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From Hospital Costing to Public Tariffs: A Systematic Evidence Map of Step-Down and Activity-Based Costing

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Abstract

Background

Public hospital tariffs are policy prices, yet the route from cost measurement to reimbursement decisions is often opaque. Step-down costing can allocate institutional overhead and support costs, whereas activity-based costing (ABC) and time-driven activity-based costing (TDABC) can provide pathway-level granularity. Whether, where, and how these functions should be combined for public tariff setting remains uncertain.

Methods

We conducted a systematic evidence map and narrative synthesis of English-language peer-reviewed and authoritative institutional sources identified through six bibliographic databases, targeted journals, and institutional websites; the final search update was 15 June 2026. Records were classified as empirical/implementation studies, reviews, policy/guidance sources, or methods-only anchors. Tariff linkage was coded as direct when a source explicitly informed, specified, compared, or evaluated a tariff, reimbursement rate, or provider-payment decision; all other costing evidence was coded as indirect/contextual. Heterogeneity precluded quantitative pooling.

Results

Fifty-one records were catalogued: 46 substantive sources and five methods-only anchors. Fifteen substantive sources had direct tariff linkage (nine empirical/analytic studies, one review, and five policy/guidance sources), whereas 31 were indirect/contextual. TDABC evidence was substantially more common than step-down/top-down evidence. The literature supports complementary accounting functions, but no included source evaluated the system-level effect of a complete integrated step-down-plus-ABC/TDABC framework on tariff accuracy, expenditure, access, quality, or provider behaviour.

Conclusions

The principal evidence gap lies between costing and payment decision-making. A two-layer framework—step-down allocation for institutional full costs followed by selective ABC/TDABC refinement where pathway heterogeneity is material—should therefore be treated as a testable design proposition rather than an established superior model. Prospective pilots should separate measured base costs from explicit policy adjusters and evaluate accuracy, implementation burden, budget impact, access, quality, and provider responses.

1. Introduction

Hospital charges in public healthcare systems perform more than an accounting function. They translate scarce public budgets into signals for providers, determine how costs are shared between payers and facilities, and influence whether hospitals can sustain essential services without shifting hidden costs to patients. In tax-funded or social insurance systems, tariffs and case-based payments are often intended to replace arbitrary billing with a transparent schedule of prices. However, the economic legitimacy of such prices depends on the quality of the underlying cost evidence. Where tariffs are set by historical budgets, negotiation, political compromise or opaque mark-ups, they can underfund high-complexity services, over-reward low-complexity services, and create incentives for volume, coding manipulation or service avoidance. The current policy problem is therefore not simply that charges are “too high” or “too low,” but that they are often insufficiently traceable to the resources used to produce safe and effective care.

Hospital costing methods differ in the level at which resources are traced and allocated. Top-down and step-down approaches begin with financial ledgers and distribute overhead and support-department costs to final services using allocation bases such as floor area, staffing, weighted workload, or patient days. Bottom-up micro-costing identifies resources at the patient,

procedure, or activity level. ABC assigns costs through activities and cost drivers, whereas TDABC uses capacity cost rates and the time required to perform activities. Methodological work also cautions that "unit cost," "price," "charge," "reimbursement rate," and "tariff" are not interchangeable concepts [1, 2]. This distinction is central to the present review because a public tariff is a policy decision informed by, but not identical to, an estimate of resource cost.

Recent reviews show that ABC and TDABC can improve visibility of resource use in complex pathways, including oncology, orthopaedics, emergency care, rehabilitation, and hospital-at-home services [3, 4, 5]. These methods can identify variation in staff time, equipment use, consumables, idle capacity, and process configuration that is obscured by aggregated averages. Step-down accounting addresses a different function: it distributes institutional shared costs including administration, utilities, information systems, maintenance, sterilization, and other support functions across service units. The relevant policy question is therefore not whether one method should universally replace another, but whether different costing functions can be combined in a transparent sequence that improves the traceability of tariff decisions.

The translation problem is visible in public payment systems. NHS costing guidance and national cost collection infrastructure link standardized provider cost submissions with payment-policy processes [6, 7, 8]. In India, multi-site hospital costing has informed provider-payment rates, and subsequent econometric analyses have examined supply-side adjustments to case-based payment [9, 10, 11]. Across low- and middle-income countries (LMICs), however, the route from costing exercises to final reimbursement decisions remains incompletely documented [12]. These examples show that cost measurement and tariff setting are connected but analytically distinct stages.

Previous syntheses have examined separate segments of this chain. Reviews have focused on TDABC applications and healthcare performance [3, 4, 5], hospital costing methods over time [13], hospital pricing as an interdisciplinary policy problem [14], and the role of cost accounting in pricing and reimbursement in LMICs [12]. Collectively, this literature establishes a substantial methodological and implementation base, but it does not map across costing approaches and policy sources where empirical cost evidence actually reaches a tariff or provider-payment decision. The unresolved gap is therefore translational rather than purely methodological: which parts of the cost-to-tariff chain are directly documented, which are supported only indirectly, and where policy judgement begins.

The primary review question was: What evidence directly or indirectly informs the use of step-down costing and ABC/TDABC in public hospital tariff development? Secondary questions examined (1) which source types directly inform tariff design or use; (2) which costing functions are supported only indirectly; (3) what governance and data conditions are reported; (4) where measured costs end and policy adjustment begins; and (5) which outcomes should be evaluated before any integrated framework is scaled.

2. Methods

2.1 Review design and protocol

This study was designed as a systematic evidence map with narrative synthesis and was reported with reference to PRISMA 2020 principles [15]. The purpose was to characterize the distribution, role, and tariff relevance of a heterogeneous evidence base rather than to estimate a pooled intervention effect. The review is registered in PROSPERO (CRD420261497000). Eligibility criteria, search logic, extraction domains, and synthesis categories were specified before the final synthesis.

2.2 Review-question framework

The review used a PCC-style framework: population/context = public hospitals, hospital services and public healthcare systems; concept = step-down costing, ABC, TDABC, micro-costing, cost centers, service-line costing and tariff development; consequences/outcomes = unit cost, full cost, charge reform, reimbursement, provider payment, public tariff, case-based payment, cost recovery and value-based purchasing.

2.3 Information sources and search strategy

Searches were conducted in Scopus, Web of Science Core Collection, PubMed/MEDLINE, Embase, CINAHL, and EconLit, supplemented by targeted journal and institutional website searches. The final search update was 15 June 2026. Searches emphasized publications from 2020 to 2026, while older methodological and policy sources were retained when they directly informed definitions, provider-payment design, or reporting methods. Eligible source types were peer-reviewed empirical studies, systematic or scoping reviews, methodological articles, and authoritative policy or guidance documents. Editorials, news items, blogs, unverifiable records, and records without a hospital, costing, or public-payment connection were excluded. Institutional sources were included because tariff design and costing standards are frequently specified in official payment and costing guidance. Table 1 reports the search logic available for the review. Original database exports were not available for this revision; consequently, the flow counts were reconciled arithmetically and the unmatched record is explicitly identified as requiring source-log verification. Complete database- and source-specific search strategies are provided in Additional file 1.

Table 1
Search strategy and information sources

Source	Boolean search string	Rationale / expected yield
Scopus	TITLE-ABS-KEY(("hospital charges" OR tariff* OR "provider payment" OR reimbursement OR "price setting") AND ("step-down costing" OR "activity-based costing" OR TDABC OR "time-driven activity-based costing" OR microcosting OR "cost accounting") AND (hospital* OR "public healthcare" OR "public health system")) AND PUBYEAR > 2019	Broad interdisciplinary coverage of health policy, accounting and management journals.
Web of Science Core Collection	TS=(("hospital charges" OR tariff* OR reimbursement OR "provider payment") AND ("step-down costing" OR "activity-based costing" OR TDABC OR microcosting) AND (hospital* OR "health system")) Refined by 2020–2026, article/review.	Citation-sensitive search across health services and economics journals.
PubMed/MEDLINE	("activity-based costing"[Title/Abstract] OR "time-driven activity-based costing"[Title/Abstract] OR "cost accounting"[Title/Abstract] OR microcosting[Title/Abstract]) AND (hospital[Title/Abstract] OR healthcare[Title/Abstract]) AND (tariff[Title/Abstract] OR reimbursement[Title/Abstract] OR payment[Title/Abstract] OR charge* [Title/Abstract])	Biomedical and health economic empirical records.
Embase, CINAHL and EconLit	("hospital cost*" OR "cost accounting" OR "provider payment") AND ("activity based" OR TDABC OR "step-down") AND (tariff OR reimbursement OR price*)	Captures nursing, economics and policy studies not indexed in PubMed.
Targeted journal websites	BMJ Open, BMC Health Services Research, Health Policy, Value in Health, Health Policy and Planning, Applied Health Economics and Health Policy, Journal of Health Organization and Management.	Manual confirmation of DOI/stable records and full-text access.
Institutional sources	NHS England costing guidance, NHS Digital PLICS, WHO price regulation, World Bank provider payment, Joint Learning Network costing manual.	Public tariff development requires policy documents and official costing standards.

2.4 Eligibility criteria

Eligibility criteria were applied at title/abstract and full-text stages using the operational definitions in Table 2. Records required a clear hospital, public-payer, costing-method or tariff-development connection. Records reporting billed charges without a costing method, unverifiable bibliographic metadata or no hospital/public-payment connection were excluded. Reporting, appraisal and terminology sources were retained as methods-only anchors and were not used as substantive evidence for the hybrid model. Operational definitions used for evidence classification are provided in Additional file 1.

Table 2
Inclusion and exclusion criteria

Domain	Inclusion criteria	Exclusion criteria
Population / setting	Hospitals, hospital departments, service lines, inpatient/outpatient hospital services, public payer contexts, or public healthcare systems.	Pure primary care studies without hospital relevance; private-only pricing studies with no public payment implications.
Costing method	Step-down costing, top-down allocation, ABC, TDABC, micro-costing, cost centers, cost accounting standards, patient-level costing.	Studies reporting only charges or billed prices without a costing method.
Tariff relevance	Tariff development, reimbursement, provider payment, case-based payment, public charges, price-setting, cost recovery or payment adjusters.	Clinical cost-effectiveness studies with no service costing or payment relevance.
Publication type	Peer-reviewed empirical studies, systematic/scoping reviews, methodological papers and authoritative policy/guidance documents.	Editorials, news, blogs and unverifiable records.
Date/language	Primary emphasis on 2020–2026, with older cornerstone methodological papers retained when necessary.	Non-English texts not interpretable by the review team; outdated records superseded by newer guidance.
Data integrity	Stable DOI, PubMed/PMC record, publisher page or official institutional URL.	References without a verifiable bibliographic record or inaccessible bibliographic metadata.

2.5 Study selection and extraction

One reviewer conducted title/abstract screening and structured extraction using the predefined eligibility criteria and extraction form. Uncertain eligibility decisions and bibliographic details were rechecked against full text, DOI, PubMed/PMC, publisher, or official institutional records. Independent duplicate screening and extraction were not consistently documented and are therefore not claimed. During reconciliation, the evidence table and reference list contained 51 unique records. One record previously counted in the working flow as included could not be matched to either source list; it was excluded from the analytic corpus and retained as an unmatched record pending verification against the original screening log.

2.6 Source appraisal and limitations

Because the corpus crossed empirical studies, reviews, methodological papers, and policy documents, a single pooled risk-of-bias score was not considered valid. ROBIS, MMAT, and CHEERS 2022 informed attention to review bias, mixed-design methodological limitations, and reporting completeness, respectively [16, 17, 18]; they were not treated as interchangeable instruments or converted into a common quality score. Institutional guidance was interpreted according to issuing authority, scope, methodological transparency, currency, and tariff relevance. Completed record-level appraisal forms were not available for this revision; accordingly, no source-level quality grading or aggregate risk-of-bias heat map is reported. Five reporting, appraisal, or terminology sources were classified as methods-only anchors and were not used as substantive evidence for the proposed framework.

2.7 Evidence stratification and synthesis

For synthesis, records were classified into four evidence streams: empirical/implementation studies (n = 25), reviews (n = 13), policy/guidance sources (n = 8), and methods-only anchors (n = 5). Within the 46 substantive sources, tariff linkage was coded as direct only when the source explicitly used, specified, compared, recommended, validated, or evaluated a cost estimate in relation to a tariff, reimbursement rate, package price, or provider-payment decision. A source that discussed reimbursement context, costing feasibility, process measurement, or governance without demonstrating such a linkage was coded as indirect/contextual. This operational definition was applied to distinguish evidence about costing from evidence about cost-to-payment translation. The full record-level evidence classification is provided in Additional file 1.

Synthesis proceeded first within evidence streams and then across them. Claims were bounded by the strongest supporting source type: empirical or analytic observations were separated from review-level synthesis and normative policy guidance.

Because studies did not share a common intervention, comparator, or outcome, quantitative pooling was not attempted. The proposed framework was derived by mapping complementary costing functions, points of direct tariff linkage, and gaps in the translation pathway; it was treated as a synthesis-derived hypothesis rather than an evaluated intervention.

2.8 Use of generative AI-assisted technology in manuscript preparation

During manuscript revision, a large language model was used for language editing, structural refinement, and assistance with figure redesign. It was not used to generate or alter study data, determine study eligibility, or make independent methodological decisions. All AI-assisted outputs were reviewed and verified by the authors, who take full responsibility for the accuracy, integrity, citations, analyses, and conclusions of the manuscript.

3. Results

3.1 Study selection

The search process identified 553 records. After removal of 156 duplicates, 397 titles/abstracts were screened and 291 were excluded. Of 106 reports sought for retrieval, six were not retrieved, leaving 100 full-text reports assessed. The reconciled analytic corpus contains 51 records; therefore, 49 full-text reports are represented as excluded. Forty-eight exclusions were documented by reason, while one previously included record could not be matched to the evidence table or reference list and is shown separately as an unmatched record pending source-log verification. Figure 1 presents the arithmetically reconciled flow without treating the unmatched record as substantive evidence.

3.2 Characteristics of included evidence

The 51 catalogued records comprised 25 empirical/implementation studies, 13 reviews, eight policy/guidance sources, and five methods-only anchors; 46 were substantive. TDABC predominated in patient- or pathway-level costing, whereas ABC supported service-line costing and step-down/top-down evidence supported shared-cost allocation. Evidence linking measured costs directly to tariff or provider-payment decisions was uncommon. Table 3 summarizes the evidence profile and tariff-linkage roles; the full 51-record evidence table is provided in Additional file 1.

Table 3
Evidence profile and tariff-linkage summary

Evidence category	n	Role in synthesis	Inference boundary
Empirical/implementation studies	25	Substantive evidence	Includes costing applications and implementation evidence; direct tariff linkage is coded separately.
Reviews	13	Substantive evidence	Synthesizes methodological and implementation evidence; only one review met the direct tariff-linkage definition.
Policy/guidance sources	8	Substantive evidence	Documents costing standards, payment design, and policy requirements; normative guidance is not treated as causal evidence.
Methods-only anchors	5	Reporting/appraisal/terminology	Supports reporting, appraisal, or terminology only; excluded from substantive framework claims.
Direct tariff linkage (subset of 46 substantive sources)	15	9 empirical/analytic; 1 review; 5 policy/guidance	Shows an explicit cost-to-tariff or provider-payment link, but does not establish causal effectiveness of an integrated framework.
Indirect/contextual (subset of 46 substantive sources)	31	Costing/process/governance evidence	Supports costing feasibility, process measurement, or governance without demonstrated use in a tariff decision.

3.3 Distribution of methods and settings

Within the 46-source substantive corpus, 15 records had direct tariff linkage: nine empirical or analytic studies, one review, and five policy/guidance sources. Thirty-one records were indirect/contextual. Methodologically, the evidence base was asymmetric: 27 records addressed TDABC, nine ABC, and six step-down/top-down costing, with overlapping categories. This distribution supports detailed inference about activity-based costing applications but provides a thinner empirical basis for claims about integrated step-down-plus-ABC/TDABC implementation. Accordingly, the framework developed here should be interpreted as a structured synthesis of complementary functions rather than a comparative effectiveness result. Figure 2 summarizes the distribution of evidence across the main costing and tariff-method categories.

Implementation conditions also differed across settings. High-income public systems more often documented standardized patient-level or national cost collection, whereas LMIC sources emphasized heterogeneous accounting systems, provider trust, and limited documentation of how costing estimates entered reimbursement decisions. Patient-level approaches offered greater detail for heterogeneous pathways, while service-line costing appeared more feasible for routine tariff maintenance. These are descriptive patterns and do not establish that one architecture produces more accurate tariffs or better outcomes across settings.

3.4 Evidence relevance and limits of inference

Figure 3 shows the inferential role of the evidence rather than a pooled quality score. Five of 51 records were methods-only anchors. Among 46 substantive sources, 15 had direct tariff linkage and 31 were indirect/contextual; the direct group comprised nine empirical/analytic records, one review, and five policy/guidance records. Direct linkage indicates relevance to a tariff or payment decision, not causal evidence of effectiveness. No included source evaluated the system-level effect of a complete integrated step-down-plus-ABC/TDABC framework on tariff accuracy, expenditure, access, quality, or provider behaviour.

3.5 Synthesized findings

Four bounded findings emerged. First, empirical and methodological evidence supports the distinct accounting functions of shared-cost allocation and pathway-level resource tracing. Second, direct tariff evidence is substantially thinner than costing evidence, making the cost-to-payment transition the central evidence gap. Third, the proposed sequencing of step-down allocation followed by selective ABC/TDABC refinement is a synthesis-derived design proposition rather than an established standard; the available corpus does not supply comparative evidence showing when the added granularity changes a tariff decision enough to justify its implementation burden. Fourth, policy sources consistently emphasize data standards, auditability, stakeholder engagement, explicit adjustment rules, and periodic recalibration. Table 4 separates these evidence-supported observations from implications that require prospective evaluation.

Table 4
Narrative synthesis matrix and boundaries of inference

Synthesis domain	Main finding	Implication and inference status
Cost object	Studies varied between patient episode, procedure, department, service line and package/tariff units.	Define cost objects before data collection and avoid mixing measured unit costs with prices or tariffs. Evidence-supported descriptive implication.
Overhead allocation	Step-down/top-down methods are necessary for support costs but can obscure pathway-level variation.	Use step-down allocation for shared costs; test whether selective ABC/TDABC materially changes estimates for heterogeneous services. Integration sequence is synthesis-derived.
Clinical pathway granularity	TDABC provides visibility into time, personnel and capacity cost rates.	Use ABC/TDABC selectively where time, capacity, or pathway heterogeneity is decision-relevant. Selective-use rule requires prospective validation.
Policy adjusters	Payment studies show tariffs often require adjustments for teaching, geography, ownership, quality or capacity.	Keep measured base costs separate from explicit policy adjustments to preserve traceability. Supported by direct payment/policy evidence.
Data systems	NHS PLICS and national cost collection show the value of standardized patient-level submissions.	Use standardized templates, validation rules, audit trails, and provider feedback loops. Supported primarily by policy/guidance evidence.
Implementation barriers	LMIC studies report limited trust, heterogeneous accounting systems and weak documentation of pricing decisions.	Pair costing reform with governance, stakeholder validation, and staged implementation. Supported by contextual implementation evidence.
Strength of inference	Only 15 of 46 substantive sources had direct tariff linkage; nine were empirical/analytic, and no included source evaluated the complete integrated framework at system level.	Treat the hybrid framework as a prospective hypothesis and evaluate accuracy, data burden, implementation cost, budget impact, access, quality, and provider behaviour before scale-up.

4. Discussion

4.1 What the evidence establishes

The evidence establishes a functional distinction rather than a winner among costing methods. Step-down/top-down approaches address institutional shared-cost allocation, whereas ABC/TDABC can expose clinically and operationally meaningful variation within selected pathways. These functions operate at different levels of the costing system and can therefore be complementary. The stronger contribution of this review is the identification of the translation boundary: robust cost measurement does not itself determine a public tariff, because cost estimates must subsequently be converted into payment units, adjusted for policy objectives, validated, and monitored.

4.2 Where evidence remains uncertain

The principal uncertainty concerns the added value and scope of integration. TDABC dominates the empirical literature in this corpus, while direct evidence on step-down-plus-ABC/TDABC integration is sparse. Consequently, criteria such as high cost, high volume, high variation, complex staffing, expensive equipment, or material idle capacity should be treated as candidate triggers for additional costing granularity, not as validated thresholds. A prospective comparison should test whether selective ABC/TDABC materially changes service weights, tariff decisions, or uncertainty relative to a defensible step-down baseline and whether any gain justifies the additional data and implementation burden. Figure 4 expresses this as a testable framework, with policy adjustments deliberately separated from the measured cost base.

4.3 Translating measured costs into public tariffs

Direct tariff-linked sources illustrate several routes from cost evidence to payment policy. Indian studies describe multi-site costing and policy translation into provider-payment rates, while later work considers differential payment weights [9, 10, 11];

qualitative work on hospital cost accounting also emphasizes the need for standardized provider-generated cost information for reimbursement [19]. NHS sources document standardized costing infrastructure and national price adjustments [6, 7, 8, 41]. Provider-payment manuals and international policy guidance similarly emphasize explicit costing objectives, transparent methods, and separation of technical estimates from policy choices [42, 43, 51]. These sources support traceability in cost-to-tariff translation, but they do not establish a universal adjustment formula or show that the proposed hybrid sequence improves outcomes in every health system.

4.4 Data infrastructure and governance

The reviewed evidence identifies a minimum implementation infrastructure: linked financial, human-resource, payroll, supply, equipment, activity, coding, and encounter data; explicit allocation rules; reproducible cost objects; version control; audit; provider feedback; and a scheduled revision cycle. Governance should also specify who approves assumptions and adjustments for unused capacity, teaching, geography, equity, quality, and strategic access. Standardization improves comparability but does not eliminate judgement. Accordingly, each policy adjustment should be reported separately from the underlying measured cost so that the final tariff remains auditable.

4.5 What prospective evaluation should test

Prospective evaluation should focus on decision consequences rather than costing precision alone. At minimum, pilots should compare costing accuracy or uncertainty, data burden, implementation cost, the magnitude of tariff reclassification, budget impact, service access, quality signals, and provider behavioural responses. Sensitivity analysis should test allocation bases, practical-capacity assumptions, time estimates, depreciation rules, and policy adjusters. The key evaluative question is not whether ABC/TDABC yields a different number, but whether the difference is material enough to change a tariff decision while remaining feasible, reproducible, and governable. A pilot should therefore pre-specify the minimum change in service weight or tariff that would justify retaining the added costing granularity.

4.6 A tariff learning cycle for prospective testing

The proposed learning cycle operationalizes that evaluation agenda. A pilot would define tariff-relevant cost objects, map cost centres and selected pathways, estimate unit or episode costs, simulate base tariffs and explicit adjusters, validate assumptions with providers and payers, and monitor variation and outcomes before recalibration. Pre-specified stopping or revision rules should determine when added granularity is retained, simplified, or withdrawn. Figure 5 therefore functions as an evaluation pathway rather than as evidence that integration is already effective.

4.7 Strengths and limitations of the review

The review's main strength is the explicit separation of costing functions, tariff linkage, policy adjustment, and inferential status across an interdisciplinary source base. The direct-versus-contextual classification makes visible where evidence reaches a payment decision and where the proposed framework relies on synthesis. Limitations are substantial: the corpus is heterogeneous; fully independent duplicate screening and extraction were not consistently documented; original database exports and record-level appraisal forms were unavailable for this revision; and one working-flow record remains unmatched pending source-log verification. Most importantly, direct tariff evidence is limited and no included study evaluated the complete integrated framework at system level. These limitations constrain causal and comparative conclusions but do not negate the evidence map's central finding that the cost-to-tariff translation step is under-evaluated.

5. Conclusion

Hospital costing and tariff setting should be treated as linked but distinct analytical tasks. The reviewed evidence supports complementary accounting functions for step-down allocation and ABC/TDABC, yet it provides much stronger evidence for costing applications than for their translation into public payment decisions. The principal research gap therefore lies at the cost-to-tariff boundary. A defensible next step is a staged prospective pilot in which step-down costing establishes institutional full costs, selective ABC/TDABC is applied only where pathway heterogeneity may materially change service weights or tariff decisions, and measured base costs remain separate from explicit policy adjusters. Before scale-up, payers should test

accuracy, uncertainty, implementation burden, budget impact, access, quality, and provider behaviour under transparent governance and periodic recalibration. This decision threshold would shift evaluation from asking whether methods produce different cost estimates to asking whether those differences improve payment decisions.

Abbreviations

ABC
activity-based costing
CHEERS
Consolidated Health Economic Evaluation Reporting Standards
DRG
diagnosis-related group
HTA
health technology assessment
LMIC
low- and middle-income country
MMAT
Mixed Methods Appraisal Tool
NHS
National Health Service
PLICS
Patient-Level Information and Costing System
PRISMA
Preferred Reporting Items for Systematic Reviews and Meta-Analyses
ROBIS
Risk of Bias in Systematic Reviews
TDABC
time-driven activity-based costing
VBHC
value-based health care.

Declarations

Ethics approval and consent to participate

Not applicable. This study synthesized published literature and authoritative institutional documents and did not involve human participants, individual-level human data, human tissue, or animals.

Consent for publication

Not applicable.

Availability of data and materials

The dataset(s) supporting the conclusions of this article are included within the article and Additional file 1.

Competing interests

The authors declare that they have no financial or non-financial competing interests.

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Authors' contributions

AMN conceived the study, developed the review framework and methodology, conducted the literature search and evidence screening, performed data extraction and synthesis, developed the conceptual framework and visualizations, and drafted the manuscript. SMA contributed to the study conceptualization and methodology, provided expertise in health economics, hospital costing, casemix and provider-payment systems, supervised the development of the study, and critically revised the manuscript. LN contributed to methodological development, analytical interpretation and validation of the review findings, and critically revised the manuscript. MFO contributed to evidence assessment, interpretation of findings and critical revision of the manuscript. AA contributed to the methodological review, interpretation of health-system and policy implications, and critical revision of the manuscript. MHJ contributed to the interpretation of health-economic and healthcare-financing implications and critically reviewed the manuscript. SMHASAR contributed expertise in casemix, hospital costing and tariff development, assisted in interpreting the proposed cost-to-tariff framework, and critically revised the manuscript. SAZAR contributed to evidence interpretation, manuscript review and refinement of the health-system and policy implications. All authors reviewed and approved the final manuscript and agree to be accountable for the integrity and accuracy of the work.

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References

1. Cunnama L, Sinanovic E, Ramma L, Foster N, Berrie L, Stevens W, Meyer-Rath G (2020) A general framework for classifying costing methods for economic evaluation of health care. Eur J Health Econ 21:529–542. 10.1007/s10198-019-01157-9
2. Billaux M et al (2025) An introduction to costing and the types of costs used within health economic analysis. PharmacoEconomics Open. 10.1007/s41669-025-00602-1
3. Keel G, Savage C, Rafiq M, Mazzocato P (2017) Time-driven activity-based costing in health care: A systematic review of the literature. Health Policy 121(7):755–763. 10.1016/j.healthpol.2017.04.013
4. Ninerola A, Hernández-Lara AB, Sánchez-Rebull MV (2021) Improving healthcare performance through activity-based costing and time-driven activity-based costing. Int J Health Plann Manag 36(6):2079–2093. 10.1002/hpm.3304
5. Li Y et al (2025) Time-driven activity-based costing and its use in health economic analysis: A systematic literature review. PharmacoEconomics 43:1–16. 10.1007/s40258-025-00988-3
6. NHS England. Approved costing guidance (2026) https://www.england.nhs.uk/costing-in-the-nhs/approved-costing-guidance/. Accessed 27 Sep 2026
7. NHS England. National Cost Collection for the NHS (2026) https://www.england.nhs.uk/costing-in-the-nhs/national-cost-collection/. Accessed 27 Sep 2026
8. NHS Digital. Patient-level information and costing system data collections (2026) https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/patient-level-information-and-costing-system-plics-data-collections. Accessed 27 Sep 2026
9. Chauhan AS, Guinness L, Bahuguna P, Singh MP, Aggarwal V, Rajsekhar K, Tripathi S, Prinja S (2022) Cost of hospital services in India: A multi-site study to inform provider payment rates and health technology assessment. BMC Health Serv Res 22:1343. 10.1186/s12913-022-08707-7

10. Prinja S, Singh MP, Rajsekar K, Sachin O, Gedam P, Nagar A et al (2021) Translating research to policy: Setting provider payment rates for strategic purchasing under India's national publicly financed health insurance scheme. Appl Health Econ Health Policy 19:353–370. 10.1007/s40258-020-00631-3
11. Prinja S, Bahuguna P, Singh MP, Guinness L, Goyal A (2023) Aggarwal, V. Refining the provider payment system of India's government-funded health insurance programme: An econometric analysis. BMJ Open 13(10):e076155. 10.1136/bmjopen-2023-076155
12. Guinness L, Ghosh S, Mehndiratta A, Shah HA (2022) Role of healthcare cost accounting in pricing and reimbursement in low-income and middle-income countries: A scoping review. BMJ Open 12(9):e065019. 10.1136/bmjopen-2022-065019
13. Rocha C et al (2023) Hospital costing methods: Four decades of literature review. J Risk Financial Manage 16(10):433. 10.3390/jrfm16100433
14. Sirur S, Pillai R (2024) Pricing of hospital services: Evidence from a thematic review. Health Econ Policy Law 19(2):234–252. 10.1017/S1744133123000397
15. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al (2021) The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. BMJ 372:n71. 10.1136/bmj.n71
16. Whiting P, Savović J, Higgins JPT, Caldwell DM, Reeves BC, Shea B et al (2016) ROBIS: A new tool to assess risk of bias in systematic reviews. J Clin Epidemiol 69:225–234. 10.1016/j.jclinepi.2015.06.005
17. Hong QN, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M et al (2018) Mixed Methods Appraisal Tool (MMAT), version 2018: User guide. McGill University. http://mixedmethodsappraisaltoolpublic.pbworks.com/w/file/fetch/127916259/MMAT_2018_criteria-manual_2018-08-01_ENG.pdf. Accessed 27 Sep 2026
18. Husereau D, Drummond M, Augustovski F, de Bekker-Grob E, Briggs AH, Carswell C et al (2022) Consolidated Health Economic Evaluation Reporting Standards 2022 (CHEERS 2022) statement: Updated reporting guidance for health economic evaluations. Value Health 25(1):3–9. 10.1016/j.jval.2021.11.1351
19. Guinness L et al (2024) Health care cost accounting in the Indian hospital sector. Health Policy Plann 39(7):731–740. 10.1093/heapol/czae040
20. Etges APBS, Jones P, Liu H, Zhang X, Haas D (2024) Improvements in technology and the expanding role of time-driven, activity-based costing to increase value in healthcare provider organizations: A literature review. Front Pharmacol 15:1345842. 10.3389/fphar.2024.1345842
21. Jiang Q, Zhu X, Chen L, Zhao Z, Chen Y (2021) Research on time-driven activity-based management system of public hospitals. Front Public Health 9:763829. 10.3389/fpubh.2021.763829
22. Malmmose M, Lydersen JP (2021) From centralized DRG costing to decentralized TDABC—Assessing the feasibility of hospital cost accounting for decision-making in Denmark. BMC Health Serv Res 21:835. 10.1186/s12913-021-06807-4
23. Koster F, Kok MR, van der Kooij J, Waverijn G, Weel-Koenders AEAM, Barreto DL (2023) Dealing with time estimates in hospital cost accounting: Integrating fuzzy logic into time-driven activity-based costing. PharmacoEconomics Open 7:393–402. 10.1007/s41669-023-00413-2
24. Iachecen F, Dallagassa MR, Santos EAP, Carvalho DR, Ioshii SO (2023) Is it possible to automate the discovery of process maps for the time-driven activity-based costing method? A systematic review. BMC Health Serv Res 23:1337. 10.1186/s12913-023-10411-z
25. Cardoso RB, Marcolino MAZ, Marcolino MS, Fortis CF, Moreira LB, Coutinho AP et al (2023) Comparison of COVID-19 hospitalization costs across care pathways: A patient-level time-driven activity-based costing analysis in a Brazilian hospital. BMC Health Serv Res 23:198. 10.1186/s12913-023-09049-8
26. Lai YF et al (2023) Economic evaluation of novel models of care for patients with acute medical problems. JAMA Netw Open 6(9):e2333471. 10.1001/jamanetworkopen.2023.33471
27. Rahimi H, Goudarzi R, Markazi-Moghaddam N, Nezami-Asl A, Zargar Balaye Jame (2023) Cost-benefit analysis of intensive care unit with activity-based costing approach in the era COVID-19 pandemic: A case study from Iran. PLoS ONE 18(5):e0285792. 10.1371/journal.pone.0285792

28. Rognoni C, Furnari A, Lugli M, Maleti O, Greco A, Tarricone R (2023) Time-driven activity-based costing for capturing the complexity of healthcare processes: The case of deep vein thrombosis and leg ulcers. Int J Environ Res Public Health 20(10):5817. 10.3390/ijerph20105817
29. Chen YH, Blommestein HM, Klazenga R, Uyl-de Groot C, van Vulpen M (2023) Costs of newly funded proton therapy using time-driven activity-based costing in the Netherlands. Cancers 15(2):516. 10.3390/cancers15020516
30. Nagra NS et al (2021) Time-driven activity-based costing in breast cancer care delivery. Ann Surg Oncol 28:7799–7808. 10.1245/s10434-021-10465-5
31. Ljuboja D, Ahmed M, Ali A, Perez E, Subrize MW, Kaplan RS, Sarwar A (2021) Time-driven activity-based costing in interventional oncology: Cost measurement and cost variability for hepatocellular carcinoma therapies. J Am Coll Radiol 18(8):1095–1105. 10.1016/j.jacr.2021.03.027
32. McClintock TR, Friedlander DF, Feng AY, Shah MA, Pallin DJ, Chang SL et al (2021) Determining variable costs in the acute urolithiasis cycle of care through time-driven activity-based costing. Urology 157:107–113. 10.1016/j.urology.2021.05.102
33. Bendini C et al (2022) What is the inpatient cost of hip replacement? A time-driven activity-based costing pilot study in an Italian public hospital. J Clin Med 11(23):6928. 10.3390/jcm11236928
34. Fang CJ, Mazzocco JC, Sun DC, Shaker JM, Talmo CT, Mattingly DA, Smith EL (2021) Total knee arthroplasty hospital costs by time-driven activity-based costing: Robotic vs conventional. Arthroplasty Today 12:43–47. 10.1016/j.artd.2021.09.014
35. Ghasemi Rad M, Wynne D, Ghasemi M, Lincoln C, Whigham C (2022) Time-driven, activity-based costing to reduce interventional radiology suite idle time. Cureus 14(11):e31862. 10.7759/cureus.31862
36. Keppetipola, K. M., Leibold, A., Trivedi, J., Kabani, A. S., Sarikonda, A., Self,D. M., et al. Time-driven activity-based costing for cervical myelopathy surgery:A step towards total episode costs. ClinicoEconomics and Outcomes Research. 2025;17:419–428.doi:10.2147/CEOR.S502217
37. van der Poort EKJ, van der Helm D, de Vries APJ, van den Hout (2025) W. B., van den Akker-van Marle, M. E. Costs in value-based health care dashboards: A qualitative study on stakeholder requirements. BMC Health Serv Res 25:1232. 10.1186/s12913-025-13054-4
38. Schneider NB, Roos EC, Marcolino MAZ, Etges APBS, Polanczyk CA (2025) Evaluation of reporting in time-driven activity-based costing studies on cardiovascular diseases: A scoping review. J Comp Eff Res. 10.57264/cer-2024-0013
39. Risør BW, Duvald I, Nielsen CP, Tayyari N (2026) Developing hospital at home tariffs in Denmark: A time-driven activity-based microcosting approach within a randomised controlled trial. BMJ Open 16(4):e113738. 10.1136/bmjopen-2025-113738
40. Jyani G, Gedam P, Sharma S, Dixit J, Prinja S (2025) Financial viability of private hospitals operating under India's national health insurance scheme Ayushman Bharat Pradhan Mantri-Jan Arogya Yojana (AB PM-JAY). Appl Health Econ Health Policy 23:841–853. 10.1007/s40258-025-00966-9
41. NHS England (2023) /25 NHS Payment Scheme: Annex D prices and cost adjustments. 2024. https://www.england.nhs.uk/wp-content/uploads/2023/03/23-25NHSPS-amended_Annex-D-Prices-and-cost-adjustments_2024-25.pdf. Accessed 27 Sep 2026
42. Joint Learning Network for Universal Health Coverage. Costing of health services for provider payment: A practical manual based on country costing challenges, trade-offs, and solutions (2014) https://jointlearningnetwork.org/wp-content/uploads/2019/11/JLN_Costing_Manual.pdf. Accessed 27 Sep 2026
43. World Bank. Costing of health services provider payment: An introduction for health policy makers (2021) https://documents1.worldbank.org/curated/en/099645106272233786/pdf/P175905067de810b809f42024e046b2c94d.pdf. Accessed 27 Sep 2026
44. Organisation for Economic Co-operation and Development. Comparing price levels of hospital services across countries (2010) https://www.oecd.org/en/publications/comparing-price-levels-of-hospital-services-across-countries_5km91p4f3rzw-en.html. Accessed 27 Sep 2026
45. Turner HC et al (2022) Understanding differences in health care spending: A comparative study of prices and volumes across OECD countries. Health Serv Insights 15:11786329221109755. 10.1177/11786329221109755

46. Leusder M, Porte P, Ahaus K, van Elten H (2022) Cost measurement in value-based healthcare: A systematic review. BMJ Open 12(12):e066568. 10.1136/bmjopen-2022-066568
47. Jeet G et al (2021) Costing of essential health service packages: A systematic review of methods from developing economies. Value Health 24(11):1700–1713. 10.1016/j.jval.2021.05.021
48. Cantero-Muñoz P et al (2021) Is time-driven activity-based costing coming out on top? A comparison with activity-based costing in health care. Healthcare 9(9):1113. 10.3390/healthcare9091113
49. Mohammadpour F, Basakha M, Kamal SHM, Azari N (2022) Costing the outpatient rehabilitation services: Time-driven activity-based costing approach. Cost Eff Resource Allocation 20:31. 10.1186/s12962-022-00366-z
50. Munaa N, Rahmawati NV, Nurdiana F, Kusdiyana A, Kusbiantoro D, Sholihah EM (2024) Analysis of activity based costing as the basis for inpatient services tariff at Intan Medika Lamongan Hospital. Jurnal Manajemen Kesehatan Indonesia 12(2):185–193. 10.14710/jmki.12.2.2024.185-193
51. World Health Organization. Price setting and price regulation in health care: Lessons for advancing universal health coverage (2019) https://www.who.int/publications/i/item/9789241515924. Accessed 27 Sep 2026

Figures

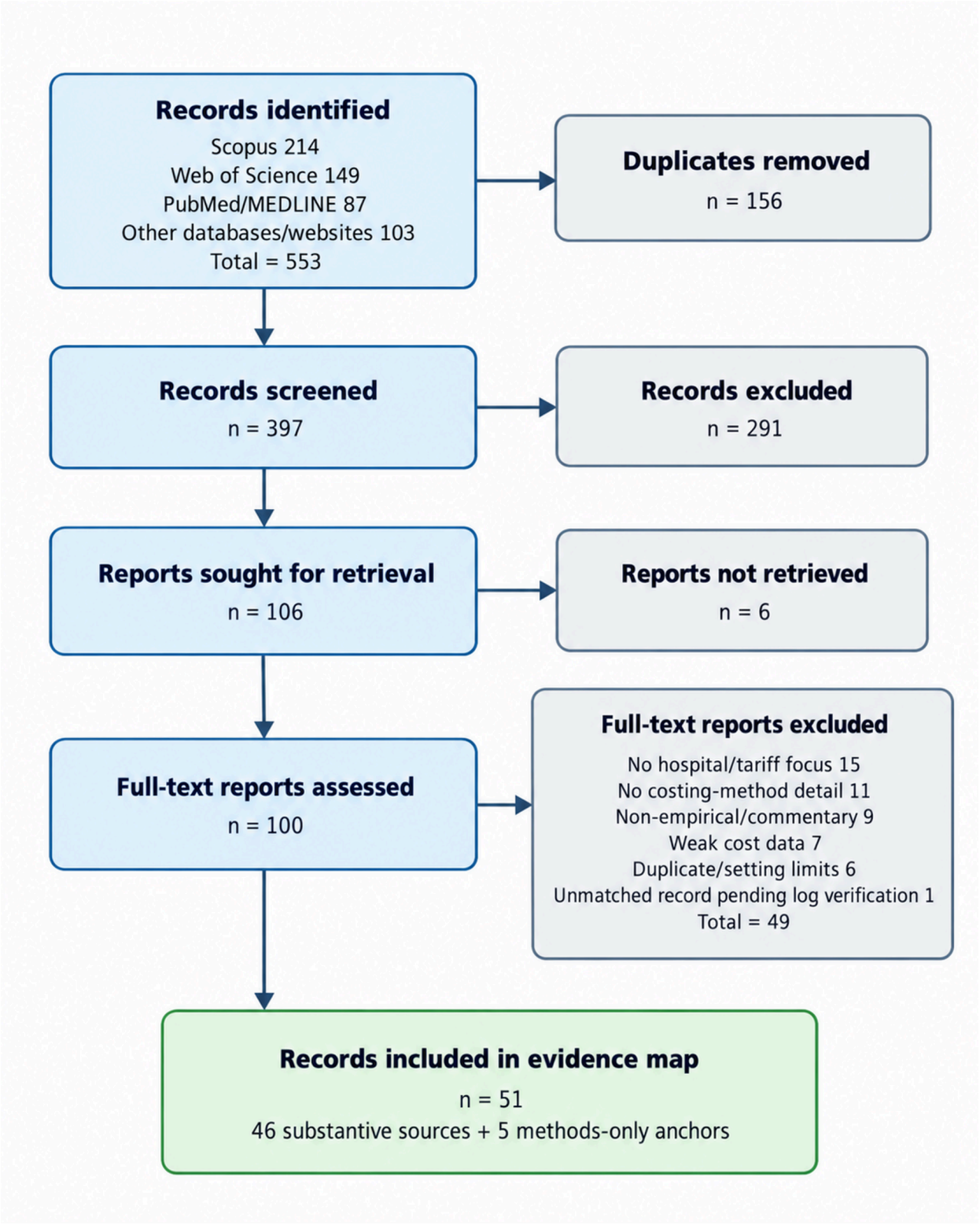

Figure 1

Study selection and reconciled PRISMA 2020 flow. The analytic corpus contains 51 records. One unmatched record is shown among full-text exclusions pending source-log verification.

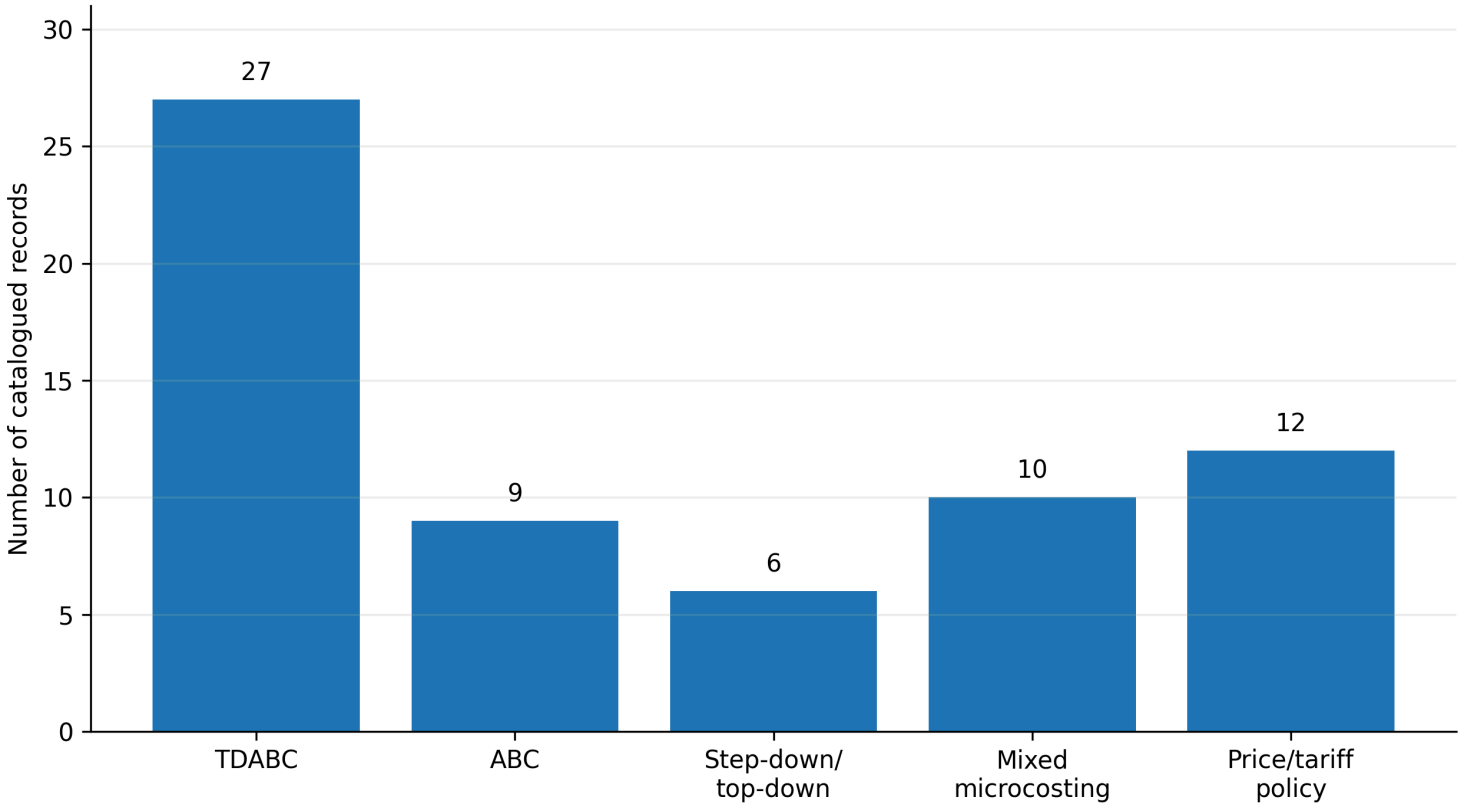

Figure 2

Distribution of evidence by costing and tariff method. Categories are non-mutually exclusive; totals exceed the number of records because some sources addressed more than one method. Counts are descriptive and are not pooled effect estimates.

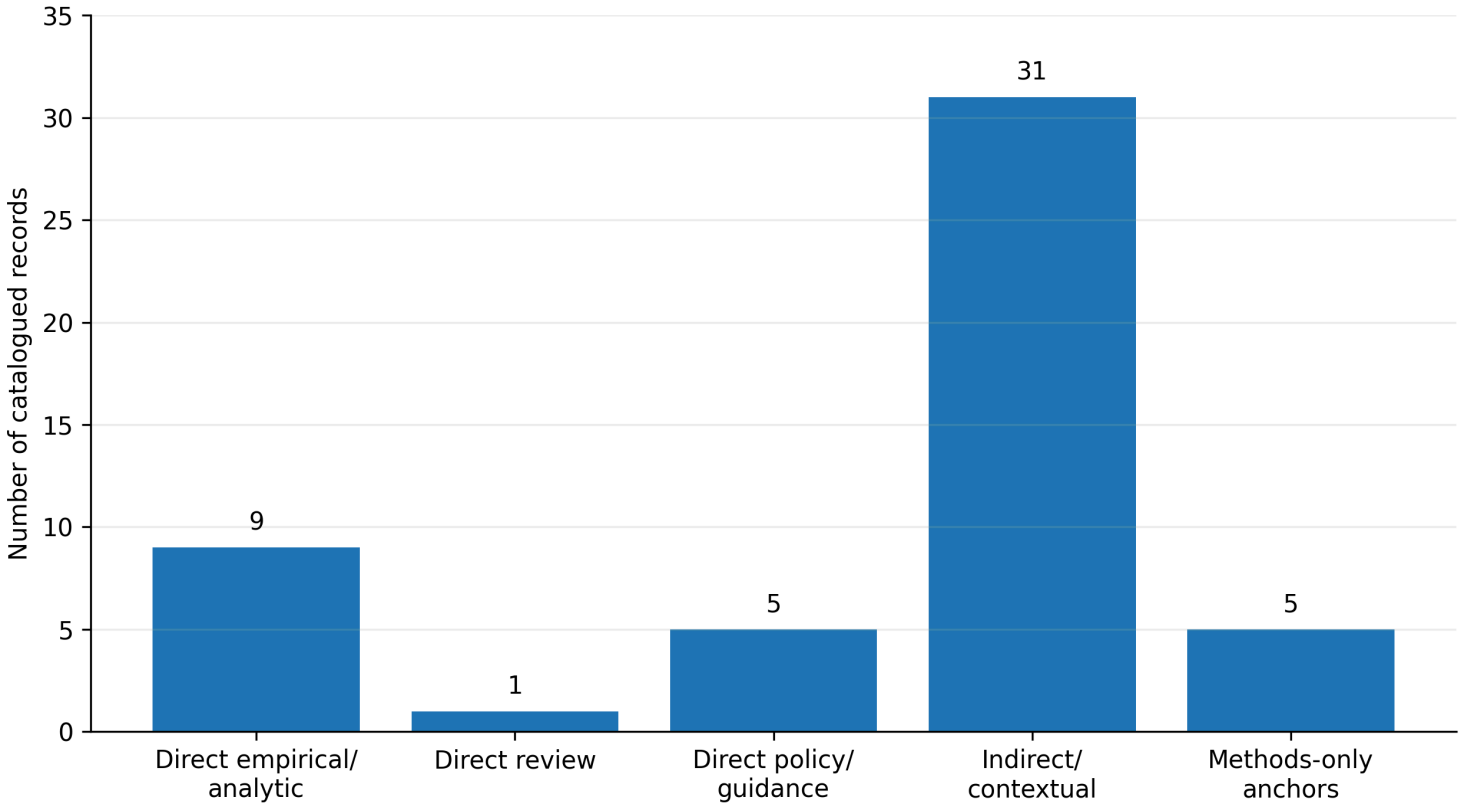

Figure 3

Role of included sources in tariff inference. Categories distinguish direct empirical/analytic, review, and policy/guidance linkage from indirect/contextual evidence and methods-only anchors; they indicate relevance to tariff inference rather than risk of bias or causal certainty.

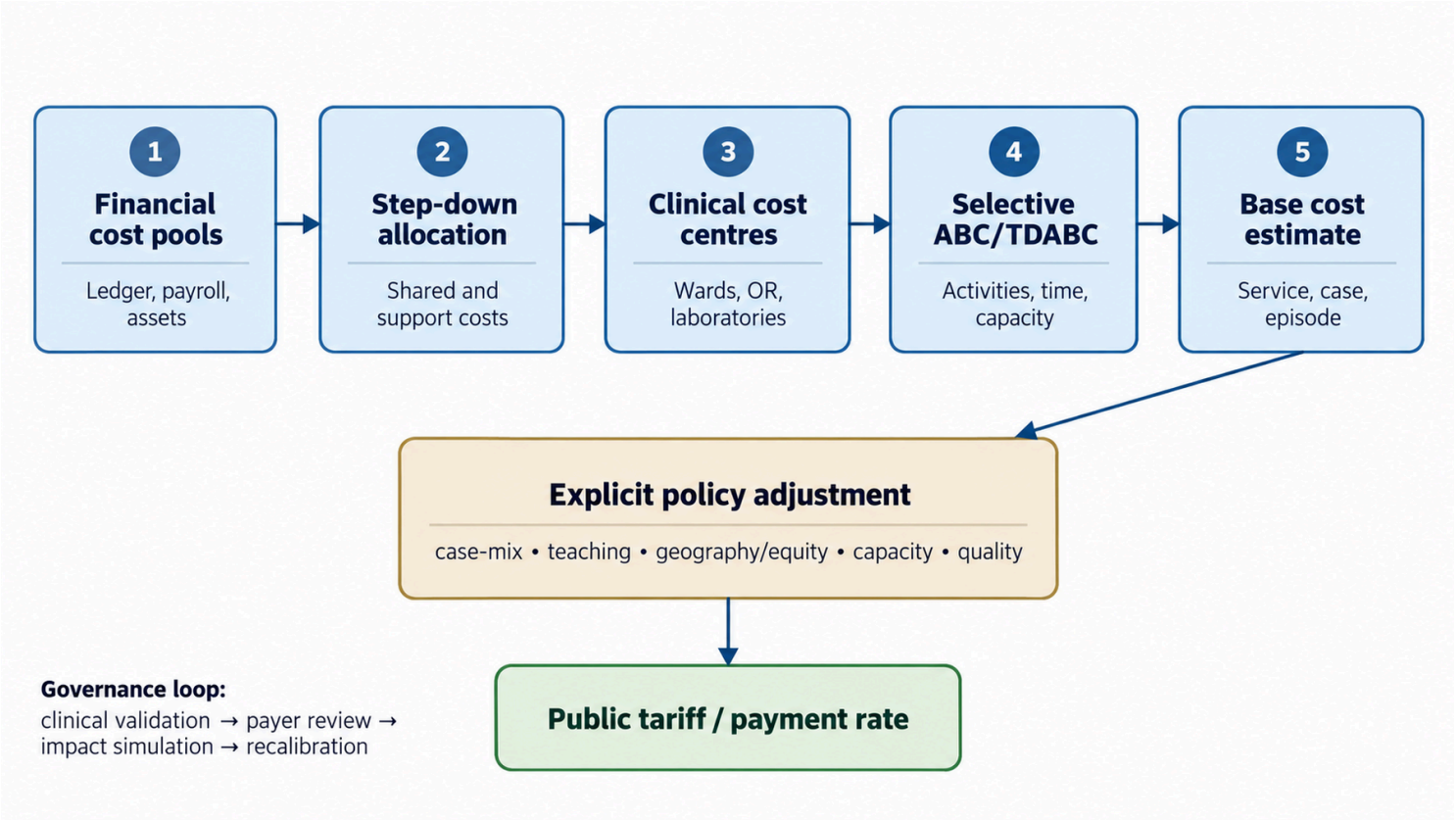

Figure 4

Evidence-informed cost-to-tariff framework. Step-down allocation establishes institutional shared costs, selective ABC/TDABC can refine heterogeneous services, and explicit policy adjustments translate measured base costs into public tariffs. The sequence is a prospective design hypothesis, not a proven superior model.

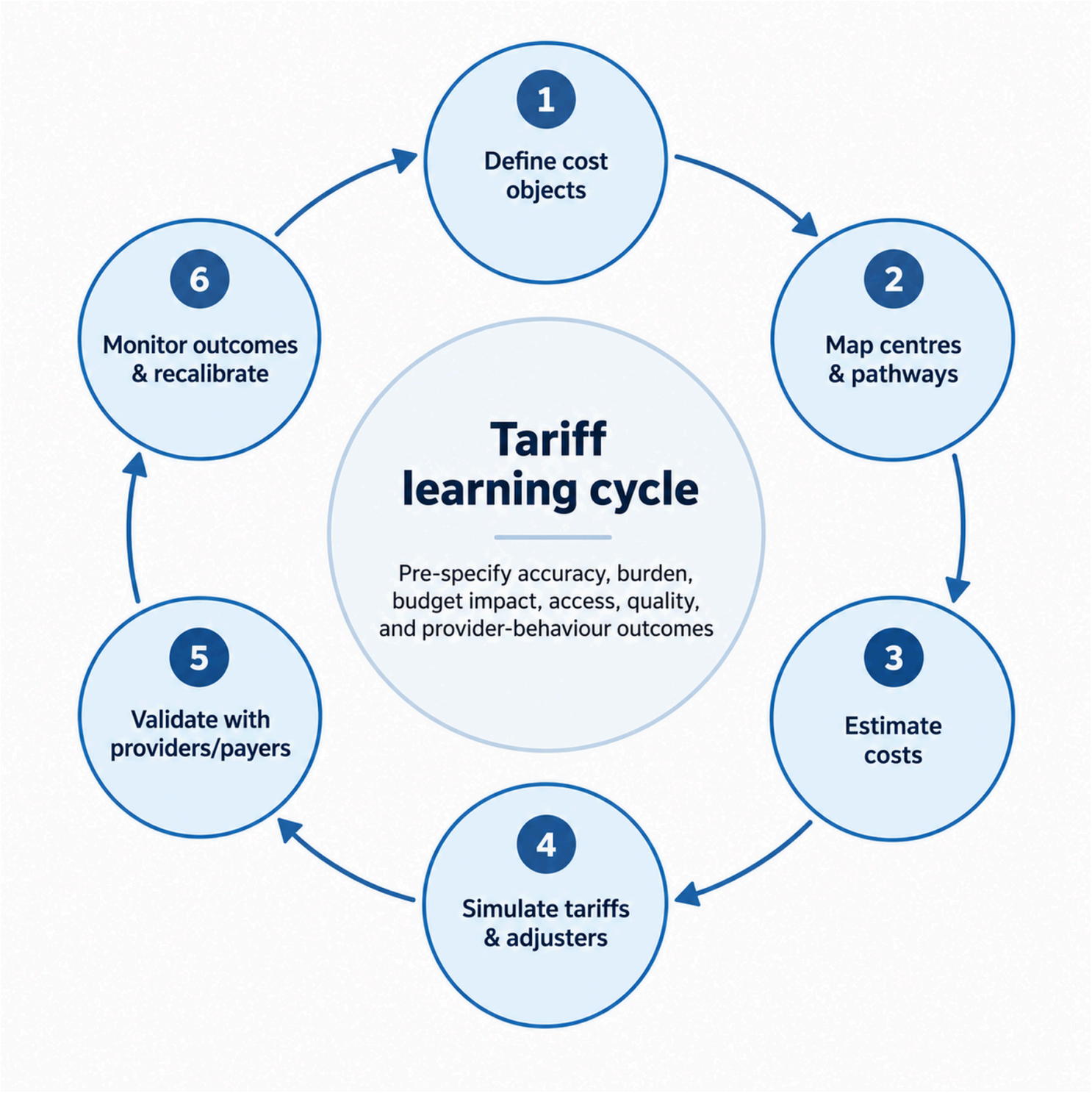

Figure 5

Tariff learning cycle for prospective evaluation. The cycle links cost measurement to tariff simulation, stakeholder validation, outcome monitoring, and periodic revision; it is an evaluation framework rather than evidence of established superiority.

Supplementary Files

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