SHORT COMMUNICATION

Modeling Medical Peer Review: Moving towards an Accuracy–Speed Governance System

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Cite this article:
Shomoossi N, Nezhad HE. Modeling Medical Peer Review: Moving towards an Accuracy–Speed Governance System. Int Rev Lifestyle Med. 2026;1(2):98-109.
https://doi.org/10.22034/irlm.2026.604298.1021

Article history
Received: 25 Aug 2026
Revised: 18 Sep 2026
Accepted: 01 Oct 2026

Abstract

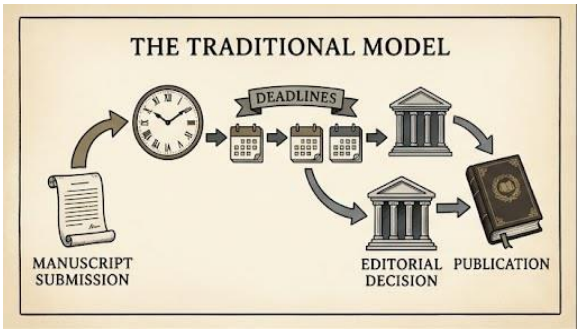
Background and Objective: Peer review is commonly described as quality control, but this description is incomplete. In medical publishing, editorial systems often measure review speed directly while inferring accuracy indirectly, creating an asymmetry that rewards visible promptness even when the diagnostic value of reviews is weak. This article is written to suggest a governance model that reframes peer review performance around "diagnostic yield per unit time" rather than speed alone, and to translate this construct into a practical editorial architecture.
Methods: This narrative review draws on signaling theory, principal–agent theory, and incentive design to model the exchanges of imperfect signals among authors, reviewers, editors, and journals.
Results: The article proposes an editorial architecture built on five linked functions: (1) transparent manuscript signals; (2) competence-sensitive reviewer matching; (3) coverage-based review prompts; (4) lightweight quality assurance; and (5) recognition tied to useful diagnosis rather than mere completion. The model preserves reviewer independence by distinguishing governance of the review process from control of substantive judgment, and it addresses conflicts of interest, language-related inequity, open peer review, reviewer training, and the role of artificial intelligence.
Conclusion: The proposed system offers a testable framework for improving accuracy, timeliness, fairness, and sustainability in medical peer review without reducing it to a mechanical score.
Keywords: peer review; incentives; accuracy–speed tradeoff; editorial governance; medical publishing; signaling; principal–agent theory.

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Introduction

Peer review is indispensable to medical publishing because editorial decisions need to be made by judging whether a manuscript is methodologically credible, clinically meaningful, ethically acceptable, and sufficiently transparent, and this important judgment is generated throughout the review process. In addition, much of the relevant information for judging is distributed across the manuscript, supplementary materials, reviewer reports, and editorial judgment. Reviewers, therefore, do more than evaluating the correct writing or recommend acceptance. They also perform a diagnostic function by identifying defects that may alter the interpretation, validity, reproducibility, or clinical relevance of a study. Contemporary accounts of peer review increasingly emphasize its changing history, workload, technologies, and social expectations; however, the process remains governed by a deceptively simple operational indicator, i.e., how quickly a review is returned (1). This is characteristic of the traditional peer review systems (Figure 1).

Figure 1 - The Traditional Peer Review



The speed imperative is understandable because long review times delay knowledge dissemination, increase undesirable uncertainty for authors, and impose costs on journal publishers, editors, and reviewers. Authors often adopt a perspective reflecting that duration is a meaningful dimension of the publication experience, although duration and perceived quality do not necessarily move together (2).

At the system level, peer review consumes a large quantity of researchers' unpaid time, making inefficient allocation of reviewer attention economically consequential (3). Journals also face difficulty recruiting reviewers, while experienced reviewers require motivation, training, and recognition rather than indefinite appeals to professional duty (4,5).

The problem is not that journals value speed but the problem is that speed is comparatively easy to observe, whereas review accuracy is a latent and multidimensional aspect often less viewed as the core of the review process. A report returned within five days can be rigorous, but it can also be generic, incomplete, overconfident, or inattentive to the manuscript's decisive weakness. Conversely, a delayed review may reflect poor organization, or careful detection of a subtle methodological problem. When an observable metric becomes a proxy for an unobserved objective, agents may rationally optimize the proxy. In peer review, this can produce a governance equilibrium in which rapid completion is rewarded even when diagnostic value is low.

This article intends to raise a novel argument: medical peer review should be designed as an accuracy-speed governance system rather than being managed as a time-to-completion trajectory (Figure 2). The key performance object is not accuracy or speed in isolation, but diagnostic yield per unit time must be the desired goal, i.e., the amount of decision-relevant information generated by a review relative to the expert time required. This formulation does not reduce quality to a single numerical score. Instead, it provides a design principle for aligning incentives, reviewer support, editorial measurement, and quality assurance.

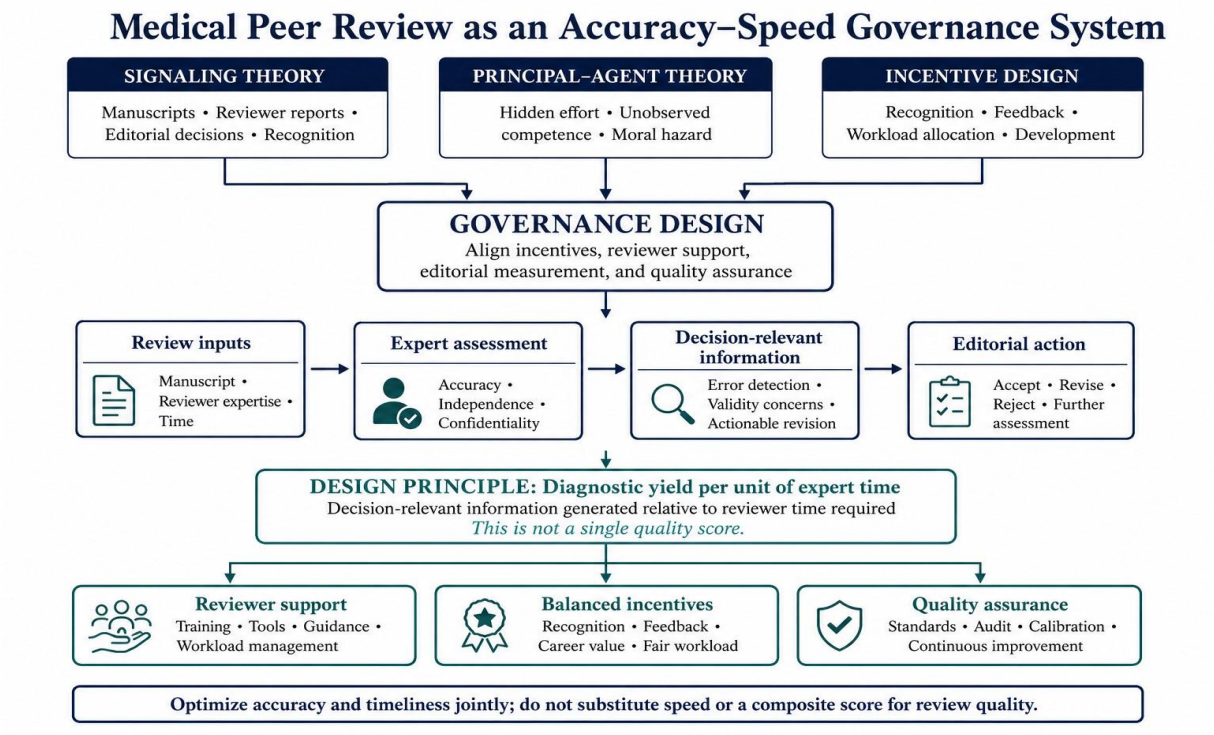
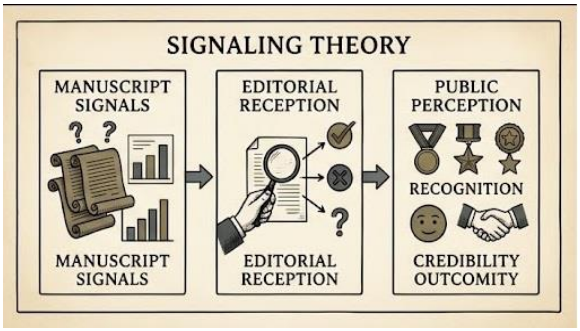


Figure 2 – The Accuracy–Speed Governance Framework

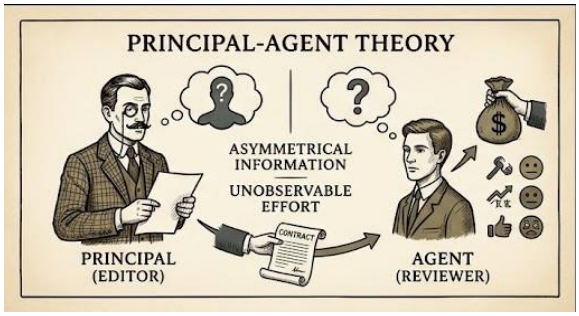
As displayed above, the proposed framework integrates three theoretical perspectives to generate a unified and vehement framework for applied purposes embracing the accuracy and speed in the peer review process. First, the Signaling Theory explains how manuscripts, reviewer reports, editorial decisions, and recognition mechanisms communicate information under uncertainty (Figure 3).

Figure 3 - The Signaling Theory



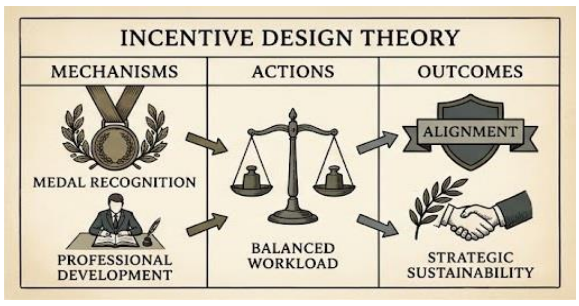
Second, the Principal–agent Theory explains why journals cannot fully observe reviewer effort or competence and why poorly designed incentives create moral hazard (Figure 4).

Figure 4 - The Principal–agent Theory



Finally, the theory of Incentive Design explains how recognition, feedback, workload allocation, and professional development can make careful reviewing strategically sustainable (Figure 5).

Figure 5 - The Theory of Incentive Design



Consequently, the resulting model is deemed to be more practical for the editors: it identifies interventions that a medical journal can implement without compromising reviewer independence and confidentiality.

Peer review as an information problem

A manuscript is not a transparent container of truth. It is a bundle of claims supported by varying levels of design quality, reporting completeness, analysis, interpretation, and contextual justification. Authors signal the reliability of that bundle through methods transparency, reporting completeness, data availability, protocol registration, appropriate statistical reasoning, and candid discussion of limitations. These signals may be costly to produce, but they reduce the information burden placed on reviewers. Conversely, missing information increases the probability that reviewers will infer rather than verify key features of the study.

Manuscript reviewers produce a second-order signal; not merely do they approve or reject a manuscript, but they base decisions on what they notice and how they reason, then their intellectual contribution guides which revisions would finally change the editorial assessment. A useful review makes its diagnostic pathway visible by distinguishing fatal problems from remediable ones, connecting criticisms to evidence in the manuscript, recognizing strengths, and explaining whether the conclusions follow from the design and analysis. Comprehensive reviewing guides emphasize systematic appraisal of the research question, methods, results, interpretation, presentation, and ethical dimensions (6-9). These domains are not a checklist for bureaucratic completeness; rather, they are coverage areas through which hidden defects become observable.

Journal editors are the interpreters of these signals; they must infer reviewer competence from the specificity, internal consistency, evidentiary grounding, and predictive usefulness of reports. Yet a recommendation alone is a noisy signal. Two reviewers may recommend rejection for entirely different reasons; two reviewers may agree on “major revision” while identifying different levels of risk. Editorial research shows that reviewers’ roles and tasks are understood heterogeneously across biomedical journals, which makes explicit role definition important (10). A governance system should therefore evaluate the information contained in a report, not merely the recommendation attached to it.

This perspective also clarifies why professionalism matters since it includes timeliness, confidentiality, respectful communication, disclosure of conflicts, and appropriate handling of the manuscript’s content, but it also includes intellectual responsibility. Empirical work on professionalism suggests that reviewing behavior can be described and assessed through observable dimensions rather than treated as an entirely private virtue (11). The editorial challenge is to assess those dimensions without creating incentives for formulaic reports or suppressing legitimate disagreement.

The Accuracy-Speed Tradeoff

Speed and accuracy are not intrinsically antagonistic. A well-informed reviewer who uses a clear rubric may produce a rapid and rigorous report. The conflict arises when the journal treats speed as a direct output and accuracy as an assumed by-product. Under conditions of high workload, ambiguous expectations, and weak recognition, reviewers may rationally minimize effort while preserving the appearance of compliance. Generic statements, excessive focus on language, unsupported methodological objections, and unprioritized lists of minor corrections are all possible products of this equilibrium.

A more useful model separates four variables: [1] Timeliness: when the report

becomes available for editorial use; [2] Coverage: whether the review addresses the manuscript's decision-critical domains; [3] Diagnostic validity: whether the identified concerns are accurate, relevant, and supported by the manuscript or appropriate external knowledge; and [4] Actionability: whether the report enables authors and editors to determine what should happen next.

In practice, a review can be timely but weak in coverage; comprehensive but diagnostically mistaken; accurate but too vague to guide revision; or highly actionable but unnecessarily delayed. The journal's objective is therefore multidimensional. A conceptual production function can be written as:

$$Q = f(C, D, A, T, A)$$

where Q is review utility, C coverage, D diagnostic validity, A actionability, T timeliness, and M reviewer–manuscript matching. In this model, timeliness is a component of utility, not its substitute. The practical target is an increase in Q/Te, where Te represents expert time consumed.

This reframing attempt gains importance because the cost of peer review is not measured only in calendar days. It includes the opportunity cost of expert labor, the editorial time required to interpret poor reports, the rework imposed on authors, and the downstream risk of publishing an undetected error. Estimates of the economic value of researchers' reviewing time demonstrate that the system represents a substantial collective contribution rather than an invisible free resource (3). A fast but uninformative report can therefore be expensive even when it satisfies a deadline.

A Principal-Agent Model of Reviewing

The journal is the principal as it seeks reliable decisions and efficient use of scarce expertise. The reviewer is an agent who possesses private information about competence, effort, and the reasoning behind the report. The editor cannot observe all dimensions of the reviewer's work at the moment of decision. This is a classic hidden-action and hidden-information environment.

Accordingly, three agency problems follow. First, the journal may not know whether a reviewer has the expertise required for a specific design or clinical domain. Second, it may not know how much effort a reviewer invested or whether the report reflects a careful reading. Third, it may not be able to determine immediately whether a criticism is correct. The recommendation is therefore an incomplete performance signal.

Poor incentives can intensify these problems. If the only visible performance indicator is whether a report arrived before the deadline, reviewers have a reason to prioritize completion. If recognition is based on the number of reviews, a high-volume reviewer may appear more valuable than a slower reviewer whose reports prevent repeated rounds of revision. If editors respond to every disagreement by demanding consensus, reviewers may avoid independent judgments. If authors' suggested reviewers are used without adequate safeguards, conflicts and network effects may distort the signal environment (12).

The Agency Model does not imply that reviewers are opportunistic. Most reviewers evidently act conscientiously, and reviewing is widely understood as a professional obligation that supports the scientific community (13). The point is structural in the sense that even motivated professionals operate within constraints. A system that makes high-quality reviewing costly and low-quality reviewing easy will eventually produce uneven results. Motivation must therefore be supported by institutional design, training, feedback, and credible recognition (4,14).

The journal should also avoid an overly narrow conception of the agent's task. Reviewers are not substitute editors, ghost authors, or instruments for enforcing stylistic conformity. Their function is to provide independent, evidence-based assessment. A high-quality guide to clinical and translational reviewing emphasizes the need to evaluate the scientific question, design, analysis, interpretation, and clinical implications while preserving a constructive tone (15). Governance should standardize the information expected from a report, not dictate the reviewer's conclusion.

The proposed governance architecture

1. Convert manuscript transparency into a usable signal

Editorial governance begins before reviewer assignment. Authors should be asked to make the manuscript's key claims, design features, analytic decisions, ethical approvals, reporting standards, and limitations sufficiently visible for evaluation. This is not merely a compliance exercise. Transparent manuscripts reduce reviewer search costs and allow experts to spend more time on diagnostic reasoning.

Journals should distinguish missing information that blocks assessment from information that merely improves readability. A concise pre-review transparency screen can identify absent registration details, unclear participant flow, unexplained exclusions, incomplete outcome definitions, unavailable analysis plans, or unreported conflicts. The screen should not become an automatic rejection device; its purpose is to route manuscripts toward appropriate review and to prevent reviewers from spending scarce time reconstructing basic facts.

In addition, language should be handled carefully. Language-related problems can obscure scientific meaning, but linguistic fluency is not a valid proxy for methodological quality. A science-over-language approach is particularly important for authors from low- and middle-income countries, whose work may address clinically important populations and settings that are underrepresented in the literature (16,17). Editors should separate essential clarity problems from stylistic preferences and should not allow language bias to become a hidden selection mechanism.

2. Match reviewers by diagnostic need

Reviewer matching is often described as a subject-area task, but a manuscript may require several kinds of diagnosis. One reviewer may be best positioned to assess causal inference, another advanced statistic, another clinical applicability, and another implementation or ethics. Matching should therefore be based on the manuscript's risk profile rather than title keywords alone.

A practical matching matrix can classify the manuscript by design, intervention or exposure, population, outcome, analytic complexity, ethical sensitivity, and translational relevance. The editor then identifies the minimum diagnostic capabilities needed. This approach avoids the common assumption that a famous or senior reviewer is automatically the best reviewer for every dimension. It also creates opportunities to include trained early-career reviewers under supervision, expanding the reviewer pool without lowering standards.

Admittedly, reviewer recruitment is a recognized bottleneck. Journals report difficulty recruiting suitable reviewers, and the global demand for review continues to grow (18,19). Matching can improve recruitment because invitations become more specific; for instance, the reviewer can be asked to assess a defined contribution rather than accept an undefined obligation. A prospective reviewer may be more willing to review a complex observational study if the journal explains that the principal need concerns confounding and outcome

definition, while another reviewer is covering clinical interpretation.

3. Replace generic forms with coverage-based prompts

A structured form should not ask reviewers to produce a longer report; it should help them produce a more informative one. The central design principle is coverage of decision-critical domains. A journal may ask reviewers to state, in a few sentences, the manuscript's principal claim, the strongest supporting feature, the most consequential threat to validity, and the minimum revision required for a defensible conclusion.

The form can then include domain-specific prompts:

- Is the research question clear, important, and appropriately bounded?
- Does the design support the stated inference?
- Are eligibility criteria, interventions or exposures, outcomes, and missing data adequately described?
- Are the statistical methods appropriate, transparent, and sufficiently justified?
- Are the results internally consistent and presented without selective emphasis?
- Do the conclusions remain within the evidentiary limits of the study?
- Are ethical, reporting, data, and conflict-of-interest requirements addressed?
- Which concerns are fatal, major but remediable, or minor?

The reviewer should be able to select "not applicable" and explain uncertainty. Forced ratings can create false precision. The objective is not to calculate a universal reviewer score but to expose the reasoning relevant to the editorial decision. Step-by-step guidance and structured training have been recommended across specialties, and journal-led mentoring programs show promise for improving reviewer preparation (6-9,20,21).

4. Measure diagnostic yield, not speed alone

The proposed system needs measurement, but measurement can damage what it seeks to improve. A simplistic score for "review quality" may reward verbosity, agreement with the editor, or conformity to a template. The safer approach tends to be a lightweight, multidimensional, and developmental framework.

After a decision, editors can record whether the report identified a concern that materially influenced the decision, whether it contained actionable reasoning, whether it was internally consistent, whether its tone and conduct were professional, and whether it arrived within the agreed window. These observations should be used to improve matching, training, and recognition, not to create an unclear ranking system.

A useful conceptual index can be described as follows:

$$DY=\alpha C+\beta D+\gamma A+\delta RTe,$$

Where DY is diagnostic yield, C coverage, D diagnostic validity, A actionability, R reproducibility or consistency, and Te expert time. The weights should be journal-specific and transparent in any relationship. Then the equation can be considered as a governance heuristic, not merely a publication metric.

Indeed, editorial calibration is still crucial and plays a vital role. Editors should periodically compare reviewer comments with the final decision and with post-publication corrections or author responses where appropriate. However, this does not mean judging reviewers by whether the manuscript was accepted or rejected. For instance, a reviewer can provide an excellent report that supports acceptance, while another reviewer may make a valuable contribution even when an editor ultimately disagrees, and declines to accept the comments. The question is whether the report improved the decision by adding valid information.

5. Align recognition with useful contribution

Recognition systems should reward reviewers' behaviors that improve the information environment, e.g., timely acceptance or decline of invitations, careful disclosure of conflicts, substantive diagnostic comments, respectful communication, and participation in training or calibration. While the volume and speed can remain visible, they should not dominate the reviewing ecosystem.

Recognition may include certificates, verified records, editorial acknowledgments, access to reviewer development, opportunities for mentorship, or consideration for editorial roles. Financial incentives are possible but should be designed cautiously because payment may introduce new conflicts or commodify a shared obligation. Recent discussions of incentives argue that peer review requires reforms capable of recognizing its contribution to scientific advancement rather than relying exclusively on altruism (22).

In addition, recognition must be equitable. Reviewers in resource-constrained settings may face greater time pressure, less institutional support, and language barriers, while their expertise may be essential to evaluating locally relevant research. A system that rewards only rapid English-language production risks reproducing existing inequalities. Journals should make deadlines realistic, provide clear forms, and distinguish language polishing from scientific assessment.

Integrity, independence, and technology

A governance system is legitimate only if it protects reviewers' independence. Reviewers must disclose relevant conflicts of interest, maintain confidentiality, avoid using unpublished information, and treat authors respectfully. COPE's ethical guidance provides a baseline for these responsibilities (23), yet formal policies alone are insufficient. Recent research indicates variability in conflict-of-interest policies for editors and reviewers, suggesting a need for clearer and more consistently implemented standards (24).

Open peer review can also strengthen accountability by making identities or reports visible, but transparency is not universally beneficial. Reviewers may become less willing to criticize powerful authors, and junior reviewers may hesitate to offer independent judgments. While evidence on attitudes toward open peer review is mixed and context-dependent (25), the proposed architecture is compatible with single-blind, double-blind, or open models, provided that the journal explains what information is visible, when it becomes visible, and how conflicts are managed.

Quite recently, the arguments have shifted towards the use of artificial intelligence (AI) in the process. However, AI can create both opportunities and hazards. Automated tools may assist with manuscript triage, reporting-check detection, reference verification, language support, and identification of statistical or textual anomalies. On the contrary, they may generate bias, hallucinate criticisms, expose confidential manuscripts, or produce plausible but non-diagnostic reports. AI therefore should be treated as an assistive signal-processing layer, not as an independent reviewer. Recent analyses describe the tension between efficiency and integrity, while other commentaries warn that AI may become a source of new confidentiality, accountability, and quality problems (26-29).

Alternatively, a responsible policy may be suggested to entail disclosure of substantive AI use, prohibit uploading confidential manuscripts to unauthorized systems, preserve human responsibility for the report, and require reviewers to verify every AI-generated suggestion. While AI can help a reviewer consider domains more reliably, it

cannot replace expert judgment about clinical importance, causal plausibility, or the consequences of uncertainty. The proposed model thus places AI on the coverage-support side of the architecture, not on the accountability side of the process.

A testable implementation pathway

The framework can be implemented through a staged pilot rather than a wholesale redesign. First, the journal should define three to five decision-critical review domains for each major article type. Second, it should revise invitation language to identify the manuscript's diagnostic need and clarify expected review outputs. Third, it should introduce a concise structured form that separates major validity concerns from minor presentation issues. Fourth, it should train editors to record post-decision observations using a small number of quality indicators. Fifth, it should provide reviewers with individualized feedback and recognition based on diagnostic contribution.

In addition, evaluation should use a quasi-experimental or stepped-wedge design. Relevant outcomes may include time to first decision, proportion of reviews returned on time, number of editorial clarification requests, frequency of repeated review rounds, author-reported usefulness, inter-reviewer agreement on major concerns, post-publication corrections, reviewer acceptance rates, and reviewer retention. Equity indicators should include reviewer geographic distribution, career stage, gender where ethically appropriate, language background, and representation of low- and middle-income settings.

Indeed, the central hypothesis is not that structured forms will make all reviewers agree. Rather, the hypothesis is that they will make disagreement more interpretable. A successful system can allow editors to distinguish substantive disagreement from incomplete coverage, methodological disagreement from stylistic preference, and reviewer error from uncertainty inherent in the research question.

To reach an optimal level, several safeguards are essential. First, quality indicators must never be reduced to a single automatic score. Second, editors should periodically audit whether the system disadvantages certain fields or article types. Third, reviewers must have a route to contest inappropriate feedback or recognition decisions. Fourth, the journal should publish its review expectations and AI policy. Fifth, speed targets should be calibrated to manuscript complexity rather than imposed uniformly.

Discussion

The conventional editorial pipeline treats peer review as a sequence of tasks: invite, receive, decide. The governance model proposed here treats it as a resilient information system. The concept of resilience here means that the system can absorb reviewer scarcity, complex methods, disagreement, technological change, and unequal resource environments without converting every disruption into lower quality or longer delay.

The concept of diagnostic yield explains why resilience depends on more than recruiting additional reviewers. If a journal simply increases invitation volume without improving matching, prompts, or recognition, it may expand the quantity of reviews while preserving informational noise. Conversely, a smaller number of well-matched reviewers can improve decisions if their reports cover the relevant risks and make uncertainty explicit.

The model also changes how journals should interpret reviewer disagreement. Disagreement is not automatically failure. In medical science, divergent interpretations may reflect genuine uncertainty, different causal assumptions, or different thresholds for clinical importance. Governance should therefore seek structured disagreement:

reviewers should state the assumption or evidence on which their judgment depends. This makes disagreement useful to editors and may prevent premature consensus.

However, this framework suggested hereby has its own limitations. Diagnostic validity is primarily a concept which is less likely to lend itself to measurement because editorial decisions are themselves imperfect and because reviewers may identify risks that cannot be verified before publication. The proposed index may be misused if translated into a rigid ranking. Incentives can produce gaming, especially when reviewers learn which phrases or boxes editors reward. Finally, journals differ in mission, article type, staffing, and resources; a high-impact clinical journal, a specialty journal, and a regional open-access journal may require different weights and workflows.

These limitations do not weaken the central argument. They show why governance must be iterative, transparent, and context-sensitive. The appropriate alternative to imperfect measurement is not measurement of speed alone; rather, it is a modest measurement system that acknowledges uncertainty and uses feedback to improve human judgment.

Conclusion

Medical peer review should be governed as an information-production system in which speed is valuable only when coupled to diagnostic usefulness. The hidden-action problem at the heart of reviewing makes deadline compliance an inadequate proxy for quality. A more sustainable equilibrium can be created by improving manuscript transparency, matching reviewers to diagnostic needs, structuring reports around coverage and actionability, applying lightweight quality assurance, and recognizing substantive contribution rather than speed or volume alone.

The principal innovation of this framework is the shift from a time-to-review metric to diagnostic yield per unit time. This does not turn peer review into a machine or eliminate expert decision. It gives journals a more precise question: under what conditions does careful reviewing become feasible, visible, and professionally worthwhile? By answering that question, journals can protect independence while making accuracy strategically sustainable. The result is not merely faster peer review, but a more intelligent allocation of expert attention and, therefore, a stronger foundation for medical evidence.

Use of AI: Images are generated by Gemini, 2026; editing and grammar are improved with ChatGPT; formula and equations suggested in this paper are fine-tuned with the use of AI but the original idea is that of the authors.

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