The Radiology AI Handbook

Elsevier
1600 John F. Kennedy Blvd.
Ste 1800
Philadelphia, PA 19103-2899

THE RADIOLOGY AI HANDBOOK ISBN: 978-0-323-87760-2

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Printed in India

Last digit is the print number: 9 8 7 6 5 4 3 2 1

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CHAPTER 1

AI in Radiology—Past and Present

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KEY POINTS

- Artificial intelligence (AI) is revolutionizing radiology with applications such as computer-aided diagnosis, image quantification, and workflow automation.
- Nearly 1000 AI healthcare tools have been approved by the FDA, with the largest percentage in radiology.
- Although AI has multiple potential benefits, concerns include medical-legal responsibility, algorithm transparency and explainability, cost, potential job displacement, and ethical considerations, including bias and fairness of models. Seamless integration into point-of-care systems must be addressed in order for tools to be broadly adopted.

GLOSSARY OF TERMS AND DEFINITIONS

Machine Learning (ML): A subset of artificial intelligence that involves the use of algorithms and statistical methods to enable computer systems to learn from data and improve their performance on a specific task without being explicitly programmed (Fig. 1.1).

Deep Learning (DL): A subset of machine learning that utilizes convolutional neural networks with multiple hidden layers to process and analyze data and is especially well suited for complex tasks like image analysis, enabled by current computational capabilities (Fig. 1.1).

Convolutional Neural Network (CNN): A type of machine learning architecture designed for processing grid-like data, such as images and videos, by applying convolution operations to mathematically extract relevant features in data.

Computer-Aided Detection/Diagnosis (CADe/x): A system that employs computer algorithms to assist radiologists in interpreting medical images and providing diagnostic support by identifying potential abnormalities. Some CAD systems use classical machine learning with human-defined features, whereas others use data-driven CNN architectures.

Natural Language Processing (NLP): A branch of artificial intelligence that focuses on the interaction between computers and human language, enabling machines to understand, interpret, and generate human language.

Software as a Medical Device (SaMD): Software intended to be used for one or more medical purposes that perform these purposes without being part of a hardware medical device.[5]

Reference Standard: The correct or true label (sometimes called ground truth) used for training and evaluating AI systems, against which their accuracy and performance are measured.

Transparency: The degree to which the inner workings of an AI system can be understood by humans, including how decisions are made and the rationale behind those decisions.

Explainable AI: AI systems designed to provide clear and comprehensible explanations for their decision-making processes, enhancing trust and accountability.

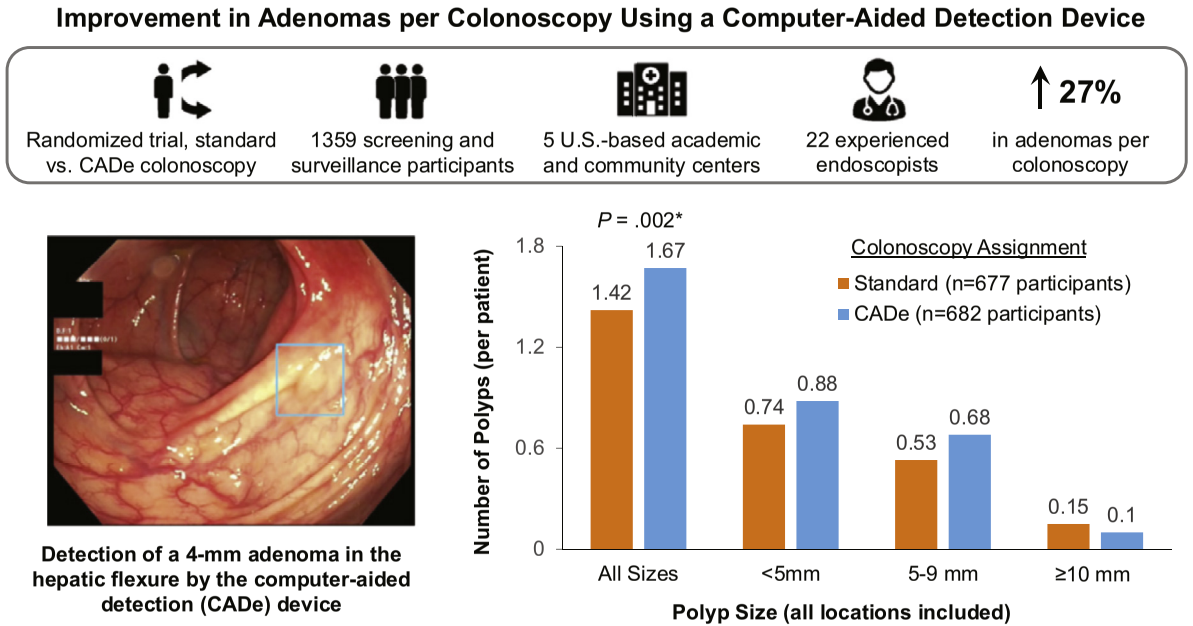

Fig. 8.2 Key findings of the randomized controlled trial that evaluated the performance of SKOUT, an FDA-approved computer-assisted device used in the detection of polyps during colorectal cancer screening via colonoscopy. (Image adapted from Shaukat A, Lichtenstein DR, Somers SC, et al. Computer-aided detection improves adenomas per colonoscopy for screening and surveillance colonoscopy: a randomized trial. *Gastroenterology*. 2022;163(3):732–741.)

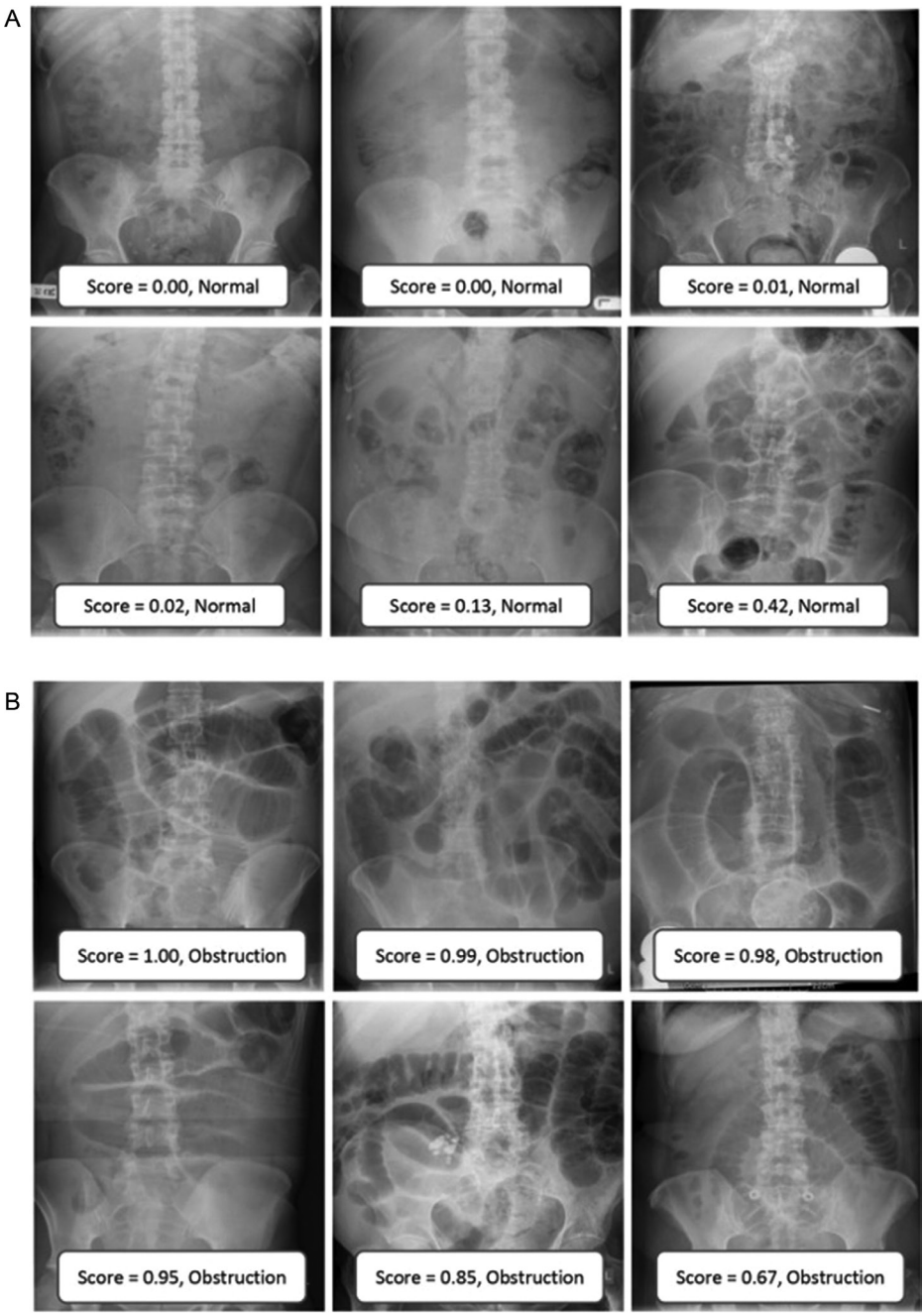

Fig. 8.3 Plan abdominal radiographic images correctly identified as normal or obstruction using a deep learning model. (Image adapted from Kim DH, Wit H, Thurston M, et al. An artificial intelligence deep learning model for identification of small bowel obstruction on plain abdominal radiographs. *Br J Radiol*. 2021;94(1122):20201407.)

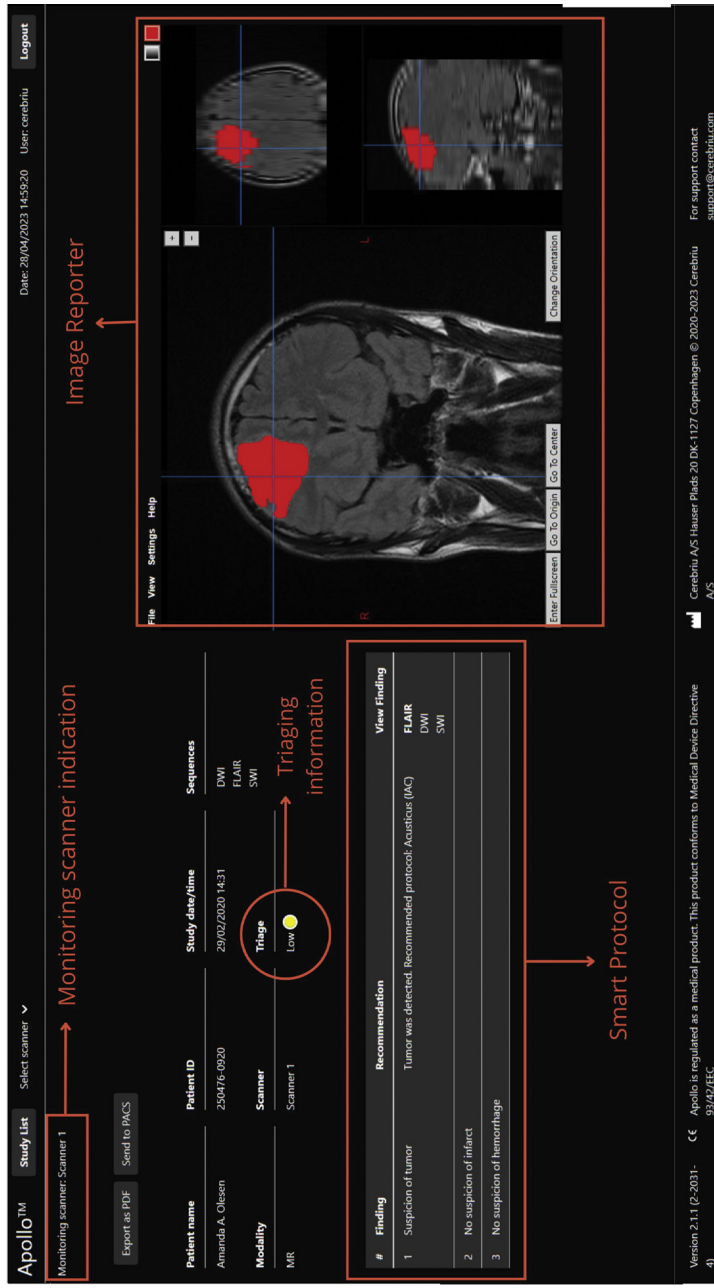

Fig. 16.1 Apollo study interface with explanations for a deidentified patient.