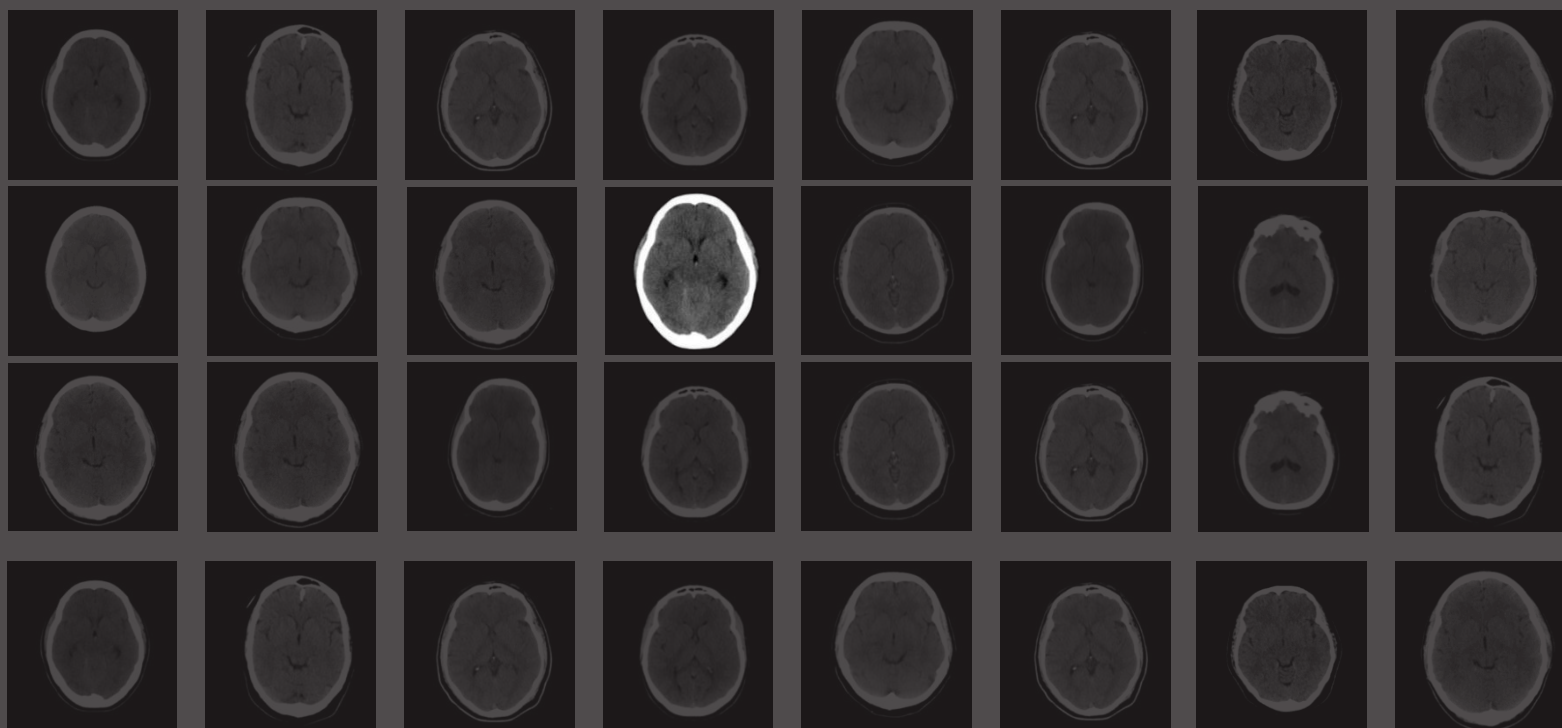


# AI in Radiology: Making an Impact Today, While Charting a Path to the Future



# Introduction

*Beyond theory, vRad is using practical AI to impact patient care today, while paving the way to the future of radiology*

Artificial intelligence (AI) will enhance the practice of radiology more than any technology since Wilhelm Roentgen's x-ray. This is no longer speculation. Our AI models are at work today, helping prioritize critical cases and improve reporting accuracy and compliance. But we're just getting started.

AI will permeate the practice and business of medical imaging, to the benefit of both patients and practitioners. In coming years, we will see AI:

- **Empower radiologists** to rapidly detect ever more subtle, serious and rare abnormalities, using complex strings of hundreds, even thousands, of nested AI searches.
- **Conquer mountains of administrative burden**, creating and auditing reports in real time based on natural language inputs; ensuring complete and relevant reporting through content-driven prompts; and automating time-consuming tasks, such as extracting significant findings from prior reports, and recording measurements.
- **Strengthen health care delivery** through demonstrated quality improvements, such as faster turnaround times, intelligent prioritization of critical cases, greater reporting accuracy, and compliant billing practices.

vRad has assembled a dedicated team of practicing radiologists and computer scientists with unsurpassed AI expertise. In this white paper, we present examples of practical AI applications currently impacting patient care, critical process elements that drive successful radiological AI program development and refinement and our long-term strategies for achieving the potential of AI in radiology.

We are excited to lay the foundation for radiological AI on which the future will be built.

*The vRad Imaging Platform employs multiple AI models in the processing of over 20,000 radiology studies each day. Our radiological AI is improving care by silently prioritizing critical cases, identifying potential reporting discrepancies that might delay accurate billing and flagging data omissions that could present compliance issues.*

### AI Worklist Prioritization – Accelerating care delivery in critical cases

AI helps ensure potentially critical patients receive priority attention by assessing individual cases based on identified criteria.

**How AI operates.** Using trained convolutional neural networks (CNN), proprietary vRad Radiology AI screens thousands of cases daily, accurately recognizing images that exhibit a high likelihood for specific pathologies and immediately moving critical cases to the top of radiologists’ worklists. Unlike other “prioritization” models, our AI does so silently, without alerting the provider that the case was flagged by AI. This allows our radiologists to continue to use high vigilance to screen cases on the clinical conditions they identify without bias.

vRad Radiology AI models in production (March 2021)			
Model	Modality	Region	Cases Reviewed Daily (avg)
Aortic dissection	CTA	Chest, abdomen	2,600
Edema	X-ray	Chest	2,600
Hip Fracture	X-ray	Pelvis	200
Intracranial hemorrhage	CT non-contrast	Head	1,500
Pneumonia	X-ray	Chest	2,600
Pneumoperitoneum	X-ray	Chest	2,600
Pneumothorax	X-ray	Chest	2,600
Pulmonary embolism	CTA	Chest	900
Testicular Torsion	Ultrasound	Abdomen	50

**“AI is helping us deliver on the full scope of our health care mission.” – Joshua Morais, MD**

From his reading room in Walnut Creek, California, neuroradiologist Joshua Morais, MD opened the next case on his vRad worklist one afternoon in 2019. The non-contrast head CT of an Iowa woman revealed acute intracranial hemorrhage. Dr. Morais urgently reported his diagnosis to the ordering physician, **just 2.9 minutes** after the CT images had been uploaded.

What Dr. Morais didn’t know at the time was that a proprietary vRad AI algorithm had identified the criticality of the woman’s case and elevated it to the top of his worklist. This enabled him to quickly deliver his findings — getting the patient to surgery **10 minutes faster with AI** than the typical time. Learning of this later, Dr. Morais stated: “For this patient, I have no doubt AI was a critical element for her survival.”



Hemorrhage identified by AI

**The radiologist's experience.** Using AI for prioritization is transparent to the individual radiologist. While sitting at her workstation, she simply selects the next study on her worklist. Though the case may have been escalated by AI, there are no annotations on the images; there is no note to the radiologist with regard to the AI findings; there is no indication in the worklist that this case has been identified by the model. The radiologist isn't prejudiced or biased with knowledge of the AI result. She will simply review the case sooner than if AI had not elevated the case in her list.

**Results.** vRad Radiology AI algorithms are achieving above 90% specificity. With potentially critical findings detected and prioritized by AI:

- **14 critical cases each day are read an estimated 10 to 15 minutes sooner** than if the AI models had not run, accelerating appropriate care delivery to patients in need.
- **15 patients per month are provided care up to 24 hours sooner** when escalated from non-emergent.

## AI in Reporting – Ensuring accuracy and compliance

AI is helping manage regulatory compliance and adherence to best practices to ensure quality care, which should avoid unnecessary medical expenses and mitigate malpractice risk.

**How AI operates.** Using natural language processing (NLP), the vRad Imaging Platform reviews all radiology reports, flagging potential clinical improvements or compliance issues. For example, a radiologist will be alerted if the pathology has a specific reporting requirement — such as Fleischner criteria for a lung nodule, or a LI-RAD score for a liver lesion — or when intelligent validation detects left/right or male/female anatomic discrepancies.

What's more, our AI-enabled imaging platform employs NLP in real time. As the report is being created, the system will prompt the radiologist for required information based on report content.

**The radiologist's experience.** AI streamlines the reporting process while helping ensure accuracy. If an issue is detected, the system prompts the radiologist with steps to address it. Where reporting requirements are needed, the radiologist can choose to link to the relevant grading or coding system for the pathology presented. For example: A radiologist creates a report on a thyroid ultrasound describing a thyroid nodule. The system will check the report for a TI-RAD score. If missing, it will prompt the radiologist to "Please include a TI-RAD score," and include a link to how a TI-RAD score is determined, if needed.

**Results.** AI has enabled vRad to scale our radiology practice without compromising the quality and veracity of each patient diagnosis. AI helps us more effectively manage compliance with evolving regulatory requirements, without burdening our radiologists.

By actively checking each report, AI significantly reduces the risk of a delayed result or incomplete record for billing based on a misplaced keystroke, transcription error, omitted merit-based incentive data or individual mistake — a huge advantage for a practice processing nearly 7.5 million studies annually.

*Two components are essential to successfully establish, develop and sustain applied AI in radiology: Uncompromised collaboration between radiologists and computer scientists, and access to a constant flow of data that is representative of a highly diverse population. This is the foundation of vRad Radiology AI.*

### Empower the team with radiological and digital data expertise

A dedicated vRad team of leading radiologists, expert data scientists and product engineers work side by side with a common goal of leveraging advanced technology to improve their patients' outcomes.

Our computer scientists contribute expertise in developing leading-edge AI algorithms that are expanding the boundaries of machine learning. They recognize that creating systems that affect patient outcomes requires understanding diagnostic imaging and the individual experience of each radiologist reporting from a workstation.

Our radiologists provide clinical insight. They bring practical experience that spans the complete spectrum of subspecialties, modalities and reporting requirements. Their diagnoses determine the validity of algorithms and provide insights to refine AI sensitivity and specificity. Their guidance helps determine where application of AI technology has the greatest potential for patient benefit.

### Fuel AI with large volumes of representative data

AI thrives on data. Small samples of select data are useful for modeling and testing prototype algorithms. However, to build meaningful AI applications that perform consistently in real-world conditions requires large volumes of representative, properly annotated data.

To test and refine AI applications, vRad employs the most comprehensive database of current radiology studies available. The vRad platform processes 7.5 million studies annually, created by over 150,000 imaging devices, from more than 2,100 partner facilities across all 50 states and Puerto Rico. It compiles the diagnostic reports of 550 radiologists, including generalists and every area of subspecialty expertise.

This huge dataset is projectable to the entire U.S. and can be sampled to address specific patient populations. It contains incidences of virtually every conceivable variation in pathology, modality and circumstance. Further, it is refreshed by over 20,000 new case records every day.

Access to this massive dataset has been instrumental in putting practical AI solutions to work for vRad and will be vital in helping us continue to refine and expand the role AI will play in the future of radiology.

**vRad Radiology AI.**  
**The most comprehensive real-time radiology database available.**

**7.2+ million** studies annually

**150,000+** imaging devices

**2,100+** partner facilities

**50** states and Puerto Rico

**500+** board-certified radiologists

## Focus on the intersection of radiology needs and AI capabilities

Early on, our collaborative team discovered that AI models can be useful in identifying specific pathologies. While it is currently impractical to design an image-reading algorithm that can answer: “What is wrong with this chest?” or “What is wrong with this head?”, it is viable to make an algorithm that will reliably identify a specific abnormality, such as intracranial hemorrhage.

With this understanding, our radiologists develop a prioritized list of pathologies. We select the most urgent conditions, where reducing turnaround times by even a few minutes can be expected to significantly improve outcomes. We consider the frequency with which each condition occurs and keep an eye towards those conditions that are most readily identifiable in imaging studies, providing a higher probability for AI to correctly identify the presence of the given pathology.

To date, nine models have achieved favorable levels of specificity and are currently live with over 10,000 studies passing through them on a typical day to identify critical pathologies for escalation. These are the subjects of the prioritization AI outlined above.

## Ensure uncompromised care quality

vRad scans thousands of studies for the five current critical pathologies, which are among the over 20,000 studies conducted by our radiologists every day. Before implementing AI applications, it is first necessary to test the potential impact on all studies and the overall workings of the entire radiology ecosystem.

The benefits from prioritizing specific studies with AI must outweigh any potential delays to non-AI-escalated studies. Based on study volumes and AI accuracy, we can calculate the potential impact of an algorithm on overall turnaround times. In general, we establish at least 90% specificity before we move a prioritization model to production.

*AI is changing radiology. vRad is committed to leading the way. Following are some strategies we are using to optimize the performance of AI currently in use, while realizing the potential of radiological AI to reduce the cost of care and mitigate risk.*

## Enhance sensitivity and specificity of current models

Radiologists currently working with vRad Radiology AI applications “in the wild” are providing critical data and insights that are shaping and defining the next generation of AI tools. We continually compare the models’ results with actual case reports. If a model prioritizes a suspected case of pulmonary embolism, the radiologist report should validate that finding. However, if the algorithm generates a false positive or false negative based on the radiologist report, the report data can be used to improve future performance.

*“We’ve always excelled at applying technology to patient care. AI was the natural next step. We have spent years developing a level of AI expertise that does not exist anywhere else. Because of that, we’re improving patient care today and the results are truly astounding.”*

Benjamin W. Strong, MD  
Chief Medical Officer, vRad

## Expand the list of specific pathologies prioritized by AI

As noted above, we are working with a prioritized list of pathologies that present urgent threats to patients at a relatively high rate of frequency. We are currently training individual algorithms to accurately identify these pathologies. As the algorithms achieve acceptable levels of sensitivity and specificity, they will be integrated into the vRad Imaging Platform used by our physicians.

## Empower radiologists to meet present and future challenges

Radiologists are recognizing AI not as a substitute for their skills, but as an essential tool to help them provide the best quality patient care in a rapidly changing environment. As the medical industry continues to morph, vRad is advancing AI to help radiologists respond.

Where increasing demand for studies is driving higher image volumes — AI will help cull inconclusive images, enabling radiologists to focus on the critical scans.

Where a flat-to-declining number of radiologists in the field is placing more pressure on individuals — AI can promote more efficient study assignment and reporting, empowering radiologists to handle larger caseloads.

Where spiraling regulatory requirements can distract radiologists from patients — AI will reduce administrative burdens, enabling radiologists to focus “eyes on images.”

## Risk mitigation through AI

We are already demonstrating that AI can improve diagnostic reporting quality, accuracy and turnaround times. Consider the cumulative impact over time of fewer negative outcomes and reduced exposure to litigation. Risk mitigation as a result of AI can benefit the entire health system by reducing legal incidents and deflating medical malpractice liability reserves. Already, we are seeing third-party payer engagement on the issue of reimbursement and demonstrated quality improvements. We anticipate such engagement to continue, further differentiating vRad from other providers.

Our AI models are at work today prioritizing critical cases, improving reporting accuracy and assisting billing compliance. But we're just getting started. AI will permeate the practice and business of medical imaging to empower radiologists, conquer mountains of administrative burden and strengthen health care delivery.

Whether you're a radiologist wanting the power of AI at your back or a health care administrator seeking new advantages for your organization and patient population, let's discuss how you can leverage our AI today.

Visit [vrad.com](http://vrad.com) to contact us.

## Authors



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Dr. Strong is at the forefront of efforts to expand access to quality, affordable care through telemedicine. As CMO for the nation's largest radiology practice, he collaborates with radiologist and hospital partners, uncovering opportunities to enhance the practice environment. Dr. Strong first completed residency in internal and emergency medicine, and later was drawn to the fast-paced flow of diagnostic puzzles that is the practice of radiology.



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Mr. Nijim is a health care informatics expert whose focus is driving continuous advancement at the intersection of radiology and the IT systems that support it. His innovative solutions are helping enhance imaging accuracy, reporting and workflows across multiple disciplines, including oncology, cardiology, general diagnostics, ECG management and enterprise data archiving and management. A seasoned traveler, Mr. Nijim has visited more than 25 countries, both for personal enrichment and professionally as director of international software development, deployment, localization and translation teams.

