aidoc

CLINICAL STUDIES OVERVIEW

REDEFINING STANDARDS OF CARE

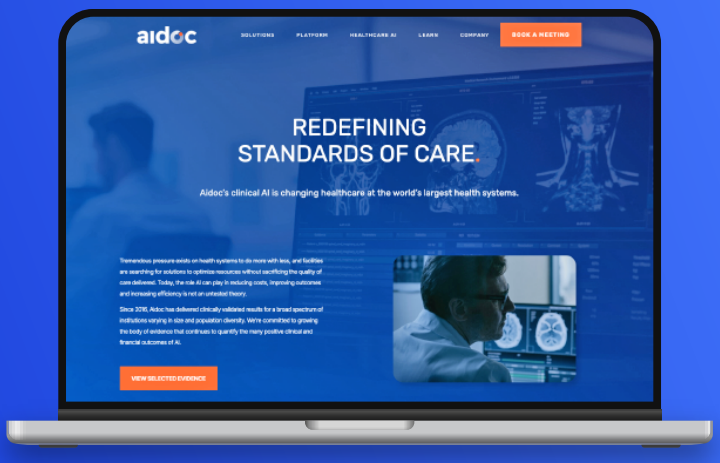
Clinical research has been performed on Aidoc's solutions spanning across a broad spectrum of institutions varying in size and population diversity. This paper will expand upon the growing body of clinical research that has been performed on Aidoc's AI solutions. Research conducted has further quantified the positive clinical outcomes from the use of an artificial intelligence tool for prioritization — specifically in reducing turnaround time, facilitating peer review and increasing efficiency.

This paper presents a body of research conducted using Aidoc's solution, with some assessing products and use cases that are currently under R&D or investigational use only.

For information on Aidoc's cleared products indications for use; safe and correct usage and risk information, please refer to Aidoc's 510(k) premarket notifications on the FDA's website and to the product's User Guide.

Since 2016, Aidoc has delivered clinically validated results for a broad spectrum of institutions varying in size and population diversity. We're committed to growing the body of evidence that continues to quantify the many positive clinical and financial outcomes of AI.

Learn more about the clinical impact of Aidoc's AI



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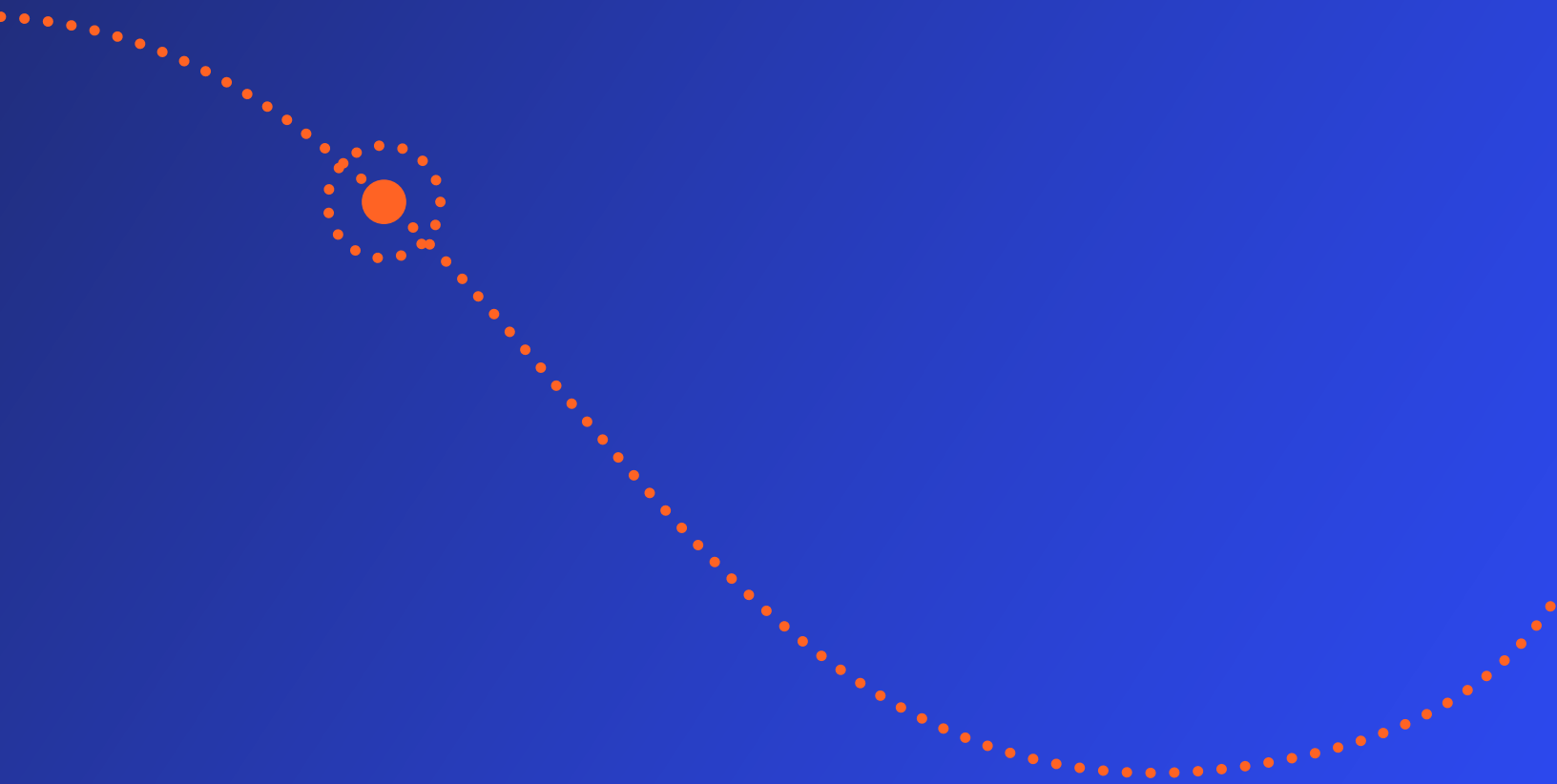
INCREASED DISEASE AWARENESS



CEDARS-SINAI MEDICAL CENTER

AI-Augmented Review of CT Cases to Facilitate Peer Review of Intracranial Hemorrhage by Practicing Neuroradiologists

CHODAKIWEWITZ Y., MAYA M., PRESSMAN B.

Presented at International Stroke Conference 2020

Keywords: Discrepancies, ICH

Materials & Methods

A retrospective study compared discrepancies between CT reports and AI-based detection of ICH. All non-contrast CT brain cases were collected over two months; cases reported as negative for ICH were included (n=1,812), while cases reported as suspicious for ICH (n=504) were excluded. Fellowship-trained neuroradiologists finalized all reports. An AI-tool trained to detect ICH was then run on the case set.

Results

Upon final consensus, 22 cases of ICH detected by AI were missed on finalized reports, yielding an error rate of 4.2% (22/(504+22)).

Conclusions

AI-augmentation can flag potential discrepancies between scans and their reports, possibly improving the quantification of error rates among practicing radiologists.

View abstract

YALE NEW HAVEN HOSPITAL

Utility of Artificial Intelligence Tool as a Prospective Radiology Peer Reviewer - Detection of Unreported Intracranial Hemorrhage

RAO B., ZOHRABIAN V., CEDENO P., SAHA A., PAHADE J., DAVID M.

Published in American Radiology 2021

Keywords: Discrepancy, ICH, Workload

Materials & Methods

AI solution retrospectively applied to all consecutive non-contrast computed tomography (CT) head scans to assess the prevalence of ICH in scans reported as negative for ICH. The study was performed at six imaging sites affiliated to the institution. In the 6,565 non-contrast CT head scans which met the inclusion criteria, 5,585 scans were reported to have no ICH (“negative-by-report” cases). The AI solution was applied to these “negative-by-report” cases.

Results

The AI solution suggested there were ICH in 28 of these scans (“negative-by-report” and “positive-by-AI solution”). After consensus review by three neuroradiologists, 16 of these scans were found to have ICH which was not reported (missed diagnosis), with false negative rate of radiologists for ICH detection at 1.6%.

Conclusions

The study demonstrates that an AI solution can help radiologists diagnose ICH and decrease error rate.

View paper

YALE NEW HAVEN HOSPITAL

Use of a Machine Learning Algorithm to Detect Incidental Pulmonary Embolus

BADER A., TOCINO I., KHAN I., CORTOPASSI I.

Presented at SIIM 2020

Keywords: Discrepancy, iPE

Materials & Methods

An artificial intelligence (AI) tool trained to detect PE was applied to a retrospective cohort of 2,632 consecutive contrast enhanced chest CT exams performed at a large healthcare system between Jan. 1 and Feb. 28, 2018. CTA chest exams using a PE protocol were excluded from the cohort. Natural language processing (NLP) of the cohort reports was used to identify cases where incidental PE was described by the radiologist. All discrepant cases between the algorithm and the NLP results were reviewed by a board-certified cardiothoracic radiologist with more than five years of experience.

Results

The prevalence of incidental PE was 1.2% (31 cases), lower than the reported 2.6%. The algorithm was 94% sensitive and 99.6% specific in detecting incidental PE. The positive predictive value was 74% and the negative predictive value was 99.9%. Of the 25 discrepant cases that were positive according to the algorithm,14 (56%) demonstrated incidental PE on secondary review.

Conclusions

The integration of an AI algorithm can improve the detection of incidental PE, expedite interpretation and identify patients that may need immediate medical attention.

View abstract

UNIVERSITY HOSPITAL OF BASEL

Assessment of a Deep Learning Algorithm for the Automatic Detection of Rib Fractures on Trauma CTs

WEIKERT T., NOORDTZIJ L., BREMERICH J., STIELTJES B., PARMAR V., CYRIAC J., SOMMER G., SAUTER A.

Published in KJR 2020

Keywords: Discrepancies, Rib Fractures

Materials & Methods

Retrospective identification of all trauma CTs referred from the emergency department between Jan. 2018 and Dec. 2018 (n=511). Examinations were categorized as positive (n=102) or negative (n=409) for rib fractures according to the clinically approved written CT reports. After anonymization, the bone kernel series (1.5 mm slice thickness) served as input for a rib fracture detection prototype algorithm based on a deep convolutional neural network (DCNN) that was previously trained on an independent sample (n=11,000).

Results

75 fractures (50 acute; 25 chronic) detected by the algorithm were not mentioned in the written CT reports.

Conclusions

The AI solution was able to detect rib fractures that were previously not mentioned in CT reports. The algorithm has potential clinical application to be used in reading assistance.

View paper

CHRISTIANA CARE HEALTH SYSTEM

Implementation of Quality Assurance for CTA PE Interpretation Utilizing AI Monitoring, to Avoid Missed Diagnosis of Acute Pulmonary Embolism

HASAN R., MOLAVI SS., MOON MJ., KHASAT VJ., DEMAURO C., SHIN MF.

Presented at RSNA 2020

Keywords: Discrepancy, PE, QA Process

Materials & Methods

As part of the QA protocol, a team of four radiologists and a PACS administrator was formed. All positive cases detected by AI during a four-month period from Dec. 2019 to March 2020 were compared with a radiologists' report for discordant results. Studies with discordant results were reviewed by the radiologists on the QA team daily. Email notifications were sent to the radiologist who interpreted the study as well as to the QA team and true positive cases were addended.

Results

335 CT scans were detected by AI as positive for PE. Retrospective review confirmed 236 cases as true positives (PPV = 70%). 220 cases were correctly interpreted as positive for PE by the radiologists. 16 cases were overlooked despite being correctly identified by AI. 11 cases were due to human error (notification overlooked) and five cases were due to technical errors (notification was late/not received). All 16 cases were reviewed by the QA team and communicated to the referring providers within 12 hours.

Conclusions

6.8% (16 out of 236) of PE cases were overlooked by the radiologists. Creating a multifaceted QA approach with the addition of AI can help avoid missing critical findings and prevent adverse clinical outcomes.

View presentation

UNIVERSITY OF ROCHESTER MEDICAL CENTER

A Novel Hybrid Human-Machine Interoperability Approach for Quality Assurance in Radiology – Efficiently Identifying Missed Intracranial Hemorrhage Cases in Emergent Care Non-Contrast Head CT

WISMÜLLER A., SHRIER D., STOCKMASTER L., WEINBERG E. P., VOSOUGHI A.

Presented at ASNR 2021

Keywords: Discrepancy, Efficiency, ICH

Materials & Methods

A total of 1,936 consecutive non-contrast head CT scans from two CT scanners used for inpatient and emergency room patients at a large academic hospital were prospectively acquired over 47 consecutive days. Scans were automatically analyzed for the presence of intracranial hemorrhage (ICH) using commercially available software (Aidoc,).

ICH-AI+ cases, radiologists' missed ICH detection rates as defined by the ratio of the number of missed ICH cases and the number of all true ICH-AI+ cases was calculated and compared between flagged and non-flagged ICH-AI+ cases, where images of all ICH-AI+ cases with ICH-negative results as detected by NLP of final radiology reports (ICH-AI+NLP- cases) were re-analyzed by a neuroradiology expert panel to identify true ICH+ cases missed by original radiology readings.

Results

Among all 1,936 CT scans, a total of 381 ICH-AI+ cases were found, of which 190 cases were flagged. A total of 29 ICH-AI+NLP- cases were found, where six had been reported ICH+ by the radiology report. Of the remaining non-reported 23 ICH-AI+ cases, neuroradiology expert review identified six non-reported true ICH+ cases, where five cases were non-flagged, and only one
case was flagged.

Conclusions

Combining AI-based image analysis with NLP-based pre-selection of discordant cases for targeted human expert review can efficiently identify missed findings in radiology reports and can thus expedite radiology QA programs.

View conference

UNFALLKRANKENHAUS BERLIN (UKB)

Deep Learning Algorithm in Detecting Intracranial Hemorrhages on Emergency Computed Tomographies

KUNDISCH A., HÖNNING A., MUTZE S., KREISSL L., SPOHN F., LEMCKE J., SITZ M., SPARENBERG P., GOELZ L.

Published in PLOS One 2021

Keywords: Discrepancy, ICH

Materials & Methods

In a retrospective multi-center cohort study, consecutive emergency non-contrast HCT scans were analyzed by a commercially available ICH detection software (Aidoc, Tel Aviv, Israel). Discrepancies between AI analysis and initial radiology report (RR) were reviewed by a blinded neuroradiologist to determine the number of additional ICHs detected and evaluate reasons leading to errors.

Results

4,946 HCT (May 2020 to Sept. 2020) from 18 hospitals were included in the analysis. 205 reports (4.1%) were classified as hemorrhages by both radiology report and AI. Out of a total of 162 (3.3%) discrepant reports, 62 were confirmed as hemorrhages by the reference neuroradiologist. 33 ICHs were identified exclusively via RRs. The AI algorithm detected an additional 29 instances of ICH, missed 12.4% of ICH and overcalled 1.9%; RRs missed 10.9% of ICHs and overcalled 0.2%. Many of the ICHs missed by the AI algorithm were located in the subarachnoid space (42.4%) and under the calvaria (48.5%). 85% of ICHs missed by RRs occurred outside of regular working-hours. Calcifications (39.3%), beam-hardening artifacts (18%), tumors (15.7%), and blood vessels (7.9%) were the most common reasons for AI overcalls. ICH size, image quality, and primary examiner experience were not found to be significantly associated with likelihood of incorrect AI results.

Conclusions

Complementing human expertise with AI resulted in a 12.2% increase in ICH detection. The AI algorithm overcalled 1.9% HCT.

View paper

THE UNIVERSITY OF TEXAS MEDICAL BRANCH (UTMB)

Clinical Outcome of Incidental Pulmonary Embolism Detected by Artificial Intelligence Software: A Retrospective Analysis

GEORGE JK., PALACIO DM.

Presented at RSNA 2022

Keywords: Accuracy, Discrepancies, iPE

Materials & Methods

iPE algorithm was applied retrospectively to 2,793 consecutive patients undergoing chest CT between May 2020 to Jan. 2021 and compared to the original radiology report. Concordant cases between the original report and AI were considered ground truth. Discordant cases deemed positive by AI and negative by the report were reassessed by the radiologist.

Results

iPE prevalence was 2.3% (65/2,792). 45 cases were positive by both AI and radiologist report and AI detected 23 additional discordant positive cases. 87% (20/23) were considered true positive on secondary review. The AI-enhanced detection rate was 44.4% (20/45). 10% (2/20) were chronic PE, 90% (18/20) were acute/subacute PE. 70% (14/20) were subsegmental PE. 40% (8/20) had follow-up imaging, and in 50% (4/8) cases iPE was not resolved. In 38% (3/8) iPE was noticed on follow-up and reported. In all three, anticoagulation therapy was initiated. The average treatment delay was 132 days. In 35% (3/20) discrepant anticoagulation was given for other reasons. In the remaining 65% (13/20) cases, iPE was unnoticed by the radiologist or clinician and the patient did not receive any treatment. 25% (5/20) of patients died of unrelated causes.

Conclusions

The improved detection rate of iPE by AI may bring significant benefits for prompt management in selected individuals, especially the ones at risk for recurrent thromboembolic events.

View conference

ENVISION HEALTHCARE

Effectiveness of a Convolutional Neural Network Artificial Intelligence Algorithm in the Detection of Intracranial Hemorrhage on Noncontrast CT Imaging

JACOB A., DOAN B., GRANVILLE C.

Presented at RSNA 2022

Keywords: Accuracy, Discrepancies, ICH

Materials & Methods

An FDA approved AI solution based on a convolutional neural network was used to assess 8,468 NCCTs. Data was collected from 29 different facilities. NCCTs were retrospectively processed through the AI solution and assigned a positive or negative for ICH allocation. Each report was analyzed by NLP software and assigned a positive or negative for ICH allocation per the radiologist's interpretation. Cases that were discordant were assessed by three radiologists for ground truth.

Results

Concordant cases included 288 double positives (AI+/Rad+) and 7,950 double negatives (AI-/Rad-). 132 discordant cases included 100 scans positive by AI and negative per radiologist's report (AI+/Rad-), and 32 scans negative by AI and positive by report (AI-/Rad+). AI demonstrated an accuracy of 98.8%, sensitivity of 93.6%, and a specificity of 99.1%. The radiologists detected 309 positive cases, and an additional 18 ICHs were detected by the AI solution, providing an added detection rate of 5.8%

Conclusions

The combined precision and accuracy of the AI-radiologist combination highlights the value of coupling a high sensitivity screening test (AI) with a higher specificity validation test (radiologist).

View conference

MAYO CLINIC

Evaluating the Performance of a Commercially Available AI Algorithm for Automated Detection of Pulmonary Embolism on CECT and CTPA of COVID-19 Patients

ZAAZOUE KA., MCCANN MR., AHMED AK., CORTOPASSI IO., ERBEN YM., LITTLE BP., STOWELL JT., TOSKICH BB., RITCHIE CA.

Published in Mayo Clinic Proceedings: Innovations, Quality & Outcomes 2023

Keywords: Accuracy, PE, CTPA, COVID-19

Materials & Methods

Retrospective analysis was performed of all contrast-enhanced chest CT scans of patients admitted for COVID-19 between March 1, 2020 and Dec. 31, 2021. Based on the original radiology reports, all PE-positive examinations were included (n=527). Using a reversed-flow single-gate diagnostic accuracy case-control model, a randomly selected cohort of PE-negative examinations (n=977) was included. Pulmonary parenchymal disease severity was assessed for all the included studies using a semiquantitative system, the total severity score. All included CT scans were sent for interpretation by the commercially available AI algorithm, Aidoc. Discrepancies between AI and original radiology reports were resolved by three blinded radiologists, who rendered a final determination of indeterminate, positive, or negative.

Results

A total of 78 studies were found to be discrepant, of which 13 (16.6%) were deemed indeterminate by readers and were excluded. The sensitivity and specificity of AI were 93.2% (95% CI, 90.6%-95.2%) and 99.6% (95% CI, 98.9%-99.9%), respectively. The accuracy of AI for all total severity score groups (mild, moderate, and severe) was high (98.4%, 96.7%, and 97.2%, respectively). Artificial intelligence was more accurate in PE detection on CT pulmonary angiography scans than on contrast-enhanced CT scans (P<.001), with an optimal Hounsfield unit of 362 (P=.048).

Conclusions

The AI algorithm demonstrated high sensitivity, specificity, and accuracy for PE on contrast-enhanced CT scans in patients with COVID-19 regardless of parenchymal disease. Accuracy
was significantly affected by the mean attenuation of the pulmonary vasculature. How this affects the legitimacy of the binary outcomes reported by AI is not yet known.

View paper

UNIVERSITY OF WISCONSIN HEALTH

Artificial Intelligence-Augmented Detection of Missed Extraluminal Free Air on Abdominal CT

JIANG A., GARRETT J., TOIA G.

Abstract for SAR 2023

Keywords: Discrepancies, Free Air

Materials & Methods

A commercially available artificial intelligence algorithm (Aidoc) trained to detect the presence of extraluminal free air was applied to 2,406 CT examinations of the abdomen and pelvis performed in the emergency department between Jan. 30, 2021 and April 1, 2021. Natural language processing software was used to identify concordant and discordant cases. Concordant cases were those with positive detections by AI and positive by final report. Discordant cases were those with positive detections by AI and negative by final report. Discordant case imaging was independently reviewed by two abdominal radiologist readers to establish a reference gold standard for actual presence or absence of extraluminal air. Chart review was performed in discordant cases to assess for significant changes to clinical care.

Results

The prevalence of AI-detected extraluminal air was 2.9% (69/2,406). 89.9% (62/69) cases were concordantly positive between AI and report. AI detected an additional 17 discordantly positive cases. Of the discrepant only cases, 41.2% (7/17) were true positive as distinguished by independent reader secondary review. The AI-enhanced detection rate was 11.3% (7/62). Of the seven cases labeled discordantly positive by AI, 57.1% (4/7) had extraluminal gas in the post-operative state, 28.5% (2/7) had intraperitoneal dialysis catheters, and 14.4% (1/7) had a gas-containing fluid collection. No large volume extraluminal air was identified in any discordant case. No significant change to clinical care was identified in these patients. Ten cases were identified positive by AI and negative by reader secondary review. In 90.0% (9/10) of these cases, the air was intraluminal and in 10.0% (1/10) cases, the air was intrapulmonary.

Conclusions

The improved AI-augmented detection for extraluminal free air could be helpful to timely and appropriately triage patient exams. In this study, none of the free air additionally identified by AI-augmentation was clinically significant and clinical management did not change.

View conference

REGION HALLAND

Unreported Incidental Pulmonary Embolism in Patients With Cancer: Radiologic Natural History and Risk of Recurrent Venous Thromboembolism and Death

WIKLUND P., MEDSON K., ELF J.

Published in Thrombosis Research 2023

Keywords: PE, Outcomes

Materials & Methods:

Matched cohort study on cancer patients with a CT study including the chest between Jan. 1, 2014 and June 30, 2019. Studies were reviewed for unreported iPE and cases were matched with controls without iPE. Cases and controls were followed for one year, with recurrent VTE and death as outcome events.

Results

Of the included 2,960 patients, 171 patients had unreported and untreated iPE. While controls had a one-year VTE risk of 8.2 events per 100 person-years, cases with a single subsegmental iPE had a recurrent VTE risk of 20.9 events, and between 52.0 and 72.0 events per 100 person-years for multiple subsegmental iPE and more proximal iPE. In multivariable analysis, multiple subsegmental and more proximal iPE were significantly associated with the risk of recurrent VTE, while single subsegmental iPE was not associated with the risk of recurrent VTE ($p = 0.13$). In the subgroup of patients ($n = 47$) with cancer not in the highest Khorana VTE risk category, no metastases and up to three involved vessels, recurrent VTE occurred in two patients (4.7 cases per 100 person-years). There were no significant associations between iPE burden and risk of death.

Conclusions

In cancer patients with unreported iPE, iPE burden was associated with the risk of recurrent VTE. However, having a single subsegmental iPE was not associated with the risk of recurrent VTE. There were no significant associations between iPE burden and risk of death.

View paper

MAYO CLINIC

The Use of Artificial Intelligence to Improve Detection of Incidental Pulmonary Emboli

KUZO R., LEVIN DL., BRATT A., HOUGHTON D., SUMAN G., WALKOFF L.

Abstract for ECR 2023

Keywords: Discrepancies, iPE

Materials & Methods:

An artificial intelligence algorithm (Aidoc) was used to retrospectively review 14,453 conventional chest CT exams with IV contrast for the presence of incidental pulmonary emboli. All exams were performed as part of a combined CT of the chest, abdomen, and pelvis and read by thoracic radiologists. Natural language processing was used to search the exam reports to find cases of iPE detected prospectively. All cases read as positive for pulmonary emboli by the AI algorithm and NLP search were reviewed by thoracic radiologists to confirm the presence of acute PE. The most proximal level of clot and overall clot burden were assessed during this review.

Results

A total of 254 chest CT exams had acute iPE detected by AI or by review of the radiologist original reports and confirmed by subsequent review for a prevalence of 1.8%. 218 iPE were detected prospectively by radiologists. The sensitivity of radiologists for iPE detection was 0.858. AI detected an additional 36 cases of iPE that were missed prospectively (radiologist false negative rate of 14.2%). 30 cases indicated as positive by the AI algorithm were classified as negative on further clinical review. The AI algorithm had a sensitivity for iPE detection of 0.882 and specificity of 0.998 and accuracy of 0.996. Of the 36 cases of iPE missed by the radiologist, 19 were solitary segmental or subsegmental emboli and the average Qanadli score of clot burden was 1.9. Of the 30 cases of iPE missed by the AI algorithm, one case had large central emboli, but the other cases had small emboli with 23 having solitary subsegmental emboli and an average Qanadli score of 1.5. Tumor/adenopathy adjacent to the pulmonary vessel was the most common cause of AI false positives. Beam hardening artifact, motion artifact, and image noise were also causes of AI false positives.

Conclusions

Acute iPE are sometimes missed during interpretation of conventional chest CT with IV contrast. The use of an AI tool significantly improved detection of iPE which had been missed prospectively. The AI tool had high accuracy with a low false positive rate. The iPE missed by the radiologist were small. Further studies of patient outcome are needed to assess the clinical significance of missed untreated iPE.

View conference

ISALA HOSPITAL

Added Value of an Artificial Intelligence Algorithm in Avoiding Missed Incidental Pulmonary Embolism in Routine Chest CT

LANGIUS-WIFFEN E., DE JONG, P., MOHAMED HOESEIN FAA., DEKKER L., V. D. HOVEN A., NIJHOLT IM., BOOMSMA MF., VELDHUIS WB.

Abstract for ECR 2023

Keywords: Discrepancies, iPE

Materials & Methods:

Consecutive scan data of 3,089 patients referred to the radiology department for examination, including a routine contrast enhanced chest CT, to determine the reference standard. Discordant findings were independently evaluated by a medical doctor and a chest radiologist. In case of disagreement, another experienced cardiothoracic radiologist with knowledge of the initial report and the AI output adjudicated.

Results

Of the 67 PE positive scans, 25 (37.3%) were not detected in the initial reading and three (4.5%) were not detected by the AI algorithm, resulting in a significantly higher sensitivity of the AI algorithm than the initial report (respectively 95.5% vs. 62.7%, $p < 0.001$). The PE that were missed in the routine assessment included three cases with lobar PE and high clot burden. The other missed cases concerned 15 segmental PE and seven subsegmental PE.

Conclusions

Our study showed that the sensitivity of the AI algorithm to detect acute incidental PE on routine chest CT was significantly higher than the initial report. Rapid implementation in clinical practice could be supported by including AI in the required diagnostic workup of routine contrast-enhanced chest CT in national and international guidelines.

View conference

UNIVERSITY OF TEXAS MEDICAL BRANCH

Clinical Outcome of Incidental Pulmonary Embolism on Contrast-Enhanced Abdominal CT Detected by Artificial Intelligence Software: A Retrospective Analysis

NAHYUN CJ., ATWOOD M., EDHAYAN G., MUNEEB A., PALACIO D., BHARGAVA P.

Abstract for SAR 2023

Keywords: iPE, Accuracy

Materials & Methods:

The iPE algorithm was applied to 4,494 consecutive patients undergoing CTAP between Oct. 2020 to Jan. 2021, and compared to the original report. Concordant cases were considered ground truth. Discordant cases deemed positive by AI and negative by the report were reassessed by an experienced chest radiologist to establish the true diagnosis. The clinical outcome was determined by a retrospective review of the medical record, including re-admission, outpatient encounters, follow-up imaging, or death.

Results

The prevalence of iPE was 0.71% (32/4494). Fourteen cases were found to be positive by both AI and radiologist reports. AI detected 18 additional discordant positive cases. Of these, 83% (15/18) were true positives. Of the 15 ground truth cases, 12 (80%) were subsegmental PE, and three (20%) were segmental.

iPE resolved in 33% of cases (5/15) on follow-up imaging and persisted in 20% (3/15). Of the three patients, one patient showed a central saddle embolus in a CT Angiogram performed five days later, and anticoagulation was initiated. Another patient with segmental PE, had concomitant DVT. The third patient had a right main PE. None of the latter two patients were anticoagulated due to life-threatening bleeding.

Of the patients without follow-up imaging, 47% (7/15), one died from metastatic cancer two years after the iPE diagnosis. The rest had no follow-up imaging and clinical follow-ups without symptoms of acute or chronic PE.

Conclusions

The incidence of iPE in our study was extremely low (<1%). About half the time (48%,14/29), the radiologist detected PE. AI-enhanced detection may benefit prompt evaluation and management in high-risk patients. Further studies on a larger patient population are warranted.

View conference

YALE NEW HAVEN HOSPITAL

Clinical Implementation of a Combined Artificial Intelligence and Natural Language Processing Quality Assurance Program for Pulmonary Nodule Detection in the Emergency Department Setting

CAVALLO JJ., SANTO IDO., MEZRICH JL., FORMAN HP.

Published in Journal of the American College of Radiology 2023

Keywords: Pulmonary Nodule, QA

Materials & Methods:

In all, 19,246 CT examinations including at least some portion of the lung anatomy performed in the emergent setting from Oct. 1, 2021 to June 1, 2022, were processed by the combined AI-NLP program. The program used an AI algorithm trained on 6-mm to 30-mm pulmonary nodules to analyze CT images and an NLP to analyze radiological reports. Cases flagged as negative for pulmonary nodules by the NLP but positive by the AI algorithm were classified as suspected discrepancies. Discrepancies resulted in secondary review of examinations for possible addenda.

Results

Out of 19,246 CT examinations, 50 examinations (0.26%) resulted in secondary review, and 34 of 50 (68%) reviews resulted in addenda. Of the 34 addenda, 20 patients received instruction for new follow-up imaging. Median time to addendum was 11 hours. The majority of reviews and addenda resulted from missed pulmonary nodules on CT examinations of the abdomen and pelvis.

Conclusions

A background quality assurance process using AI and NLP helped improve the detection of pulmonary nodules and resulted in increased numbers of patients receiving appropriate follow-up imaging recommendations. This was achieved without disrupting in-shift radiologist workflow or causing significant delays in patient follow for the diagnosed pulmonary nodule.

View paper

MILTON KEYNES UNIVERSITY HOSPITAL

Artificial intelligence in Early Detection and Notification of Incidental Pulmonary Embolism - Analysis of Accuracy and Impact on Early Treatment of PE

SUBRAMANIAN K.

Abstract for BIR AI 2023

Keywords: iPE, Accuracy

Materials & Methods:

All post contrast staging scans performed Sept. and Oct. 2022 were included in the study. An artificial intelligence algorithm that detects pulmonary emboli on staging scans and provides notification on a widget placed in the radiologists' reporting station was implemented. All studies were analyzed by the algorithm as soon as they were performed. The AI positive CT examinations were flagged to reporting radiologists. The accuracy of the AI findings was retrospectively compared with the radiologists' final reports. The lead time gained in treating PE by urgent reporting of the flagged cases was calculated based on the average waiting time for reporting O/P staging scans during this month.

Results

A total of 563 studies were retrospectively reviewed and analyzed by the AI algorithm. The prevalence of iPE was 1.8% (10/563). The AI algorithm had a sensitivity of 100% (69.2%-100.0%) and specificity of 99.6% (98.7%-100.0%) for the detection of iPE. The AI flagged two false positive and zero false negatives resulting in a PPV of 83.3% (55.6%-95.2%) and NPV of 100.0% (100.0%-100.0%). The average lead time gained to treat iPE was four weeks.

Conclusions

AI algorithms have high sensitivity and specificity in identifying pulmonary embolism on outpatient staging CT scans. By notifying the radiology team immediately, these were reported urgently, and a significant lead time was gained in treating PE in these outpatients.

View conference

ISALA HOSPITAL

Retrospective Batch Analysis to Evaluate the Diagnostic Accuracy of a Clinically Deployed AI Algorithm for the Detection of Acute Pulmonary Embolism on CTPA

LANGIUS-WIFFEN E., DE JONG P., HOESEIN FAM. DEKKER L., VAN DEN HOVEN A., NIJHOLT I., BOOMSMA M., VELDHUIS W.

Published in Insights Into Imaging 2023

Keywords: PE, Accuracy

Materials & Methods:

Consecutive CTPA scan data of 3,316 patients referred because of suspected PE between Feb. 24, 2018 and Dec. 31, 2020, were retrospectively analyzed by a CE-certified and FDA-cleared AI algorithm. The output of the AI was compared with the attending radiologists' report. To define the reference standard, discordant findings were independently evaluated by two readers. In case of disagreement, an experienced cardiothoracic radiologist adjudicated.

Results

According to the reference standard, PE was present in 717 patients (21.6%). PE was missed by the AI in 23 patients, while the attending radiologist missed 60 PE. The AI detected two false positives and the attending radiologist detected nine false positives. The sensitivity for the detection of PE by the AI algorithm was significantly higher compared to the radiology report (96.8% vs. 91.6%, $p < 0.001$). Specificity of the AI was also significantly higher (99.9% vs. 99.7%, $p = 0.035$). NPV and PPV of the AI were also significantly higher than the radiology report.

Conclusions

The AI algorithm showed a significantly higher diagnostic accuracy for the detection of PE on CTPA compared to the report of the attending radiologist. This finding indicates that missed positive findings could be prevented with the implementation of AI-assisted reporting in daily clinical practice.

View paper

MOUNT SINAI HOSPITAL

Initial Experience With an Artificial Intelligence System for Pulmonary Embolism Response Team Activation and Coordination in a Large Urban Health System

CARLON T., GOLDMAN D., KORFF R., WATCHMAKER J., MENDELSON D., LOOKSTEIN R.

Abstract for SIR 2023

Keywords: PERT, Accuracy

Materials & Methods:

All CT pulmonary angiograms between Jan. and Aug. 2022, were triaged using an AI-based automated PERT activation algorithm. AI PERT activation was based on the location of clot (central vs. peripheral) and CT evidence of right ventricular strain (RV to LV ratio greater than 1.0). A retrospective review was conducted of all institutional PERT activations over the same period.

Results

Pulmonary embolism was identified on 954 CT pulmonary angiograms, and the AI algorithm sent an automated PERT notification on 155 (16.2%) of these. The institutional PERT was formally activated for 121 patients, of whom 38 underwent at least one intervention beyond anticoagulation alone (three systemic thrombolysis, four surgical thrombectomy, six catheter-directed thrombolysis, 19 percutaneous thrombectomy, 15 inferior vena cava filter, and two ECMO). Thirty-two patients who initially presented to satellite facilities were transferred to a hospital with both endovascular and open cardiothoracic surgery capabilities. The sensitivity and specificity of the AI algorithm for identifying true PERT activations were 62.8% and 90.5% respectively. Among patients requiring transfer for possible intervention, sensitivity was 84.4% and specificity 88.1%. Among patients who underwent any intervention, sensitivity was 78.9% and specificity 86.4%. When catheter-directed intervention is considered separately, sensitivity and specificity were 95.8% and 85.8% respectively.

Conclusions

The system's initial experience demonstrates high sensitivity and specificity of the AI algorithm in identifying candidates for endovascular pulmonary embolism intervention despite poor correlation with PERT activations overall. Ongoing research will further assess the clinical benefits and optimal uses for this technology.

View conference

REDUCTION
IN LENGTH
OF STAY

CEDARS-SINAI MEDICAL CENTER

Decreased Hospital Length of Stay for ICH and PE After Adoption of an Artificial Intelligence-Augmented Radiological Worklist Triage System

PETRY M., LANSKY C., CHODAKIEWITZ Y., MAYA M., PRESSMAN B.

Published in Radiology Research and Practice 2022

Keywords: LoS, ICH, Outcomes, PE

Materials & Methods

A longitudinal interventional study assessing differences between length of stay (LoS) for inpatients diagnosed with ICH or PE before and after implementation of AI triage software (Aidoc). All patient non-contrast head computed tomography (CT) or CT chest angiogram (CTCA) procedures from April 2016 to April 2019 were included for ICH and PE. Three separate control groups were defined: (i) all remaining patients that underwent the designated imaging studies; (ii) patients diagnosed with hip fractures; and (iii) all hospital-wide encounters during the study period.

Results

ICH demonstrated an 11.9% (1.30 days) percentage decrease in LoS post-Aidoc implementation. PE demonstrated a 26.3% (2.07 days) percentage decrease in LoS post-Aidoc implementation. Control groups included all patients undergoing the same imaging, patients diagnosed with hip fractures (selected due to similar acuity and treatment-related factors), and all hospital-wide patient encounters. None of which showed clinically meaningful or significant decreases in length of stay.

Conclusions

The introduction of computer-aided triage and prioritization software into the radiological workflow was associated with a significant decrease in length of stay for patients diagnosed
with ICH and PE.

View paper

YALE NEW HAVEN HOSPITAL

Machine Learning and Improved Quality Metrics in Acute Intracranial Hemorrhage by Noncontrast Computed Tomography

DAVIS M., RAO B., CEDENO P., SAHA A., ZOHRABIAN V.

Published in Current Problems in Diagnostic Radiology 2022

Keywords: Clinical Outcomes, ICH, LOS, ED

Materials & Methods

A machine learning (ML) algorithm was incorporated across CT scanners at imaging sites in January 2018. Report turnaround time (RTAT) and length of stay (LoS) were derived for reports and patients between July 2017 and Dec. 2017, prior to implementation of ML, and compared to those between Jan.2018 and June 2018, after implementation of ML. A total of 25,658 and 24,996 ED and inpatient cases were evaluated across the entire healthcare system before and after ML, respectively.

Results

Inpatient LoS for positive cases decreased from 6.91 days to 6.16 days ($p>.05$). ED LoS decreased by 59.10 minutes, from 566.56 minutes to 507.56 minutes ($p<.001$).

Conclusions

The clinical application of an AI platform for the detection of ICH significantly decreased LoS, indicating that patients were efficiently triaged to the appropriate care.

View paper

EFFICIENCY GAINS AND IMPROVEMENTS IN TURNAROUND TIME

CEDARS-SINAI MEDICAL CENTER

Mechanical Thrombectomy, Artificial Intelligence and the Activation of a Pulmonary Embolism Response Team

GUPTA K., LIPSHUTZ G., FRIEDMAN O., ET AL.

Presented at PERT Consortium 2022

Keywords: Clinical Outcomes, LoS, PERT

Materials & Methods

Mechanical pulmonary arterial thrombectomies performed for acute PE and CT angiogram (CTA) were reviewed over a four-year period. The algorithm to directly notify PERT members was initiated in early 2022. The cohort was divided into pre-implementation and post-implementation groups. Time of CTA acquisition, time of notification of a clinical provider by the reading diagnostic radiologist, and time of thrombectomy were gathered and used to compare times to thrombectomy and time from imaging to notification of a clinical provider between the two groups. Clinical outcomes including hospital length of stay and ICU length of stay were collected.

Results

A total of 13 patients including six patients in the pre-implementation phase and seven patients in the post-implementation phase. Implementation of the algorithm was associated with a mean decrease in time from CT angiography to mechanical thrombectomy by 40% (17.1 hours vs. 10.1 hours) and time from imaging to notification of clinical provider by 38% (0.8 hours vs. 0.3 hours). Clinical outcomes showed a 23% (13 days vs. 10 days) reduction in the length of stay in the ICU and 18% (17 days vs. 14 days) in overall inpatient length of stay.

Conclusions

The use of an AI algorithm suggests a significant reduction in time from initial imaging to mechanical pulmonary arterial thrombectomy by screening CT angiograms and directly notifying a PERT of potential candidates.

View conference

UNIVERSITY OF ROCHESTER MEDICAL CENTER

The Effect of Artificial Intelligence-Based Intracranial Hemorrhage Detection on Study Turnaround Time for Emergent Care Non-Contrast Head CT – A Prospective Randomized Clinical Trial

STOCKMASTER L., CHUGHTAI KA., EDWARDS S., BRAHMBHATT AN., WEINBERG EP., WISMUELLER A.

Presented at RSNA 2019

Keywords: ICH, Read time, RCT, TAT

Materials & Methods

A total of 1,936 consecutive non-contrast head CT scans from two CT scanners used for inpatient and emergency room patients at a large academic hospital were prospectively acquired over 47 consecutive days. Study turnaround time (TAT) was measured automatically as the time difference between study completion time (=study accessible to radiologists for reporting) to study reporting time (=first report visible to clinicians, regardless of whether preliminary or final).

Results

A total of 381 ICH-AI+ cases were found, of which 190 cases were flagged. TATs for flagged cases (52 ± 25 min.) were significantly lower than TATs for non-flagged (82 ± 31 min.) cases ($p<0.05$, Wilcoxon signed-rank test).

Conclusions

Notifying radiologists on automatically detected ICH statistically significantly reduces TAT for reporting ICH to clinicians in emergency setting. Reduced TAT may expedite clinically indicated therapeutic interventions.

View conference

UNIVERSITY OF ROCHESTER MEDICAL CENTER

A Prospective Randomized Clinical Trial for Measuring Radiology Study Reporting Time on Artificial Intelligence-Based Detection of Intracranial Hemorrhage in Emergency Care CT

WISMÜLLER A., STOCKMASTER L.

Published in SPIE Medical Imaging 2020

Keywords: Efficiency, ICH, TAT

Materials & Methods

A total of 620 consecutive non-contrast head CT scans from CT scanners used for inpatient and emergency room patients at a large academic hospital. Immediately following image acquisition, scans were automatically analyzed for the presence of ICH using commercially available software (Aidoc). Cases Identified as positive for ICH by AI (ICH-AI+) were automatically flagged in the radiologists' reading worklists, where flagging was randomly switched off with a probability of 50%. Study turnaround time (TAT) was measured automatically as the time difference between study completion and first clinically communicated study reporting, with timestamps for these events automatically retrieved from various radiology IT systems.

Results

TATs for flagged cases (73 ± 143 min.) were significantly lower than TATs for non-flagged (132 ± 193 min.) cases ($p<0.05$, one-sided t-test), where 105 of the 122 ICH-AI+ cases were true positive reads. Total sensitivity, specificity, and accuracy over all analyzed cases were 95.0%, 96.7%, and 96.4%, respectively.

Conclusions

Automatic identification of ICH reduces study TAT for ICH in emergent care head CT settings and can improve clinical management of ICH by accelerating clinically indicated therapeutic interventions.

View paper

CEDARS-SINAI MEDICAL CENTER

AI Prescreening of Radiology CT Worklists can Improve Radiologist Read-Time Efficiency in Clinical Practice

CHODAKIEWITZ Y., MAYA M., PRESSMAN B.

Presented at ACR-AUR 2019

Keywords: Efficiency, ICH, Read time, Workflow

Materials & Methods

Radiological “read-times” were compared before and after institutional implementation of an AI-screening system for detecting intracranial hemorrhage (ICH) on CT brain scans. “Read-time” was defined as the time from when a radiological study was opened for viewing until either a finalized report or a wet read (whichever came first) was placed in the electronic medical record (EMR). Cases were collected from non-contrast CT brain cases ordered from the emergency department (ED) during equivalent seven-week pre-implementation and post-implementation time periods.

Results

Radiologist average “read-times” were reduced after AI-augmented system implementation (by 9% when including combined ICH positive and negative case; by 27% when considering just positive cases).

Conclusions

AI-assisted ICH detection can decrease average radiological read-time on CT-brain cases ordered from the ED, possibly through a psychological “urgency effect” or “validation effect” prompted by the AI-prescreen result.

View conference

UNIVERSITY OF TEXAS SOUTHWESTERN MEDICAL CENTER

Active Reprioritization of the Reading Worklist Using Artificial Intelligence has a Beneficial Effect on the Turnaround Time for Interpretation of Head CTs with Intracranial Hemorrhage

O'NEILL J., XI Y., STEHEL E., BROWNING T., NG Y., BAKER C., PESHOCK R.

Published in Radiology: Artificial Intelligence 2020

Keywords: ICH, Prioritization, TAT

Materials & Methods

The algorithm to flag abnormal non-contrast CT examinations for ICH was implemented in a busy academic neuroradiology practice. The algorithm was introduced in three places: (a) as a "pop-up" widget on ancillary monitors, (b) as a marked examination in reading worklists, and (c) as a marked examination for reprioritization based on the presence of the flag.

Results

A reduction in queue adjusted wait time was observed between negative (15.45 min.; 95% confidence interval [CI]: 15.07, 15.38) and positive (12.02 minutes; 95% CI: 11.06, 12.97; P<.0001) artificial intelligence ICH detected examinations with reprioritization. Reduced wait time was present for all order classes but was greatest for examinations ordered as routine for both inpatients and outpatients due to their low priority.

Conclusions

Implementation of an algorithm for the detection of intracranial hemorrhage on non-contrast enhanced head CTs into the clinical workflow reduced wait time and overall turnaround time when specifically used to prioritize examinations.

View paper

YALE NEW HAVEN HOSPITAL

The Clinical Impact of an Artificial Intelligence Tool on the Turnaround Time of Patients With Suspected Intracranial Hemorrhage

DAVIS M., RAO B., CEDENO P., SAHA A., ZOHRABIAN V.

Presented at RSNA 2019

Keywords: ICH, TAT

Materials & Methods

The artificial intelligence software platform was installed on CT scanners in two imaging sites across the health system. The software prospectively evaluated all CT head without contrast studies performed at these sites beginning Jan. 1, 2018. Turnaround time (TAT) was obtained for all imaging cases performed in emergency departments across the health system between Jan. 2018 and June 2018 and compared to imaging cases performed between July 2017 and Dec. 2017. 26,249 cases were evaluated in 2017 and 25,544 cases in 2018.

Results

TAT decreased from 53 minutes to 46 minutes for positive cases ($p<.001$).

Conclusions

Implementation of an algorithm for the detection of intracranial hemorrhage on non-contrast enhanced head CTs into the clinical workflow reduced wait time and overall turnaround time when specifically used to prioritize examinations.

View conference

LAHEY MEDICAL CENTER

Worklist Reprioritization Using Artificial Intelligence Improves Turnaround Times of Chest CT Examinations Positive for Acute Pulmonary Embolism

HARRISON B.

Presented at RSNA 2021

Keywords: PE, Incidental PE, TAT

Materials & Methods

A total of 4,069 CT chest with contrast scans performed at a tertiary care medical center between Oct. 2019 and Feb. 2020 were retrospectively identified (ED – 1,470, Inpatient - 667, Outpatient – 1,932). Positive cases were flagged by the AI algorithm and brought to the top of the radiology worklist. The remaining 1,327 scans were read according to their priority, with no AI prioritization. All 4,069 case reports were classified as positive or negative for pulmonary embolism using Natural Language Processing (NLP) on the radiology report to establish ground truth. The radiology turnaround time (RTAT) between positive and negative cases was compared for the cases that had AI result and cases that did not. RTAT was defined as the time difference between scan completion and report completion time.

Results

The average RTAT of positive pulmonary embolism (by NLP) cases that were analyzed by AI was 34.2 minutes, while the average RTAT of negative pulmonary embolism cases was 68.25 minutes. The difference between positive and negative cases of pulmonary embolism was 34.05 minutes (CI: 21.3275 to 46.7725 $P < 0.01$). The average RTAT of positive pulmonary embolism (by NLP) cases that were not analyzed by AI was 58.80 minutes while the average RTAT of negative incidental pulmonary embolism cases was 51.18 minutes. The difference between positive and negative cases of incidental pulmonary embolism was +7.62 minutes.

Conclusions

Using an AI algorithm that prioritizes cases with a positive pulmonary embolism, including incidentally detected pulmonary embolism, have a substantially shorter turnaround time when compared to negative cases.

View conference

UNIVERSITY OF CHICAGO

Implementation of Machine Learning Software on the Radiology Worklist Decreases Scan View Delay for the Detection of Intracranial Hemorrhage on CT

GINAT D.

Published in Brain Sciences 2021

Keywords: ICH, TAT

Materials & Methods

Cases analyzed by Aidoc software for triaging acute intracranial hemorrhage cases on non-contrast head CT were retrospectively reviewed. The scan view delay time was calculated as the difference between the time the study was completed on PACS and the time the study was first opened by a radiologist. The scan view delay was stratified by scan location, including emergency, inpatient, and outpatient. The scan view delay times for cases flagged as positive by the software were compared to those that were not flagged.

Results

A total of 8,723 scans were assessed by the software, including 6,894 cases that were not flagged and 1,829 cases that were flagged as positive. Although there was no statistically significant difference in the scan view time for emergency cases, there was a significantly lower scan view time for positive outpatient and inpatient cases flagged by the software versus negative cases, with a reduction of 604 min. on average, 90% in the scan view delay (p-value < 0.0001) for outpatients, and a reduction of 38 min. on average, and 10% in the scan view delay (p-value <= 0.01) for inpatients.

Conclusions

The use of artificial intelligence triage software for acute ICH on head CT scans is associated with a significantly shorter scan view delay for cases flagged as positive than cases not flagged among outpatients and inpatients at an academic medical center.

View paper

NETHERLANDS CANCER INSTITUTE (NKI)

Added Value of an Artificial Intelligence Tool for Prioritization of Incidental Pulmonary Embolism on Chest CT

TOPFF L.

Presented at RSNA 2022

Keywords: Accuracy, Discrepancies, iPE

Materials & Methods

A prospective study, assessing the AI software deployment in a clinical environment to analyze routinely acquired chest CT scans of adult oncology patients. Three time periods of 15 weeks each were compared: routine workflow without AI, manual triage without AI, and worklist prioritization with AI. Diagnostic accuracy of the tool was evaluated on both prospectively and retrospectively collected data. Temporal endpoints including Detection and Notification Times (DNT) were assessed.

Results

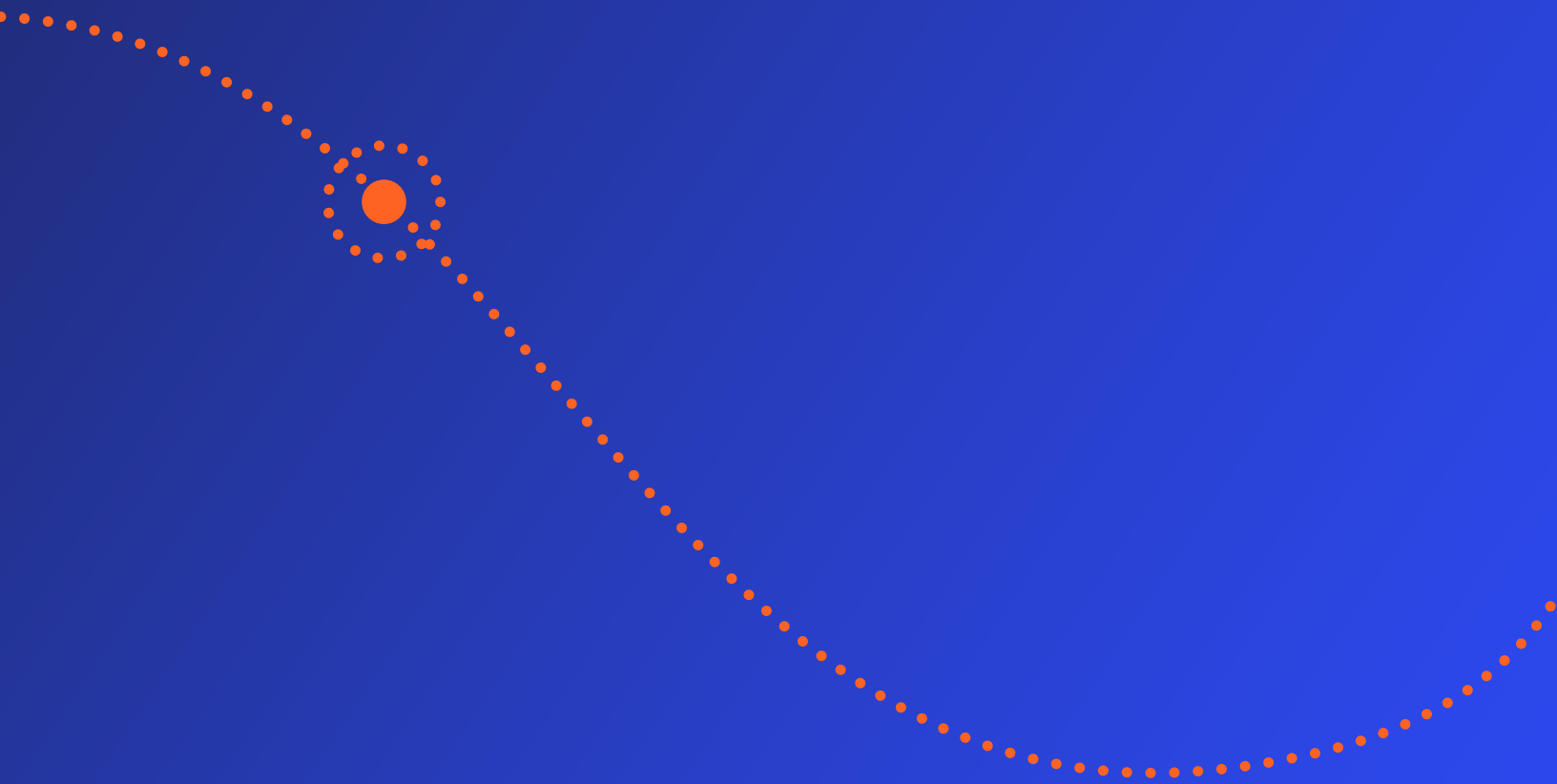
A total of 11,736 CT scans were evaluated. Prevalence of iPE was 1.2% (n=143). The AI software detected 131 TP, 12 FN, 31 FP, and 11,559 TN. Sensitivity was 91.6%, specificity 99.7%, NPV 99.9%, and PPV 80.9%. When applied retrospectively, the AI software found iPEs in 47 CTs (44.8%) that were missed in the radiology report. The median DNT for iPE positive examinations was 7,714, 4,973, 87 min. for the respective time periods. The difference in DNT between positive and negative CTs was largest when using AI assistance and was significantly different from both workflows without AI.

Conclusions

A commercially available AI tool was found to have a high diagnostic efficacy in detecting iPE on CT of oncology patients. AI assisted worklist prioritization was shown to be effective in significantly reducing the time to diagnosis of iPE cases compared to the routine clinical workflow.

View conference

SOLUTION ACCURACY



ENVISION HEALTHCARE

Man and Machine: Implications of an Artificial Intelligence Based Algorithm in the Detection of Pulmonary Embolism on Computed Tomography Angiography

JACOB A., DOAN B., GRANVILLE C.

Presented at the Society of Interventional Radiology (SIR) Conference 2022

Keywords: Accuracy, Discrepancies, PE

Materials & Methods

A retrospective study evaluated the diagnostic accuracy of AI-based detection of PE on CTA chest exams compared with diagnostic radiologists. CTA chest exams were collected using the AI algorithm. NLP assigned positive/negative results on each case per radiologist interpretation. Discordant cases were reviewed by three independent radiologists.

Results

1,281 consecutive CTPA chest exams over two weeks from July 2020. The performance of the AI was: sensitivity: 99% (CI: 94.6% - 100.0%); specificity: 99.3% (CI: 98.7% - 99.7%) and miss rate 0.1%. The performance of the unaided radiologist (no-AI) was: sensitivity: 86% (CI: 77.6% - 92.1%) specificity: 99.7% (CI: 99.3% - 99.9%) and miss rate 1.1%. The AI demonstrated a 14% enhanced detection rate compared to the un-aided (by AI) radiologist. The miss rate of the un-aided radiologist resulted in about one in seven PEs missed, of which 57% (8/14) were segmental.

Conclusions

The study demonstrates the benefit of the complementary performance of the radiologists plus AI is better than either party alone; standalone AI was superior to the standalone radiologist for sensitivity and how the opposite was true for specificity.

View summary

REGION HALLAND

Incidental Pulmonary Embolism in Patients With Cancer: Prevalence, Underdiagnosis and Evaluation of an AI Algorithm for Automatic Detection of Pulmonary Embolism

WIKLUND P., MEDSON K., ELF J.

Published in European Radiology 2022

Keywords: Accuracy, iPE

Materials & Methods

A retrospective cohort study assessing the prevalence of reported and unreported incidental pulmonary embolism (iPE) in patients with cancer were identified through automatic detection with an AI algorithm. All patients with cancer with an elective CT (chest and/or abdo) study, including the chest, between July 1, 2018 to June 30, 2019, were included and study reports and images were reviewed and processed by the AI algorithm.

Results

1,892 CT studies were included. Per study, iPE was present in 4.0% of the oncology population. 80% miss rate (53/65) showed a >400% enhanced detection rate by AI (53/12). Of those 58% (31/53) of the misses were lobar or segmental and 59% (13/22) of the subsegmental findings involved multiple vessels (i.e.: higher clinical significance than a solitary sub-seg finding). The sensitivity 90.7%, specificity 99.8%, PPV 95.6%, NPV 99.6%.

Conclusions

In a retrospective single-center study on patients with cancer, unreported iPE were common, with the majority lying proximal to the subsegmental arteries. The evaluated AI algorithm had very high sensitivity and specificity, so it has the potential to increase the detection rate of iPE.

View paper

UNIVERSITY OF WASHINGTON MEDICINE

The Utility of Deep Learning: Evaluation of a Convolutional Neural Network for Detection of Intracranial Bleeds on Non-Contrast Head Computed Tomography Studies

OJEDA P., ZAWAIDEH M., MOSSA-BASHA M., HAYNOR D.

Published in SPIE Medical Imaging 2019

Keywords: Accuracy, ICH

Materials & Methods

The algorithm was tested on 7,112 non-contrast head CTs acquired during 2016–2017 from two large, urban academic and trauma centers.

Results

Promising results of a scalable and clinically pragmatic AI model tested on a large set of real-world data from high-volume medical centers. Results showed a 98% level of accuracy, with 95% sensitivity and over 98% specificity.

Conclusions

The AI algorithm had high levels of accuracy (98%), sensitivity (95%) and over 98% specificity (98%)

View paper

CEDARS-SINAI MEDICAL CENTER

Prescreening for Intracranial Hemorrhage on CT Head Scans with an AI-Based Radiology Workflow Triage Tool: An Accuracy Study

CHODAKIEWITZ Y., MAYA M., PRESSMAN B.

Published in Journal of Medical Diagnostic Methods 2019

Keywords: Accuracy, ICH

Materials & Methods

A retrospective dataset of 533 non-contrast head CT scans was collected from a large, urban tertiary academic medical center. Following convention for studies evaluating sensitivities and specificities of imaging computer-aided detection and diagnosis devices, a prevalence-enriched dataset was utilized such that a 50% prevalence of intracranial hemorrhage was obtained. The algorithm was run on the dataset. Cases flagged by the algorithm as positive for ICH were defined as “positive”, and the rest as “negative.” The results were compared to the ground truth, determined by a neuroradiologist review of the dataset.

Results

Algorithm sensitivity was 96.2% (CI: 93.2%-98.2%); specificity was 93.3% (CI: 89.6-96.0%). Estimated real-world NPV was determined as at least 96.2% (CI: 93.2%-97.9%), and an estimated upper threshold for PPV was estimated as 93.4% (CI: 90.1%-95.7%).

Conclusions

The tested device detects ICH with high sensitivity and specificity. The potential utility of using the device may be to autonomously surveil radiology worklists for studies containing critical findings and triage a busy workflow, ultimately improving patient care in clinically time-sensitive cases.

View paper

UNIVERSITY HOSPITAL OF BASEL

Automated Detection of Pulmonary Embolism in CT Pulmonary Angiograms Using an AI-powered Algorithm

WEIKERT T., WINKEL D., BREMERICH J., STIELTJES B., PARMER V., SAUTER A., SOMMER G.

Published in European Radiology 2020

Keywords: Accuracy, PE

Materials & Methods

Retrospective identification of all CTPAs conducted in 2017 (n=1,499). Exams with clinical questions other than PE were excluded from the analysis (n=34). The remaining exams were classified into positive (n=232) and negative (n=1,233) for PE based on the final written reports, which defined the reference standard. The fully anonymized 1-mm series in soft tissue reconstruction served as input for the PE detection prototype algorithm that was based on a deep convolutional neural network comprising a Resnet architecture. It was trained and validated on 28,000 CTPAs acquired at other institutions.

Results

The algorithm correctly identified 215 of 232 exams positive for pulmonary embolism (sensitivity 92.7%; 95% confidence interval [CI] 88.3–95.5%) and 1,178 of 1,233 exams negative for pulmonary embolism (specificity 95.5%; 95% CI 94.2–96.6%). On a per finding level, 1,174 of 1,352 findings marked as embolus by the algorithm were true emboli. Most of the false positive findings were due to contrast agent–related flow artifacts, pulmonary veins, and lymph nodes.

Conclusions

The AI solution can automatically detect PE cases including a high sensitivity of 92.7% in identifying positive exams for PE and a high specificity of 95.5% in identifying negative PE exams.

View paper

ANTWERP UNIVERSITY HOSPITAL

Detection of Intracranial Hemorrhage on CT of the Brain Using a Deep Learning Algorithm

DESBUQUOIT D., DEKEYZER S., HUYSKENS J., NICOLAY S., DE SMET E., VAN GOETHEM J., VAN DEN HAUWE L., PARIZEL P.

Presented at ECR 2019

Keywords: Accuracy, ICH

Materials & Methods

500 non-contrast enhanced CTs of the brain performed in June, July and Aug. 2018 were independently analyzed on the presence of pathological hyperdensities by a deep learning software package and a fourth-year radiology resident. Their results were compared to a "gold standard analysis," performed by a senior neuroradiologists.

Results

Pathological hyperdensities were present in 134/500 patients, the majority of which were hemorrhages (128/134; 95.5%). Pathological hyperdensities were correctly identified by Aidoc software in 125/134 cases (93.3%), compared to 133/134 (99.3%) for the resident. Aidoc's false-negative ratio was 9/134 (6.7%). When no pathological hyperdensities were present, the exam was rated negative by Aidoc software in 345/366 cases (94.3%), compared to 362/366 (98.9%) for the resident. Aidoc's false-positive ratio was 21/366 (5.7%). The use of a deep learning algorithm for the detection of pathological intracranial hyper densities helped to detect urgent cases more quickly.

Conclusions

The AI prototype algorithm has a high degree of diagnostic accuracy for the detection of hyperdensities on CT. Sensitivity and specificity are balanced, which is a prerequisite for its clinical usefulness.

View abstract

UNIVERSITY HOSPITAL OF BASEL

Evaluation of an AI-Based Detection Software for Acute Findings in Abdominal Computed Tomography Scans: Toward an Automated Work List Prioritization of Routine CT Examinations

WINKEL D., HEYE T., WEIKERT T., BOLL D., STIELTJES B.

Published in Investigative Radiology 2019

Keywords: Abdominal Free Gas, Accuracy, Prioritization

Materials & Methods

Using a RIS/PACS (Radiology Information System/Picture Archiving and Communication System) search engine, 100 consecutive abdominal CTs were obtained with at least one of the following findings: free-gas, free-fluid, or fat-stranding, and 100 control cases were obtained with absence of these findings. The CT data were analyzed using a convolutional neural network algorithm previously trained for detection of these findings on an independent sample.

Results

Overall, the algorithm achieved a 93% sensitivity (91/98, seven false-negative) and 97% specificity (93/96, 3 false-positive) in the detection of acute abdominal findings.

Conclusions

The algorithm's autonomous detection of acute pathological abdominal findings demonstrated a high diagnostic performance, enabling guidance of the radiology workflow toward prioritization of abdominal CT examinations with acute conditions.

View paper

YALE NEW HAVEN HOSPITAL

Automated Detection of Intracranial Proximal Vessel Occlusion on Computed Tomography Angiography

KHUNTE A., WU X., IKUTA I., PAYABVASH S., MALHOTRA A.

Presented at ASNR 2020

Keywords: Accuracy, LVO

Materials & Methods

A retrospective review of 243 stroke cases from the institutional stroke database was performed — including 105 known proximal LVOs-Internal Carotid artery (ICA) and Proximal MCA (M1) occlusions — and confirmed on conventional angiography. Another cohort of 138 consecutive patients undergoing CTA in the month of Aug. 2019 were included as controls for analysis.
The algorithm results for the second cohort were compared with the radiologist reads.

Results

The total cohort of 243 patients included 105 patients with an LVO. The algorithm showed sensitivity of 92.3% and specificity of 94.9% for detecting M1 and ICA occlusions.

Conclusions

The automated algorithm has tremendous potential in the emergency setting as a screening tool to expedite formal diagnosis and improve workflow.

View abstract

YALE NEW HAVEN HOSPITAL

Use of an Artificial Intelligence Algorithm to Detect Pulmonary Embolus

BADER S., TOCINO I., KHAN I., CORTOPASSI I.

Presented at STR 2020

Keywords: Accuracy, PE

Materials & Methods

An artificial intelligence (AI) algorithm was applied to a retrospective cohort of 1,387 consecutive CT pulmonary angiograms performed at a large academic institution between Jan. 21 and April 28, 2019. Natural language processing (NLP) of the cohort reports was used to identify if PE was present. Discrepant cases between the algorithm and NLP results were reviewed by three board-certified thoracic radiologists and the emboli called in error were graded based on location. Quality of contrast bolus and respiratory motion were also graded.

Results

The prevalence of PE was 13.6% (189 cases). The algorithm was 93% sensitive and 96% specific in the detection of PE. The positive predictive value was 77% and the negative predictive value was 99%.

Conclusions

The AI algorithm was sensitive and specific in the detection of PE on CTPA. The high negative predictive value suggests this algorithm has the potential of becoming a screening tool to aid expedite diagnosis and appropriate management of patients with pulmonary embolism.

View conference

ALFRED HEALTH

Clinical use of Aidoc “Always On AI”: Does it Help Increase Radiologists’ Efficiency and Improve Patient Care?

RATNAKANTHAN P., ET AL.

Presented at RANZCR 2020

Keywords: Accuracy, ICH, Prioritization

Materials & Methods

The FDA-cleared ICH-detection AI solution, based on a convolutional neural network, analyzed all technically adequate CT brain exams performed at Alfred Health between Oct. 2019 and Nov. 2019. An independent radiologist retrospectively second-read all CT scans and reports in this timeframe to confirm ICH presence. The independent radiologist then reviewed the output of the AI solution for True/False-Positives/Negatives.

Results

1,269 CT brain scans were analyzed by the AI solution. The independent radiologist confirmed that 184 were ICH-positive and 1,085 were ICH-negative. The sensitivity and specificity of the AI solution were 90.8% (n=167 TP) and 97.2% (n=1,055 TN), respectively. The PPV and NPV were 84.8% and 98.4%, respectively.

Conclusions

The AI solution has high sensitivity, specificity and PPV and helps drive the prioritization of positive cases, in turn leading to increased efficiency and reliability. Increased efficiency in prioritization of positive cases has been shown to improve patient outcomes.

View conference

MASSACHUSETTS GENERAL HOSPITAL

Predictive Values of AI-based Triage Model in Suboptimal CT Pulmonary Angiography

EBRAHIMIAN S., DIGUMARTHY SR., HOMAYOUNIEH F., BIZZO BC., DREYER K., KALRA MK.

Published in Clinical Imaging 2022

Keywords: Accuracy, PE, Suboptimal Imaging

Materials & Methods

In an IRB-approved retrospective study, 104 consecutive, suboptimal CTPA, which were deemed as suboptimal for PE evaluation in radiology reports due to motion, artifacts and/or inadequate contrast enhancement, were identified. The dataset was enriched with an additional 226 optimal CTPA (over same timeframe as suboptimal CTPA) with and without PE. Two thoracic radiologists (ground truth) independently reviewed all 330 CTPA for adequacy (to assess PE down to distal segmental level), reason for suboptimal CTPA (artifacts or poor contrast enhancement), as well as for presence and location of PE. CT values (HU) were measured in the main pulmonary artery. The same attributes were assessed in 80 patients who had repeat or follow-up CTPA following suboptimal CTPA. All CTPA were processed with the PE-AI (Aidoc).

Results

Among 104 suboptimal CTPA (mean age ± standard deviation 56 ± 15 years), 18/104 (17%) were misclassified as suboptimal for PE evaluation in the radiology reports but relabeled as optimal on ground truth evaluation. Of 226 optimal CTPA, 47 (21%) were reclassified as suboptimal CTPA. PEs were present in 97/330 CTPA. PE-AI had similar performance on suboptimal CTPA (sensitivity 100%; specificity 89%; AUC 0.89, 95% CI 0.80–0.98) and optimal CTPA (sensitivity 96%; specificity 92%; AUC 0.87, 95% CI 0.81–0.93).

Conclusions

Suboptimal CTPA examinations do not impair the performance of PE-AI triage model; AI retains clinically meaningful sensitivity and high specificity regardless of diagnostic quality.

View paper

IMADIS TELERADIOLOGY

How Artificial Intelligence Improves Radiological Interpretation in Suspected Pulmonary Embolism

CHEIKH AB., GORINCOUR G., NIVET H., MAY J., SEUX M., CALAME P., THOMSON V., DELABROUSSE E., CROMBE A.

Published in European Radiology 2022

Keywords: Accuracy, PE, Teleradiology

Materials & Methods

A retrospective multicentric study including patients with suspected PE from Sept. to Dec. 2019 (i.e., during a preliminary evaluation period of an approved AI algorithm). CTPA quality and conclusions by emergency radiologists were retrieved from radiological reports. The gold standard was a retrospective review of CTPA, radiological and clinical reports, AI outputs, and patient outcomes. Diagnostic performance metrics for AI and radiologists were assessed in the entire cohort and depending on CTPA quality.

Results

1,202 patients were included. PE prevalence was 15.8% (190/1202). The AI algorithm detected 219 suspicious PEs, of which 176 were true PEs, including 19 true PEs missed by radiologists. In the cohort, the highest sensitivity and negative predictive values (NPVs) were obtained with AI (92.6% vs. 90% and 98.6% vs. 98.1%, respectively), while the highest specificity and positive predictive value (PPV) were found with radiologists (99.1% vs. 95.8% and 95% vs. 80.4%, respectively). Accuracy, specificity, and PPV were significantly higher for radiologists except in subcohorts with poor-to-average injection quality. Radiologists positively evaluated the AI algorithm to improve their diagnostic comfort (55/79 [69.6%]).

Conclusions

The AI algorithm showed excellent performance in diagnosing PE on CTPA (sensitivity and specificity 92.6% and 95.8%; accuracy ≥ 95%) and increased the sensitivity and NPV of emergency radiologists in clinical practice, especially in cases of poor-to-moderate injection quality.

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NETHERLANDS CANCER INSTITUTE (NKI)

Artificial Intelligence Tool for Detection and Worklist Prioritization Reduces Time to Diagnosis of Incidental Pulmonary Embolism at CT

TOPFF L., RANSCHAERT ER., BARTELS-RUTTEN A., NEGOITA A., MENEZES R., BEETS-TAN RGH., JACOB J., VISSER JJ.

Published in Radiology: Cardiothoracic Imaging 2023

Keywords: Accuracy, iPE, Wait time, Turn around time

Materials & Methods

In this study with historical controls and prospective evaluation, regulatory-cleared AI software was evaluated to prioritize iPE on routine chest CT scans with intravenous contrast agent in adult oncology patients. Diagnostic accuracy metrics were calculated, and temporal end points, including detection and notification times (DNTs), were assessed during three time periods (April 2019 to Sept. 2020): routine workflow without AI, human triage without AI, and worklist prioritization with AI.

Results

In total, 11,736 CT scans in 6,447 oncology patients (mean age, 63 years ± 12 [SD]; 3,367 men) were included. Prevalence of iPE was 1.3% (51 of 3,837 scans), 1.4% (54 of 3,920 scans), and 1.0% (38 of 3,979 scans) for the respective time periods. The AI software detected 131 true-positive, 12 false-negative, 31 false-positive, and 11,559 true-negative results, achieving 91.6% sensitivity, 99.7% specificity, 99.9% negative predictive value, and 80.9% positive predictive value. During prospective evaluation, AI-based worklist prioritization reduced the median DNT for iPE-positive examinations to 87 minutes (vs. routine workflow of 7,714 minutes and human triage of 4,973 minutes). Radiologists' missed rate of iPE was significantly reduced from 44.8% (47 of 105 scans) without AI to 2.6% (one of 38 scans) when assisted by the AI tool ($P < .001$).

Conclusions

AI-assisted workflow prioritization of IPE on routine CT scans in oncology patients showed high accuracy and significantly shortened the time to treatment in a setting with a backlog of examinations.

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UNIVERSITY OF TEXAS SOUTHWESTERN MEDICAL CENTER

Radiologist Worklist Reprioritization Using Artificial Intelligence: Impact on Report Turnaround Times for CTPA Examinations Positive for Acute Pulmonary Embolism

BATRA K., XI Y., BHAGWAT S., ESPINO A., PESHOCK RM.

Published in American Journal of Roentgenology 2023

Keywords: Accuracy, PE, Wait time, Turn around time

Materials & Methods

This retrospective single-center study included patients who underwent CTPA before (between Oct. 1, 2018 and March 31, 2019; pre-AI period) and after (between Oct. 1, 2019 and March 31, 2020; post-AI period) implementation of an AI tool that reprioritized CTPA examinations to the top of radiologists' reading worklist if detecting acute PE. EMR and dictation system timestamps were used to determine examinations' wait time (time from examination completion to report initiation), read time (time from report initiation to report availability), and report turnaround time (sum of wait and read times). Times for reports positive for PE, using final radiology reports as reference, were compared between periods.

Results

The study included 2,501 examinations in 2,197 patients (mean age, 57.4±17.0 years years; 1,307 women, 890 men), including 1,166 and 1,335 examinations from pre-AI and post-AI period, respectively. For PE-positive examinations, post-AI period, compared to pre-AI period, showed significantly shorter mean report turnaround time [47.6 vs 59.9 minutes; mean difference, 12.2 minutes (95% CI, 0.6-26.0 minutes)] and mean wait time [21.4 vs 33.4 minutes; mean difference, 12.0 minutes (95% CI, 0.9-25.3 minutes)]. During regular operational hours, wait time was significantly shorter in post-AI than pre-AI period for routine-priority examinations [15.3 vs 43.7 minutes; mean difference, 28.4 minutes (95% CI, 2.2-64.7 minutes)].

Conclusions

AI-driven worklist reprioritization yielded reductions in report turnaround time and wait time for PE-positive CPTA examinations.

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ATLANTIC HEALTH SYSTEM

Assessing the Impact of AI-Based Prioritization and Triage of Positive non-CTPAs on Wait Time in the Outpatient Setting

KLEIN D., PHAM K.

Abstract for ATS 2023

Keywords: PE, Wait time

Materials & Methods

Consecutive scan data of patients undergoing enhanced chest CT (non-CTPA) or abdominal CT scans were collected between Jan. 2021 and Sept. 2022. A wait time metric was calculated for AI-notified cases with suspected positive incidental PE findings and compared to negative, not AI-notified cases. Wait time was defined as the difference between the time of study acquisition completion to the time a radiologist opens the case for report dictation. The median wait times were calculated for the positive and negative cases across the outpatient (OP) setting.

Results

A total of 11,727 OP cases were collected. AI triggered notifications for suspected incidental PE were sent for 0.33% (37/11,727) of OP cases. The median wait time for OP patients was 89 minutes (IQR:1,280) for positive cases compared to 952 minutes (IQR: 3,354) for negative cases. An observed median OP wait time reduction of 90% (863 minutes) was statistically significant (p=0.021).

Conclusions

The AI prioritization of suspected PE cases on non-CTPAs in the outpatient population resulted in a significant reduction on wait time. Active prioritization of the worklist in the outpatient setting has the potential to improve radiologist prioritization and facilitate treatment intervention.

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AI CASE STUDY

MIDDLESEX HOSPITAL

Introducing Artificial Intelligence Applications at Our Community Hospital: A Contrarian Approach

JAIN R.

Published in JACR 2021

Keywords: Case Study, Community Hospital, ICH, PE, LVO

The Problem

With artificial intelligence (AI), the challenge was which applications should be introduced first to get all the stakeholders (health system administrators, patients, clinicians and radiologists) interested in the AI culture and maintain their enthusiastic support.

The Solution

We found three FDA-cleared AI solutions available in the marketplace that aligned with three clinical situations we wanted to improve. These included long acquisition time for PET/CT and MRI scans, and long wait times for the radiologist's report on critical CT findings.

Outcomes and Limitations

AI for flagging the emergency department cases for ICH, PE, and LVO was introduced. Three months of validation of the AI software took place, with false-negative rate as the primary method of validation. No false-negative cases were found during the validation phase. A very small subdural ICH identified by the AI software may have been missed by the radiologist. The accuracy of the algorithms for PE and LVO is extremely high, and AI excels in identifying PE in the small vessels.

Conclusions

Relatively small subdural ICH identified by the AI software may have been missed by the radiologist. The accuracy of the algorithms for PE and LVO is extremely high, and AI excels in identifying PE in the small vessels.

View abstract


AI AT
SCALE

UNIVERSITY OF ROCHESTER MEDICAL CENTER

Evaluation of a Large-Scale Multi-Year AI Rollout in an Academic Radiology Department.

WISMULLER A., ET AL.

Presented at RSNA 2022

Keywords: AI at Scale, Deployment

Materials & Methods

Key analytics, trends, and milestones that are critical for a successful rollout of AI at scale in a large academic radiologist department were extracted from our department. The study provides a set of guidelines applicable to help other institutions for metrics and best practice for monitoring of AI.

Results

During this time period, the use of AI grew from two pathologies/modules to a total of nine pathologies/modules, deployed throughout the hospital system. Monthly analyzed cases grew from 1,687 cases/month to 18,307 cases/month over a period of 30 months. The total number of active users, defined as a user who received a prioritization alert, grew from 50+ users to 150+ from Jan. 2021 to June2021.

Over 18% of monthly studies were analyzed by two or more AI modules during advanced deployment. The trend showed the added value of scaling up AI on multiple pathologies of common anatomical regions. A key shift occurred when the LVO module was activated around Jan. 2021. An example of a multi-module use case is a head CT protocol containing both CTA and non-contrast CT series analyzed for LVO, BA and ICH,

Conclusions

Our case study may provide insights and value to other radiology practices and hospital systems as a basis for defining best practice guidelines.

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MULTI-SITE CONSORTIUM

Early-Stage COVID-19 Pandemic Observations on Pulmonary Embolism Using Nationwide Multi-Institutional Data Harvesting

WISMULLER A., DSOUZA A., ABIDIN A., ET AL.

Published in Nature Digital Medicine 2022

Keywords: Accuracy, Covid-19, PE

Materials & Methods

A multi-institutional data harvesting (MIDH) method for retrospective, longitudinal observation of medical imaging utilization and reporting for computed tomography pulmonary angiograms (CTPA) (n=40,037) was conducted across 13 academic sites. Compared two, 70-day observational periods, namely (i) a pre-pandemic control period from Nov. 25, 2019 to Feb. 2, 2020, and (ii) a period during the early COVID-19 pandemic from March 8, 2020 through May 16, 2020. Natural language processing (NLP) on final radiology reports served as the ground truth for identifying positive PE cases.

Results

Fewer CTPA exams were performed during the early COVID-19 pandemic than during the pre-pandemic period (9,806 vs. 12,106). The PE positivity rate was significantly higher during the early COVID-19 pandemic than during the pre-pandemic period (11.6 vs. 9.9%, $p < 10-4$). NLP accuracy of 98% based on a manual review of 2,400 radiology reports

Conclusions

The positivity of PE was significantly higher during the COVID era and fewer CTPA exams were performed. This MIDH method showed the successful scalability and ability of the Aidoc solution to overcome typical challenges of multi-institution data silos while maintaining a high level of accuracy in PE classification.

View paper

MULTI-SITE CONSORTIUM

Tracking the Impact of Global Iodinated Contrast Agent Shortage on Radiology in the United States - Nationwide Multi-Institutional Data Analysis of CT Exam Volumes at 13 Major Healthcare Systems

WISMUELLER A., GANGE C., BATRA K., VOSOUGHI A., ABBARA S., STOCKMASTER L., GARCIA GM., Y. XI Y., KLIGERMAN SJ.

Abstract for ECR 2023

Keywords: Covid-19, PE

Materials & Methods

Using repurposed software infrastructure of an AI-based image analysis vendor (Aidoc), we analyzed daily volumes of radiology service request data for 243,203 Computed Tomography (CT) exams from 13 U.S. healthcare systems before and during the recent global iodinated contrast agent shortage (April 1, 2022 through July 1, 2022), namely 34,781 CT pulmonary angiography exams, 52,465 non-angiography contrast-enhanced thoracic CT exams, and, for comparison, 155,957 non-contrast head CT exams. Specifically, we compared two observational periods, namely (i) a pre-shortage control period, April 14, 2022 through May 5, 2022, and (ii) a contrast shortage period, May 21, 2022 through June 11, 2022. Descriptive statistics using a percentage change metric of case volumes were calculated, where we report relative changes of daily sevenday moving averages relative to a baseline measurement period from April 1, 2022 through April 14, 2022. Observational periods were compared for statistical significance using Welch's unequal variances t-test.

Results

Case volumes of contrast-enhanced CT scans dropped significantly from baseline during the contrast agent shortage period, by 25.1% ± 6.6% for non-angiography contrast-enhanced thoracic CT exams, and 19.1% ± 1.4% for CT pulmonary angiography exams, respectively ($p<10^{-4}$). For comparison, non-contrast head CT volumes dropped by only 0.6% ± 2.7%, with no significant difference between pre-shortage and shortage periods.

Conclusions

Results suggest a significant reduction of contrast-enhanced chest CT exams in the participating 13 U.S. healthcare systems during the observed global contrast agent shortage period, where CT pulmonary angiography exams were slightly less affected than other nonangiography chest CT studies, such as cancer follow-up exams. The difference may be related to the perceived clinical urgency of CT pulmonary angiography exams.

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ABOUT AIDOC

Aidoc is a pioneering force in clinical AI. We focus on aiding and empowering healthcare teams to optimize patient treatment, which results in improved economic value and clinical outcomes.

Since 2016, Aidoc's clinically proven AI solutions have eliminated silos, increased efficiencies and improved outcomes by delivering critical information when and where care teams need it – leading to immediate collective action.

Powered by Aidoc's exclusive aiOS™, we analyze and aggregate medical data to enable care teams to operationalize the unexpected and work seamlessly with a continued focus on the patient.

Used in more than 1,000 medical centers worldwide, Aidoc has the most FDA clearances (13) in clinical AI and its AI-based solutions cover 75 percent of patient populations, enabling physicians to make informed decisions based on real-time data.

Aidoc AI is always on, running in the background to change the foreground.

Learn how the power of AI can impact your facility

Aidoc.com

This paper presents a body of research conducted using Aidoc's solution, with some assessing products and use cases that are currently under R&D or investigational use only. For information on Aidoc's cleared products indications for use; safe and correct usage and risk information, please refer to Aidoc's 510(k) premarket notifications on the FDA's website and to the product's User Guide.