
AI in action.
A closer look
at the future
of radiology.
NUANCE

# The transformation of radiology.

**The transformation of radiology**
Artificial intelligence (AI), machine learning, and deep learning are poised to usher in a new era of growth in radiology by elevating the role of radiologists while reducing burdensome, tedious tasks. As AI's advanced tools become integrated in the day-to-day workflow, AI will empower radiologists to focus more on active patient care as integral members of the team, helping improve quality and outcomes.

In this companion paper to *Moving beyond words: Artificial Intelligence and the transformation of radiology**, Tarik Alkasab, MD, PhD, takes us on a ten-step journey depicting how AI tools might be applied to a real-world clinical scenario.

* https://www.nuance.com/content/dam/nuance/en_us/collateral/healthcare/white-paper/wp-moving-beyond-words-ai.pdf

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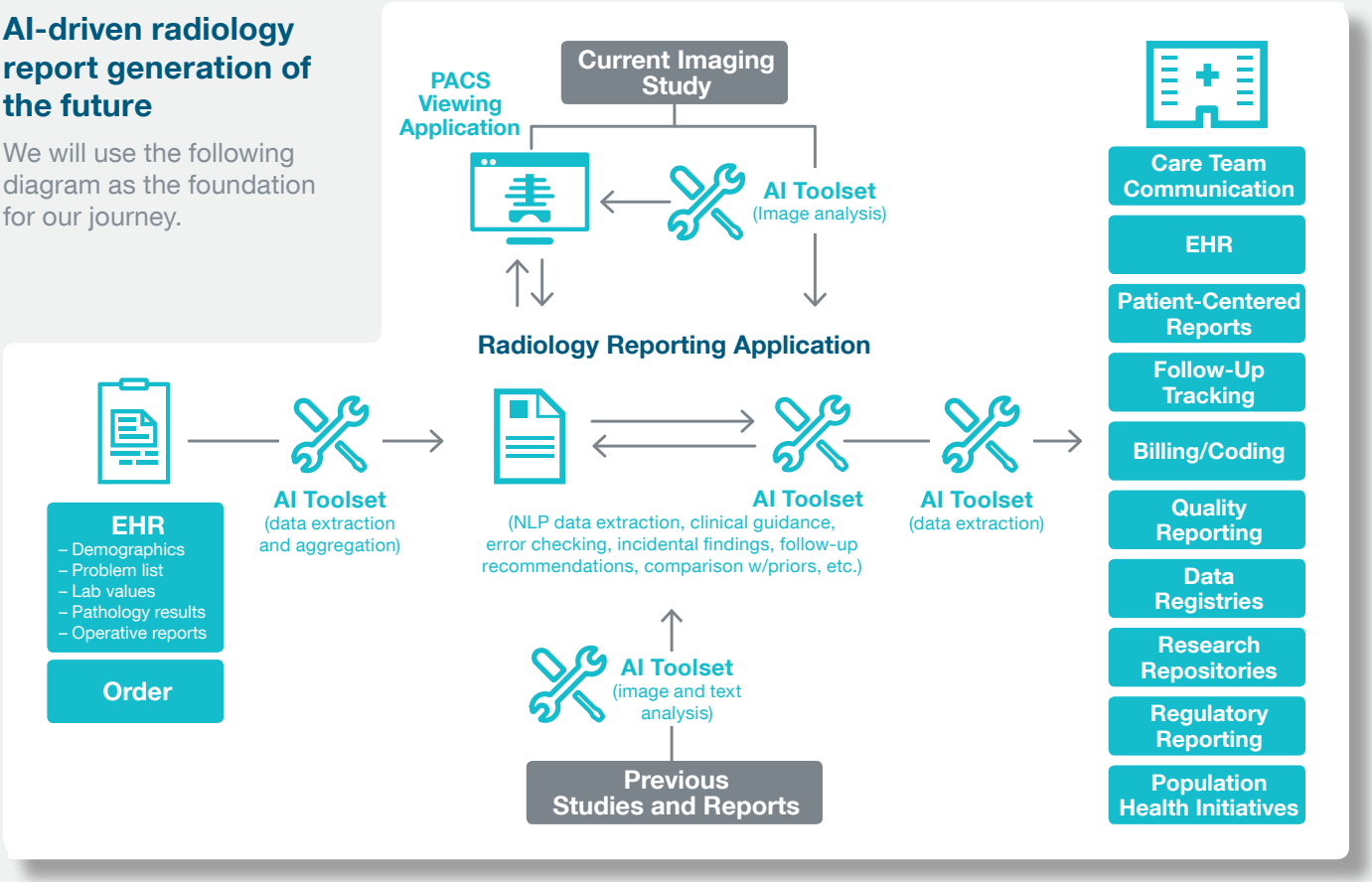
## AI-driven radiology report generation of the future

We will use the following diagram as the foundation for our journey.



## 1) Patient arrives in ED

Our patient arrives in the emergency department (ED) with **chest pain and slight shortness of breath.** The ED providers take the patient's history, perform an exam, and record their findings in the EHR.

Based on the patient's clinical presentation and the available historical data, the ED physician orders an EKG and checks cardiac enzymes, both of which are normal. The patient's **D-dimer** is slightly elevated, which could indicate a pulmonary embolism (PE). The ED physician thus orders a chest CT; when that is complete, the results are sent to the PACS.

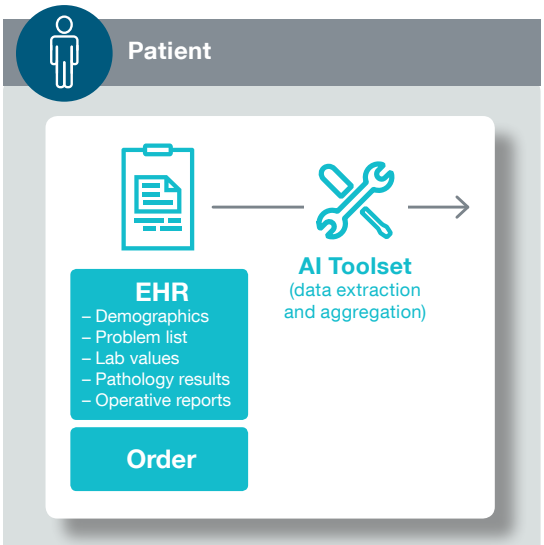
## 2) AI tools extract relevant information from the EHR

AI-driven tools use algorithms specifically developed to look for the types of information that are important for our type of patient. These tools **automatically extract pertinent data** from the patient's EHR, including lab values, patient and family history, and so on. The ED radiologist then receives this relevant information in a single summary, eliminating the need to manually review data from multiple sources and minimizing the possibility of overlooking key information. This same information can also be used by the AI tools further downstream in the diagnostic process.

## 3) AI image analysis tools automatically applied to current study

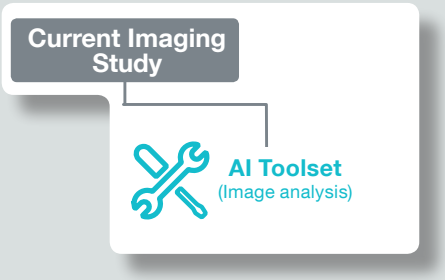
Next, AI-driven image analysis tools are automatically applied to the chest CT. In fact, a veritable legion of intelligent tools is likely to be mobilized across the acquired images to **automatically detect and characterize various conditions.** For example, algorithms have been (or could be) developed to detect or measure instances of pneumothorax, pulmonary nodules, and other conditions such as:

- Filling defects in pulmonary arteries that may represent PE
- Rib and vertebral body fractures
- Patterns of interstitial lung disease
- Volumes of pleural effusions
- Abnormal heart chamber sizes
- Thyroid nodules
- Abnormal lymph nodes
- Abnormal vessel sizes




### AI extracts patient data from EHR

- ED physician presented with relevant patient data
- ED physician's workflow expedited
- Patient care expedited




### AI automatically detects filling defect

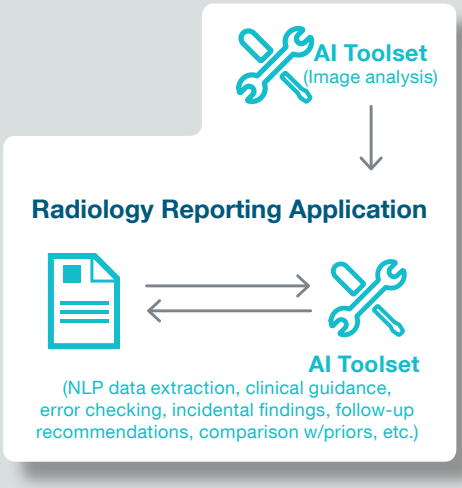
- Radiologist saves time and effort by expediting image review
- AI tool highlights important findings for radiologist to review

## 4) AI tools communicate with radiology reporting application

Each AI tool generates a different set of data to send to the radiologist's reporting environment. The **PE-detecting tool** detects areas of decreased opacification in the pulmonary arteries, and sends information about the size of the filling defect, the pulmonary arteries involved, and the precise location in the images where the defect can be found.

The **pulmonary nodule tool** detects the presence of a pulmonary nodule, categorizes the lesion as solid or sub-solid, measures its size, and records its location within the lungs and the exact location in the images.

The other modules do not report significant findings, and this lack of findings is reported back to the radiology reporting application along with the other data. This combination greatly reduces the radiologist's manual data entry and documentation burden.




### AI tool sends positive PE and pulmonary nodule results to reporting application

- Radiologist's manual documentation and data entry greatly reduced

## 5) AI image and text analysis tools applied to prior studies and reports

Meanwhile, the AI-driven algorithms also know to look for PE-related findings in **prior studies and reports.** These tools automatically review potentially large volumes of data and images located in multiple systems, eliminating a tedious manual process. For example, if the current pulmonary embolism or pulmonary nodules have been seen on prior exams, they would be detected by these algorithms.

The associations between the newly detected findings and the previously described lesions would then become part of the data context related to this exam. This application of AI image and text analysis tools eliminates the need for a manual review, saving the radiologist time and effort.


### AI tool within reporting application mines prior exams

- Radiologist saves time and effort by eliminating tedious manual review of priors

## 6) Radiologist begins interaction with PACS viewer and reporting application

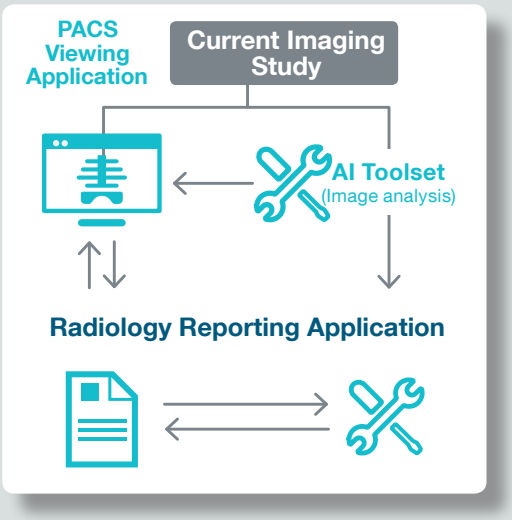
Because the AI tools identified a PE, the study moves higher on the PACS worklist priority, and the radiologist begins to review the case.

Once the radiologist opens the study in the PACS viewer, the system alerts him or her to the automatically detected PE, while the reporting application automatically pre-populates the radiology report with AI-derived data. Throughout this process, the reporting application is aware of the radiologist's activities in the PACS viewer.

And because the reporting application knows the location of the AI-detected findings within the images, when the radiologist reports on a particular feature, the reporting application can direct the PACS viewer to show those findings. This electronic interplay happens automatically and seamlessly, allowing the radiologist to move quickly among the outputs of the AI toolset.

In this way, the radiologist's role is elevated to that of **confirming, correcting, and completing.** First, the radiologist confirms the PE is a true finding. Second, the radiologist modifies the descriptors of the finding (vessel location, location, etc.) as needed. Third, the radiologist adds other necessary information, such as evidence of infarction in the lung associated with the obstructed vessel.

**Confirm, Correct, Complete**




### AI drives interaction between radiologist, PACS viewer, and reporting application

- Radiologist alerted to potential findings
- Radiologist's workflow streamlined, time-consuming burdensome tasks reduced, needs only confirm, correct, and complete AI findings

## 7) Radiologist continues interaction with PACS and reporting application

Once the radiologist confirms the PE, the AI toolset recognizes that it would be valuable to assess for right heart strain. The AI environment then pulls additional images from the PACS to **evaluate for associated findings** (e.g., interventricular septal bowing or right/left ventricular ratio), and the appropriate data is extracted and subsequently brought back into the reporting application.

**Confirm, Correct, Complete**

### AI tools evaluate for right heart strain

- Radiologist elevated to "data supervisor" role
- Manual data entry reduced
- Radiologist's workflow further streamlined
- Final report documents pertinent positives/negatives

## 8) Radiologist continues to interact with reporting application

Back in the reporting application, the radiologist reviews the **AI-derived data** relative to the patient's possible right heart strain and confirms there is no evidence of this complication. As before, the reporting application gives the radiologist the opportunity to make any **corrections or additions** to the description.

## 9) Radiologist completes interaction with reporting application

The radiologist completes the report using a variety of **embedded tools.** For example, clinical guidance/ computer-assisted decision support can recognize that the radiologist has confirmed the presence of PE without right heart strain, and suggest standardized phrasing for the report. It can also automatically generate recommendations for the patient's physicians to follow a standard care pathway for patients with medium-risk PE in the emergency department.

The radiologist also evaluates the pulmonary nodules that have been automatically detected. The reporting application can use the information from prior exams and reports to show the radiologist the currently detected nodules and the nodules as they appeared on prior exams.

The radiologist then associates the current findings with the same nodules over time and confirms that they are unchanged. An **assisted reporting tool** then guides the radiologist to report that these nodules have been unchanged long enough that they are likely benign, and inserts the appropriate language into the report. The tool also automatically generates a table of nodule size over time.

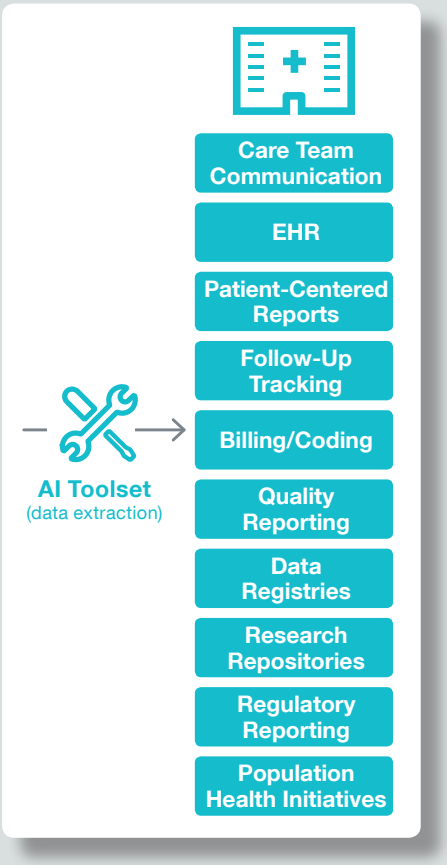
## 10) Final report and data sent to downstream consumers

With the report now complete, **downstream consumers benefit** from the application of AI. The report and associated data are automatically sent to the ED physician along with an alert about the PE. In addition, when the ordering provider views the result in the EHR, a link in the report result can automatically bring up the recommended order set, which includes clinical guidelines for further patient management. The radiologist's report can trigger additional actions; for example, the patient's primary care physician can be notified to schedule a follow-up, a step that is often missed.

AI data extraction tools automatically send accurate, validated data about the findings to billing, coding, and the EHR. The EHR also receives information about the recommended follow-up, both imaging and other steps, after diagnosis of PE.

In addition, data about the PE is sent to appropriate data registries and research repositories, and the patient is automatically registered with population health management systems to confirm proper ongoing treatment for hypercoagulability. This is enabled by a set of standard, registered definitions called common data elements (CDEs) which label the data exchanged between the reporting application and the EHR or other repositories such that all entities can understand what a particular piece of data means.

Finally, information is sent to quality tracking systems to record the radiologist's use of automated AI tools for this patient. Logging the use of AI and guideline assistance will be important for reimbursement under value-based care payment models, such as for MACRA/MIPS compliance.




### AI-based data extraction tools support downstream consumers

- Accurate and appropriate data automatically distributed
- Delays minimized
- Manual tasks reduced

## This journey concludes but the benefits continue beyond words

Throughout this journey, we've seen a few examples of how radiology and the entire healthcare ecosystem can benefit from AI:

- Physicians receive relevant clinical data in meaningful formats that expedite patient care.
- Radiologists are spared from tedious, burdensome data review and data entry.
- The possibility of missing key information or clinical findings, including incidental findings such as pulmonary nodules, is greatly reduced.
- Clinical guidance is provided to aid consistency and adherence to standards.
- Downstream consumers receive exactly the information they need, in the way they need it.
- Billing, coding, and reimbursement become more straightforward and accurate.
- Radiologist's use of quality enhancing tools is automatically recorded.

And the list goes on—beyond words and beyond our current imagination.

## Making AI a reality

Machine learning and deep learning algorithms can improve radiologists' productivity and accuracy while reducing repetitive tasks that lead to burnout. Making AI-powered tools and algorithms widely and easily available and integrated into the day-to-day workflow will unleash the full power of AI. In our example, we have shown how AI not only helps elevate the radiologist's role as an integral member of the patient care team by assisting the radiologist in generating the most useful data, the tools enable the radiologist to focus on answering the big diagnostic questions.

The Nuance AI Marketplace for Diagnostic Imaging, based on a comprehensive model for AI development, validation, and adoption, will help deliver the full benefits of AI to a wider range of stakeholders while making it both usable and practical.

The Nuance AI Marketplace comes at a critical time for radiologists. Not only are they being inundated with incredible amounts of imaging data, they also face the pressing need to spend more time and expertise advancing patient care and less time on tedious processes and paperwork. The availability and acceptance of machine learning and AI algorithms through the AI Marketplace helps address these challenges by enabling care professionals to take advantage of data that has been collected across a range of disciplines.

### Define and build

AI developers can utilize a wide array of AI development platforms and leverage the PowerShare™ Network to feed these development environments with vast amounts of relevant imaging data from any authorized imaging repository, regardless of physical location.

### Publish and share

Using the PowerShare Network, any AI developer, anywhere, can publish their properly approved, propriety algorithms for any of the more than 20,000 radiologists who use PowerScribe® 360 to leverage their interpretation workflow.

### Access, subscribe, and use

Any hospital or radiology group that uses PowerScribe 360 can easily subscribe to algorithms of their choice. Once subscribed, those algorithms will be applied automatically to relevant imaging studies. The AI results are utilized in radiology reporting workflow, and the feedback from the radiologists is used to enable continuous learning and refinement of algorithms.

To learn more about Nuance Healthcare solutions, please call 1-800-805-5902 or visit nuance.com/healthcare/engage-us.

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