Unlocking Value in Your Medical Imaging Data for Accelerated AI Development

> Medical imaging data holds tremendous power. When utilized to its full potential, it can improve diagnostic accuracy, unlock new treatments and advance patient care.

But medical enterprises face unique hurdles in handling, interpreting and leveraging this wealth of information effectively. The exponential growth in medical imaging data, coupled with increasing data complexity, siloed data, and a lack of consistency in format and quality, underscores the pressing need for innovative solutions that unlock the untapped potential within these datasets.

Artificial intelligence (AI) technology holds the promise of revolutionizing medical imaging data management by offering advanced algorithms and tools that can automate tasks, improve diagnostic accuracy and streamline workflows. These benefits lead to greater operational efficiency in fields such as radiology, oncology, neurology, ophthalmology and more, improving patient care by reducing wait times for scans and ensuring more incidental findings are addressed.

However, the excitement to use AI to improve patient outcomes runs into the problem of complex workflows in which models need to be purchased or created separately and then implemented manually. And collecting enough data to create original models or generate meaningful results from existing ones involves pulling your own patient data together with that of other locations and institutions, making matters more complicated.

Implementing a medical imaging AI platform offers the potential to break down silos within medical enterprises by integrating disparate datasets. It can provide a unified, scalable solution for managing and analyzing vast amounts of medical imaging data. By harnessing enterprise data and empowering users to develop AI algorithms, a medical imaging AI platform can facilitate accelerated studies, enable more comprehensive analysis, and ultimately drive improvements in patient care through faster and more accurate diagnoses.

This white paper will explore the challenges medical enterprises face in managing medical imaging data and presents strategies for harnessing the transformative power of AI to accelerate advancements in research and patient care.

Understanding the challenges of medical imaging data management for AI

The central challenges to medical enterprises when it comes to managing imaging data come down to a few key elements. They are: data volume and underutilization; accessibility and interoperability; quality and consistency; and satisfying privacy requirements.

80% of a data scientist's time is spent finding, curating, and organizing data.

Imaging data is massive, growing and underutilized

Like all data, the amount and size of imaging data files is growing at a seemingly exponential rate. One study found the annual growth rates of dataset sizes are 27% for MRI, 30% for CT and 32% for fMRI.

Although this growth is a positive development for training AI models, as they need large datasets to be accurate, imaging data is often underutilized due to a number of factors, such as a lack of adequate resources — i.e., the right people. At large academic medical centers, the need for dedicated IT resources to support small research team's medical imaging data is particularly apparent.

With project backlogs and staffing shortages, research and AI model development projects aren't always a top priority for hospital IT departments. Many medical institutions also lack the resources to share data with others.

This leads to the problem of underutilization of all this valuable data. According to the World Economic Forum, 97% of healthcare data is not utilized. With imaging data accounting for approximately 90% of all healthcare data, this problem can be particularly egregious when it comes to imaging.

As a result, health systems are missing a huge opportunity to advance innovation, improve patient care and realize increased revenues.

Data is often siloed and faces interoperability issues

One of the most pervasive issues health systems face when trying to capitalize on their medical imaging data is that these data are often siloed from each other. Medical

imaging datasets may be fragmented across disparate systems, institutions and formats. This fragmentation hampers the seamless exchange and integration of data, hindering collaborative research efforts and impeding the development of robust AI models.

The lack of interconnectivity and cohorting capabilities among disparate picture archiving and communication systems (PACS) and vendor-neutral archives (VNAs) among these locations makes it difficult to incorporate the diverse datasets needed to train AI models for a wide array of clinical scenarios. Imaging AI initiatives are hamstrung by the inability to efficiently combine data from various sources, including different imaging modalities and patient populations. As the Radiology Society of North America has said, "electronic image transfer between all institutions across different platforms remains virtually non-existent."

As a result, the potential of medical imaging AI to revolutionize diagnosis and treatment planning remains largely untapped.

Data faces inconsistency in quality and standards

Medical imaging datasets often vary significantly in terms of image quality, annotation and adherence to standardized protocols. This variability stems from differences in imaging equipment, imaging protocols, patient demographics and the expertise of researchers across different healthcare institutions. As a result, AI algorithms trained on particular datasets may not work for diverse patient populations and clinical settings.

The variability in data formats and annotation practices makes the problem of data inconsistency even worse. Without uniform guidelines for data collection, storage and annotation, it becomes increasingly difficult to ensure the reliability and reproducibility of AI models trained on disparate datasets.

Medical imaging data must meet privacy requirements to be shared

Another significant impediment to optimizing imaging datasets for AI is the stringent privacy requirements that medical imaging data must adhere to before being shared or utilized for research purposes. Patient privacy and data security are paramount concerns in healthcare, governed by regulations such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in Europe. These regulations mandate strict safeguards for the handling, storage and transmission of patient health information, including medical images.

As a result, accessing and sharing medical imaging data for AI research and development often involves navigating complex legal and regulatory frameworks. Healthcare institutions must implement robust data anonymization and

de-identification techniques, such as removing or substituting patient identifiers like name, address and hospital identification number. This protects patient privacy while ensuring that data remains suitable for research purposes.

In addition, the need for secure data transfer mechanisms further complicates the sharing of medical imaging data across institutions and geographical boundaries. Institutions need to follow best practices around transport security, selective encryption of DICOM (Digital Imaging and Communications in Medicine) headers, encrypted DICOM files, digital signatures and watermarking techniques.

These stringent regulations are especially important given that 30% of large data breaches occur in hospitals. Personal health information (PHI) is highly valuable to cyber criminals — perhaps 10 times more valuable than credit card information — so healthcare institutions need to safeguard their systems to dodge cyber threats wherever possible.

Creating revenue-generating AI-ready datasets at UTMB

The University of Texas Medical Branch (UTMB) wanted to realize greater value from its imaging assets and collaborate more efficiently inside and outside the health system's walls. Dr. Peter McCaffrey, Medical Director, Augmented Intelligence and Disruptive Technologies, was tasked with leading informatics efforts in radiology. He recognized the need for a solution that would allow investigators to collaborate efficiently and remotely while leveraging their growing radiology archive.

With Flywheel, they were able to centralize imaging data in a "living repository," enabling seamless sharing and annotation, and fueling UTMB's research efforts on COVID-19 and traumatic brain injury (TBI).

Through Flywheel's support for annotation and image analysis, UTMB was able to create AI-ready datasets with structured metadata, **significantly enhancing the value and utility of their imaging assets**. They also saw **cost reductions** through improving staffing efficiency and simplifying their infrastructure, alongside **revenue generation** through streamlining grant submissions and the ability to collaborate with commercial entities.

The promise of AI in imaging

With interoperable and secure datasets that are consistent in quality and shareable across institutions, medical organizations have the potential to do great things with their medical imaging data. From research that informs the next generation of treatments to improving patient care in the here-and-now, AI has the power to enhance many efforts that involve imaging data.

Enhanced diagnostic accuracy

AI presents a transformative opportunity to enhance diagnostic accuracy by improving the detection of abnormalities; aiding in identifying structures like tumors, blood vessels and organs; and helping to predict outcomes. Through advanced machine learning algorithms, AI systems can analyze medical images with speed and precision, aiding clinicians in identifying subtle abnormalities and early signs of diseases such as cancer, neurological disorders and cardiovascular conditions. By augmenting human expertise with AI-powered tools, clinicians can help to generate more accurate diagnoses — and more timely interventions.

Workflow efficiency

AI algorithms have the potential to improve overall efficiency when it comes to medical imaging workflows. They can aid with scan protocoling, or matching imaging modality and contrast administration to clinical indication, by quickly reviewing information such as patient charts, labs and previous studies and then recommending the right imaging protocol. Automated image analysis algorithms can also help triage and prioritize imaging studies, helping researchers focus their attention on cases that require immediate attention while expediting the interpretation of routine scans. Additionally, AI can help automate repetitive tasks, such as image preprocessing, image segmentation and measurement, freeing up researchers' time for more complex cases.

Personalized medicine

AI algorithms can facilitate more personalized care by recognizing pixel-level information in medical imaging not visible to the human eye. This can lead to earlier and more accurate diagnosis of diseases. And by analyzing medical images with patient data, AI algorithms can create patient-specific insights for treatment plans that consider the individual's specific anatomy, physiology and disease characteristics.

Research advancement

AI accelerates imaging research by automatically recognizing complex patterns and offering quantitative assessments of characteristics within datasets. Essentially, AI can comb through more images than people can in shorter time and with greater precision. However, AI models must work within a system that allows them to be open and easily examined to ensure reproducibility of studies.

Getting to 94% diagnosis accuracy

Researchers from the University of Wisconsin-Madison (UW-Madison) Medical School demonstrated remarkable success in diagnosing COVID-19 using Flywheel for AI model training.

Leveraging Flywheel's secure accessibility, teams collaborated remotely to migrate 50,000 datasets of chest X-rays and PCR test results from various sources. The resulting AI model, CV19-NET, achieved a diagnosis accuracy of 94%, outperforming experienced thoracic radiologists by 9%.

"Ten-thousand cases used to take six to eight months to get through, and now we can easily process them in a day."

—John Garrett, Assistant Professor and Director of Informatics at UW-Madison Department of Radiology

How to build reliable, scalable AI for imaging: leveraging a medical AI imaging platform

To adequately leverage AI in their studies and workflows, researchers need a way to easily incorporate AI solutions with their existing systems, such as picture archiving and communication systems (PACS). They need systems that can handle diverse imaging modalities, such as X-ray, MRI, CT and ultrasound.

A medical imaging AI platform needs to accommodate large-scale datasets with varying levels of complexity. It should include robust image processing algorithms that can work across different patient populations and clinical scenarios. And it should give institutions the power to create their own algorithms.

With the right system in place, researchers and clinicians can locate analysis-ready cohorts within their data and share those with other institutions and locations, where the same models can be run on all data available between different systems. Datasets can be standardized, annotated and quality-controlled, ensuring the reliability and reproducibility of AI models, with built-in, compliance-friendly workflows.

By centralizing data management, a medical imaging AI platform can facilitate collaborative research efforts, enabling researchers to access diverse datasets for algorithm development and validation — and to end up with more thorough, accurate and actionable results.

Benefits of a medical imaging AI platform

Medical imaging AI platforms offer healthcare institutions numerous benefits, including:

Identifying potential revenue opportunities, such as increased grant submissions and clinical trial enrollments.

Enabling the health system's data to be used for training AI models specific to the patient population rather than relying on more generalized data sets.

Reducing the burden on IT staff to write scripts to extract and transform data and make that imaging data available for downstream research reuse.

Supporting an organization's goal of attracting and retaining top staff and faculty to lead AI innovation.

5 ways a medical imaging AI platform transforms research capabilities:

1. Creating a compliant, living repository with complete provenance to avoid versioning issues.
2. Establishing ground truth data for training and validating models.
3. Enabling sharing of curated data sets in multi-site trials.
4. Creating and documenting image annotations and related metadata.
5. Avoiding knowledge loss and downtime that may result from internal staff turnover.

Flywheel unlocks your imaging data for greater research capabilities and improved patient outcomes

The Flywheel medical imaging platform is helping medical institutions around the globe revolutionize their imaging data management practices and expedite AI development. Flywheel unifies your imaging sources into one platform that seamlessly integrates data storage, processing and analysis in a secure and scalable cloud-based environment.

How Flywheel solves challenges around medical imaging data and AI

Flywheel addresses many challenges medical enterprises face when trying to prepare their imaging data for AI integration — so they can stay competitive and improve patient care.

- **Powerful data management:** Flywheel offers scalable infrastructure to efficiently manage the large amount of imaging data needed from different modalities, locations and populations to properly train and run AI models.
- **Improved accessibility and availability:** With a centralized repository and intuitive user interface, users can easily upload and process imaging data from different locations. This allows researchers and clinicians to better share data between locations and with outside institutions to generate more meaningful results from studies.

- **Data consistency:** Flywheel helps you ensure data quality and consistency through standardization of formats, pre-processing and metadata so you can create analysis-ready datasets.

- **Ensuring compliance:** With built-in data provenance, access controls and encryption, you can keep sensitive patient data safe and stay in compliance with regulations from HIPAA to 21 CFR Part 11.

Getting started with AI and Flywheel

To fully harness the power of AI, healthcare organizations must overcome obstacles related to data volume, interoperability, quality and compliance to ultimately improve patient care. While AI can solve many of the challenges inherent in imaging data management, it needs the right implementation and infrastructure to work.

A medical imaging AI platform such as Flywheel can help you revolutionize your radiology workflows, improve diagnostic accuracy and drive personalized medicine initiatives.

Empowered by advanced analytics tools, scalable infrastructure, and a commitment to compliance and security, you can unlock new insights from your imaging data and drive better clinical outcomes.

*Visit **flywheel.io***
Schedule a demo or get in touch with a Flywheel representative.

Sources

1. "2016 Data Science Report." CrowdFlower.

2. "Dataset Growth in Medical Image Analysis Research - PMC." n.d. PubMed Central (PMC). Accessed March 14, 2024. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8404917/.

3. Ollis, Brad. 2023. "Medical Imaging 'People' Challenges." Ballad Health. https://www.healthtechmagazines.com/medical-imaging-people-challenges/.

4. Willemink, Martin J., et al. 2020. “Preparing Medical Imaging Data for Machine Learning.” Radiology. Radiological Society of North America. February 18, 2020. https://pubs.rsna.org/doi/full/10.1148/radiol.2020192224.

5. “4 Ways Data Is Improving Healthcare.” 2019. World Economic Forum. Global Innovation Index. December 5, 2019. https://www.weforum.org/agenda/2019/12/four-ways-data-is-improving-healthcare/.

6. Kevin Zhou, S., et al. “A Review of Deep Learning in Medical Imaging: Imaging Traits, Technology Trends, Case Studies with Progress Highlights, and Future Promises.” 2020. ArXiv.Org. August 2, 2020. https://arxiv.org/abs/2008.09104.

7. Sirtonski, Laura. 2022. “Interinstitutional Electronic Image Exchange: A ‘Last Mile Problem.’” RSNA News. Radiological Society of North America. May 5, 2022. https://www.rsna.org/news/2022/may/electronic-image-exchange.

8. Mandal, Mrinal, et al. 2021. “Dataset Growth in Medical Image Analysis Research - PMC.” Journal of Imaging, August 7, 2021. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8404917/.

9. Kjelle, Elin, and Catherine Chilanga. 2022. “The Assessment of Image Quality and Diagnostic Value in X-Ray Images: A Survey on Radiographers’ Reasons for Rejecting Images - PMC.” Insights Imaging, March. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8894552/.

10. Kohli, Marc D., et al. 2017. “Medical Image Data and Datasets in the Era of Machine Learning—Whitepaper from the 2016 C-MIMI Meeting Dataset Session - PMC.” The Journal of Digital Imaging, May. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5537092/.

11. Lotan, Eyal , et al. 2020. “Medical Imaging and Privacy in the Era of Artificial Intelligence: Myth, Fallacy, and the Future - PMC.” Journal of the American College of Radiology, September. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7484310/.

12. Diaz, Oliver, et al. 2020. “Data Preparation for Artificial Intelligence in Medical Imaging: A Comprehensive Guide to Open-Access Platforms and Tools - ScienceDirect.” Physica Medica Vol. 83, November 30, 2020. https://www.sciencedirect.com/science/article/pii/S1120179721000958.

13. Eichelberg, Marco, et al. 2020. “Cybersecurity in PACS and Medical Imaging: An Overview | Journal of Imaging Informatics in Medicine.” Journal of Imaging Informatics in Medicine, October. https://link.springer.com/article/10.1007/s10278-020-00393-3.

14. Eichelberg, Marco, Klaus Kleber, and Marc Kämmerer. 2020. “Cybersecurity in PACS and Medical Imaging: An Overview.” Journal of Digital Imaging, no. 6 (October): 1527–42. https://doi.org/10.1007/s10278-020-00393-3.

15. Palatty, Nivedita James. 2023. “80+ Healthcare Data Breach Statistics 2024.” Astra. December 22, 2023. https://www.getastra.com/blog/security-audit/healthcare-data-breach-statistics/.

16. “What Makes PHI so Attractive to Hackers?” 2017. Sfax. January 30, 2017. https://www.scrypt.com/blog/makes-phi-attractive-hackers/.

17. Pinto-Coelho, Luís. 2023. “How Artificial Intelligence Is Shaping Medical Imaging Technology: A Survey of Innovations and Applications.” Bioengineering, no. 12 (December): 1435. https://doi.org/10.3390/bioengineering10121435.

18. Song, Julie. 2023. “Using Artificial Intelligence to Improve Radiology Workflow.” The Doctors Company. TDC Group. December 2023. https://www.thedoctors.com/articles/using-artificial-intelligence-to-improve-radiology-workflow/.

19. Najjar, Reabal. 2023. “Redefining Radiology: A Review of Artificial Intelligence Integration in Medical Imaging.” Diagnostics, no. 17 (August): 2760. https://doi.org/10.3390/diagnostics13172760.

20. Bunga, Raj Kumar. 2023. “How AI Is Being Used to Improve the Accuracy and Efficiency of Medical Imaging?” Continental Hospitals. November 7, 2023. https://continentalhospitals.com/blog/how-ai-is-being-used-to-improve-the-accuracy-and-efficiency-of-medical-imaging/.