specific search strategies.

Important author verification note: The search syntax below has been reconstructed from the methods and conceptual domains stated in the manuscript. It must be checked against the original database search histories before being represented as the exact historical search used. The study-level table likewise requires completion from the original Covidence/data-charting export.

Eligibility limits: English language; publication date 1 January 2018 through 31 December 2025. No study-design filter should be added unless it was used in the original search.

PubMed (reconstructed syntax for verification)

((("Drug Industry"[Mesh] OR "Pharmaceutical Preparations"[Mesh] OR pharmaceutical*[Title/Abstract] OR medicine*[Title/Abstract] OR drug*[Title/Abstract]) AND (procurement[Title/Abstract] OR purchasing[Title/Abstract] OR tender*[Title/Abstract] OR "group purchasing"[Title/Abstract] OR pooled procurement[Title/Abstract] OR "value-based purchasing"[Title/Abstract] OR "risk sharing"[Title/Abstract] OR "managed entry agreement*" [Title/Abstract] OR "reference pricing"[Title/Abstract] OR rebate*[Title/Abstract] OR negotiation[Title/Abstract]) AND (surg*[Title/Abstract] OR perioperative[Title/Abstract] OR postoperative[Title/Abstract] OR arthroplast*[Title/Abstract] OR "joint replacement"[Title/Abstract] OR "coronary artery bypass"[Title/Abstract] OR cholecystectomy[Title/Abstract] OR cesarean[Title/Abstract]) AND (hospital*[Title/Abstract] OR "Hospitals, Public"[Mesh] OR "public hospital*" [Title/Abstract]) AND ("health system*" [Title/Abstract] OR financing[Title/Abstract] OR reimbursement[Title/Abstract] OR "fee for service" [Title/Abstract] OR bundled payment*[Title/Abstract] OR "episode-based"[Title/Abstract] OR "global budget*" [Title/Abstract] OR Beveridge[Title/Abstract] OR Bismarck[Title/Abstract] OR "national health insurance"[Title/Abstract])) AND ("2018/01/01"[Date - Publication] : "2025/12/31"[Date - Publication]) AND English[Language]

Scopus (reconstructed syntax for verification)

TITLE-ABS-KEY ((pharmaceutical* OR medicine* OR drug*) AND (procurement OR purchasing OR tender* OR "group purchasing" OR "pooled procurement" OR "value-based purchasing" OR "risk sharing" OR "managed entry agreement*" OR "reference pricing" OR rebate* OR negotiation) AND (surg* OR perioperative OR postoperative OR arthroplast* OR "joint replacement" OR "coronary artery bypass" OR cholecystectomy OR cesarean) AND (hospital* OR "public hospital*") AND ("health system*" OR financing OR reimbursement OR "fee for service" OR "bundled payment*" OR "episode-based payment*" OR "global budget*" OR Beveridge OR Bismarck OR "national health insurance")) AND PUBYEAR > 2017 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE, "English"))

Web of Science Core Collection (reconstructed syntax for verification)

TS=((pharmaceutical* OR medicine* OR drug*) AND (procurement OR purchasing OR tender* OR "group purchasing" OR "pooled procurement" OR "value-based purchasing" OR "risk sharing" OR "managed entry agreement*" OR "reference pricing" OR rebate* OR negotiation) AND (surg* OR perioperative OR postoperative OR arthroplast* OR "joint replacement" OR "coronary artery bypass" OR cholecystectomy OR cesarean) AND (hospital* OR "public hospital*") AND ("health system*" OR financing OR reimbursement OR "fee for service" OR "bundled payment*" OR "episode-based payment*" OR "global budget*" OR Beveridge OR Bismarck OR "national health insurance")) Refined by: PUBLICATION YEARS=(2018-2025) AND LANGUAGES=(ENGLISH)

Search-process reporting fields to verify

- Date each database was last searched
- Exact platform/interface (e.g., PubMed, Scopus, Web of Science Core Collection)
- Any database-specific filters not represented above
- Citation-tracking dates and tools
- OSF registration URL/DOI

Tab. S2. PRISMA-ScR counts reconciliation.

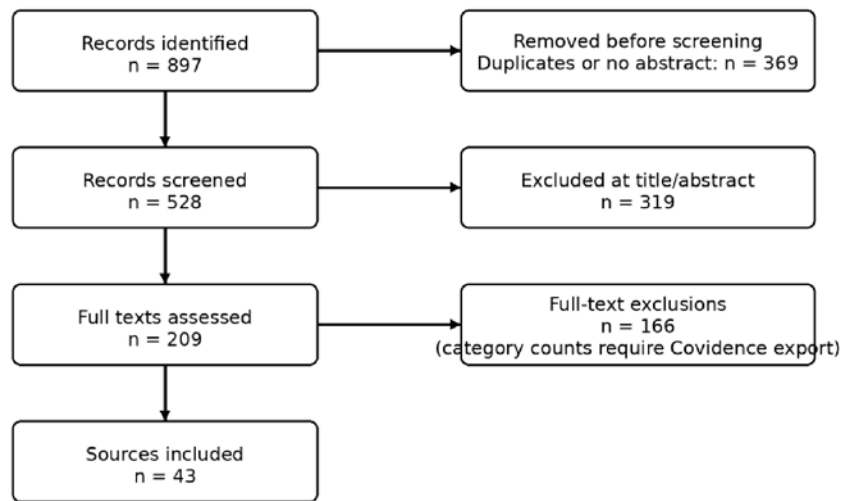
Stage	Count	Status / action
Records identified	897	Reported in manuscript figure
Removed before screening	369	Reported as duplicates or no abstract; separate category counts if available
Title/abstract screened	528	Reported
Excluded at title/abstract	319	Reported
Full texts assessed	209	Reported
Full texts excluded	166	Reported; add exclusion-reason categories from Covidence
Included in synthesis	43	Reported

Tab. S3. Characteristics of all included sources.

ID	Citation	Country/ region	Health- system type	Study design	Hospital setting	Surgical procedure/ specialty	Procurement mechanism	Pricing/ payment lever	Key outcome(s)	Directness to surgical pharma- ceuticals	Evidence- strength note
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Suggested evidence-strength note

Complete one row per included source using the original data-charting/Covidence export. Forty-three rows are provided to match the reported number of included sources. Do not infer or reconstruct missing fields from the manuscript reference list alone. For each source, use a descriptive rather than pseudo-quantitative label: empirical comparative/observational; single-site descriptive/QI; economic/modeling; policy analysis; systematic/scoping review; authoritative policy/guidance. Note whether the source directly evaluates surgical pharmaceuticals or is indirect/background evidence.

Fig. S1. Revised PRISMA-ScR flow diagram. Full-text exclusion categories remain to be verified from the Covidence audit trail.

Note: Full-text exclusion categories should be added from the original Covidence audit trail before submission.