

## The PROVIDERS [Preferred Reporting of Variables in Implant Dentistry Education and Research Studies] checklist

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### Abstract

Implant dentistry is an evolving field. Variability in study designs, outcome measures and reporting standards among the implant dentistry research papers create challenges for the comparability and reproducibility of research findings. To mitigate these challenges, a Preferred Reporting of Variables in Implant Dentistry Education and Research Studies checklist is being proposed, which provides identifying the variables that are essential in the reporting of dental implant-based studies. The objective is to propose comprehensive recommendations to enhance transparency, quality and consistency in reporting dental implant-related research. This checklist will not only standardise the key methodological details across studies and post-implant care, but will also facilitate an easier data synthesis for meta-analyses in the future by addressing potential challenges related to inconsistency in the 'effect size measures', making it invaluable for the researchers and clinicians. The proposed checklist would function as a teaching tool in educational settings, fostering evidence-based practice and improving the reproducibility of research in implant dentistry.

**Keywords:** Dental implants, Education, Research.

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### Introduction

In recent years, implant dentistry has undergone substantial advancements in biomaterials, surgical techniques, digital workflows, and patient-centred care. These developments have contributed to improved clinical outcomes, and have broadened the scope of implant-based rehabilitation.<sup>1</sup> However, alongside this rapid growth, there has been a notable increase in heterogeneity across published studies, particularly in terms of study designs, outcome measures and reporting

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practices.<sup>2-10</sup> Such variability limits the ability to critically appraise the scientific evidence, compare findings across studies, and perform meaningful data synthesis.<sup>11</sup>

Standardised reporting frameworks have proven essential in improving the transparency, reproducibility and the quality of research in healthcare.<sup>11-13</sup> In implant dentistry, however, there remains a lack of a dedicated, comprehensive checklist that could specifically address the wide range of variables influencing clinical outcomes, educational methodologies and research reporting.<sup>14</sup> Inconsistent documentation of patient-related factors, implant characteristics, surgical protocols, prosthetic considerations and follow-up parameters further complicates the interpretation and generalisation of the results achieved with implant-based reconstructions.<sup>7,9</sup>

The absence of uniform reporting standards also poses challenges for the researchers conducting systematic reviews and meta-analyses, where inconsistencies in the variable definitions and outcome reporting can lead to difficulty in calculating and comparing the effect sizes.<sup>5,15</sup> Moreover, in educational settings, the lack of structured reporting guidelines may hinder the development of standardised teaching and assessment frameworks in implant dentistry training programmes.<sup>10</sup>

To address these gaps, the current study was planned to generate a Preferred Reporting of Variables in Implant Dentistry Education and Research Studies (PROVIERS) checklist designed to provide a structured and comprehensive framework for consistent reporting of essential variables in the implant-related studies, encompassing clinical, methodological and educational domains.

### Methods and Results

The methodological validation study was conducted at Aga Khan University Hospital (AKUH), Karachi, between August and December 2024. Since the study did not entail human participants, patient data, biological materials, or any clinical or therapeutic interventions, therefore, approval from the ethics review committee was not required.

The PROVIDERS checklist was developed after an

**Table:** The proposed PROVIDERS checklist.

|    |                             |                                        |                                        |                                    |
|----|-----------------------------|----------------------------------------|----------------------------------------|------------------------------------|
| 1. | <b>Host-related factors</b> | Name                                   | XYZ                                    |                                    |
|    |                             | Medical record number (MR#)            | XXX-XX-XX                              |                                    |
|    |                             | Age                                    | In Years                               |                                    |
|    |                             |                                        | In Categories                          |                                    |
|    |                             | Gender                                 | Male                                   |                                    |
|    |                             |                                        | Female                                 |                                    |
|    |                             |                                        | Other                                  |                                    |
|    |                             | Site                                   | Maxilla/mandible                       |                                    |
|    |                             |                                        | Anterior/posterior                     |                                    |
|    |                             |                                        | Proposed implant site and tooth number |                                    |
|    |                             | Proximity structures to                | Inferior alveolar nerve                |                                    |
|    |                             |                                        | Maxillary Sinus                        |                                    |
|    |                             |                                        | Mental foramen                         |                                    |
|    |                             |                                        | Nasal floor                            |                                    |
|    |                             | Mouth Opening                          | Normal or adequate                     |                                    |
|    |                             |                                        | Somewhat restricted                    |                                    |
|    |                             |                                        | Significantly reduced or limited       |                                    |
|    |                             | *Bone quality <sup>20</sup>            | Type I                                 |                                    |
|    |                             |                                        | Type II                                |                                    |
|    |                             |                                        | Type III                               |                                    |
|    |                             |                                        | Type IV                                |                                    |
|    |                             | Bone dimensions                        | Height                                 |                                    |
|    |                             |                                        | Width                                  |                                    |
|    |                             | Gingival phenotype                     | Thick                                  |                                    |
|    |                             |                                        | Thin                                   |                                    |
|    |                             |                                        | Moderate                               |                                    |
|    |                             |                                        | Keratinized tissue width               |                                    |
|    |                             | Aesthetic considerations <sup>25</sup> | Gingival display at full smile         | Low                                |
|    |                             |                                        |                                        | Medium                             |
|    |                             |                                        |                                        | High                               |
|    |                             |                                        | Soft tissue anatomy                    | Soft-tissue intact                 |
|    |                             |                                        |                                        | Soft-tissue defect                 |
|    |                             |                                        | Patient's esthetic expectations        | Realistic                          |
|    |                             |                                        |                                        | Unrealistic                        |
|    |                             | Systemic conditions health             | Diabetes                               |                                    |
|    |                             |                                        | Hypertension                           |                                    |
|    |                             |                                        | Osteoporosis                           |                                    |
|    |                             |                                        | Cardiac/valvular abnormalities         |                                    |
|    |                             |                                        | Cancer                                 |                                    |
|    |                             |                                        | Hypothyroid/hyperthyroid               |                                    |
|    |                             |                                        | Others                                 |                                    |
|    |                             | Habits                                 | Yes                                    | Parafunctional (bruxism/clenching) |

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|    |                                 |                                                                         |              |                                                                               |
|----|---------------------------------|-------------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------|
|    |                                 |                                                                         |              | Smoking (number of cigarettes/day)                                            |
|    |                                 |                                                                         |              | Drug abuse                                                                    |
|    |                                 |                                                                         |              | Alcohol use                                                                   |
|    |                                 | Medications                                                             | Yes          | No                                                                            |
|    |                                 |                                                                         |              | Corticosteroids                                                               |
|    |                                 |                                                                         |              | Bisphosphonates                                                               |
|    |                                 |                                                                         |              | Antineoplastic                                                                |
|    |                                 |                                                                         |              | Antiangiogenic                                                                |
|    |                                 |                                                                         |              | Anticoagulants                                                                |
|    |                                 |                                                                         |              | Prophylactic antibiotics                                                      |
|    |                                 |                                                                         |              | Others                                                                        |
|    |                                 | Patient type                                                            | No           | Anxious/ difficult                                                            |
|    |                                 |                                                                         |              | Calm & cooperative                                                            |
|    |                                 | Periodontal health                                                      | Satisfactory | Unsatisfactory                                                                |
|    |                                 |                                                                         |              | Unsatisfactory                                                                |
| 2. | Operator-related factors        | Experience level                                                        |              | Years of practice in implant dentistry                                        |
|    |                                 |                                                                         |              | Total number of implants placed                                               |
|    |                                 | Specialization                                                          |              | Oral Surgery                                                                  |
|    |                                 |                                                                         |              | Periodontics                                                                  |
|    |                                 |                                                                         |              | Prosthodontics                                                                |
|    |                                 |                                                                         |              | General Dentistry                                                             |
|    |                                 |                                                                         |              | Others or additional training/certification in implantology                   |
| 3. | Biologic factors                | Bone graft used                                                         | Yes          | Type (autograft, allograft, alloplast, xenograft)                             |
|    |                                 |                                                                         |              | Volume (mm <sup>3</sup> )                                                     |
|    |                                 |                                                                         |              | Securing method (screws, tacks, others)                                       |
|    |                                 | Membrane used                                                           | No           | No                                                                            |
|    |                                 |                                                                         |              | Type                                                                          |
|    |                                 |                                                                         |              | Resorbable                                                                    |
|    |                                 |                                                                         |              | Non-resorbable                                                                |
|    |                                 |                                                                         |              | Securing method                                                               |
|    |                                 |                                                                         |              | Screws, tacks, others                                                         |
|    |                                 | Mesh used                                                               | Yes          | No                                                                            |
|    |                                 |                                                                         |              | Yes/No (if yes, then details)                                                 |
| 4. | Implant fixture related factors | Implant size                                                            |              | Yes/No (if yes, then details)                                                 |
|    |                                 |                                                                         |              | PRP/PRF used                                                                  |
|    |                                 | Implant size                                                            |              | Yes/No (if yes, then details)                                                 |
|    |                                 |                                                                         |              | Yes/No (if yes, then details)                                                 |
|    |                                 | Implant type (e.g., cylindrical, tapered)                               |              | Length                                                                        |
|    |                                 |                                                                         |              | Diameter                                                                      |
|    |                                 | Implant brand                                                           |              | Implant type (e.g., cylindrical, tapered)                                     |
|    |                                 |                                                                         |              | Implant brand                                                                 |
|    |                                 | Implant material (e.g., Titanium, Titanium alloys, Zirconia and others) |              | Implant material (e.g., Titanium, Titanium alloys, Zirconia and others)       |
|    |                                 |                                                                         |              | Angled implants: (whether any angled implants or tilted implants were placed) |

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|                 |                    |                                                                      |                                                              |                                        |                                         |                     |
|-----------------|--------------------|----------------------------------------------------------------------|--------------------------------------------------------------|----------------------------------------|-----------------------------------------|---------------------|
|                 |                    | Connection type: (internal vs. external hexagon, conical connection) |                                                              |                                        |                                         |                     |
|                 |                    | Platform switching: (whether or not platform switching is used)      |                                                              |                                        |                                         |                     |
|                 |                    | Surface treatments/<br>characteristics                               | SLA (Sandblasted, Large-grit, Acid-etched)                   |                                        |                                         |                     |
|                 |                    |                                                                      | Laser treatment                                              |                                        |                                         |                     |
|                 |                    |                                                                      | Acid etched                                                  |                                        |                                         |                     |
|                 |                    |                                                                      | HA (Hydroxyapatite)/BMP ( Bone Morphogenetic Protein) coated |                                        |                                         |                     |
|                 |                    |                                                                      | Nanostructured                                               |                                        |                                         |                     |
|                 |                    |                                                                      | Others                                                       |                                        |                                         |                     |
| 5.              | Surgical factors   | Surgical placement technique                                         |                                                              | Submerged                              |                                         |                     |
|                 |                    |                                                                      |                                                              | Non-submerged                          |                                         |                     |
|                 |                    | Platform to crest distance at baseline                               |                                                              | Millimetres (mm)                       |                                         |                     |
|                 |                    | Flap technique                                                       |                                                              | Flap raised                            |                                         |                     |
|                 |                    |                                                                      |                                                              | Flapless                               |                                         |                     |
|                 |                    | Implant placement timing                                             |                                                              | Immediate                              |                                         |                     |
|                 |                    |                                                                      |                                                              | Early                                  |                                         |                     |
|                 |                    |                                                                      |                                                              | Delayed                                |                                         |                     |
|                 |                    | Bone manipulation                                                    |                                                              | †Sinus lift                            | Yes                                     | Staged/simultaneous |
|                 |                    |                                                                      |                                                              |                                        | No                                      | Crestal/lateral     |
|                 |                    |                                                                      |                                                              | Ridge split (yes/no)                   |                                         |                     |
|                 |                    | Primary stability                                                    | Yes                                                          | Insertion torque                       |                                         |                     |
|                 |                    |                                                                      |                                                              | Implant stability quotient (ISQ)       |                                         |                     |
|                 |                    |                                                                      | No                                                           |                                        |                                         |                     |
|                 |                    | Surgery type                                                         |                                                              | Free hand                              |                                         |                     |
|                 |                    |                                                                      |                                                              | Guided                                 | Static                                  |                     |
| Dynamic         |                    |                                                                      |                                                              |                                        |                                         |                     |
| 6.              | Prosthetic factors | Prosthesis type                                                      |                                                              | Single crown                           |                                         |                     |
|                 |                    |                                                                      |                                                              | Fixed partial denture                  |                                         |                     |
|                 |                    |                                                                      |                                                              | Full arch prosthesis                   |                                         |                     |
|                 |                    | Abutment                                                             |                                                              | Type                                   | Straight/angled                         |                     |
|                 |                    |                                                                      |                                                              |                                        | Customised (Milled, Casted, 3D printed) |                     |
|                 |                    |                                                                      |                                                              |                                        | Prefabricated                           |                     |
|                 |                    |                                                                      |                                                              | Retention method                       | Screw-retained                          |                     |
|                 |                    |                                                                      |                                                              |                                        | Cement-retained                         |                     |
|                 |                    |                                                                      |                                                              |                                        | Hybrid                                  |                     |
|                 |                    | Material                                                             |                                                              | Titanium, Zirconia, or other materials |                                         |                     |
|                 |                    | Interim prosthesis provided                                          |                                                              | Yes                                    |                                         |                     |
|                 |                    |                                                                      |                                                              | No                                     |                                         |                     |
| Occlusal scheme |                    | Canine guidance                                                      |                                                              |                                        |                                         |                     |

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|     |                                           |                                                                                   |                                                                                                                          |                   |
|-----|-------------------------------------------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------|
|     |                                           |                                                                                   | Group function                                                                                                           |                   |
| 7.  | Loading protocol                          | Time between implant placement and loading                                        |                                                                                                                          | Immediate loading |
|     |                                           |                                                                                   |                                                                                                                          | Early loading     |
|     |                                           |                                                                                   |                                                                                                                          | Delayed loading   |
| 8.  | Adjunct surgery                           | Yes                                                                               | Coronal positioning flap                                                                                                 |                   |
|     |                                           |                                                                                   | Tunneling technique                                                                                                      |                   |
|     |                                           |                                                                                   | Any other periodontal procedure                                                                                          |                   |
|     |                                           | No                                                                                |                                                                                                                          |                   |
| 9.  | Retention of full denture (if applicable) | ERA (Extracoronary Resilient Attachment)                                          |                                                                                                                          |                   |
|     |                                           | Ball attachment                                                                   |                                                                                                                          |                   |
|     |                                           | Others                                                                            |                                                                                                                          |                   |
| 10. | Outcome measures                          | Success                                                                           | Absence of sign/symptoms (pain, peri-implant bone loss, suppuration, bleeding on probing)                                |                   |
|     |                                           |                                                                                   | Osseointegration                                                                                                         | Yes/No            |
|     |                                           |                                                                                   | Aesthetics                                                                                                               |                   |
|     |                                           |                                                                                   | Function                                                                                                                 |                   |
|     |                                           | Survival                                                                          | Implant remaining in situ                                                                                                |                   |
|     |                                           | Patient-reported outcomes (PROMS)                                                 | Patient satisfaction, oral health-related quality of life (OHRQoL), and functional outcomes e.g., speech and mastication |                   |
| 11. | Educational and research considerations   | Study design: randomised controlled, retrospective, or observational study design |                                                                                                                          |                   |
|     |                                           | Sample size and power                                                             |                                                                                                                          |                   |
|     |                                           | Statistical methods                                                               |                                                                                                                          |                   |
|     |                                           | Biases and confounders                                                            |                                                                                                                          |                   |

PROVIDERS: Preferred Reporting of Variables in Implant Dentistry Education and Research Studies.

\*Type I: Entirely homogeneous compact bone.

Type II: A thick layer of compact bone surrounding a core of dense trabecular bone.

Type III: A thin layer of cortical bone surrounding dense trabecular bone of favourable strength.

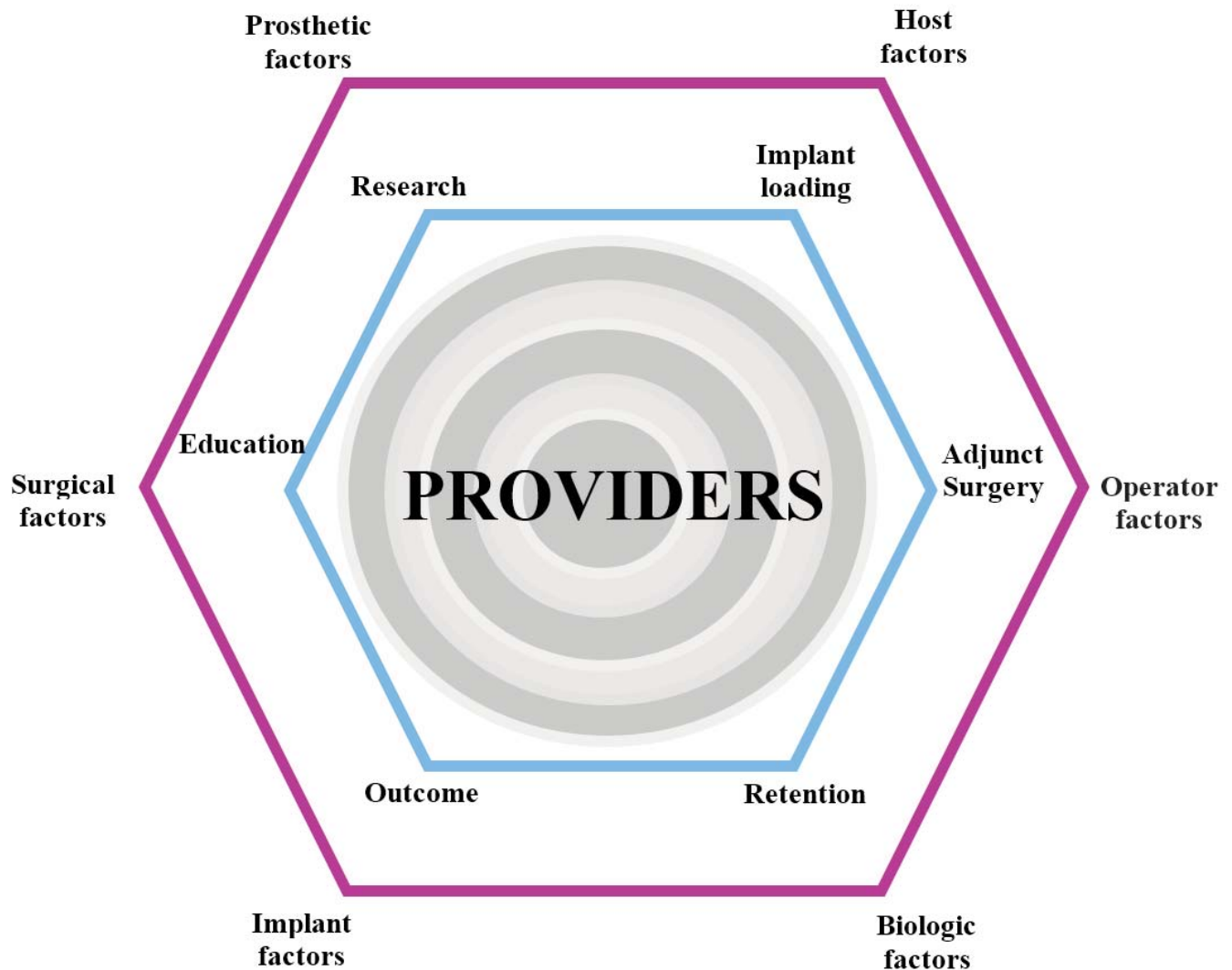
Type IV: A thin layer of cortical bone surrounding a core of low-density trabecular bone.

†Sinus lift: Staged - Separate sinus lift without implant placement.

Simultaneous - Sinus lift with implant placement.

extensive review of existing guidelines and reporting frameworks used in medicine and dentistry,<sup>10-16</sup> such as Consolidated Standards of Reporting Trials (CONSORT) for clinical trials, Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) for systematic reviews, and (Case Report (CARE) guidelines for case reports.<sup>17-20</sup> These existing guidelines serve as a foundation for the educational and research-related domains, while the PROVIDERS checklist fills a critical gap

by focusing specifically on the unique reporting needs of dental implant-based studies. The attention to details in the technical aspect of dental implantology, especially the technical variables related to implant surgery and implant prosthetics, were found missing in the existing frameworks<sup>17-20</sup>, which led to the collection of variables that influence the outcome in implantology. This, in turn, resulted in the formation of the PROVIDERS checklist (Table).



**Figure:** The PROVIDERS Hex showing all variables in the checklist to be connected with each other in the success and longevity of implant treatment. PROVIDERS: Preferred Reporting of Variables in Implant Dentistry Education and Research Studies.

The content validation of the checklist was conducted using the Content Validity Index (CVI) to assess its relevance and comprehensiveness.<sup>21, 22</sup> A panel of 10 experts belonging to various sub-specialties of dentistry, including clinicians with additional training in implantology, experienced researchers and educators, participated in the validation process. Each expert rated the relevance of each checklist item on a 4-point scale, ranging from 1 = not relevant to 4 = highly relevant. The item-level CVI (I-CVI) for individual items was calculated, with most items achieving a score >0.75. The overall scale-level CVI (S-CVI) for the checklist was found to be 0.82, indicating a concrete level of agreement amongst the experts, supporting the content validity of the checklist. During the process, items with lower relevance scores (S-CVI <0.70) were critically evaluated and

excluded from the final checklist. These primarily included variables considered to have limited clinical applicability or minimal influence on treatment outcomes, such as detailed implant thread characteristics, such as thread design and inter-thread distance, micro-level surface descriptors beyond standard classifications, implant packaging or delivery system specifics, and highly technique-sensitive parameters that lack standardisation across clinical settings.

### Discussion

The PROVIDERS checklist covers a wide range of factors influencing implant success, from host-related variables, like age, bone quality and systemic health, to implant-specific elements, such as material, size and surface characteristics. It also emphasises the importance of

reporting on surgical and prosthetic techniques, biological factors and patient-reported outcomes (Figure). By incorporating these factors, the PROVIDERS checklist ensures that studies in implant dentistry are comprehensive and comparable, leading to better clinical decision-making and patient care.

The PROVIDERS checklist marks a significant advancement in implant dentistry and educational research by enhancing transparency and ensuring that key methodological details are consistently reported across studies. Although several checklists exist in implant studies, they frequently fall short in terms of completeness, often concentrating solely on surgical aspects or being relevant only to clinical trials or outcome reporting. They tend to overlook a broader range of factors that could enhance the scope of the studies.<sup>4, 15, 23-25</sup> This limitation diminishes their utility for observational studies. In contrast, the PROVIDERS checklist encompasses all relevant data, making it a valuable tool for both clinical trials and observational research. The checklist goes beyond simply focusing on outcomes, and incorporates a comprehensive array of factors that may influence implant success. This approach not only ensures a more thorough assessment of clinical outcomes, but also provides a structured checklist, enabling more detailed reporting of both outcomes and associated factors. As a result, the checklist offers a holistic framework for improving the clarity, comparability and overall quality of implant-related research, and allows future studies to replicate findings with precision. Additionally, by standardising variables across implant studies, the checklist facilitates easier comparison of data, enables meta-analyses, and supports the drawing of meaningful conclusions.

Beyond clinical research, the checklist offers substantial benefits in medico-legal, forensic, insurance claims and referral settings. In medico-legal and forensic cases, the checklist ensures accurate documentation of implant procedures and outcomes, providing essential evidence for legal and investigative purposes. For insurance claims, it supports treatment justification and facilitates smoother reimbursement processes. The checklist also strengthens the referral system by promoting standardised communication between healthcare providers, ensuring continuity of care. In educational and research environments, it acts as a valuable tool for teaching and enhances the quality and comparability of data, supporting evidence-based practices and improving research outcomes in implant dentistry.

While the PROVIDERS checklist provides a thorough reporting framework, it does have certain limitations. The

checklist may require modifications to suit various study designs, such as randomised controlled trials (RCTs) and observational studies. Although, the present checklist includes patient and implant-related data, the primary emphasis is on the technical aspects of implant placement. Therefore, adjustments may be necessary when planning multiple implants, as it is currently tailored for individual implants. This may necessitate the creation of separate checklists for each implant in a single patient. Consequently, future versions should consider consolidating data for multiple implants into a single checklist for each patient. Furthermore, for the checklist to achieve long-term success, it is crucial to ensure its widespread adoption among researchers, journals and reviewers. Future refinements could involve integrating the checklist with other reporting tools and updating it to account for new developments in implant technology and techniques.

## Conclusion

The PROVIDERS checklist is a framework specifically designed for implant dentistry with the aim of improving the quality, comparability and transparency of implantology practice and research. By adopting the checklist, researchers can contribute to building a more robust evidence base, improving clinical outcomes, and fostering innovation in dental implantology.

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