AI in the Diagnosis of HCC in Multi-phase CT

Systematic Review

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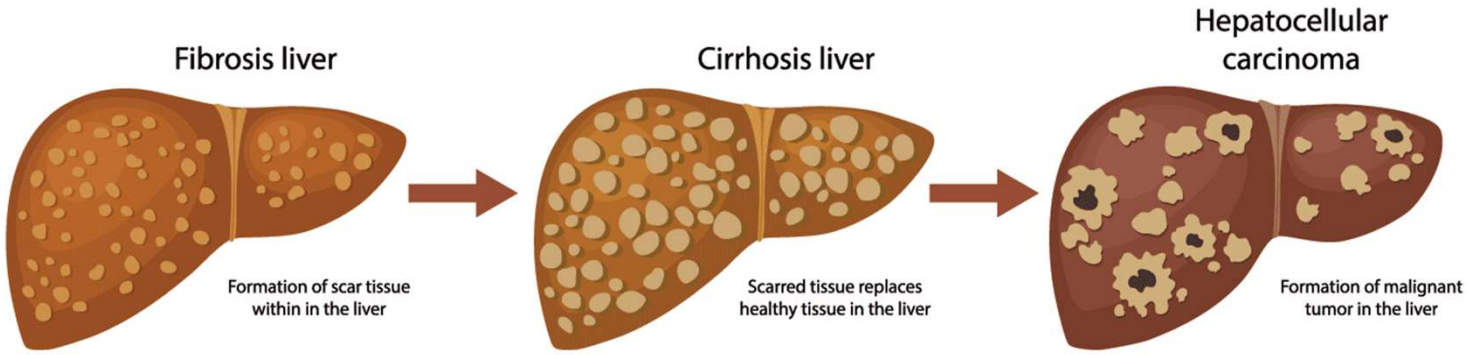
What is HCC?

- Liver cancer third in cancer death
- HCC 75-85% of primary liver cancers
- Commonly diagnosed at advanced stages
- Can be diagnosed on imaging alone



AI in CT

Labelled example data

↓

“Convolutional neural network”

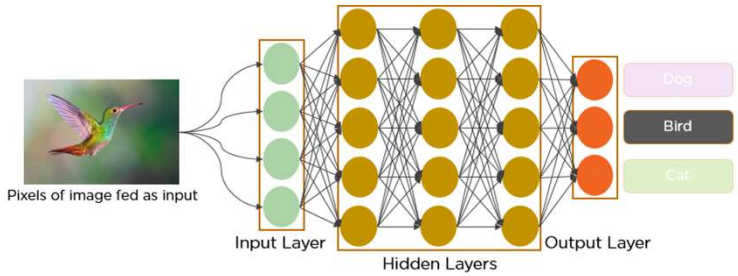


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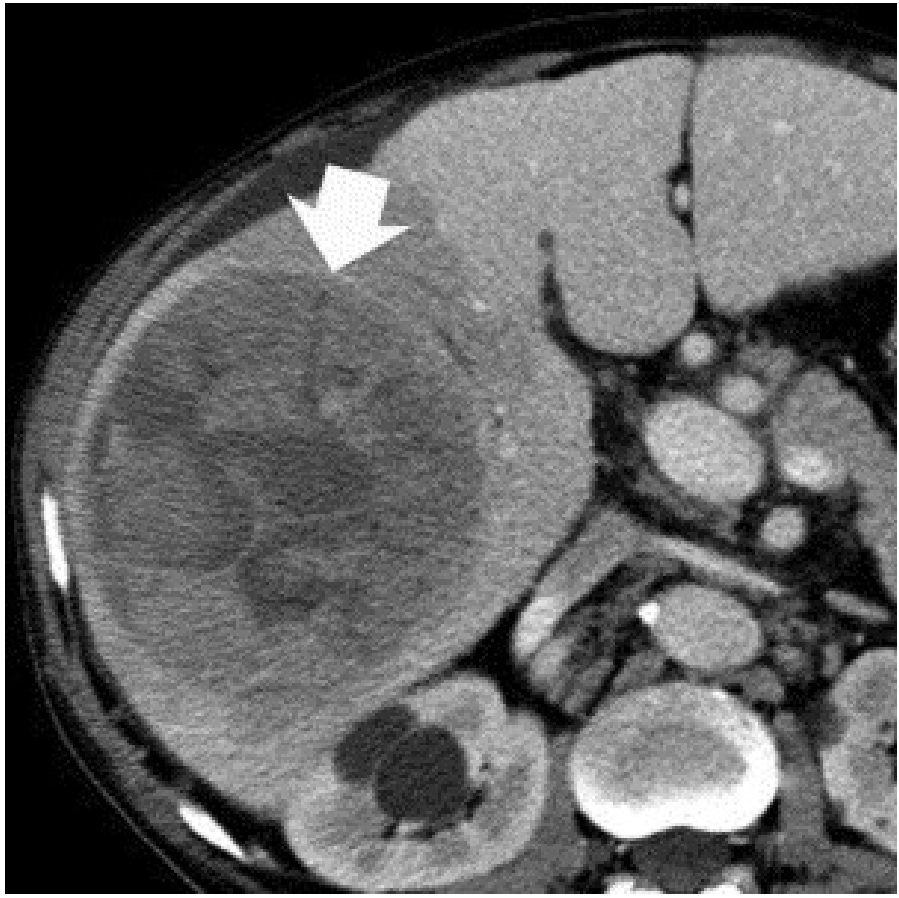
Image classification and object recognition



Aim

Investigate the diagnostic performance of AI compared to Radiologists in the diagnosis of HCC from multi-phasic CT images.

Methods

01. Databases

PubMed, Web of Science, Embase

02. Inclusions and exclusions

Inclusions: A ‘gold standard’ diagnosis, uses AI model, uses three-phase CT scans

Exclusions: Non-primary research, Large HCC vs non-HCC sample size imbalances

03. Key terms

“AI”, “multi-phase CT”, “HCC”

Search Strategy - Example

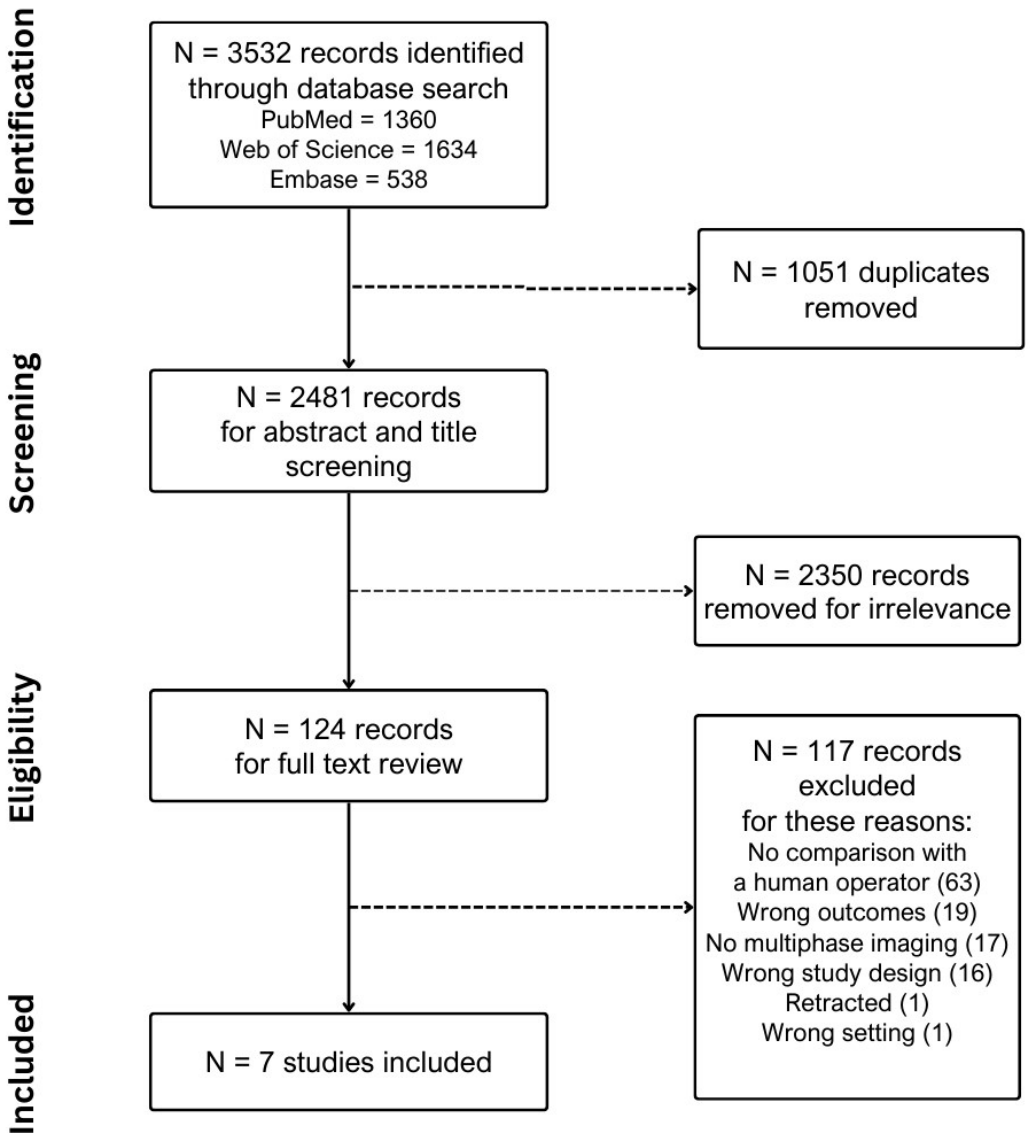
("artificial intelligence"[Mesh] OR "AI" OR "Artificial intelligence" OR "deep learning" OR "DL" OR "machine learning" OR "convolutional neural network*" OR "CNN")

AND ("tomography, x-ray computed"[Mesh] OR "CT" OR "Multi-phase CT*" OR "3-phase CT*" OR "three-phase CT*" OR "triple-phase CT*" OR "computed tomography" OR "computerised tomography" OR "computerized tomography" OR "contrast-enhance*" OR "arterial phase*" OR "venous phase*" OR contrast)

AND ("Carcinoma, Hepatocellular"[Mesh] OR "HCC" OR liver* OR "hepatocellular carcinoma*" OR hepatoma OR "liver segmentation")

AND NOT (Review[Publication Type]) NOT (Systematic Review[Publication Type]) NOT (Meta-Analysis[Publication Type]) AND ((humans[Filter]) AND (english[Filter]) AND (2018:2024[pdat]))

Articles


Identification
N = 3532 records identified through database search
PubMed = 1360
Web of Science = 1634
Embase = 538
N = 1051 duplicates removed
Screening
N = 2481 records for abstract and title screening
N = 2350 records removed for irrelevance
Eligibility
N = 124 records for full text review
N = 117 records excluded for these reasons:
No comparison with a human operator (63)
Wrong outcomes (19)
No multiphase imaging (17)
Wrong study design (16)
Retracted (1)
Wrong setting (1)
Included
N = 7 studies included

Results

Study	Algorithm Name	Human Operators	CT Studies	AI Accuracy	Human Accuracy	Conclusion
1	ResNet-18	3 & 8 years exp	462	68%	**88%**	Comparable to humans
2	ResNet-14	16 & 18 years exp	481	**92%**	87%	Comparable to humans
3	HCCNet	3 with 8-10 years exp	7,512	**81%**	79%	Comparable to humans
4	HPVD	6 & 12 years exp	771	**89%**	88%	Comparable to humans
5	LIAIDS	6 with 5-20 years exp	6,901	87%	**97%**	Comparable to humans
6	ALMSS	5 & 10 years exp	2,061	**86%**	76%	Comparable to humans
7	Not defined	7 & 8 years exp	493	**83%**	75%	Comparable to humans

Discussion

Sample size → bias

Some studies contain an unbalanced mix of HCC vs non-HCC in training data.

Incorporation into clinical practice

Not enough discussion on how clinicians interact with these models.

Lack of external validation

AI tends to perform best on the data that it was trained on.

AI Model Transparency

We don’t have a clear understanding of what image features lead the AI to diagnosis.

Summary

AI faster than humans

AI takes <1 s per diagnosis, humans' minutes

AI comparable to senior radiologists

And in some cases, performs better than radiologists

AI + humans performs best

Better than either mode independently suggesting AI is a useful tool for radiologists

Thank you!

Questions?

References

Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: A Cancer Journal for Clinicians. 2024;74(3):229-63.

Goutté N, Sogni P, Bendersky N, Barbare JC, Falissard B, Farges O. Geographical variations in incidence, management and survival of hepatocellular carcinoma in a Western country. J Hepatol. 2017;66(3):537-44.

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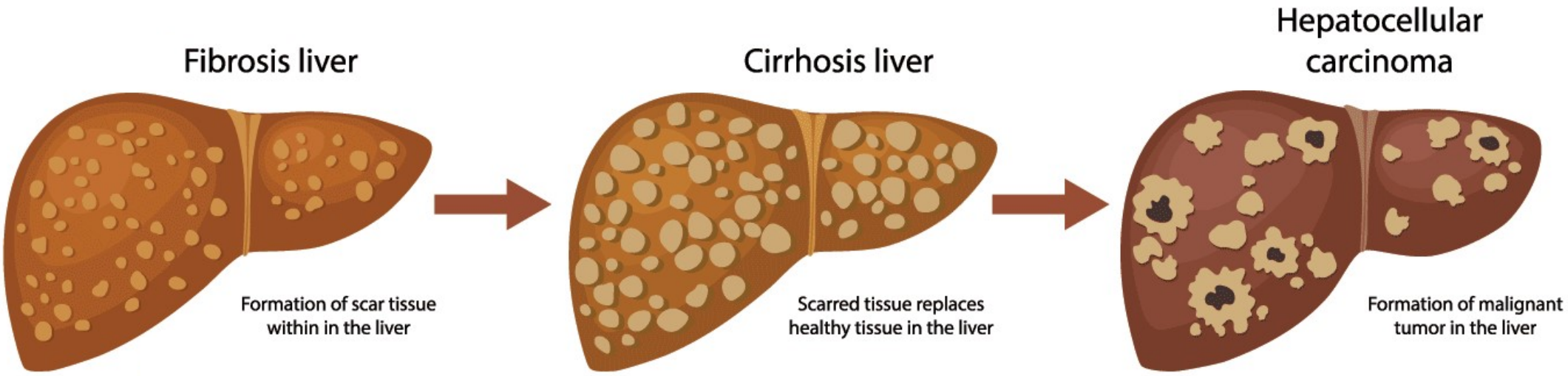
Soffer S, Ben-Cohen A, Shimon O, Amitai MM, Greenspan H, Klang E. Convolutional Neural Networks for Radiologic Images: A Radiologist's Guide. Radiology. 2019;290(3):590-606.


Fibrosis liver
Formation of scar tissue within in the liver
Cirrhosis liver
Scarred tissue replaces healthy tissue in the liver
Hepatocellular carcinoma
Formation of malignant tumor in the liver