Summer Training at

CARPL.ai Pvt. Ltd., Delhi
(Mahajan Imaging Pvt. Ltd.)

(April 4th to June 30th, 2022)

RETURN ON INVESTMENT FOR A CASE OF BUYING MEDICAL IMAGING AI

A Report by

Dr.Diya Gouchwal

PGDM (Hospital and Health Management)

2021-2023

International Institute of Health Management Research, New Delhi

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(Acknowledgement)

A summer training programme is a fantastic way to learn and grow as a person. I think of myself as fortunate for having been provided with an opportunity to undergo my summer training at **CARPL.ai Pvt. Ltd**. (Mahajan Imaging).
I owe a debt of gratitude to all of the specialists at CARPL.ai Pvt. Ltd. for sharing generously their valuable insight and precious time which motivated me to do my best during summer training.
A successful project is a combination of our efforts, encouragement, and guidance from the experienced people. I express my acknowledge and extend heartfelt recognition to the following individuals, who made the project possible,
I am grateful to CEO of CARPL.ai Pvt. Ltd., **Dr.Vidur Mahajan** & CMO, **Dr.Vasanth Venugopal** for allowing me to conduct my study in their organization.
I'd like to thank **Dr.Varsha Misra** (Commercial & Strategic Lead) - Reporting Manager for her active cooperation and support as this study could not have been possible without her constant support and mentoring. My learning and data collection regarding summer internship report would not have been possible without in depth discussions with her.
I'd want to thank everyone who has helped me thus far. **Kabita Dash** (Engineering Manager) , **Dr.Bhanushree Bahl** (Senior Analyst – Operations & Strategy), **Shivam Pundir** (Strategic Business Lead), **Himallaya Sharma** (Administration Manager), **Dr.Khushboo Arora** (Business Analyst – Operations & Strategy) , **Pipladh Arora** (Business Analyst – Operations & Strategy) for their continuous guidance, who inspite of being busy with their duties, took time to hear and guide me. Throughout the Internship Tenure, they provided valuable counsel and critical feedback.
Without the help and guidance of knowledgeable individuals, no endeavour at any level can be performed properly. All of the specialists at CARPL.ai Pvt. Ltd. owe me a huge debt of gratitude for freely sharing their expertise and time, which pushed me to perform my best during my summer training. Thank you to everyone on the incredible team.
I am highly grateful to Mentor in IIHMR **Prof. Divya Aggarwal** (Associate Dean- Admissions, Accreditations and Marketing) for giving me this opportunity to learn and to add to my experience. It would not have been feasible to do my research and finish my training without her help and direction.
I would also like to thank my beloved parents for their un-conditional love and immense support throughout the journey of our life.
I extend my sincere love and thanks to my beautiful friend **Dr. Aarushi Khosla** for her moral support.
Thank you for being a part of this with me.
Sincerely,

Dr.Diya Gouchwal
June'2022

(Completion of Summer Internship from CARPL.ai Pvt. Ltd.)

The certificate is awarded to

Dr.Diya Gouchwal

In honour of her successful completion of her Internship at

CARPL.ai Pvt. Ltd.

And has successfully completed her Project on

Return on Investment for a case of buying Medical Imaging AI

From 4th April, 2022 to June 30th, 2022

(04-04-2022 to 30-06-2022)

She comes out as a dedicated, honest, and hardworking individual with a great desire to learn.

We wish her the best of luck in her future endeavours.

Organization Supervisor
Dr.Vidur Mahajan (Chief Executive Officer)

Head-HR/Department Head
Kabita Dash (Engineering Manager)

(Certificate of Approval)

(Certificate of Approval)

The Summer Internship Project of titled **"Return on Investment for a case of buying Medical Imaging AI"** at **"CARPL.ai Pvt. Ltd. (Mahajan Imaging)"** is hereby approved as a certified study in management carried out and presented in a manner satisfactorily to warrant its acceptance as a prerequisite for the award of **PGDM (Hospital and Health Management)** for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed, or conclusion drawn therein but approve the report only for the purpose it is submitted.

Dr. Aggarwal

Prof. Divya Aggarwal
Associate Dean- Admissions, Accreditations and Marketing
IIHMR, Delhi

FEEDBACK FORM

(Organization Supervisor)

Name of the Student: **Dr.Diya Gouchwal**

Summer Internship Institution: **CARPL.ai Pvt. Ltd. (Mahajan Imaging)**

Area of Summer Internship: **AI in Medical Imaging**

Attendance: **100%**

Objectives met:

- **AI ecosystem in Imaging**
- **AI- Onboarding**
- **Deployment**

Deliverables:

- **Business case Identification**
- **Learning of AI Algorithm**
- **ROI in case of buying medical Imaging AI**
- **Onboarding & Deployment**
- **CARPL Analytics Platform**
- **PaaS as an offering for US Academic Institutions –Relationship Building**
- **R&D**- AI Algorithm Directory, AI Bible, AI Marketplaces, AI in Radiology, Prices Worldwide, & Non-FDA approved AI companies.

Strengths:

- **Task completed with desired dedication & diligence in a time bound manner**
- **Sincere & Dedicated**
- **Displays Good Analytical Skills**

Suggestions for Improvement:

More involvement with Technical Team

DocuSigned by:
Varsha Misra
1560C0B8E9874E0...

Signature of the Officer-in-Charge (Internship)
Dr.Varsha Misra (Commercial & Strategic Lead)

Date: 17th June'2022
Place: New Delhi

INTERNSHIP COMPLETION CERTIFICATE
(CARPL.ai Pvt. Ltd.)

CARPL.AI Private Limited
Reg. Address: K-18, Hauz Khas Enclave, New Delhi - 16
Off. Address: C6/8, 3rd Floor, SDA, New Delhi - 16
GSTIN: 07AALCM8162B1ZG | PAN: AALCM8162B
CIN: U73100DL2018PTC333492 | info@carpl.ai

June 29, 2022

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Dr. Diya Gouchwal, D/o Mr. Dalbir Singh a student of International Institute of Health Management Research, Dwarka pursuing PGDM in Hospital & Health Management has undergone internship at CARPL.ai as Clinical BA Intern for the period from April 04, 2022 to June 29, 2022.

We wish her all the best!

For CARPL.ai Private Limited

(Kabita Rani Dash)

Engineering Manager

FEEDBACK FORM
(IIHMR Mentor)

FEEDBACK FORM

(IIHMR MENTOR)

Name of the Student: Dr. DIYA GOUCHWAL

Summer Internship Institution: CARPL.ai (Mahajan Imaging Pvt. Ltd.)

Area of Summer Internship: AI in Medical Imaging

Attendance: 100 %

Objectives met: YES

Deliverables:
→ Weekly progress review
→ Synopsis Preparation
→ Final Report

Strengths:
→ Strong analytical skills.
→ Detail-oriented.

Suggestions for Improvement: Need to work on her confidence level.

Jisa Aggarwal
Signature of the Officer-in-Charge (Internship)

Date: June 17, 2022
Place: DELHI

(Acronyms/Abbreviations)

Sl. No.	Abbreviations	Full Form
1	AI	Artificial Intelligence
2	ML	Machine Learning
3	RIS	Radiological Information system
4	DICOM	Digital Imaging & Communications in Medicine
5	CXR	Chest X-RAY
6	ROI	Return on Investment
7	Rads.	Radiologists

Section 1: Observational Learning

INTRODUCTION

About the Organization

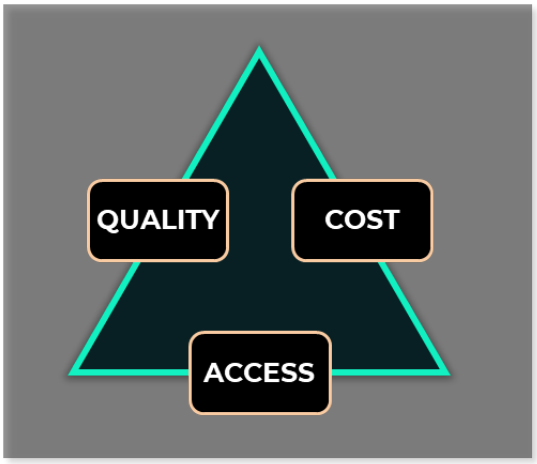
CARING, The Centre for Advanced Research in Imaging, Neuroscience, and Genomics, a recently renamed division of Mahajan Imaging, is devoted to doing cutting-edge scientific and clinical research and aiding radiology and genomics firms in creating top-tier, clinically applicable products.
In order to develop fresh perspectives and solutions for a better tomorrow, CARING is eager to collaborate with imaging researchers and engineers, neuroscientists, and genetic medicine experts. CARING currently works with more than 15 organisations, including academic institutions, start-ups, and businesses.

The **CARING Analytics Platform – CARPL – (http://carpl.ai)-** is the world's first and only end-to-end medical imaging AI application development, testing, and deployment platform. is. CARPL is used by the world's leading data scientists, start-ups, medical imaging companies, academic centres and hospitals to help ensure safe and effortless deployment of AI. CARPL comprises a data management & search platform, an annotation platform, a pre-deployment testing platform and an algorithm deployment platform.
You can learn more about CARPL from this presentation at the IIT Mumbai Tech Fest, 2020.

CARPL built by **CARING** – the Centre for Advanced Research in Imaging, Neurosciences, and Genomics – is a collection of physicians, engineers, and scientists who are fed up with the absence of AI and digital solutions in healthcare. CARING is the product group at Mahajan Imaging, India's leading and most advanced diagnostics service provider which caters to more than 500,000 patients per year.
We are currently bootstrapped and profitable!
They publish prolifically and have more than 100 papers presented at leading conferences across the world and more than 10 journal papers, including the first paper on AI in the Lancet. We work hard, party harder and love being the best at what we do and are now growing!

Specific Objectives

Improving Access, Affordability, and Quality of Medical Care by Connecting AI Applications with Healthcare Providers.



AI will impact all aspects of healthcare
Quality, cost and accessibility → **AI can bend the 'Iron Triangle' of healthcare**

There is little question that artificial intelligence (AI) is the future of healthcare services. Infinite potential for generating revenues and saving costs.

Despite the opportunity, Leveraging AI requires a 'Platform Approach' to enable seamless access to, Testing & Deployment of AI-based tool.

CARPL is built to bridge this gap- A combination of clinicians, engineers and scientists has come together to create CARPL. It is used across the health tech ecosystem. CARPL is used by the world's leading AI and clinical groups. CARPL consolidates AI across the healthcare ecosystem. A unifying tech layer connecting disparate use-cases across ecosystems.

CARPL brings 3rd party use-cases to provider's-Vendor-neutral, modality agnostic, multi-speciality use cases for the top & bottom line.

CARPL is built on **4 Platform Pillars**
Like any platform, CARPL offers Development support, market access, and trust and app deployment.

1. **Development Support**
   End-to-end AI development, in a single interface
   CARPL's extensive feature-set includes everything a developer of AI requires

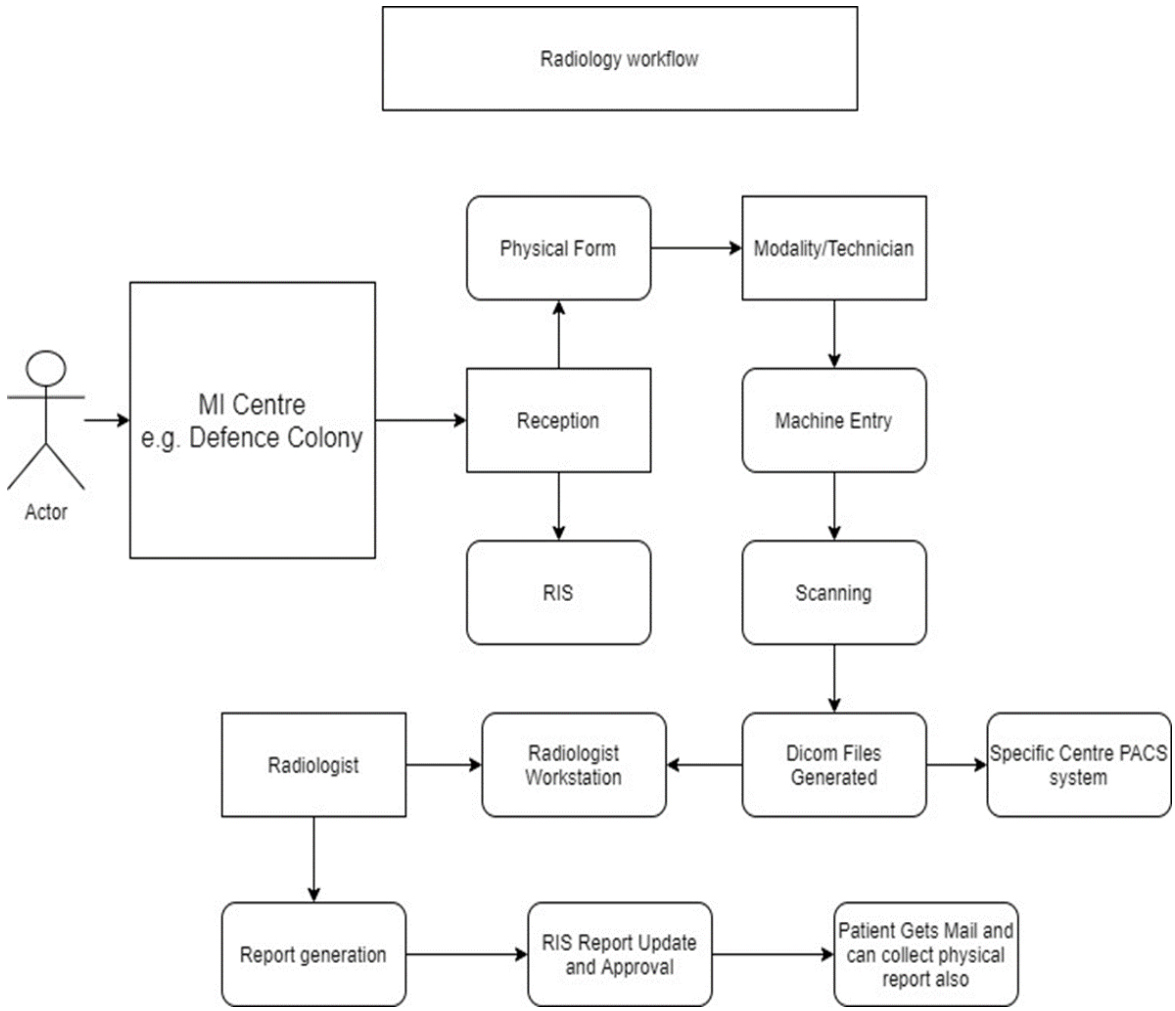
2. **Market Access**
   CARPL includes a 2-way marketplace for commercialisation
   Contribute to CARPL's data marketplace, or utilise models from its AI marketplace

3. **User Trust**
   The world's only AI validation platform
   Automated testing, bias estimation – doctors build trust in AI using CARPL

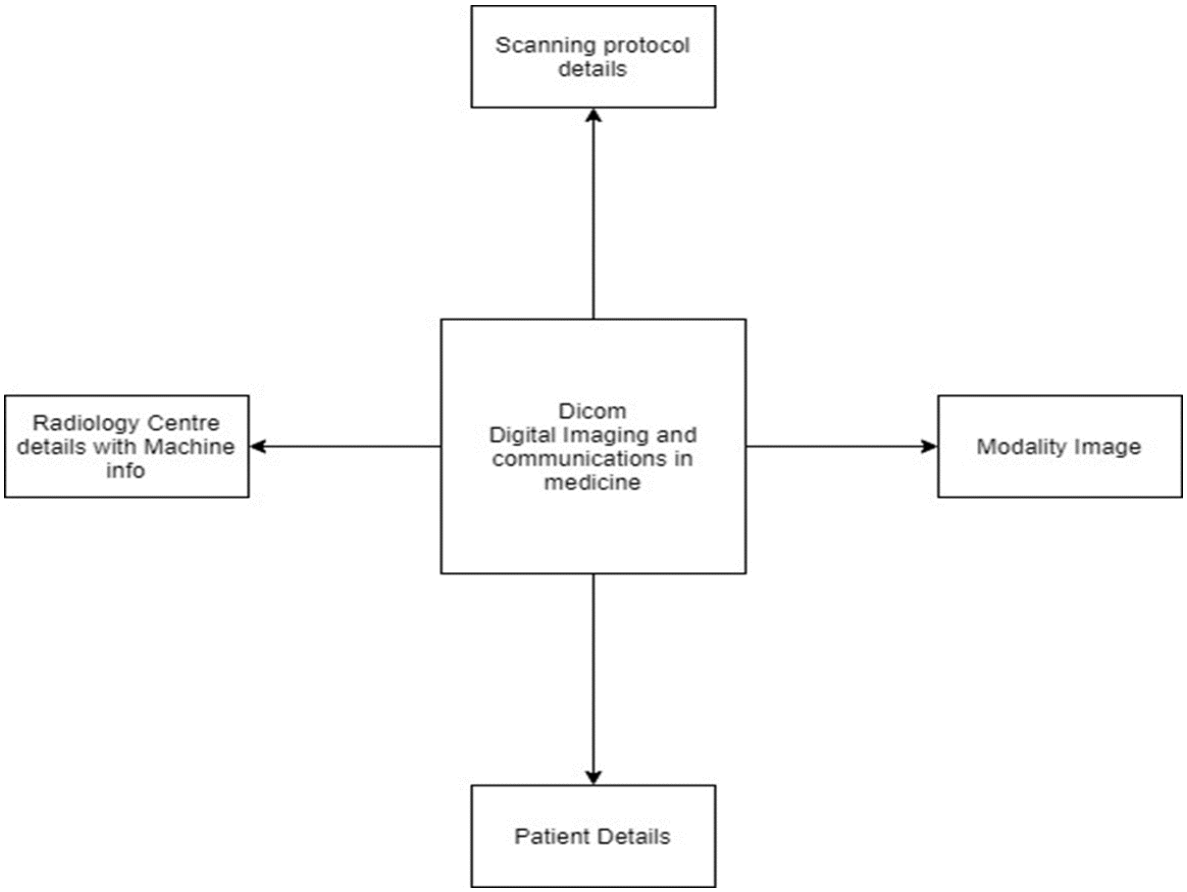
4. **Deployment**
   Single interface AI deployment using CARPL
   No need for separate RIS-PACS-HIS integrations

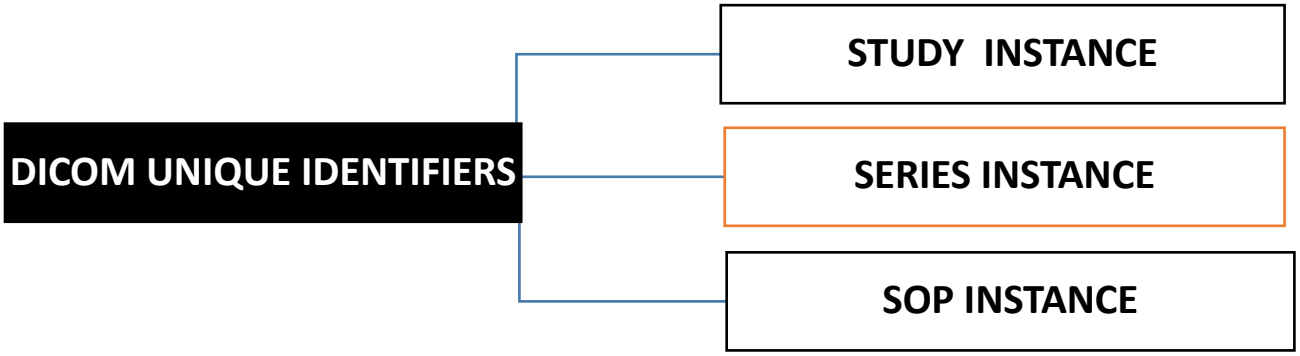
CARPL Developer Platform offers a smooth interface between clinical teams and users for a 'AI Provider.' Unlike other Healthcare AI/ML products, CARPL includes a carefully curated validation methodology, increasing the likelihood of the algorithm being applied in a clinical context.

RIS -Radiology Workflow

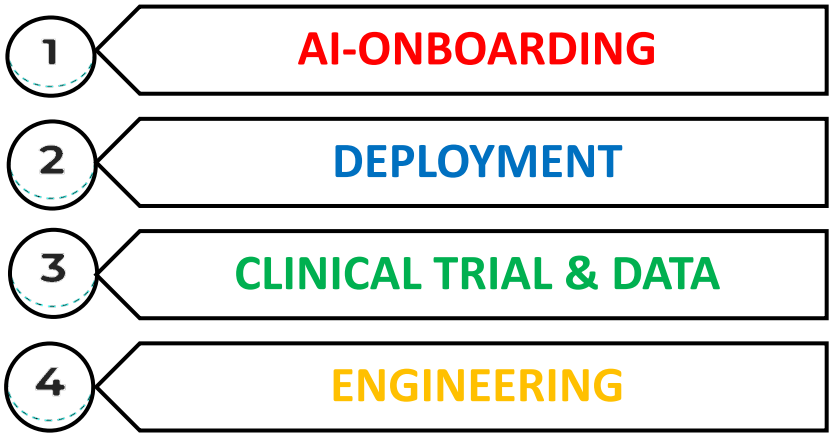


DICOM – Digital Imaging & Communications in medicine





Departments



A marketplace takes the strategy a step further by assessing apps thoroughly, including regulatory approvals, software and hardware validation, technical and end-user support, interoperability, privacy, and security concerns. This relieves the healthcare organisation of the screening process, which is now the duty of the platform provider, saving both time and money and allowing the business to confidently and swiftly construct its toolbox of imaging applications.
CARPL is the world's first medical imaging AI testing and deployment platform, connecting healthcare providers to third-party AI applications to enhance access, affordability, and quality of medical treatment. CARPL acts as a gatekeeper that links both sides of the ecosystem, bridging the gap between healthcare providers and AI developers. CARPL is essentially a single interface for accessing AI algorithms, validating and testing them, and then embedding them into radiology procedures.
CARPL is now utilised by more than 40 organisations.
One platform with infinite possibilities of emerging technologies, unbiased suite of AI, and future of medical imaging and healthcare industry.

1) ONBOARDING

CARPL is a complete platform for medical imaging AI that includes capabilities like dataset management and search, annotation, algorithmic integration, automated validation, testing, deployment, and IT integration.

- To create strategic Partner's ecosystem for enabling new business models, Co-Sell strategies, Research studies, key alliances, Enterprise business and P&L of this ecosystem.
- Driving global AI developer's strategic relationships Developing business and operational opportunities with C-suite executives of these organisations.

Onboarding AI models from across the world for various imaging modalities, to implement in the clinical deployments.
To create world's largest and most accessible AI imaging marketplace for HCP's
To help these AI models integrate with CARPL platform.

2) DEPLOYMENT

Single interface AI deployment using CARPL, No need for separate RIS-PACS-HIS integrations
CARPL is built for flexibility - it can be deployed on Cloud or On-Prem, with a configuration that is in line with your specific deployment needs. For custom deployments outside of CARING's infrastructure we require Secure SSH access to the machine where CARPL will be deployed.
Every AI company developing\validating algorithms on different modalities has this question in mind that how to deploy these algorithms in a radiology department
Different types of deployment options:

- On-cloud
- On-prem (CPU-only)
- On-prem (CPU + GPU)

3) CLINICAL TRIALS & DATA

CARPL modules and services also helps achieving regulatory approvals and compliances for AI model. Before initiating a clinical study of a medical device, it is necessary to get regulatory and ethical permission. The FDA presents examples of AI/ML-based technologies in the real world, such as an imaging system that offers diagnostic information using algorithms. Clinical trials are done for various organizations/AI companies to get regulatory approval, to know their Real world performance.

Conformité European (CE mark) - Europe
Food and Drug Administration (FDA or USFDA) - USA
Therapeutic Goods Administration (TGA) -Australia
Brazilian Health Regulatory Agency (Anvisa) - Brazil

CARPL Analytics Platform has an ANNOTATION Model on Platform, which helps these companies to monitor & test their Real World Performance.

4) ENGINEERING

Engineering team works on-

- Product Development
- Product Enhancement
- Bug Resolving
  - Reactive
  - Pro-Active
- All ASM Activities – L1 , L2, L3 Ticket Resolution based on Ticket Size
- Multiple Integrations & Testing

CARPL

Value

- To Healthcare Providers
  Improve clinical outcomes, cut costs and improve top line by getting access to AI applications from around the world through a single integration.

- To Developers of AI
  CARPL will walk you through the process of developing, testing, and deploying algorithms.

- To Data Science Researcher & Health Tech
  CARPL's provides an AI – enabled, secure yet flexible platform for all your medical imaging data management, reading & annotation needs!
  From de-identification to data management.

CARPL Analytics Platform,

- Clinical Trial & Regulatory Approval
- AI Monitoring & Feedback
- Rev Share Model
- Co-sell GTM

VALUE PROPOSITION

- **Reduction in number of Radiologists**
- **Turnaround time for report**
- **Increase in Patient footfall**
- **What human misses AI detects**
- **Increase in patient experience**
- **Dropout Gain**

What is AI?

Artificial intelligence (AI) is a subfield of computer science concerned with the creation of intelligent machines that operate and react in the same manner as humans do. The simulation of human intellectual processes by computers, particularly computer systems, is known as artificial intelligence (AI).
Expert systems, natural language processing (NLP), speech recognition, and machine vision are examples of AI applications.
The goal is to enhance the likelihood of success rather than precision. AI is used to make decisions. In healthcare, AI is being utilised to produce the next generation of AI technologies. It contributes to increased radiological production. There has been a boom in interest in medical devices based on artificial intelligence and machine learning (AI/ML).

Artificial Intelligence in Medical Imaging

Rapid technical developments in artificial intelligence (AI) technologies have fuelled explosive growth in the number of decision tools being sold by an ever-increasing number of organisations. AI advancements are mostly driven by computer scientists, informaticians, engineers, and entrepreneurs, with radiologists playing a considerably smaller role. Radiologists' involvement in AI is mostly limited to educational attempts to acquaint them with the tools and promising findings; however, strategies to help them pick which AI tools to utilise in their practises and how to measure their worth are not being addressed.

Artificial intelligence has considerably aided medical diagnosis and the development of novel pharmaceuticals. Experts predict that artificial intelligence will have a big impact by giving radiologists tools for quicker and more accurate diagnosis and prognosis, which will result in more effective therapy. Big data and artificial intelligence will revolutionise the way radiologists practise, enabling them to specialise in extremely specialised tasks since computers will be able to handle large volumes of patient data.

Scientists now anticipate that artificial intelligence will play an important part in the hunt for a cure for the growing corona virus, and therefore in easing the related terror that is afflicting people globally.

Recently, the health-care system has faced difficult problems in terms of sustaining an ever-increasing number of patients and accompanying expenses as a result of the COVID-19 epidemic.

As a result, the recent impact of COVID-19 necessitates a mental change in the health-care industry. As a result, it is critical to use current technology, such as artificial intelligence, to create and build intelligent and autonomous health-care systems.

The demand for improved clinical treatment quality and efficacy was a driving driver for the introduction of AI in medical imaging.

Scientists can rely on artificial intelligence since it can immediately diagnose high-risk individuals, monitor the course of this virus, and efficiently control this epidemic in real time. Although this technology can estimate the severity of situations by reviewing prior patients' data, the rates of accuracy, true negatives, and false positives may still be improved to avoid misunderstanding in medical treatment.

The key use of AI in the COVID-19 pandemic, which is the subject of this study, is early infection detection and diagnosis. Artificial intelligence might quickly identify problems based on symptoms and so-called red flags, alerting patients and health-care providers. It develops a low-cost, fast-decision-making algorithm. Modern COVID-19 situations may be discovered and managed in a categorised framework using a variety of AI methods.

General Findings in Learning

I, Dr.Diya Gouchwal was working as an Clinical BA (Business Analyst) Intern under the guidance of Dr.Varsha Misra for a tenure of 3 months starting from 4th April'2022 to 30th June'2022.
Throughout this tenure I learnt how AI works in Radiology.
During the Internship Training, I was part in the following activities:

- Learning of AI Algorithm
- Learned about Platform as a Service (PaaS)
- Business case Identification
- ROI
- AI-Onboarding & Deployment
- CARPL Analytics Platform
- PaaS as offering for US academic institutes – Relationship Building
- **R&D**- AI Algorithm Directory, AI Bible, AI Marketplaces, AI in Radiology, Prices Worldwide, & Non-FDA approved AI companies etc.

Conclusive Learning

- I got a broad understanding regarding how AI ecosystem in Imaging works from scratch.
- Working as an Intern, allowed me to have interaction with people associated with the Platform at grass root level, resulting in first-hand exposure to managerial tasks and, as a result, the development of interpersonal skills.

Section 2: Project Report

Defining the Return on Investment for a case of buying Medical Imaging AI.

INTRODUCTION

The forefront of the healthcare digital revolution has long been radiology. In the past 30 years, teleradiology, picture archiving and communication systems (PACS), and digital imaging technology have all changed radiology services. Once again, radiology is at a crossroads with the potential to develop into a one-stop integrated diagnostic service. In order to aid in the transition to the next generation, radiography could benefit from the development of strong new digital tools thanks to artificial intelligence and machine learning.

Radiology was one of the earliest medical specialties to use digital technologies.

A chest X-ray is the most common radiological test performed worldwide. Chest X-rays, being a non-invasive test with easy access and low costs, are the first line of defence for many diagnostics on the heart, lungs, blood vessels, airways, and even the chest and spine bones. While the X-ray is acquired in minutes, examining and analysing it takes the eyesight and experience of a professional. Unfortunately, radiologist-to-patient ratios are low, and available radiologists are overburdened by the large volume of incoming chest X-rays.

Improving the most basic and universal diagnostic test
Chest radiography is one of the most basic and fundamental diagnostic techniques used in medicine, accounting for 25% of all diagnostic imaging procedures performed each year. Unfortunately, even among professionals, miss rates for appropriate interpretation of chest radiographs can reach 30%, resulting in increased mortality from curable conditions.

Alleviating the burden in radiology workflow
The interpretative performance of chest radiographs varies by up to 30% between specialists and non-specialists.
Furthermore, 10% of chest radiographs are said to be kept back for 30 days until the final report is given.
Due to the large number of cases to interpret, radiologists only report 60% of radiographs.

50% of the lung cancer patients can be diagnosed earlier
Lunit INSIGHT successfully analysed a 55-year-old male patient's chest x-ray picture, revealing lung cancer that had been ignored for three years.

Many claims have been made regarding how technology would improve or make healthcare more inexpensive. Artificial intelligence (AI) is one out of the few inventions capable of fulfilling both of these promises.
AI has the potential to enhance healthcare systems without sacrificing quality or cost.

The promise of AI in radiography has been that it will improve health care while decreasing expenses.Six clinical goals can be aided by AI for a more effective process.

1. Less time spent reading,
2. Less dosage and contrast agents used,
3. Faster illness identification,
4. Higher diagnostic accuracy, and
5. More tailored diagnosis

The lack of instances of return on investment is the biggest hurdle to AI adoption in clinical practise. Healthcare providers must justify spending money on an AI system. It is also a necessary step in obtaining any unique technology to assist patients.
In this post, I examine how artificial intelligence (AI) may enhance healthcare systems without sacrificing cost, efficiency, or quality.
The medical AI market requires evidence of a viable business case that demonstrates cost-effective advancements.
How can the ROI of medical imaging AI be defined and proven? That is our field's most pressing problem right now. We have a three-step approach to the question, without pretending to have sorted it all out.

1. **Define the AI's benefits**
2. **Understand the incentives of the healthcare system**
3. **Match the benefits with the incentives** , in terms of
    - MONETARY GAIN
    - EFFICIENCY GAIN
    - QUALITY GAIN

Before artificial intelligence, computer-aided detection methods aimed to improve diagnostic accuracy by raising the test's sensitivity and/or specificity. Bounding boxes, markers, and probability ratings assist the radiologist in making a diagnosis whether read simultaneously with the radiologist or as a second read. There are several solutions on the market, and extensive research has shown that these algorithms are just as effective as radiologists or a gold standard.

However, because most of these items cannot be employed as a solo medical device, the accuracy of the software and radiologist combination is critical.

AIM & OBJECTIVE

"How to define the Return on Investment for a case of buying Medical Imaging AI"

Calculating the ROI of investing in medical imaging AI in terms of money, efficiency, and quality gain is the objective. The Biggest Hospital in North India will also note barriers to and enablers of using artificial intelligence (AI) technology in clinical radiology.
Technology implementation in hospitals necessitates a diverse set of stakeholders and organisational procedures, as well as strong routines and professional identities, as well as strict legal and regulatory standards.

Research Question

How AI may enhance healthcare systems while maintaining quality and cost effectiveness

Research Methodology

- Research Design – Exploratory study
- Data Type – Secondary Data
- Data Collection Method – Literature Survey
- Data Sources –Published articles , Websites
- Search Terms – Artificial Intelligence, Chest X-rays, Quality Gain, Efficiency Gain, Quality Gain

Keywords

Artificial Intelligence, Deep Learning, CAD (Computer Aided Detection), AI Algorithms, AI Marketplace, AI Companies, Monetary Gain, Efficiency Gain, Quality Gain, Chest X-rays

Defining the Case

I, being part of the Business Development unit of an IT department of The Biggest Hospital in North India, as a buyer for this HCP, convincing/explaining the benefits to the CFO/CMO of the hospital, to incorporate atleast 3 AI clinical applications for using as pulmonary management solutions to read CXR's in the Radiology Department of the hospital .
About the hospital,
Built over 44 acres of land, the hospital is furnished with 44 operation theatres, 1260 beds and over 400 critical care beds under 25 specialties.
The Radiology & Imaging branch is made up of professionals that are dedicated to providing high-quality radio-diagnosis to patients and referring physicians. The division has never failed to give flawless outcomes despite its use of cutting-edge technology, professional technicians, highly qualified physicians, and support employees.

A multi-specialty medical organisation in North India has collaborated with these solutions to use artificial intelligence technologies to improve chest x-ray interpretation.

Return on Investment (ROI) is a performance statistic used to evaluate an investment's efficiency or to compare the efficiency of investments.
In this case we will be describing the Return on investment for this case of buying Medical Imaging AI in terms of;

- MONETORY GAIN
- EFFICIENCY GAIN
- QUALITY GAIN

In this case, CXR (Pulmonary Management Solutions) AI Algorithms are to be incorporated in the IT unit of the Radiology Department.
Before addressing any healthcare system, the fundamental advantages of an AI clinical application should be understood.
We chose CXR AI Algorithms (Pulmonary management solutions) since chest X-rays are simple to work with. The most frequent radiological exam conducted worldwide is a chest X-ray. Chest X-rays, being a non-invasive test with easy access and low costs, are the first line of defence for many diagnostics on the heart,

lungs, blood vessels, airways, and even the chest and spine bones. While the X-ray is acquired in minutes, examining and analysing it takes the eyesight and experience of a professional. As a result, AI will benefit radiologists by boosting their worth, efficiency, accuracy, and personal pleasure.
Chest radiography (CR) is a quick and very cost imaging method for detecting lung abnormalities.

We have 2 ways to Buy Medical Imaging AI:-

1- From **AI marketplaces** such as CARPL, Nuance, Black ford, Incepto, DeepSee, FerumHealth, Aidoc, Sectra, Terarecon etc.
2- Directly from the AI companies such as Lunit , Oxipit, Gleamer, Qure.ai (1:1 relation)

❖ AI Marketplace- CARPL Analytics Platform
- One shop stop
- No vendor management & chaos
- Single legal window
- Platform approach rather using silos
- Run studies over multiple algorithms (Ensemble)
- Improve TAT & reduce extra cost

❖ Directly from AI Companies
- High billing
- Multi-management for SPOC
- Increases more bugs & decreases resolution
- Increase in Infra Cost
- Increase in Resources deployed for each player
-

	AI Market Place	AI Companies
PROS	Single Integration to access Multiple AI Algorithms	They have the Best control over their Product
CONS	They don't have have control over the product directly	Multiple Integrations to access AI Algorithms

Here is how we look at the possible impact of using our pulmonary management solutions, following is the list of CXR Algorithms available on CARPL Analytics Platform.

		Company Name	Product Name	No. of Findings	Regulatory Certification	Price per Inference	Geographical Location	Accuracy
1	Chest X-RAY	Lunit	INSIGHT CXR by LUNIT	10	FDA , CE Cleared	$1.0 Per Scan	Seoul, Korea	97-99% accuracy
2		Oxipit	ChestEye CAD by Oxipit	75	CE Cleared , ISO27001	$1.0 Per Scan	Vilnius, Lithuania	93% accuracy
3		Gleamer	ChestView By Gleamer	5	CE Cleared	$1.0 Per Scan	Paris, France	
4		Qure.ai	qXR v3.0 by Qure.ai	29	CE Cleared	$1.0 Per Scan	Mumbai, India	90% accuracy
5		VinDr	VinDr-ChestXR	28	-	$1.5 Per Scan	Vietnam	90% accuracy
6		Vuno	Chest X-ray by VUNO	5	CE Cleared	$1.5 Per Scan	Seoul, Korea	
7		CheXNeXt	CheXNeXt by Stanford University*	14	Open Source	Open Source	Open Source	
8			Pneumonia Detection*	2	Open Source	Open Source	Open Source	

Out of the the above list Lunit INSIGHT CXR , CHESTEYE , qXR were onboarded due to the following features :- (Onboarding Criteria)

- FDA , CE Regulatory Cleared
- High Accuracy in Clinical Trial
- AUC ROC score

Let's know more about the onboarded CXR AI Algorithms:

1. Lunit INSIGHT CXR
2. CHESTEYE CAD by Oxipit
3. qXR v3.0 by Qure.ai

	INSIGHT CXR by LUNIT	Chest Eye CAD by Oxipit	qXR v3.0 by Qure.ai
GENERAL			
Product name	Lunit INSIGHT CXR	ChestEye Quality	qXR
Company	Lunit	Oxipit	Qure.ai
Company Size	201-500 employees	11-50 employees	51- 200 employees
Subspeciality	Chest	Chest	Chest
Modality	X-ray	X-ray	X-ray
Disease targeted (Abnormal Findings)	**10**- Atelectasis, calcification, cardiomegaly, consolidation, fibrosis, mediastinal widening, nodule, pleural effusion, pneumothorax, pneumoperitoneum, tuberculosis	Algorithms supports **75** different pathologies	**29**- Tuberculosis, Covid-19, Radiological signs seen in Lung Parenchyma, Pleura, Mediastinum, Cardiac and bones visualised in the chest X-ray
Key-features	Radiologic finding detection, abnormality score, text interpretation	Quality assurance, identifying missed clinical significant findings	Abnormality detection and localization, report generation, tuberculosis screening, worklist prioritization
Suggested use	Before: adapting worklist order, flagging acute findings During: perception aid (prompting all abnormalities/results/heatmaps), report suggestion	After: diagnosis verification	Before: flagging acute findings During: perception aid (prompting all abnormalities/results/heatmaps), report suggestion
Major Benefits of using it	1-Fast triage of normal cases 2- Efficient reading via exam prioritization 3-Improved reading performance 4-Reduced overlooked lung cancers 5-Streamlined ED workflow 6-COVID-19 patient triaging and monitoring	1-It identifies chest X-ray images with no abnormality and produces preliminary reports 2-ChestEye minimizes radiologist input required to report on healthy patient cases 3-Automating healthy patient reporting 4-Customized reporting	1-Sort chest x-rays in the Worklist 2-Pre Read Assistance 3-Quantification & Progression 4-Opt for an AI-assisted workflow 5-Reduces radiology workloads 6-qXR can detect ground-glass opacities and consolidation; both indicative of COVID-19 infections
Country of Origin	Seoul , Korea	Vilnius , LT	Mumbai , India
DATA CHARACTERISTICS			
Population	Patients aged 14 years or older	Patients over 18 years old	All chest X-rays
Input	chest PA(posterior-anterior view), chest AP(anterior-posterior view)	PA or PA + LAT Digital Chest X Ray	PA/ AP view chest X-rays
Input format	DICOM	DICOM	DICOM
Output	localization(Color Map or Grayscale Map), abnormality score for each lesion/case, binary assessment of abnormality, worklist order, draft radiology report generation	List of possible False Negatives made by radiologists	Image annotations, free text draft radiology reports
Output format	DICOM Secondary Capture, DICOM GSPS(Grayscale Softcopy Presentation State)	DICOM SR or HL7 message	DICOM
TECHNOLOGY			
Integration	Integration in standard reading environment (PACS), Integration via AI marketplace or distribution platform, Stand-alone third party application, Stand-alone webbased	Integration in standard reading environment (PACS), Integration RIS (Radiological Information System), Integration via AI marketplace or distribution platform	Integration in standard reading environment (PACS), Integration RIS (Radiological Information System), Integration via AI marketplace or distribution platform, Stand-alone webbased
Deployment	Locally on dedicated hardware, Locally virtualized (virtual machine, docker), Cloud-based	Locally on dedicated hardware, Locally virtualized (virtual machine, docker), Cloud-based	Locally on dedicated hardware, Locally virtualized (virtual machine, docker), Cloud-based
Trigger for analysis	Automatically, right after the image acquisition	Automatically, right after the image acquisition, On demand, triggered by a user through e.g. a button click, image upload, etc.	Automatically, right after the image acquisition, On demand, triggered by a user through e.g. a button click, image upload, etc.
Processing time	3 - 10 seconds	3 - 10 seconds	10 - 60 seconds
Accuracy	**97-99% accuracy**	**93% accuracy**	**90% accuracy**
ROC AUC	**0.82 (0.79–0.86)**	**0.73 (0.69–0.77)**	**0.82 (0.79–0.86)**
REGULATORY CERTIFICATION			
CE	Certified, Class I, MDD	Certified, Class IIa, MDD	Certified, Class IIa, MDD
FDA	510(k) cleared, Class II	No or not yet	No or not yet
MARKET PRESENCE			
On market since	Nov-19	Sep-21	May-18
Distribution channels	GE Healthcare (Thoracic Care Suite), Philips Healthcare, INFINITT AI Platform		Nuance, Incepto, Philips IntelliSpace, Sectra Amplifier Store, Blackford, GE Healthcare, Siemens
Countries present (clinical, non-research use)		9	20+
Paying clinical customers (institutes)			20+
Research/test users (institutes)			10+
PRICING			
Price per inference	$1.0 Per Scan	$1.0 Per Scan	$1.0 Per Scan
Pricing model	Pay-per-use, Subscription	Pay-per-use, Subscription	Pay-per-use, Subscription
Based on	Number of installations, Number of analyses	Number of installations, Number of analyses	Number of installations, Number of analyses

1. LUNIT – Insight CXR by LUNIT

Lunit INSIGHT CXR is a cutting-edge artificial intelligence (AI) solution for chest x-rays that identifies **10 distinct aberrant radiologic abnormalities** with **97-99 percent accuracy** and provides TB screening on chest x-ray pictures.

Identifies 10 of the most common chest x-ray findings. –

1. Nodule
2. Pleural Effusion
3. Pneumoper itoneum
4. Pneumothorax
5. Atelectasis
6. Calcification
7. Cardiomegaly
8. Mediastinal widening
9. Consolidation
10. Fibrosis

Detects ten of the most common findings in a chest x-ray.

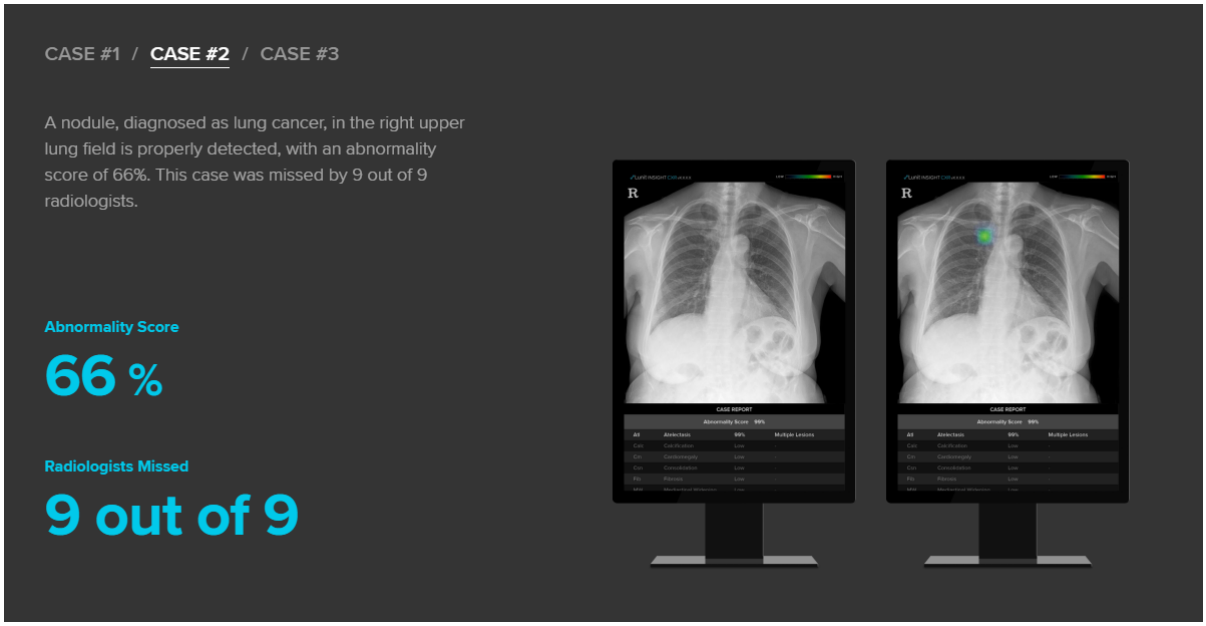
Major Benefits -

Accurate and efficient diagnosis boosted with AI

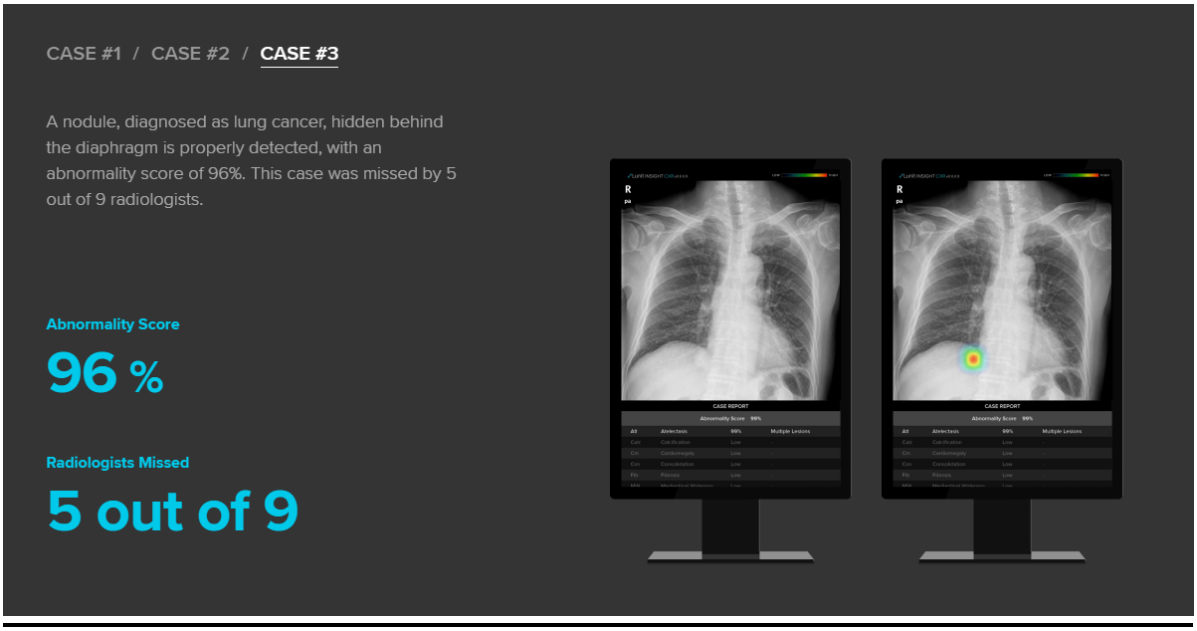
- **Fast triage of normal cases**
  Quickly triage regular instances and concentrate on reading odd ones.
- **Efficient reading via exam prioritization**
  Reduce reading time by 65 percent for normal cases and 25 percent for abnormal ones by prioritising cases based on abnormality ratings.
- **Improved reading performance**
- For significant chest anomalies, non-radiology doctors, general radiologists, and even thoracic radiologists can enhance their diagnostic accuracy.
- **Early diagnosis of lung cancer**
  With AI-assisted diagnosis of tiny, inconspicuous pulmonary nodules, you may reduce false negative instances and detect lung cancer at an early stage.
- **Streamlined workflow in Emergency Department**
  With a faster decision-making process and treatment, you can save reading time by 39%.

CASE 1

CASE 2



CASE 3



Use Case

Deep-learning algorithms for analysing chest radiographs are being developed to aid with COVID-19 patient triage.

- Current medical applications have shown that deep-learning (DL) algorithms can improve the efficiency and precision of visual interpretation. Automatic interpretation of the CR with DL algorithms could significantly lessen the burden on clinicians and radiologists during sudden surges of suspected COVID-19 patients if the DL algorithm outperforms doctors in diagnosing Coronavirus disease 2019 (COVID-19) pneumonia with chest radiography (CR).
- In this study, the DL algorithm performed well in the CR-based diagnosis of pneumonia in COVID-19 patients, with results comparable to radiology reports. In pandemic circumstances, as as the COVID-19, where medical resources and personnel are limited, the emergency medical system can be greatly burdened. The DL algorithm comes in helpful in this scenario.
- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242759
- https://asset.fujifilm.com/www/sg/files/2021-05/09d8cad3a2f7c3ded0beee9f66e03200/Lunit_INSIGHT_CXR_Medical_White_Paper.pdf

2. OXIPIT- Chest Eye CAD by OXIPIT

ChestEye Quality is a CXR tool that uses artificial intelligence to double-read the images. The software examines final radiologist reports as well as CXR pictures. ChestEye Quality, which operates in near-real time, aids in the detection of reporting inaccuracies and the improvement of patient outcomes.

The suite supports **75 of the most prevalent radiological findings**, which together make up 90% of the everyday diagnosis seen in medical facilities.
A completely automated computer-aided diagnostic (CAD) chest X-ray system is called ChestEye CAD. It generates preliminary conclusions when the chest X-ray scans show no anomalies (image in, report out). Initial reports for healthy patients are only generated when the platform is extremely confident in the findings (20-40 percent of all healthy patient cases). by speeding up the process through which radiologists report chest X-rays of healthy patients.

Supported Findings

1	Abnormal Rib	26	Granuloma	51	Pleural Plaque
2	Aortic Sclerosis	27	HD Catheter RA Placement	52	Pleural Thickening
3	Artificial Heart Valve	28	HD Catheter SVC Placement	53	Pneumomediastinum
4	Azygos Lobe	29	Hernia	54	Pneumoperitoneum
5	Barium Swallow	30	Hilar Prominence	55	Pneumothorax
6	Bowel Gas	31	Hypertension	56	Pulmonary Cavity
7	Bullous Emphysema	32	Hypoventilation	57	Pulmonary Emphysema
8	Catheter Malposition	33	Interstitial Markings	58	Removed Lung
9	Chest Tube	34	Intra Aortic Balloon	59	Respiratory Distress Syndrome
10	Congestion	35	Intubation	60	Retrosternal Airspace Obliteration
11	Consolidation	36	Intubation Malposition	61	Rib Resection
12	CV Catheter RA Placement	37	Kyphosis	62	Sarcoidosis
13	CV Catheter SVC Placement	38	Ligament Ossification	63	Scoliosis
14	Cyst	39	Linear Atelectasis	64	Spinal Compression Fracture
15	Dislocated Mediastinum	40	Lobar Collapse	65	Spinal Degenerative Changes
16	Edema	41	Loculated Effusion	66	Spinal Enthesopathy
17	Elevated Diaphragm	42	Lymph Node Calcification	67	Spinal Implant
18	Endovascular Stent	43	Lymphadenopathy	68	Spondylosis
19	Enlarged Aorta	44	Mass	69	Sternal Wires
20	Enlarged Heart	45	Nasogastric Tube	70	Subcutaneous Emphysema
21	Esophageal Stent	46	Osteoporosis	71	Thymus
22	Fibrosis	47	Pacemaker	72	Tracheal Stent
23	Fissural Thickening	48	Pericardial Effusion	73	Tuberculosis
24	Gastric Bubble	49	Pleural Adhesion	74	Ventricular Assist Device
25	Goitre	50	Pleural Effusion	75	Widened Mediastinum

Major Benefits –

ChestEye cuts the time it takes for radiologists to report on healthy patient cases:
Provides a preliminary healthy patient report for radiologist review and approval after identifying chest X-rays without anomalies for which the platform has a high level of confidence.

Reporting on healthy patients in an automated manner.
Allows radiologists to focus their efforts on studies that provide meaningful results.

Customized reporting:
Preliminary reports are fully configurable and created in your language, ensuring that reports require little to no revision and correspond to your medical institution's normal reporting requirements.

3. QURE.ai- qXR v3.0 by Qure.ai

qXR, which stands for Automated Chest X-ray Interpretation, is capable of detecting abnormalities on a chest X-ray. It can identify between normal and abnormal X-rays, as well as help with pre-reads and radiological audits. qXR includes proprietary algorithms that can recognise a total of **29 chest X-ray findings.**

1- Nodule
2- Multiple Opacities
3- Cavity
4- Consolidation
5- Fibrosis
6- Blunted CP
7- Pleural Effusion
8- Hilar Enlargement
9- Nasogastric & Endotracheal Tube Detection
10- Pneumoperitoneum
11- Pneumothorax
12- Rib Fracture

Sort chest X-rays in the Work list: identifies anomalous results, distinguishes between normal and pathological chest X-rays, and highlights them on the X-ray.
Qure.ai developed qXR using Artificial Intelligence (AI) to augment human experience with the power of contemporary technologies. Deep learning algorithms are used by qXR to scan and triage chest X-rays in under one minute, reducing the risk of late diagnosis, underdiagnosis, and even potential misdiagnosis and enabling for better patient treatment.

qXR Use Cases

- **qXR – COVID**

  Advantages

  - Determines COVID-19 risk. Allows for the triage of asymptomatic patients for RT-PCR.
  - Analyses, monitors, and evaluates lesion progression.
  - Tracks illness development.
  - Report creation is automated.

- **qXR – TB**

Tuberculosis programmes across the world employ qXR as a point-of-care screening method, followed by bacteriological/NAAT confirmation. It cuts the time it takes to diagnose a patient from days to a few hours.

Advantages

- Interprets chest X-rays automatically.
- Reduces the amount of subsequent microbiological tests.
- Reduces misdiagnosis, under-diagnosis, and treatment time.
- Mobile applications have their own mobile app/PC interface.

- **qXR – RAD Assist**

Quantification of percentages Reporting is automated, resulting in a 40% reduction in reporting burden. All negative instances and almost 10% of positive ones are automatically reported. Integrates seamlessly with work lists at all levels of escalation. Integration that is vendor neutral. Tuberculosis programmes across the world employ following bacteriological/NAAT validation, qXR was used as a point-of-care screening approach. It reduces the time required to diagnose a patient from days to only a few hours. qXR has sensitivity and specificity equivalent to experienced radiologists. It can assist radiologists by categorising their jobs as normal, abnormal, or to be reviewed. It might also provide automatic reports with precise data and quantification. It's a fantastic tool for managing lengthy to-do lists, improving reporting efficiency, and prioritising instances that require quick attention.

Advantages

- Calculation of percentages Reporting is automated, resulting in a 40% reduction in reporting burden.
- Reports all negative instances and approximately 10% of positive ones automatically. Seamlessly integrates with work lists across escalation.
- Vendor agnostic integration.

Radiology workloads are reduced. - A chest X-ray screening system based on deep learning is called qXR. It separates pathological from normal chest X-rays, finds anomalous results, and highlights them on the image. Over 3.7 million X-rays from various sources comprise the increasing library on which the CE-certified algorithms were trained and evaluated.

Pre-read Assistance- Chest X-rays could show up to 29 different abnormalities. Regardless of whether the scan is CR/DR or PA/AP, qXR can help detect a range of abnormalities in the lungs, pleura, heart, bones, and diaphragm. For quick and simple interpretation, the algorithms give outlines for lung and pleural anomalies. qXR findings are returned for each scan in under a minute thanks to its global link with several PACS providers.

Utilize pre-populated templates to speed your reporting turnaround time. Create free text reports that can be converted into structured DICOM reports and used right away in workflows. The templates used by qXR are globally compliant and can be customised to meet hospital needs.

On chest X-rays, qXR may identify up to 30 different abnormalities. qXR can help detect numerous abnormalities in the lungs, pleura, heart, bones, and diaphragm, regardless of CR/DR scans or PA/AP views. For rapid and easy interpretation, the algorithms create outlines for lung and pleural anomalies.

Make the decision to use an AI-assisted workflow. Thanks to its global connection with multiple PACS providers, qXR outputs are returned for each scan in under one minute.

Sort chest x-rays in the Work list - distinguishes between normal and pathological chest X-rays, finds abnormal findings, and highlights them on the X-ray. The CE-certified algorithms were trained and tested on a growing library of X-rays (over 3.7 million) from a variety of sources.

Quantification & Progression- People who are trained to recognise specific anomalies locate the lung lesion and assess it in relation to the total lung capacity as seen on the chest X-ray. The same patient's several scans may be analysed by qXR in order to produce a progression report that shows how the lesions have changed over time.

Source

https://qure.ai/wp-content/uploads/2021/10/Qure_qXR_brochure-1.pdf

MONETORY GAIN

The lack of instances of return on investment is the biggest impediment to AI adoption in clinical practise.
Healthcare providers must be able to justify spending money on an AI solution.
The return on investment in new technology is a critical consideration in hospital procurement.
As this hospital is the Biggest Hospital in North India, therefore it has a good patient footfall each day.
There is approximately a footfall of about **9,000** patients every day in the OPD, with about **100-120** Chest X-rays scans every day.
Let's suppose that 100 scans of Chest X-ray are done each day.

(FOR A DAY)

Pricing for Radiologist & on boarded AI Algorithms

- **For the onboarded AI Algorithms**

COMPANY NAME	PRODUCT NAME	PRICE PER INFERENCE
LUNIT	**INSIGHT CXR by LUNIT**	$1.0 Per Scan
OXIPIT	**Chest Eye CAD by Oxipit**	$1.0 Per Scan
Qure.ai	**qXR v3.0 by Qure.ai**	$1.0 Per Scan

AI can also detect both Abnormal & Normal on a scan.
Suppose there are 100 Chest X-rays per day, out of which 20 (NORMAL) & 80 (ABNORMAL).

COMPANY NAME	PRODUCT NAME	PRICE PER INFERENCE	For 100 Scans	in $	in Indian rupees ₹ ($1= ₹77.70)
LUNIT	**INSIGHT CXR by LUNIT**	$1.0 Per Scan	100 scans * $1.0 Per Scan	$100	7,770
OXIPIT	**Chest Eye CAD by Oxipit**	$1.0 Per Scan	100 scans * $1.0 Per Scan	$100	7,770
Qure.ai	**qXR v3.0 by Qure.ai**	$1.0 Per Scan	100 scans * $1.0 Per Scan	$100	7,770
				TOTAL	**₹ 23,310**

- **For the Radiologists to Read & Interpret the scans**

We have radiologists with 4-5 years of Experience
TOTAL TIME – It is defined as the time taken from the Acquisition of the Modality to Reporting.
Total Time taken by a Radiologist= **15 minutes per study**
1 hour = 4 Reports

Time taken by Radiologist	Cost of Radiologist
1 Hour = 4 Scans	Per Hour - ₹ 1062 - 1100 / Hour / Rad.
1 Report TAT =15 minutes	Per study - ₹ 53.1- 55 / CXR Study
4-5 Hours per day = 16 scan/Rad.	Per Day (4-5 hrs. a day)= 1100*4 = ₹4,400 / Rad./ Day
6 Radiologist / Day = 100-120 scans per day	For 6 Rads. / Day = 4,400*6 = ₹26,400
	TOTAL = **₹26,400**

Disclaimer:-
Source of information regarding the cost of Radiologists is Confidential, and is shared by one of the leading Radiological centres in North India.
Radiologists are Indian and not US. India has a different reimbursement model. In US, it depends on the CPT code. Rads. Reimbursement is done by pairs

(FOR A MONTH)

AI ALGORITHMS	RADIOLOGISTS
Per Day for 3 Algo's = ₹ **23,310**	Per Day for 6 Radiologists = ₹ **26,400**
Per Month for 3 Algo's = 30*23,310 = ₹ **6,99,300**	Per Month for 6 Radiologists = 30*26,400 = ₹**7,92,000**

As AI can detect both Abnormal and Normal, it has reduced the load on the radiologists to figure out the normal scans from all the scans, this way the radiologists has to now only report the abnormal cases. Therefore, the no. of radiologists required now will be less as compared to what was required before.

According to the AUCROC score, we selected Algorithm to be **Chest Eye CAD by Oxipit** which will be used on all the routine CXR scans.

THIS IS AN IDEAL WORLD, WHERE AI CAN REPLACE RADS.

According to Lithuanian start-up Oxipit, AI autonomy is now a reality, thanks to a ground-breaking class II b regulatory approval for **'Autonomous AI.'**
Oxipit's autonomy is based on its intended use:
A chest X-ray scan is evaluated automatically and autonomously (without the intervention of a radiologist). The programme is designed to detect actionable radiological abnormalities on chest radiographs automatically. Following this examination, one of two steps is taken:
(1) A report is automatically prepared if it is sure that a research has no actionable radiological results. A skilled radiologist does not report on the research.
(2) The research is ordered to be reported on by a radiologist if it cannot clearly rule out the presence of actionable radiological findings.

Source:https://pubmed.ncbi.nlm.nih.gov/31585696/https://pubmed.ncbi.nlm.nih.gov/34931859/https://pubmed.ncbi.nlm.nih.gov/34392105/

Disclaimer:-
But Today Autonomous AI is not ready to be adopted

AI ALGORITHMS	RADIOLOGISTS
Per Day for Algo. = ₹ **7,770**	Per Day for 6 Radiologists = ₹ **26,400**
Per Month for Algo. = 30*7,770 = ₹ **2,33,100**	Per Month for 6 Radiologists = 30*26,400 = ₹**7,92,000**

RESULT

Now, the Headcount of the Radiologist reporting Chest X-rays has reduced, because AI detected normal.
Total Monetary Gain for a Month, by reducing the number of Radiologist from **6 to 3 in headcount.**
= ₹ 7, 92,000 - 3, 96,000
= ₹ 3, 96,000

Now as we can check, for AI Algorithm it is **₹2,33,100** & For Radiologists it is **₹7,92,000** per month.

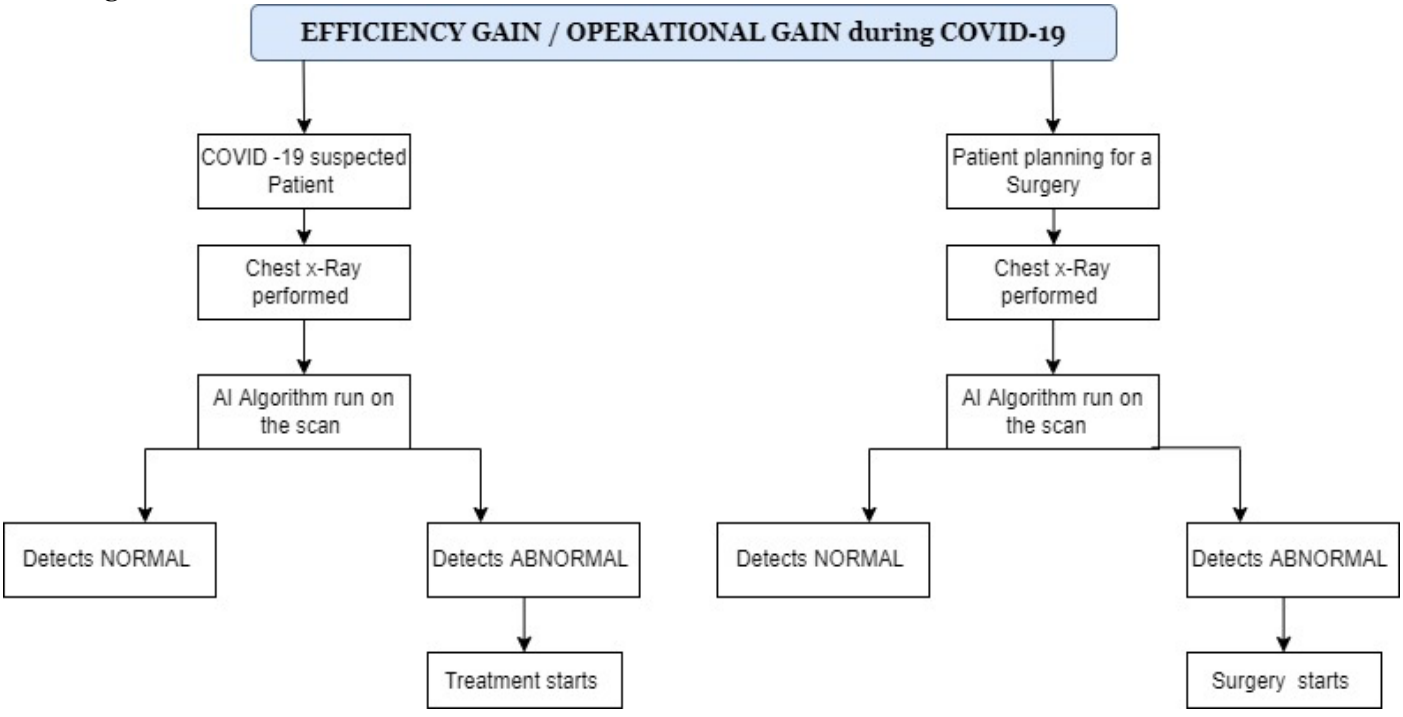
EFFICIENCY GAIN

(Operational Gain)

To enhance patient outcomes, a fast diagnosis or intervention may be the goal.
A different approach for speeding up the early discovery of important findings and reducing report turnaround times is the prioritisation of the work list based on AI-identified urgent discoveries.
In an experiment to test this theory, retrospective chest radiographs were employed, and it was shown that turnaround times for reporting significant discoveries were reduced from 80 minutes to 35–50 minutes.
A commercial algorithm for prioritising cerebral haemorrhage in the United States reduced the waiting time per positive case from 16 to 12 minutes. AI notification may identify incidental outcomes in addition to recognising significant discoveries. Using AI applied to every chest or abdomen CT, two instances include the detection of lung nodules on chest radiographs and automated vertebral fracture diagnosis to find early signs of osteoporosis.
About half of the AI products for radiology on the market attempt to improve diagnostic accuracy by raising the diagnostic test's sensitivity and/or specificity. These items are intended to improve health outcomes by reducing missed diagnoses and preventing unneeded procedures or tests.
Long before AI, computer-aided detection algorithms were utilised to boost the sensitivity and/or specificity of the diagnostic test in order to increase diagnostic accuracy. Whether they are read concurrently or as a second read, bounding boxes, markers, and likelihood ratings aid the radiologist in making their diagnosis. Numerous solutions are available, and much research has been done to show how well these algorithms perform in contrast to radiologists or other human specialists.
Because the majority of these elements cannot be used as a single medical device, the accuracy of the software and radiologist combination is critical.

I. Interpretation of Chest Radiographs to aid in the Triage of patients during COVID-19

Deep-learning (DL) algorithms have demonstrated their therapeutic value in improving the precision and speed of image interpretation in current medical applications. The automatic interpretation of the CR using DL algorithms can significantly lessen the burden on clinicians and radiologists in sudden surges of suspected COVID-19 patients if the DL algorithm performs as well as physicians in diagnosing Coronavirus disease 2019 (COVID-19) using chest radiography (CR).
In the COVID-19 times, the Radiologists are already focussing more on the COVID patient, and due to major spread of the infection in the hospital some have become positive so there is a shortage of Radiologists when there is an overload of scans.



CASE 1 – Case of a COVID-19 suspected patient

Early isolation of suspected patients owing to Coronavirus Disease 2019 (COVID-19) is the most fundamental and crucial response approach in emergency departments during outbreaks of quickly disseminated infectious illnesses (EDs). In this situation, there were patients who felt they were COVID positive and requested a CXR to confirm their concerns.
Ground-glass and consolidative opacities with bilateral, peripheral, and lower lung distribution are hallmarks of COVID-19 lung infection.
Ground-glass opacity (GGO) lesions have often fuzzy edges, and the accompanying images are frequently indistinct, making their detection in CRs difficult for non-expert clinicians. Using real-time analysis, radiologists may be able to improve the detection rate of COVID-19 pneumonia in CRs.
During this outbreak, there was an overload of CXR scans to be reported by the radiologists, but due to many reasons there is a shortage of radiologists. Therefore, the reports are taking longer than the usual, but on the other side early detection and isolation of the COVID-19 suspects was the priority.
To help in this case, AI Algorithms were on all the scans which were done on a day before the reporting done by Radiologists due to his unavailability. Through this AI detected the NORMAL & ABNORMAL cases and then the treatment and early isolation of the patients could take place.
This way the COVID-19 patients, were not dependent on the Radiologists on the Point of care.

CASE 2 - Case of a Patient planning for a surgery due to some other reason during the COVID-19 outbreak (Emergency Surgery)

During the COVID-19 outbreak of the rapidly infectious diseases, the focus of the Doctors and Radiologists was more to the patients of COVID-19.
Therefore, the patients who had to go for Emergency Surgery were not given much attention and due to this their surgery could have got delayed.
But in this case AI helped, in not delaying the Emergency Surgery which was not getting attention due to the burden of COVID cases. Before getting reported by Rads. AI was run on the scan for getting an output of the scan, which can help the Surgeon who is supposed to perform that surgery.
This way Non-Covid patients do not have to wait for the decision of Rads. for their Emergency Surgery.

II. Case of Mammography of a Patient, with Biopsy done same day without delay.

A patient's MMG scan was done in this situation. An X-ray scan of the breast is known as mammography. It's usually done to identify breast cancer or tissue abnormalities early on. This patient suspect's cancer therefore, underwent MMG scan.
And in such cases ideally there should not be any delay, as they are done for early detection and based on the reports the Treatment protocol is planned.
Even though the Radiologists was unavailable due to some reason, the AI was run on that scan, and an output was produced so that there is no delay in the Treatment- Biopsy which was performed on the same day without any delay.
AI has helped in the following cases:-

- Delay of Treatment
- Follow up issue
- Patient Experience
- Dropout Gain
- Patient Satisfaction

RESULT

By using AI in Radiology, EFFICIENCY GAIN/ OPERATIONAL GAIN can be seen as follows:-

- Increased No. of scans
- AI auto reports normal scans & Radiologist reports abnormal
- Triaging
- Case Rating by Prioritization
- Work List Prioritization
- Autoreporting
- Patient Experience Increases
- Patient Satisfaction Increases

QUALITY GAIN

Quality is defined as a product's or service's ability to meet the demands and expectations of the consumer. Estimating how many actionable nodules were missed by radiologists is a simplistic method to look at the quality increase.

In the field of radiology, artificial intelligence offers a lot of promise for increasing efficiency and accuracy. Same reports can be reported by 3/4 AI Algorithm solution, But this turns to be costly. And then the Monetary Gain turns to be NULL.

But 1 AI Algorithm solution can also help for a company who is using it for the 1st time.

WHAT AI MISSES, AI CAN DETECT

E.g. Pulmonary Nodules in a CXR scan

While reporting a CXR scan, No. of pulmonary nodules can be varied, a Rads. might miss the no. of pulmonary nodules on a CXR, which can be detected by AI Algo.

Can be useful in case of Peer to Peer advice for 2nd opinion.

Where AI helps detects, what human misses. Reduces False Negatives.

- AI Leverage the Rads.
    - 2nd Read
    - Pre-Read
- Augment clinical decision of Rads.
- Can help in an 2nd Opinion to a Rads.

CASE

AI is helping Us Fight the War Against TB- DeepTek.ai, Inc.

India is home to a quarter of the world's tuberculosis (TB) patients, more than any other country. Prime Minister Narendra Modi has pledged to rid India of tuberculosis within the next five years. AI is not only making TB diagnosis available to those who previously had no access to it, but it is also saving healthcare costs and improving reporting times by reducing radiologist work necessary in interpreting X-rays.

For decades, chest X-rays have been widely employed in public screening programmes. Many nations, including India, have adopted mobile diagnostic vans with X-ray equipment that travel about every day taking X-rays of hundreds of patients. However, there is one huge issue. Qualified radiologists are required to read X-rays.

In India, there is only one radiologist for every 100,000 patients, with the majority of radiologists clustered in cities. There are huge and unreasonable delays in reading X-rays and reporting their findings due to the acute scarcity of radiologists.

We must deliver fast and accurate diagnosis to people of all demographics if we are to eradicate tuberculosis. Artificial intelligence is a game-changer in this area.

In India, the DeepTek system was implemented in a mobile diagnostic van for a government-run population screening programme. Every day, these vehicles record thousands of X-rays. The X-ray pictures are uploaded to the cloud and analysed by DeepTek, a pioneer in smart medical imaging technologies, using an AI-driven approach.

AI is not only making TB diagnosis available to those who previously had no access to it, but it is also saving healthcare costs and improving reporting times by reducing radiologist work necessary in interpreting X-rays.

In this case the quality of care for the TB. patients has improved in the areas where there is shortage of qualified Radiologists. AI helps in leveraging the radiologists as a pre-read. So that early screening of the patients takes place.

Source
https://www.deeptek.ai/post/how-ai-is-helping-us-fight-the-war-against-tb

RESULT

AI helps to detect what human misses.

SUMMARY

	MONETORY GAIN	EFFICIENCY GAIN	QUALITY GAIN
AI ALGORITHM - Insight CXR by LUNIT - Chest Eye CAD by OXIPIT - qxr v3.0 by Qure.ai	~No. of Radiologists reporting CXR'S have been reduced (Headcount of the radiologists reduced from 6 to 3 in no.)	~AI autoreports normal scans & Radiologist reports abnormal ~Increased no. of scans ~Triaging ~Case rating by Prioritization ~Work list Prioritization ~Autoreporting	~AI helps detects what human misses ~Reduces False Negatives

The biggest challenge to AI adoption

The lack of instances of return on investment is the biggest impediment to AI adoption in clinical practise. Healthcare providers must be able to justify spending money on an AI solution. It's also a prerequisite for obtaining any unique patient-assistance gadget.

- Another obstacle for establishing clinical value with AI is the actual technical implementation and deployment of these algorithms.
- Although many AI products have FDA clearance and CE certification, this does not ensure the increased therapeutic value.

Success of AI adoption in Healthcare

"Radiology is not a standalone," Hugh Harvey, Managing Director of Hardian Health, said at the British Institute of Radiology (BIR) 2020 Congress. Because radiology is used in almost every area, the return on investment may not be limited to radiology. Health economics research should involve several departments and stakeholders."

Failure of AI adoption in Healthcare

Although AI has the potential to increase the effectiveness and accuracy of radiology, it also has biases and weaknesses. The broad use of AI-based intelligent and autonomous systems in radiology has the potential to increase the risk of catastrophic systemic errors and pose tough ethical and societal issues.
The use of AI in patient care in many clinical contexts currently has a limited amount of expertise. Additional study is required to determine the optimal way to apply AI in clinical practise. This statement reflects our shared conviction that ethical AI use in radiology should enhance wellbeing, prevent harm, and ensure that advantages and disadvantages are equitably distributed among stakeholders. We believe that AI should protect human rights and liberties, including privacy and respect for human dignity. It should be built with the highest level of dependability and transparency possible. The responsibility and accountability for AI ultimately lay with its human designers and operators for the time being.
The field of radiology should begin right away to create codes of ethics and best practises for AI that support any application that benefits patients and the public good and should forbid the use of radiology data and algorithms for financial gain without those two qualities.
Although artificial intelligence (AI) has the potential to benefit (paediatric) radiology and the patient care process, its impact has only been shown in a few instances. Most of the information is derived from simulations or retrospective analysis. The fact that the field is still developing could be one factor in the dearth of evidence. The majority of the products have only been available for the past two years. The acceptance of medical discoveries into clinical practise typically takes 17 years. One could contend that this means the use of AI in clinical practise is still in its infancy.
It takes an average of 17 years for medical advances to reach clinical practise. As a result, one may argue that AI's.

CONCLUSION

Even though AI software has a lot of potential in radiology, little is known about how it affects health care quality, efficiency, and costs. Real-world validation of these breakthroughs is critical for making informed decisions about continued research, procurement, deployment, and reimbursement, as history has demonstrated.
Examining and tracking AI product experiences and effects in clinical practise should provide insight into their contribution to the initial health-care improvement goals. Only then will we be able to establish if AI is improving health care in terms of both costs and outcomes.
The development of machine learning and artificial intelligence and its integration into ordinary clinical practise will have a big impact on how radiology currently practises. Radiology will continue to be impacted by changes in funding and practise habits. We believe that these advancements, especially those related to machine learning and artificial intelligence, will actually boost radiologists' value, efficiency, accuracy, and personal satisfaction rather than pose a serious risk to them.
While AI has the potential to improve efficiency and accuracy in radiology, it also comes with its own set of flaws and biases.

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THANK YOU