ARTIFICIAL INTELLIGENCE AND WAYS TO REPORT IT IN PEDIATRIC DENTAL RESEARCH: A REVIEW OF RECOMMENDATIONS

Jolly Shah[1]
[1]Private practitioner, United Kingdom
Correspondence: jollyhshah@gmail.com

EDUCATION

ABSTRACT: *The rise of artificial intelligence in evidence-based healthcare in the past two decades calls for a streamlining of guidelines on the reporting of these studies. Conventional reporting guidelines based on various study designs are comprehensively listed by the Equator-Network. This review presents an overview of reporting guidelines for studies in pediatric dentistry that utilize AI and that are recommended by the Equator-Network.*

Keywords: *Artificial Intelligence, Pediatric Dentistry, Machine Learning, Manuscripts, Checklist*

How to cite: Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant.2024;2(3):39. https://doi.org/10.5281/zenodo.13727195

Artificial intelligence refers to a machine's ability to solve or interpret problems based on data that is fed to it. A machine learns based on the data that is fed to it. This is in the form of algorithms that are a part of computing signals known as neural networks. These neural networks can be visualised as the neurons of the human brain. The interconnectedness of these neural networks helps the machine to give an output.[1]

Technologies utilizing AI in pediatric dentistry rely on huge datasets, also known as *big data.* The combination of multiple layers of neural network and information from the big data helps the machine to learn, recognize, or predict an output. This is called deep learning. The type of neural network used determines whether the machine is meant to solve complex problems (artificial neural network), identify patterns from graphics (convoluted neural network), or give predictions of multiples possible outcomes (Bayesian network).[1]

The use of AI in pediatric dentistry has been on the rise since the past two decades. The applications of AI in pediatric dentistry includes, and is not restricted to growth estimation, oral health evaluation, monitoring and diagnosing plaque and cavities, landmark identification, age assessment, teeth identification, supernumerary tooth identification, remote monitoring, automated cephalometric tracing, and orthodontic diagnosis.[2]

Since 2008, Equator-Network (Enhancing Quality and Transparency of Health Research) has been an umbrella organization that maintains and updates all the reporting guidelines for systematic narration of a research in healthcare. The Equator-Network defines a reporting

guideline as, "A checklist, flow diagram, or structured text to guide authors in reporting a specific type of research, developed using explicit methodology."[3]

In 2020, the Equator-Network added 'Artificial Intelligence/Machine Learning studies' as one of the categories in its reporting guideline search toolbar. As of July 2024, the section highlights 17 such reporting guidelines, and recommends five of them for being more thorough and relevant. However, out of these, only 12 can be considered relevant to the field of pediatric dentistry. This review briefly summarises the details and applications of these reporting guidelines.

TRIPOD-SRMA

The transparent reporting of multivariable prediction models for individual prognosis or diagnosis tailored for systematic reviews and meta-analyses (TRIPOD-SRMA) was developed in 2023. It was developed to help authors report studies that conduct a systematic review of prediction model studies which may or may not include meta-analysis. In this context, a prediction model is one that takes into consideration multiple variables to give an assessment which can be a prognosis or diagnosis for an individual. This prediction model can be based on machine learning or be can be derived through statistical methods. The TRIPOD-SRMA consists of 26 items. It also features a separate section of 12 items for reporting the abstracts of these studies. An example of using TRIPOD-SRMA in pediatric dentistry would be to check the accuracy of a caries risk assessment model in children.[4]

TRIPOD-AI

The transparent reporting of multivariable prediction models for individual prognosis or diagnosis' (TRIPOD) artificial intelligence (AI) extension was published in 2024. It was developed to help authors structure a research that focused on the development of a prediction model for diagnosis or prognosis using machine learning. The TRIPOD+AI guideline features 27 items for manuscripts and 13 items for abstracts.[5] Research works related to prediction models wherein a clustered data is used (multiple hospitals, multiple datasets, etc) can be better reported using the TRIPOD-Cluster guideline. An example to use TRIPOD-AI in pediatric dentistry would be to evaluate the prognosis of a restorative material based on multiple variables of the patient including masticatory load, parafunctional habits, dietary habits, etc.[6]

SPIRIT-AI

In 2013, the Standard Protocol Items: Recommendations for Intervention Trials (SPIRIT) was published to streamline the reporting of clinical trial protocols. However, in 2019, it was realized that interventions based on artificial intelligence was a growing phenomenon,

Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant. 2024;2(3):3-9.https://doi.org/10.5281/zenodo.13727195

leading to the announcement of SPIRIT-AI. A working group published the SPIRIT-AI document in 2020, which was presented as an extension of the existing SPIRIT guidelines. The SPIRIT-AI has 15 items, 12 of which are extensions of the original SPIRIT checklist and three are elaborations for AI-based interventions.[7]

CONSORT-AI

The Consolidated Standards of Reporting Trials (CONSORT) guidelines were published in 2010 to assist researchers in reporting study designs that were randomized controlled trials. However, it does not thoroughly encompass how interventions utilizing AI must be reported. Thus, the CONSORT-AI was developed in conjunction with the SPIRIT-AI. The CONSORT-AI checklist consists of 11 extensions and three elaborations of the original CONSORT guidelines.[8]

DECIDE-AI

A Decision Support System based on artificial intelligence is one that supports human decision-making by providing person-specific and situation-specific information or recommendations to improve and enhance healthcare. The Developmental and Exploratory Clinical Investigations of Decision support systems driven by Artificial Intelligence (DECIDE-AI) was developed in 2022 to guide in the reporting of the performance of AI-systems in the early stages of their development. These studies can be presented as preclinical, in silico evaluations, which report the clinical performance of AI at a smaller scale in terms of safety, and the human factors that can be considered. The DECIDE-AI consists of 17 AI-specific items and 10 generic reporting items.[9]

DEVELOPING AND REPORTING MACHINE LEARNING PREDICTIVE MODELS IN BIOMEDICAL RESEARCH

One of the earliest reporting guidelines for artificial intelligence in biomedical research was published in 2016. This 12-item checklist was made by an expert panel of 11 researchers from three different continents. The mean experience of the researchers in developing or applying machine learning methods was 8.5 years. This checklist remains one of the primers for reporting machine learning studies in any speciality of healthcare.[10]

MINIMAR

The Minimum Information for Medical AI Reporting (MINIMAR) was published in 2020. It was developed to counter the transparency issues that were prevalent in the reporting of AI-based studies. Moreover, it also catered to a broader scientific community due to its succinct

Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant. 2024;2(3):3-9.https://doi.org/10.5281/zenodo.13727195

guideline. MINIMAR expects the authors to report their studies on the grounds of transparency in the following domains: study population and setting, patient characteristics, model architecture, and model evaluation. A total of 21-items comprise this reporting guideline that also has scope for external validation to report the use of secondary sources.[11]

CAIR

Clinical Artificial Intelligence Research (CAIR) was developed to overcome the limitations of the CONSORT-AI and SPIRIT-AI checklists. The authors proposed that CAIR could address all clinical trial stages which oftentimes were not applicable or mentioned in the SPIRIT-AI or CONSORT-AI checklist. Furthermore, the CAIR checklist was developed in conjunction with a recommendation for clinicians and non-machine experts to choose the appropriate outcome metrics that is suitable to their AI-based study. A total of 15 points are described in the CAIR checklist.[12]

MACHINE LEARNING ANALYSIS IN CLINICAL RESEARCH

Despite the availability of TRIPOD-AI guidelines, a group of researchers provided a template of key elements that need to be reported in studies utilizing AI. These elements were specifically meant to be reported in the methodology and results section of these studies. The machine learning analysis that was recommended to be reported are provided as templated under the following categories: study design, data sources and preprocessing, and model development and validation.[13]

CLAIM

The Checklist for Artificial Intelligence in Medical Imaging (2024) was first proposed in 2020. It had a major revision in 2024, leading to an extension of its application in radiomics and pathomics. One of the notable features of the 44-item checklist is that it discourages the use of the term ‘validation’ for its ambiguity and instead proposes the use of ‘internal testing’ and ‘external testing’. Though not a part of the Equator-Network’s proposed guidelines, researchers interested in the reporting of AI-based studies of radiomics are also recommended to read the CLEAR (Checklist for Evaluation of Radiomics Research) guidelines. Both CLAIM and CLEAR can be used in pediatric dentistry in studies reporting odontogenic cysts or tumours and the ability of radiomics to quantifiably analyze them.[14]

MI-CLAIM

The Minimum Information about Clinical Artificial Intelligence Modelling (MI-CLAIM) was published in 2020 with two objectives. The first was to ensure that a fair and unbiased

Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant. 2024;2(3):3-9.https://doi.org/10.5281/zenodo.13727195

assessment of an AI model's clinical performance could be made. The second objective was to ensure that the AI-based study could be replicated. The published guideline was divided into six parts: study design, data, optimization, model performance, model examination, and reproducibility.[15]

ARTIFICIAL INTELLIGENCE IN DENTAL RESEARCH

In 2021, a 31-item checklist was finalized by members of the International Association of Dental Researchers and ITU/WHO's focus group members of the Artificial Intelligence for Oral Health (AI4H). This reporting guideline can serve as a template for authors who are planning, conducting, and reporting AI studies in dentistry.[16]

CONCLUSION

The reporting of studies based on the guidelines summarized in this overview ensures thorough and comprehensive structuring of a manuscript that focuses on artificial intelligence. Scholars in the field of pediatric dentistry can further strengthen their study design by balancing the content in terms of explanation of the AI models and the dental element in question.

REFERENCES

1. Babu A, Onesimu JA, Sagayam KM. Artificial Intelligence in dentistry: Concepts, Applications and Research Challenges. E3S Web of Conferences [Internet]. 2021;297(01074):1–9. Available from: https://www.e3s-conferences.org/articles/e3sconf/abs/2021/73/e3sconf_iccsre21_01074/e3sconf_iccsre21_01074.html
2. Salvatore La Rosa, Quinzi V, Palazzo G, Ronsivalle V, Antonino Lo Giudice. The Implications of Artificial Intelligence in Pedodontics: A Scoping Review of Evidence-Based Literature. Healthcare. 2024 Jun 30;12(13):1311–1.
3. Equator-Network. Artificial intelligence/Machine Learning Studies | Study Designs | EQUATOR Network [Internet]. Equator-network.org. University of Oxford; 2024 [cited 2024 Jun 2]. Available from: https://www.equator-network.org/?post_type=eq_guidelines&eq_guidelines_study_design=artificial-intelligence-machine-learning-studies&eq_guidelines_clinical_specialty=0&eq_guidelines_report_section=0&s=&btn_submit=Search+Reporting+Guidelines
4. Snell KIE, Levis B, Damen JAA, Dhiman P, Debray TPA, Hooft L, Reitsma JB, Moons KGM, Collins GS, Riley RD. Transparent reporting of multivariable

Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant. 2024;2(3):3-9.https://doi.org/10.5281/zenodo.13727195

5. prediction models for individual prognosis or diagnosis: checklist for systematic reviews and meta-analyses (TRIPOD-SRMA). BMJ. 2023 May 3;381:e073538. doi: 10.1136/bmj-2022-073538
6. Collins G S, Moons K G M, Dhiman P, Riley R D, Beam A L, Van Calster B et al. TRIPOD+AI statement: updated guidance for reporting clinical prediction models that use regression or machine learning methods BMJ 2024; 385 :e078378 doi:10.1136/bmj-2023-078378
7. Debray TPA, Collins GS, Riley RD, Snell KIE, Van Calster B, Reitsma JB, Moons KGM. Transparent reporting of multivariable prediction models developed or validated using clustered data: TRIPOD-Cluster checklist. BMJ. 2023 Feb 7;380:e071018. doi: 10.1136/bmj-2022-071018.
8. Rivera SC, Liu X, Chan AW, Denniston AK, Calvert MJ; SPIRIT-AI and CONSORT-AI Working Group. Guidelines for clinical trial protocols for interventions involving artificial intelligence: the SPIRIT-AI Extension. BMJ. 2020 Sep 9;370:m3210. doi: 10.1136/bmj.m3210.
9. Ibrahim H, Liu X, Rivera SC, Moher D, Chan AW, Sydes MR, Calvert MJ, Denniston AK. Reporting guidelines for clinical trials of artificial intelligence interventions: the SPIRIT-AI and CONSORT-AI guidelines. Trials. 2021 Jan 6;22(1):11. doi: 10.1186/s13063-020-04951-6.
10. Vasey B, Nagendran M, Campbell B, Clifton DA, Collins GS, Denaxas S, Denniston AK, Faes L, Geerts B, Ibrahim M, Liu X, Mateen BA, Mathur P, McCradden MD, Morgan L, Ordish J, Rogers C, Saria S, Ting DSW, Watkinson P, Weber W, Wheatstone P, McCulloch P; DECIDE-AI expert group. Reporting guideline for the early stage clinical evaluation of decision support systems driven by artificial intelligence: DECIDE-AI. BMJ. 2022 May 18;377:e070904. doi: 10.1136/bmj-2022-070904.
11. Luo W, Phung D, Tran T, Gupta S, Rana S, Karmakar C, Shilton A, Yearwood J, Dimitrova N, Ho TB, Venkatesh S, Berk M. Guidelines for Developing and Reporting Machine Learning Predictive Models in Biomedical Research: A Multidisciplinary View. J Med Internet Res. 2016 Dec 16;18(12):e323. doi: 10.2196/jmir.5870.
12. Hernandez-Boussard T, Bozkurt S, Ioannidis JPA, Shah NH. MINIMAR (MINimum Information for Medical AI Reporting): Developing reporting standards for artificial intelligence in health care. J Am Med Inform Assoc. 2020 Dec 9;27(12):2011-2015. doi: 10.1093/jamia/ocaa088.
13. Olczak J, Pavlopoulos J, Prijs J, Ijpma FFA, Doornberg JN, Lundström C, Hedlund J, Gordon M. Presenting artificial intelligence, deep learning, and machine learning studies to clinicians and healthcare stakeholders: an introductory reference with a guideline and a Clinical AI Research (CAIR) checklist proposal. Acta Orthop. 2021 Oct;92(5):513-525. doi: 10.1080/17453674.2021.1918389. Epub 2021 May 14.
14. Stevens LM, Mortazavi BJ, Deo RC, Curtis L, Kao DP. Recommendations for Reporting Machine Learning Analyses in Clinical Research. Circ Cardiovasc Qual Outcomes. 2020 Oct;13(10):e006556. doi: 10.1161/CIRCOUTCOMES.120.006556. Epub 2020 Oct 14.

Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant. 2024;2(3):3-9.https://doi.org/10.5281/zenodo.13727195

15. Tejani AS, Klontzas ME, Gatti AA, Mongan JT, Moy L, Park SH, Kahn CE Jr; CLAIM 2024 Update Panel. Checklist for Artificial Intelligence in Medical Imaging (CLAIM): 2024 Update. Radiol Artif Intell. 2024 Jul;6(4):e240300. doi: 10.1148/ryai.240300.
16. Norgeot B, Quer G, Beaulieu-Jones BK, Torkamani A, Dias R, Gianfrancesco M, Arnaout R, Kohane IS, Saria S, Topol E, Obermeyer Z, Yu B, Butte AJ. Minimum information about clinical artificial intelligence modeling: the MI-CLAIM checklist. Nat Med. 2020 Sep;26(9):1320-1324. doi: 10.1038/s41591-020-1041-y.
17. Schwendicke F, Singh T, Lee JH, Gaudin R, Chaurasia A, Wiegand T, et al. Artificial intelligence in dental research: Checklist for authors, reviewers, readers. Journal of Dentistry. 2021 Apr;107:103610.

Shah J. Artificial intelligence and ways to report it in pediatric dental research: a review of recommendations. The Quadrant. 2024;2(3):3-9.https://doi.org/10.5281/zenodo.13727195