Beyond Manual Compliance: Reimagining CLEAR Guidelines as an Active Component in Radiomics Workflows

A. O'Brien[1], and Professor Ferdinando Rodrigeuz y Buena[1]
[1]*Imperial College London, London, United Kingdom*
a.obrien22@imperial.ac.uk

Aims: Modern surgery increasingly relies on AI models that often lack reproducibility, because traditional quality assurance is still performed retrospectively and inconsistently. We have developed an automated system that transforms the CheckList for EvaluAtion of Radiomics research (CLEAR) [1] from a post-hoc checklist into an active component of the radiomics pipeline. By integrating CLEAR with AutoRadiomics [2], our system enforces standardised reporting throughout the workflow, directly addressing the crisis of reproducibility in radiomics research. A recent study found that only 6% of 117 published radiomics studies included reproducibility documentation [3]. Our proactive approach ensures compliance from initial study design to final model validation, laying the foundation for more reliable AI-supported surgical decisions.

Materials and Methods: Our system has three components (Fig.1): AutoRadiomics for feature extraction, Streamlit for the user interface and a CLEAR compliance application for validating methodological decisions.

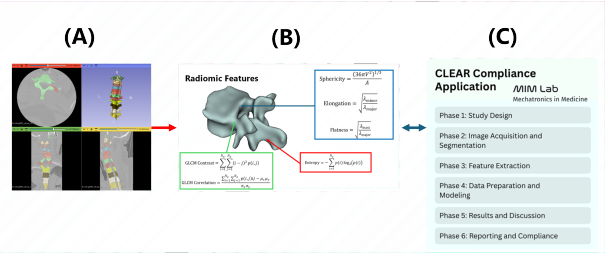

Fig.1 Schematic outline of the automated CLEAR compliance system showing integration between the (A) VerSe dataset, (B) AutoRadiomics, (C) User interface and the CLEAR compliance application.

The compliance application automatically documents the study design, the segmentation methods, the parameters for feature extraction and the model development processes. It displays real-time compliance, generates methodology descriptions based on actual parameters, and alerts users to reproducibility risks. In contrast to stand-alone feature extraction tools, our system integrates quality control into the overall radiomics workflow. Although built for vertebral analysis on the VerSe dataset [4], [5], [6], the system is adaptable to other anatomical regions.

Results: We validated our system using vertebral radiomics data from 60 subjects. Eight protocol variants were created by modifying parameters such as bin width, resampling resolution, filter configurations, GLCM spacing, and ROI extraction. In these variants, the application detected five of the six parameter changes introduced and correctly identified the specific parameter changes in almost 90% of cases. Feature classes and preprocessing modifications were recognised with perfect accuracy.

Conclusions: We have developed the first system that transforms the CLEAR guidelines from a passive checklist into an active, integrated component of radiomics workflows. It enforces standardised reporting and improves reproducibility with minimal cost. Future work will focus on expanding validation capabilities and fully automating the creation of CLEAR-compliant documentation.

References:

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