

# PROTOCOL PAPERS AS CATALYSTS FOR PUBLISHING NEW SCIENTIFIC RESEARCH ACHIEVEMENTS IN A RAPIDLY EVOLVING SCHOLARLY ECOSYSTEM

## ARTIGOS DE PROTOCOLO COMO CATALISADORES PARA A PUBLICAÇÃO DE NOVAS CONQUISTAS EM PESQUISA CIENTÍFICA EM UM ECOSISTEMA ACADÊMICO EM RÁPIDA EVOLUÇÃO

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The authors declare that there is no conflict of interest

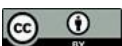
### Abstract

The academic publishing ecosystem is being reshaped by open science, platformization, and the growing expectation that research should be transparent, reusable, and timely. Protocol papers—peer-reviewed descriptions of planned methods published before results—are increasingly used to move scrutiny upstream, reduce selective reporting, and provide citable “method objects” that can be linked to data, code, and later outcome papers. Drawing on an integrative synthesis of publishing practices and policies, and using bibliometric signals reported for protocol papers indexed in Web of Science (2014–2023), this article analyzes how protocol-oriented publishing functions both as a dissemination mechanism and as a driver of innovation. The bibliometric evidence indicates large-scale uptake (119,461 protocol papers over 2014–2023), rapid growth in open access availability (from 60% in 2014 to 82% in 2023), and diversification of dissemination pathways, including protocol-related preprints across multiple servers in 2023. We discuss innovations such as dual-platform publishing (repository + journal certification), open and post-publication peer review, and emerging automated checks based on reporting standards. We also examine tensions around quality assurance, inequitable access, and incentive structures that still prioritize “positive” results over robust processes. Finally, we propose a policy and practical roadmap for funders, institutions, publishers, and infrastructure providers aimed at building a sustainable, community-centered protocol publishing ecosystem.

**Keywords:** Protocol Papers. Open Science. Scholarly Communication. Peer Review. Open

### Resumo

*O ecossistema de publicação acadêmica está sendo remodelado pela ciência aberta, pela plataformação e pela crescente expectativa de que a pesquisa seja transparente, reutilizável e oportuna. Artigos de protocolo — descrições revisadas por pares de métodos planejados, publicadas antes dos resultados — são cada vez mais utilizados para antecipar a análise, reduzir a publicação seletiva e fornecer “objetos de método” citáveis que podem ser vinculados a dados, código e artigos posteriores com os resultados. Com base em uma síntese integrativa de práticas e políticas de publicação e utilizando sinais bibliométricos relatados para artigos de protocolo indexados na Web of Science (2014–2023), este artigo analisa como a publicação orientada a protocolos funciona tanto como um mecanismo de disseminação quanto como um motor de inovação. As evidências bibliométricas indicam uma ampla adoção (119.461 artigos de protocolo entre 2014 e 2023), um rápido crescimento na disponibilidade de acesso aberto (de 60% em 2014 para 82% em 2023) e a diversificação das vias de disseminação, incluindo preprints relacionados a protocolos em múltiplos servidores em 2023. Discutimos inovações como a publicação em plataforma dupla (repositório + certificação de periódico), a revisão por pares aberta e pós-publicação e as verificações automatizadas emergentes baseadas em padrões de relato. Também examinamos as tensões em torno da garantia de qualidade, do acesso desigual e das estruturas de incentivo que ainda priorizam resultados “positivos” em detrimento de processos robustos. Por fim, propomos um roteiro político e prático para financiadores, instituições, editoras e provedores de infraestrutura, visando a construção de um ecossistema de publicação*



Access. Preprints. Research Transparency. Research Infrastructure.

*de protocolos sustentável e centrado na comunidade.*

**Palavras-chave:** *Artigos de Protocolo. Ciência Aberta. Comunicação Científica. Revisão por Pares. Acesso Aberto. Preprints. Transparência na Pesquisa. Infraestrutura de Pesquisa.*

## 1 INTRODUCTION

The journal article remains the dominant unit of scholarly communication, but contemporary research dissemination increasingly extends beyond the final, results-focused narrative. Open science principles, platform-based scholarly communication, and heightened scrutiny of reproducibility have accelerated the recognition of intermediate and modular research objects, including datasets, software, workflows, preregistrations, and protocols (Nosek *et al.*, 2015; Open Science Collaboration, 2015; Wilkinson *et al.*, 2016). This shift is consequential rather than cosmetic because it changes how credibility is established, how collaborations are coordinated, and how research contributions are evaluated within the scholarly ecosystem (Hicks *et al.*, 2015).

Concerns about reproducibility have sharpened attention to systemic vulnerabilities such as selective reporting, outcome switching, and publication bias (Ioannidis, 2005; Munafò *et al.*, 2017). In response, a growing body of work has called for research cultures that reward transparency and design rigor, not only statistically significant results (Nosek *et al.*, 2015; Nosek & Lakens, 2014). Against this backdrop, protocol papers have become distinctive because they disclose methodological decisions early and in a form that is publicly accessible and citable. In the literature, protocol papers are commonly defined as manuscripts that describe research methods in detail and are publicly disseminated via journals and/or preprint platforms, typically labelled “Study Protocol” or “Protocol,” with a structure that differs from IMRD articles by centering methods, governance, and versioning rather than completed results.

This upstream disclosure creates an auditable plan that can be assessed on methodological merits before study outcomes influence interpretation or publication decisions (Chambers & Mellor, 2018; Wang *et al.*, 2025). While protocol review and publication have longstanding precedents in high-stakes domains—most visibly in clinical medicine (Jones & Abbasi, 2004; The Editors of The Lancet, 2016)—protocol

publishing has expanded into a dedicated category supported by specialist journals and platform infrastructures (Agha, 2016; Albericio, 2018; Kelley *et al.*, 2015). In practice, protocol publishing is typically expected to advance four closely related aims: early methodological transparency, upstream quality assurance through structured review, mitigation of reporting and publication biases, and creation of reusable, citable method objects that link forward to data, code, and outcome papers.

The rise of protocol papers also aligns with broader ecosystem changes, including open access expansion (Piwowar *et al.*, 2018), the diffusion of preprint servers, workflow management platforms (Foster & Deardorff, 2017), and the mainstreaming of reporting standards for protocols and studies (Schulz *et al.*, 2010; Shamseer *et al.*, 2015; von Elm *et al.*, 2007; Chan *et al.*, 2013). Reporting guidance continues to evolve for emerging methodologies, including extensions for AI-based interventions (Cruz Rivera *et al.*, 2020). Protocol publishing can therefore be interpreted as an infrastructural response to a governance challenge: accelerating knowledge circulation while maintaining trust through clearer methods, stronger quality controls, and more transparent evaluation (Ross-Hellauer, 2017; Wang *et al.*, 2025).

Building on these developments, this paper synthesizes contemporary protocol dissemination practices, compares dominant publishing models, and interprets reported bibliometric signals (2014–2023) to identify governance mechanisms and policy levers that can support sustainable, trustworthy protocol publishing at scale.

## 2 BACKGROUND AND CONCEPTUAL FRAMEWORK

### 2.1 From article-centric publishing to lifecycle publishing

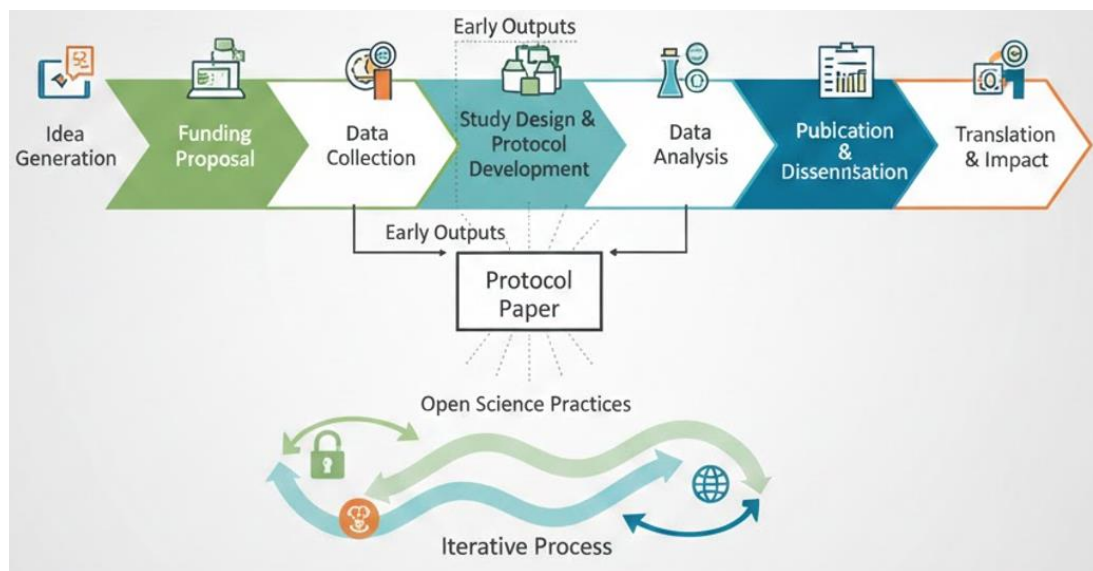
A helpful way to describe the current transition is **lifecycle publishing**: dissemination and certification occur iteratively across the research process rather than once, at the end. In lifecycle publishing, the “record” is not a single paper but a connected graph of research objects: protocols → preregistration → data and code → analyses → results papers → syntheses. Figure 1 conceptualizes protocol papers as early, citable outputs embedded within lifecycle publishing, linking design-stage transparency to downstream reproducibility and reuse.

Protocol papers sit at the front of this graph and can serve at least four functions:

1. **Method disclosure:** enabling readers and reviewers to evaluate feasibility, bias risks, and analytic choices before results.
2. **Coordination:** providing a shared blueprint for multi-site or interdisciplinary work where harmonization matters.
3. **Priority and provenance:** establishing a timestamped, citable claim about planned work and methodological choices.
4. **Reuse and standardization:** transforming methods into modular objects that others can adopt or adapt.

**Figure 1**

*Visualizes protocol papers as early outputs embedded in a broader lifecycle.*



## 2.2 Protocol papers and the “certification continuum”

Publishing is not only dissemination; it is also certification. Traditional journals combine both functions tightly: a paper is disseminated *because* it has passed a review gate. New models decouple these functions, creating a certification continuum:

- **Immediate dissemination** (preprints, repositories);
- **Community review** (open commentary, overlay journals);
- **Formal editorial certification** (journal peer review, registered reports, protocol review);
- **Post-publication updating** (versioning, corrigenda, living protocols).

Protocol papers can occupy several points on this continuum. Some are journal-first and fully peer reviewed; others are repository-first with later journal certification; still others follow registered report workflows where acceptance occurs before data collection. Registered Reports, for example, were pioneered as a formal publishing model in which methods and analysis plans are reviewed prior to results, aligning incentives toward rigor rather than significance .

### 2.3 Open science infrastructure as an enabling condition

Protocol publishing does not scale by goodwill alone. It scales through infrastructure:

- **Persistent identifiers** (DOIs for protocols; ORCID for authors; funder IDs);
- **Metadata standards** (machine-readable fields for methods, materials, ethics approvals);
- **Open access pathways** (publisher OA and repository OA);
- **Version control and linking** (connections between protocol versions, datasets, code, and outcome papers).

This infrastructural lens matters because it reframes protocol papers from “another article type” into a component of research governance: who can access methods, how fast methods travel, and how reliably they can be reused.

## 3 RESEARCH METHODOLOGY

### 3.1 Design

This paper adopts an integrative synthesis design that treats protocol publishing as a socio-technical practice embedded in evolving infrastructures (journals, repositories, preprint servers, peer review systems) and governed by heterogeneous rules (registration, ethics, reporting standards, and editorial screening). The approach is deliberately multi-stranded because protocol papers are not a single “product”; they are produced and validated through interdependent actors (authors, editors, platforms, registries, and evaluators) and through multiple channels that vary in speed and certification strength.

### 3.1.1 Strand 1: Practice synthesis (practice-to-concept mapping).

We mapped contemporary modes of protocol dissemination and evaluation by extracting recurrent workflow components from policy documents, journal instructions, and platform practices. In line with prior work that defined protocol papers as publicly released method-focused manuscripts (typically labelled “Study Protocol” or “Protocol”), we treat “protocol publishing” as an activity that makes methodological details and “how-to” steps visible early, often before results are available.

The practice synthesis therefore focused on *how* protocol objects move across the lifecycle: deposition, identifier assignment, structured metadata, editorial triage, peer review options, and post-publication updating.

### 3.1.2 Strand 2: Comparative model analysis (typology building)

We compared four dissemination models that frequently appear in the ecosystem:

- **Journal-only** protocol papers (formal certification, slower diffusion),
- **Repository-only** protocols (fast, versioned, often less formally reviewed),
- **Dual-platform** approaches (repository hosting + journal certification), and
- **Open-review** approaches (published review reports and/or signed review).

The goal was to derive analytically useful contrasts—speed vs. certification, versioning vs. fixity, openness vs. editorial gatekeeping—rather than to rank models normatively.

### 3.1.3 Strand 3: Evidence anchoring through bibliometric signals (pattern interpretation)

We interpreted bibliometric patterns as *contextual signals* that help validate whether the observed practices are marginal or mainstream and whether diffusion is concentrated in specific disciplines, journals, and regions. Importantly, our bibliometric use is not causal. It functions as a “reality check” for the practice mapping and model typology.

### 3.2 Bibliometric evidence base used for interpretation

A recent bibliometric analysis reported an initial retrieval of 412,285 records from Web of Science, refined to 119,461 protocol papers published during 2014–2023 . The same analysis reported trends in annual volume, open access availability, journal distribution, disciplinary concentration, and geographic distribution, which we use as descriptive signals rather than as causal proof.

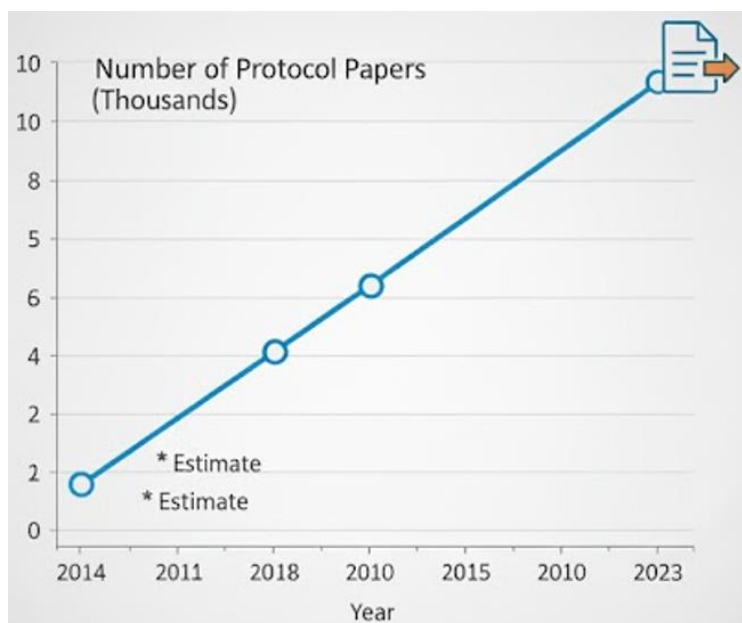
### 3.3 Analytical stance and limitations

We treat bibliometric patterns as indicators of **ecosystem behavior** (growth, concentration, diffusion), not as direct measures of research quality. Protocol papers vary widely in rigor and completeness, and bibliometrics alone cannot determine whether a protocol improved downstream reproducibility. This paper therefore pairs bibliometric signals with a governance-oriented discussion of mechanisms.

## 4 CURRENT PUBLISHING PRACTICES

**Figure 2**

*The reported increase in annual volume.*



#### 4.1 Diversified outputs and channels

Protocol papers now travel through multiple formats:

- **Journal protocol articles** (often indexed, peer reviewed, citable);
- **Repository protocols** with DOIs and versioning;
- **Preprints** that rapidly disclose planned methods;
- **Platform-native protocols** embedded in executable workflows (e.g., computational notebooks);
- **Associated artifacts** (data dictionaries, statistical analysis plans, code templates)

The key operational shift is that methods are increasingly treated as first-class scholarly objects. That shift supports reuse, but it also increases the need for structured metadata and layered quality checks.

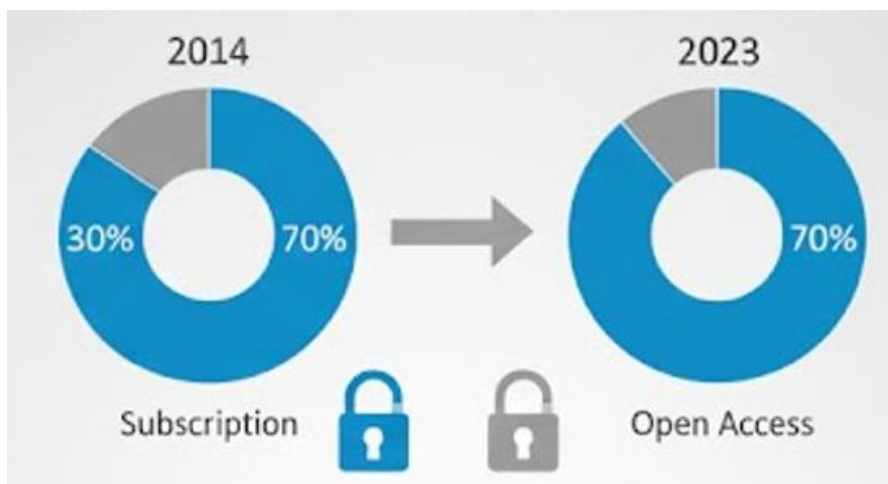
#### 4.2 Bibliometric snapshot of protocol publishing at scale

Figure 2 visualizes the growth in annual protocol-paper output, indicating sustained uptake of protocol publishing over the last decade. Figure 3 shows the rapid expansion of open access for protocol papers, with gold OA rising strongly and approaching green OA availability by 2023. A descriptive snapshot from Web of Science-indexed protocol papers (2014–2023) illustrates scale and diffusion:

- **Total protocol papers (2014–2023):** 119,461;
- **2023 annual output:** 15,511, approximately **1.14×** the 2014 level;
- **Open access availability:** OA share increased from **60% (2014)** to **82% (2023)**, with reported growth in green OA (45%→68%) and gold OA (30%→69%);
- **Preprints (2023):** protocol-related manuscripts appeared on multiple preprint servers, with **medRxiv (337)**, **Bio-protocol Exchange (246)**, and **PsyArXiv (146)** among leading platforms.

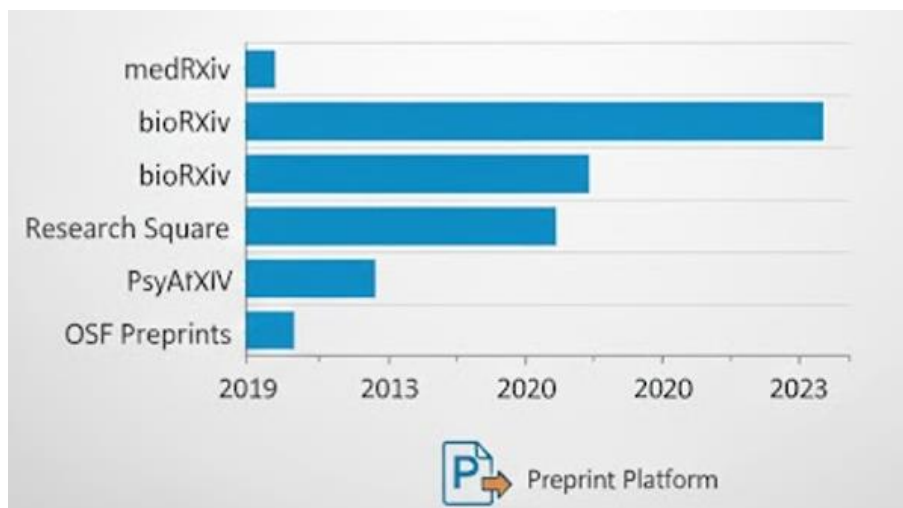
**Figure 3**

*Visualizes the reported OA expansion.*



**Figure 4**

*Summarizes leading preprint platforms for protocol-related manuscripts in 2023.*



Beyond journals, protocol-related manuscripts are increasingly visible on major preprint servers. Figure 4 summarizes the leading platforms hosting protocol-related preprints in 2023, indicating that preprints have become a non-trivial pathway for early protocol disclosure. A note of interpretation is warranted: the reported “green” and “gold” OA percentages may not be mutually exclusive if items are simultaneously accessible via repositories and publisher platforms. Regardless of categorization details, the overall pattern is consistent: protocol papers are increasingly expected to be accessible.

**Table 1***Bibliometric snapshot of protocol publishing signals (Web of Science, 2014–2023)*

Indicator	Reported signal
Initial retrieval and refined dataset	412,285 records retrieved; 119,461 protocol papers included
Annual output	2023: 15,511; ~1.14× 2014
Open access availability	OA: 60% (2014) → 82% (2023); Green: 45% → 68%; Gold: 30% → 69%
Journals publishing protocol papers	204 journals; top: BMJ Open (23,566), Trials (20,031), BMJ Open Sport & Exercise Medicine (11,370)
Preprint platforms (2023)	>1000 protocol-related preprints; medRxiv (337), Bio-protocol Exchange (246), PsyArXiv (146)
Top disciplines (2023)	Biochem & Mol Bio (4,640), General & Internal Medicine (4,355), Multidisciplinary Psychology (1,396)
Top contributing countries (2023)	US 28.6%, China 14.4%, UK 11.1%
Citation concentration	Total citations 2,786,555; mean 23.3; high-cited papers 735 with 303,715 citations (10.9%)

### 4.3 Journal ecology and disciplinary concentration

Protocol publishing is not evenly distributed. The reported dataset spans 204 journals, with a high concentration in a small set of outlets. The top three journals by volume were BMJ Open (23,566), Trials (20,031), and BMJ Open Sport & Exercise Medicine (11,370). In addition, SCIE-indexed journals accounted for 89.6% of the protocol papers in the dataset.

Disciplinary distribution in 2023 shows particularly high output in Biochemistry & Molecular Biology (4,640; 29.9%), Medicine, General & Internal (4,355; 28.1%), and Psychology, Multidisciplinary (1,396; 9.0%).

This pattern is intuitive: protocol publishing is especially valuable where methods are complex, where reproducibility depends on procedural detail, or where study governance (ethics, registration, statistical plans) is central.

### 4.4 Geographic contribution and capacity differences

The reported 2023 country distribution highlights concentration in major research systems: United States (28.6%), China (14.4%), and United Kingdom (11.1%) .

While these shares partly reflect research volume, they also reflect infrastructure maturity (trial registries, repository ecosystems), journal market access, and evaluation

norms. For policy, the crucial question is not only who publishes protocols, but whether local ecosystems make protocol publishing easy, rewarded, and trustworthy.

## 5 PUBLISHING MODELS, INSPIRATIONS, AND INNOVATIONS

### 5.1 Dual-platform publishing: repository agility + journal certification

One of the most practically influential innovations is dual-platform publishing, where a repository hosts the executable, versioned protocol and a journal provides editorial review and indexing. A representative example is the Lab Protocols model, described as combining a protocols.io-hosted stepwise protocol (with a DOI) and a PLOS ONE protocol paper that provides peer-reviewed certification. The same source argues that “rapid publication + journal publication” has become a major mode for protocol dissemination.

Why this matters:

- Repositories are well suited for *granular detail*, templates, attachments, and versioning.
- Journals are well suited for *editorial accountability*, reviewer coordination, and discoverability via indexing.

A robust ecosystem can treat these as complementary rather than competing layers.

**Table 2***A typology of protocol dissemination models*

Model	Core idea	Strengths	Risks/limitations	Best suited for
Journal-only protocol paper	Protocol as a conventional article	Formal peer review; indexing; stable record	Slower; formatting constraints; may omit executable details	Clinical and regulated research; funder-mandated transparency
Repository protocol with DOI	Protocol as a versioned method object	Granularity; attachments; rapid updates; reuse	Variable review rigor; discoverability depends on metadata	Wet-lab methods, computational workflows, teaching protocols
Dual-platform (repository + journal)	Repository hosts the protocol; journal certifies	Combines agility + certification; links protocol→paper; supports versioning	Coordination overhead; cross-platform linking must be maintained	Fields needing both stepwise detail and formal certification
Preprint-first protocol	Rapid disclosure before peer review	Speed; early feedback; open collaboration	Risk of low-quality diffusion; ambiguity about “version of record”	Fast-moving topics; early-stage community coordination
Open/post-publication review protocol	Publish then review openly	Transparency; reviewer credit; revision traceability	Social risk to reviewers; moderation needed	Method communities; computational fields; educational settings

**5.2 Protocol review and registered reports: moving review upstream**

A major inspiration for protocol publishing is the logic of front-loading peer review. Registered Reports institutionalize this logic by conducting review before data collection. Protocol papers do not always guarantee pre-collection review, but they can approximate its benefits if journals enforce clear scope: the protocol should reflect the design and analysis plans that will later govern the research.

A practical implication is that protocol publishing can be used as a budget-saving mechanism: catching design flaws early is cheaper than correcting them after data collection.

**5.3 Open and post-publication peer review**

Several journals have experimented with greater transparency in protocol peer review. For example, open review practices and non-anonymous review options have

been reported, alongside models where articles are published quickly and reviewed openly with visible revision histories.

From a governance perspective, open review can:

- Increase accountability and reviewer recognition,
- Expose the reasoning behind methodological decisions,
- Create educational value (protocol papers become teaching artifacts).

However, open review can also deter frank critique in hierarchical fields or tightly knit communities. Hybrid models—optional open identities, published review reports without names, or staged openness—may offer workable compromises.

#### 5.4 Automated screening and AI-assisted checks

Scaling protocol publishing raises a straightforward capacity issue: protocol review is time-consuming and requires methodological expertise. Editorial automation is therefore becoming attractive. Checklist-based approaches, including automated detection tools and structured reporting frameworks, have been proposed to improve efficiency. The same source suggests that domestic platforms could incorporate large language model–assisted pre-screening to check logical completeness, reproducibility elements, and ethics compliance before human review.

A sensible position is “automation as triage, not as judgment”:

- Use tools to flag missing components (ethics statement, outcomes, sample size rationale, data management plan).
- Keep scientific judgment—risk of bias, feasibility, interpretability—in human hands.

## 6 CHALLENGES AND OPPORTUNITIES

### 6.1 Quality, trust, and the speed–rigor tension

Protocol publishing creates a paradox: its value is highest when it is early and fast, but speed can erode trust if review is superficial. The solution is not to abandon speed; it is to build **layered trust controls**.

**Opportunity:** adopt a quality stack where different layers do different jobs:

- **Administrative validation:** scope, formatting, ethics statements, registration IDs.
- **Methodological review:** design coherence, bias risks, statistical plan clarity.
- **Reproducibility checks:** materials availability, code availability, data collection instruments.
- **Post-publication monitoring:** versioning, corrigenda, links to deviations.

## 6.2 Barriers: cost, inequities, and “protocol APCs”

Protocol publishing can introduce new costs (APCs, platform fees, time costs). If protocol papers become expected, APC-heavy models risk excluding researchers in less-resourced settings. This is a serious equity issue because protocols are precisely where global collaboration and reuse could generate high returns.

### Practical mitigations:

- Diamond OA or subsidized protocol sections for early-career researchers.
- Institutional agreements that cover protocol APCs explicitly.
- Repository-first approaches with optional journal certification.

**Table 3**

*A layered quality-control stack for protocol publishing*

Layer	What it checks	Practical tools and standards
Administrative validation	Scope, ethics, registration, completeness	Trial registries; registry IDs; ethics approvals
Reporting completeness	Required protocol items present	SPIRIT / PRISMA-P checklists; structured fields
Methodological and statistical review	Bias risks, feasibility, analytic plan coherence	Specialist reviewers; statistical review
Reproducibility readiness	Materials/code/data availability statements	FAIR-aligned metadata; repository links
Automation-assisted triage	Flag missing elements, inconsistencies	Checklist automation; metadata extraction
Post-publication stewardship	Versioning, deviations, corrections	Version history; linked deviations; living protocol updates

### 6.3 Incentives and evaluation: credit for process, not only outcomes

Protocol papers reveal a deeper problem: academic evaluation systems still reward “novel positive findings” more than robust processes. When protocols are undervalued, researchers treat them as administrative burdens rather than intellectual contributions.

A constructive alternative is to recognize protocols as:

- Evidence of rigorous design,
- Reusable community resources,
- Contributions to reproducibility and efficiency.

Metrics can be richer than citations: downloads, forks, reuse in multi-site consortia, and links to later outcome papers.

### 6.4 The risk of “method drift” and misinterpretation

Once a protocol is published, real-world constraints may force deviations. If deviations are not tracked transparently, protocol publishing can backfire: readers assume the study followed the protocol when it did not.

**Best practice:** treat protocols as living objects:

- publish deviations with timestamps,
- maintain version histories,
- link final outcomes to protocol versions and analysis plans.

## 7 POLICY AND PRACTICAL IMPLICATIONS

### 7.1 For funders

- **Mandate protocol availability** for funded projects with clear timing (e.g., before data collection begins).
- Fund **infrastructure and curation**, not only APCs: protocol repositories, DOI assignment, metadata standards.
- Require **deviation reporting** and linking between protocol versions and outcomes.

## 7.2 For research institutions

- Include protocol outputs in evaluation dossiers (promotion, hiring, annual review).
- Provide support services: methodology clinics, statistical consultation, and protocol peer-review training.
- Maintain institutional repositories that can host protocols with persistent identifiers.

## 7.3 For journals and publishers

- Publish explicit scope criteria: what counts as a protocol paper and what does not.
- Provide structured templates aligned with community standards (SPIRIT for trials; PRISMA-P for systematic reviews).
- Offer staged review models: rapid administrative checks + focused methodological review + post-publication updating.

## 7.4 For infrastructure providers and platform builders

- Enable robust linking among protocol → preregistration → dataset → code → outcome paper.
- Support versioning and “diff” views so readers can see what changed and why.
- Develop transparent automation: checklist-based screening and traceable flags (not opaque scoring).

## 8 CONCLUSION

Protocol publishing has moved decisively beyond the status of a niche editorial format to become a foundational component of contemporary scholarly communication. Rather than functioning merely as a preparatory document, the protocol paper now operates as an early-stage, citable research output that reshapes how credibility, coordination, and cumulative knowledge production are negotiated within open science ecosystems. By making methodological assumptions, procedural decisions, and

governance arrangements visible before results are known, protocol papers reallocate epistemic scrutiny to the front end of the research lifecycle, where design flaws and biases can be identified at lower cost and with greater corrective potential.

The bibliometric signals reported for the period 2014–2023 underscore both the scale and the structural transformation of protocol publishing. Sustained growth in output, a rapid expansion of open access availability, concentration in high-impact journals, and diffusion across multiple disciplines and national research systems collectively indicate that protocol papers are no longer peripheral artifacts. Instead, they have become embedded in mainstream publishing infrastructures, particularly in fields where reproducibility, ethical oversight, and methodological precision are paramount. Importantly, the strong uptake of gold open access suggests that protocol papers are increasingly treated as public research goods, intended not only for validation but also for reuse and adaptation by wider communities.

At the same time, this expansion exposes a critical inflection point. The next phase of development is not primarily about volume, but about governance maturity. Protocol publishing can accelerate scientific progress and enhance trust only if it is supported by coherent institutional arrangements. These include layered quality-control mechanisms that distribute responsibility across administrative checks, methodological peer review, and post-publication stewardship; sustainable funding models that prevent protocol publication from becoming an exclusionary practice; and incentive structures that recognize transparent research processes as legitimate scholarly achievements rather than auxiliary outputs.

Failure to address these governance dimensions risks hollowing out the promise of protocol publishing, reducing it to a formalistic compliance exercise. Conversely, aligning protocol papers with research evaluation, funding accountability, and infrastructure development can transform them into a stabilizing force within rapidly evolving publication ecosystems. In this sense, protocol papers should be understood not merely as technical documents, but as boundary objects that connect researchers, publishers, funders, and evaluators around shared norms of responsible research.

In conclusion, protocol publishing represents a strategic lever for reconciling speed with rigor in modern science. Its long-term contribution will depend on whether research systems can move beyond ad hoc adoption toward coordinated frameworks that integrate standards, platforms, and evaluation practices. When embedded within such

frameworks, protocol papers have the potential to strengthen the epistemic foundations of scientific knowledge, improve the efficiency of research investment, and support a more transparent, inclusive, and trustworthy scholarly record.

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### Authors' Contribution

All authors contributed equally to the development of this article.

### **Data availability**

All datasets relevant to this study's findings are fully available within the article.

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