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# Man vs Machine: How will Artificial Intelligence and Machine Learning Systems Impact Cancer Diagnosis and the Patient-Physician Relationship?

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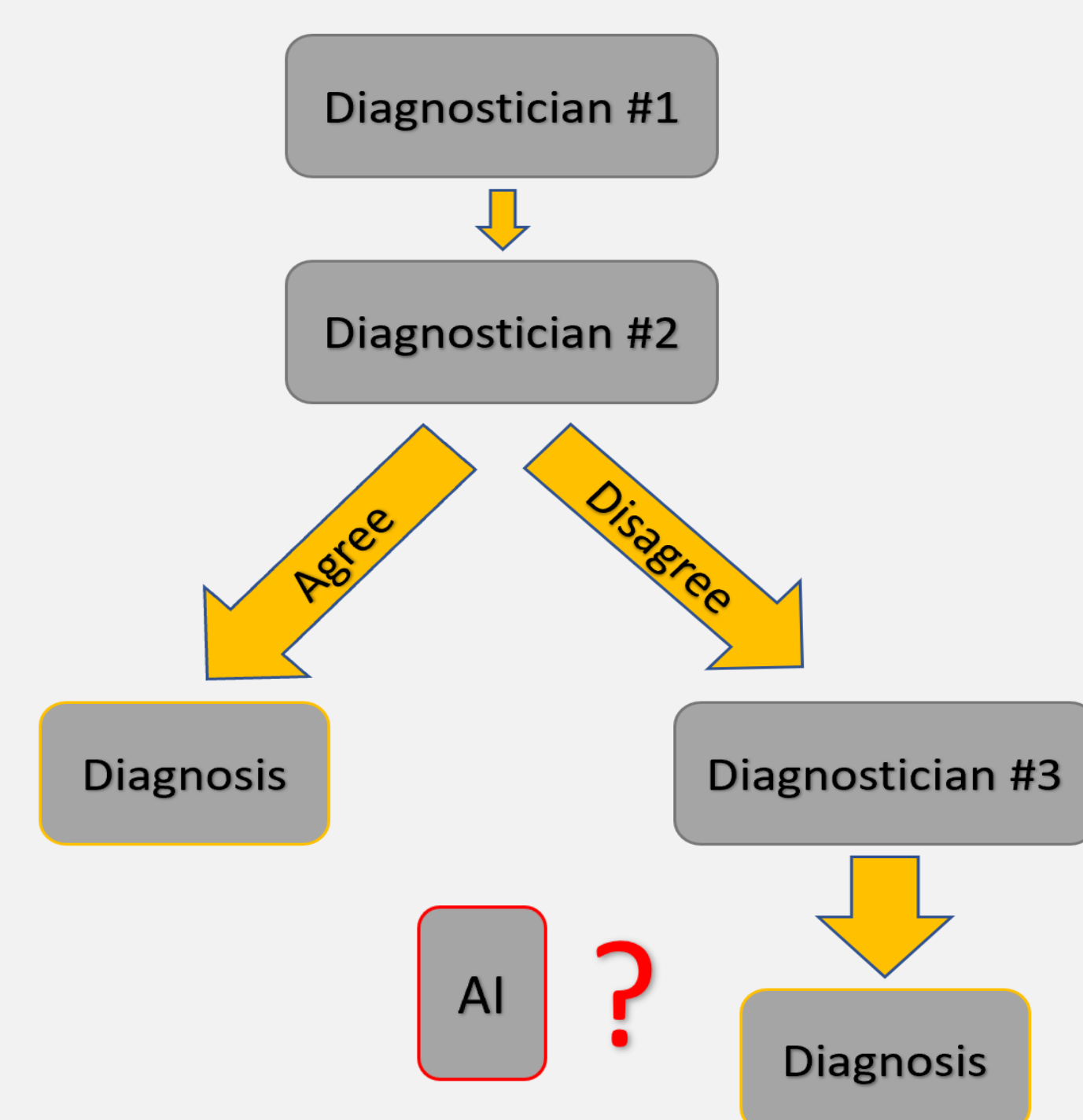
## Abstract

Oncologic diagnosticians are physicians who specialize in interpreting diagnostic exams to diagnose cancer. Software companies have been developing artificial intelligence [AI] systems to interpret these exams. These AI systems may affect the traditional role of diagnosticians if they were to be implemented in the clinical setting. Therefore, I set out to answer the research question: How will AI and machine learning systems impact the roles of oncologic diagnosticians in diagnosing cancer and in the patient-physician relationship? By analyzing surveys and studies, I examined the attitudes of oncologic diagnosticians and cancer patients toward implementing AI systems in healthcare. Furthermore, I compared the diagnosing accuracies of AI systems and oncologic diagnosticians to uncover which screening entity is superior. I also evaluated specific diagnostic workflows to explore the practical implementations of AI systems in oncology. I investigated AI systems' potential effects on the oncologic patient-physician relationship. Moreover, I reviewed the ethics of utilizing AI systems in cancer diagnostics to determine if AI implementation is practical. I observed positive attitudes amongst oncologic diagnosticians and patients towards the usage of AI systems, especially if these systems are to be used as assistance programs for physicians. In terms of screening accuracy and the impact on patient-physician relationships, surveys showed a lack of consensus. There are also several ethical implications present, but policies and guidelines can be implemented to regulate and manage the usage of AI systems as diagnostic tools. In summary, AI and machine learning systems seem unlikely to replace oncologic diagnosticians. Instead, studies suggest that these devices will assist physicians to reduce diagnostic errors and improve accuracy and reliability. The extent to which the patient-physician relationship is influenced by AI systems seems likely to depend on the physician and their style of practice.

## Summary Figure

### Current Diagnostic Model

- Typically, two diagnosticians interpret the cancer screening exam
- If they agree on the diagnosis, the diagnosis is established
- If they disagree on the diagnosis, another diagnostician interprets the cancer screening exam and becomes the deciding factor
- AI has the capability to interpret and evaluate cancer diagnostic and screening exams
- AI can potentially be integrated into this diagnostic model



## Statement of Problem

- Diagnostic errors are an established problem in cancer screening.
- The burden that new cancer cases and deaths place on hospitals is directly related to the resources required to diagnose cancer.
- While AI will not reduce new cancer cases, the number of cancer deaths can be reduced with increased screening and improved turnaround times of results, which may be improved by AI.

## Methods

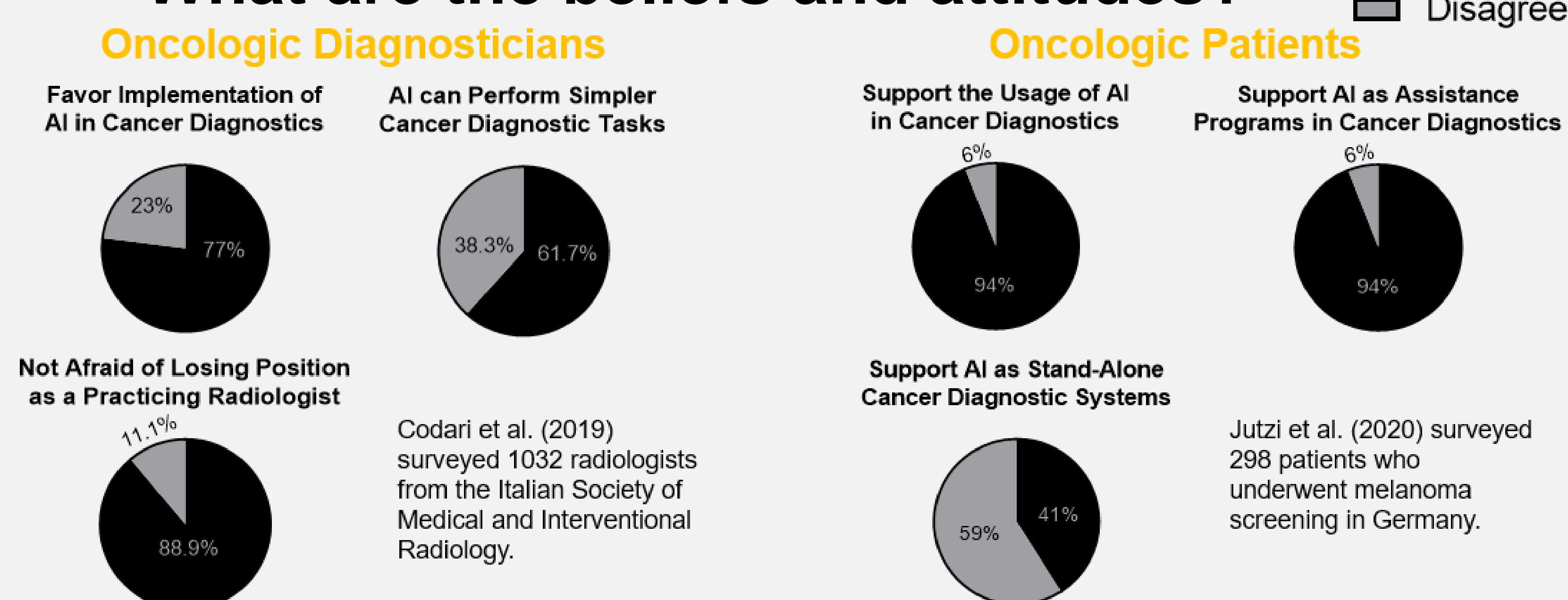
**Systematic Literature Review:** The following perspectives in the literature were analyzed

- Attitudes of oncologic diagnosticians and cancer patients on AI in healthcare
- Diagnosing accuracies of AI systems versus diagnosing accuracies of oncologic diagnosticians
- Diagnostic workflows to outline the practical implementations of AI systems in oncology
- AI's potential effects on the oncologic patient-physician relationship
- Ethics of utilizing AI systems in cancer diagnostics to determine if AI implementation is practical

**Statistics:** Graphs created in GraphPad Prism. Statistics from McNemar's test.  $p < 0.1^*$ ,  $p < 0.01^{**}$ ,  $p < 0.001^{***}$ ,  $p < 0.0001^{****}$ .

## Results

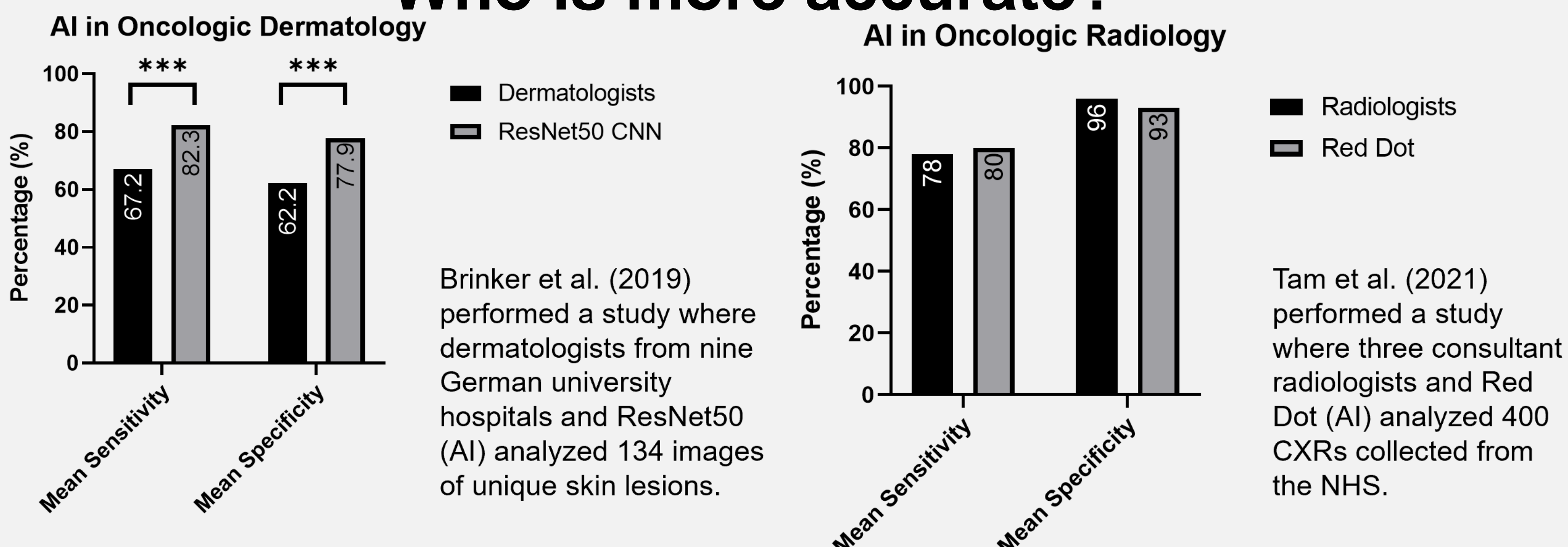
### What are the beliefs and attitudes?



**Figure 1. Opinions of Oncologic Diagnosticians and Patients on AI**

Oncologic diagnosticians (left) have a favorable and optimistic attitude towards the integration and usage of AI in diagnostic oncology. Oncologic patients (right) mostly have a positive attitude towards integrating AI into diagnostic oncology as assistance programs for diagnosticians.

### Who is more accurate?



**Figure 2. Diagnostic Accuracy of AI versus Diagnosticians**

AI system ResNet50 CNN was compared with dermatologists (left) when analyzing 134 unique skin lesions of known outcomes for melanoma. "Sensitivity" = correctly diagnosing melanoma-positive samples; "Specificity" = correctly diagnosing melanoma-negative samples. ResNet50 CNN had superior mean sensitivity and specificity rates compared to the dermatologists. AI system Red Dot was compared with radiologists (right) when analyzing 400 chest x-rays (CXRs). Red Dot had similar mean sensitivity and specificity rates compared to the radiologists.

- There is a lack of consensus in the literature on whether AI systems or oncologic diagnosticians are superior because results vary with medical specialty.
- AI systems are either comparable or superior to oncologic diagnosticians depending on specialty → AI does not seem to be less accurate than oncologic diagnosticians

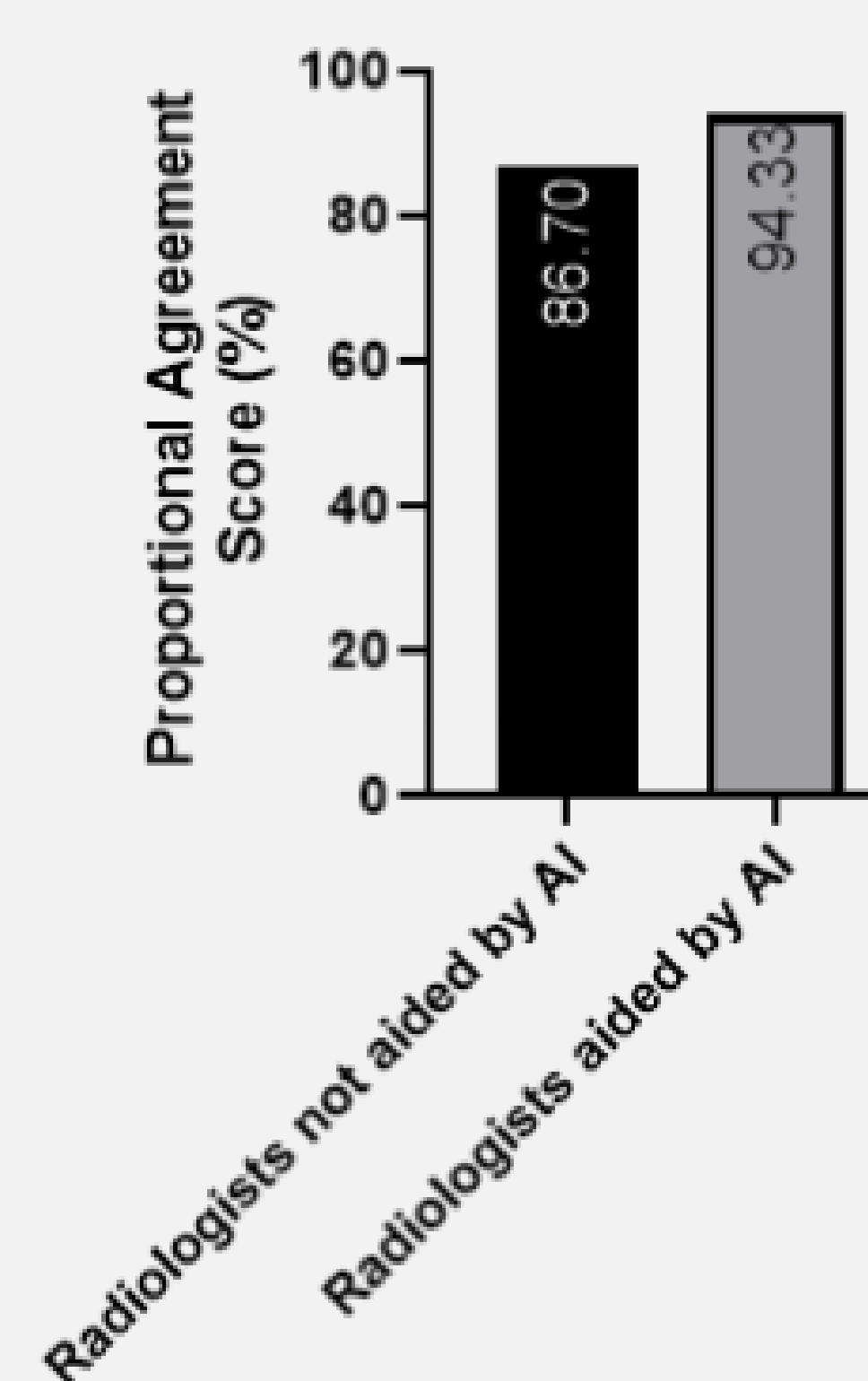
## Results

### What is a practical diagnostic workflow?

**Figure 3. Proposed Diagnostic Workflows**

Proportional agreement score measures the percentage of cases where all screening entities agree on the diagnosis. In this figure, screening entities include radiologists and AI system Red Dot. Radiologists had improved proportional agreement score when aided by AI, which indicates there was more consensus on diagnoses when the AI was present in the diagnostic workflow.

**Proposed Diagnostic Workflows**



Tam et al. (2021) performed a study where three consultant radiologists and Red Dot (AI) analyzed 400 CXRs collected from the NHS.

- AI may introduce bias and influence diagnosticians

## Conclusions & Future Directions

### Conclusions:

- Oncologic diagnosticians and cancer patients have favorable and optimistic beliefs and attitudes towards the integration and usage of AI systems in diagnostic oncology. Cancer patients express positivity towards AI being used as assistance programs, but they express negativity towards AI being used as stand-alone diagnostic systems. (Fig. 1)
- AI will influence the patient-physician relationship, but the extent of influence depends on the amount of reliance the physician places on it and the tasks it is assigned to perform. (Fig. 1)
- The accuracy rates of AI and oncologic diagnosticians seem to fluctuate depending on specialty. In dermatology, AI was superior in the study shown here. In radiology, AI was comparable to radiologists. However, it appears that AI is not less accurate than oncologic diagnosticians. (Fig. 2)
- There are multiple AI systems, and they can vary in performance. An ethical concern is present because there needs to be regulated standardization of AI systems that will be integrated into cancer diagnostics. (Fig. 2)
- Oncologic diagnosticians are more in agreement with each other regarding diagnoses when they are aided by an AI system. One should consider if AI is biasing diagnosticians' decision making. (Fig. 3)

These findings support that AI is unlikely to replace oncologic diagnosticians because AI will likely assist physicians to reduce diagnostic errors. The extent to which the oncologic patient-physician relationship is influenced is dependent upon how diagnosticians use the AI system.

### Future directions:

- The studies analyzed here to assess the usage of AI systems as oncologic diagnostic tools were performed on a small scale with small sample sizes.
- Future studies and experiments should be performed on a large scale with large sample sizes to understand AI's effects in cancer diagnostics.

## Acknowledgements

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