Please see below for a link to the webinar recording for the Trials Methodology Research Partnership:

CONSORT-AI and SPIRIT-AI guidelines

Xiao Lui, University of Birmingham

11 January 2021

On behalf of Health Data Research UK

The slides are also available below.

For any queries, please contact <u>uktmn@nottingham.ac.uk</u>

https://www.youtube.com/watch?v=wTjd3KDpSfc



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The SPIRIT-AI and CONSORT-AI initiative is an international collaborative effort to improve the **transparency** and **completeness** of reporting of **clinical trials** evaluating interventions involving artificial intelligence (AI)

Xiao Liu, Alastair Denniston



On behalf of The SPIRIT-AI & CONSORT-AI Working Group

Is there a problem with reporting in AI?

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*Joint first authors

Department of

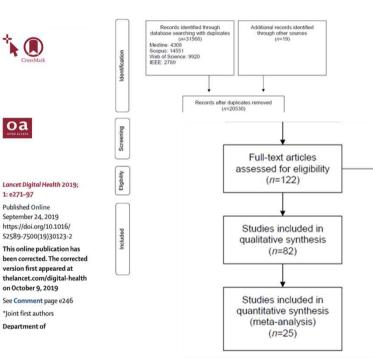
A comparison of deep learning performance against health-care professionals in detecting diseases from medical imaging: a systematic review and meta-analysis

Xiaoxuan Liu*, Livia Faes*, Aditya U Kale, Sieafried K Wagner, Dun Jack Fu, Alice Bruynseels, Thushika Mahendiran, Gabriella Moraes, Mohith Shamdas, Christoph Kern, Joseph R Ledsam, Martin K Schmid, Konstantinos Balaskas, Eric J Topol, Lucas M Bachmann, Pearse A Keane, Alastair K Denniston

Summary

Background Deep learning offers considerable promise for medical diagnostics. We aimed to evaluate the diagnostic Lancet Digital Health 2019; 1: e271-97 accuracy of deep learning algorithms versus health-care professionals in classifying diseases using medical **Published Online** imaging. September 24, 2019

Methods In this systematic review and meta-analysis, we searched Ovid-MEDLINE, Embase, Science Citation Index, and Conference Proceedings Citation Index for studies published from Jan 1, 2012, to June 6, 2019. Studies comparing the diagnostic performance of deep learning models and health-care professionals based on medical imaging, for any disease, were included. We excluded studies that used medical waveform data graphics material or investigated the accuracy of image segmentation rather than disease classification. We extracted binary diagnostic accuracy data and constructed contingency tables to derive the outcomes of interest: sensitivity and specificity. Studies undertaking an out-of-sample external validation were included in a meta-analysis, using a unified hierarchical model. This study is registered with PROSPERO, CRD42018091176.



Is there a problem with reporting in AI?

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Check for updates

accuracy of image segmentation rather than disease classifical OPEN ACCESS Artificial intelligence versus clinicians: systematic review of design, reporting standards, and claims of deep learning studies

RESEARCH

Myura Nagendran,¹ Yang Chen,² Christopher A Lovejoy,³ Anthony C Gordon,^{1,4} Matthieu Komorowski,⁵ Hugh Harvey,⁶ Eric J Topol,⁷ John P A Ioannidis,⁸ Gary S Collins,^{9,10} Mahiben Maruthappu³

For numbered affiliations see end of the article.	ABSTRACT OBJECTIVE	REVIEW METHODS Adherence to reporting standards was assessed		
Correspondence to: M Nagendran, Intensive Care, St Mary's Campus, Imperial College London, Praed Street, London W2 1NK, UK myura. nagendran@imperial.ac.uk (or @MyuraNagendran on Twitter: ORCID 0000-0002-4656-5096)	To systematically examine the design, reporting standards, risk of bias, and claims of studies comparing the performance of diagnostic deep learning algorithms for medical imaging with that of expert clinicians.	by using CONSORT (consolidated standards of reporting trials) for randomised studies and TRIPOD (transparent reporting of a multivariable prediction model for individual prognosis or diagnosis) for non- randomised studies. Risk of bias was assessed by		
	DESIGN	using the Cochrane risk of bias tool for randomised		
Additional material is published online only. To view please visit the journal online. Cite this as: <i>BMJ</i> 2020;368:m689	Systematic review.	studies and PROBAST (prediction model risk of bias		
	DATA SOURCES Medline, Embase, Cochrane Central Register of	assessment tool) for non-randomised studies. RESULTS Only 10 records ware found for door loaming		

Inadequate Reporting

- Population characteristics for datasets
- Inclusion/exclusion criteria of participants .
- Inclusion/exclusion criteria of images .
- Methods for splitting the datasets
- Image preparation and pre-processing
- Procedures for poor quality images
- Provision of the full algorithm
- Instructions on how to use the algorithm .
- Decisions made during algorithm training
- Expertise of the human comparator

Randomised Controlled Trials

Randomized Trials of AI Deep Neural Networks in Medicine

Procedure	Detection	Design	N Patients	N Sites	Place	Citation
Colonoscopy	Adenomas	Double- blind, sham control	1046	1	China	Wang P, Lancet Gastro Hep 2020
Colonoscopy	Adenomas	Unmasked	704	1	China	Gong D, Lancet Gastro Hep 2020
Colonoscopy	Adenomas	Unmasked	659	1	China	Su et al, Gastro Endoscopy 2020
Esophagogastro- duodenscopy	Blind spots	Unmasked	324	1	China	Wu L, Gut 2019
Colonoscopy	Adenomas	Unmasked	1058	1	China	Wang P, Gut 2019
Slit-lamp Photography	Childhood Cataracts	Unmasked	350	5	China	Lin H, E Clinical Medicine 2019

MENU Y nature medicine

Comment | Published: 24 September 2019

Reporting guidelines for clinical trials evaluating artificial intelligence interventions are needed

The CONSORT-AI and SPIRIT-AI Steering Group

Nature Medicine 25, 1467–1468(2019) | Cite this article 4097 Accesses | 150 Altmetric | Metrics



Enhancing the QUAlity and Transparency Of health Research



The CONSORT-AI Extension: Reporting Guidelines for Artificial Intelligence and Machine Learning Interventions in Randomised Trials (registered on 8th of May, 2019)

Steering Group: Professor Alastair Denniston, Professor Melanie Calvert, Dr Christopher Yau, Professor David Moher, Professor An-Wen Chan, Dr Pearse Keane, Professor Lucas Bachmann, Professor Chris Holmes, Dr Sebastian Vollmer, Dr Xiaoxuan Liu. Dr Livia Faes

> Protocol Guidelines for Artificial Intelligence and Machine Learning Interventions in Randomised Trials (SPIRIT-AI Extension) (registered 21 June 2019)

Steering Group: Professor Alastair Denniston, Professor Melanie Calvert, Dr Christopher Yau, Professor David Moher, Professor An-Wen Chan, Dr Pearse Keane, Professor Lucas Bachmann, Professor Chris Holmes, Dr Sebastian Vollmer, Dr Xiaoxuan Liu, Dr Livia Faes



randard Protocol Items: Recommendations for Interventional Trials



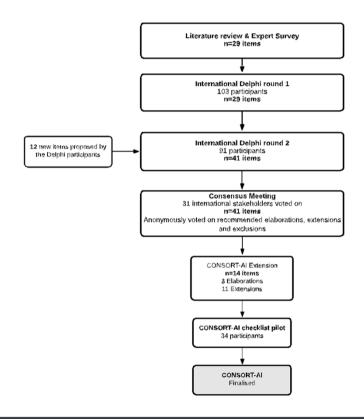
Developing SPIRIT-AI and CONSORT-AI

Review of existing guidance:

- ClinicalTrials.gov search for registered trials
 - 316 Studies found for: "machine learning" OR "deep learning" OR "artificial intelligence" on clinicaltrials.gov
 - 7 completed clinical trials with published results
 - 1 with a published protocol
- Regulatory bodies and policy
 - FDA: "Proposed Regulatory Framework for Modifications to Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD) Discussion Paper and Request for Feedback" April 2019
 - EMA: none
 - MHRA: none
 - NICE Evidence standards framework for digital health technologies
 - Academic literature
 - Kim et al 2019 design characteristics of reporting diagnostic analysis of medical images;
 - England and Cheng 2018, AI for medical image analysis: a guide for authors and reviewers;
 - Park et al 2018 Connecting Technological Innovation in Artificial Intelligence to Real-world Medical Practice through Rigorous Clinical Validation;
 - Park et al 2018 Principles for evaluating the clinical implementation of novel digital healthcare devices;
- Expert survey
- Liu & Faes *et al.* Lancet Digital Health, 2019.



Developing SPIRIT-AI and CONSORT-AI



- 103 international experts took part in the Delphi study
- 31 took part in the 2-day consensus meeting in Birmingham in January 2020.
- Healthcare professionals, methodologists, statisticians, computer scientists, industry representatives, journal editors, policy makers, health informaticists,

experts in law and ethics, regulators, patients and funders.





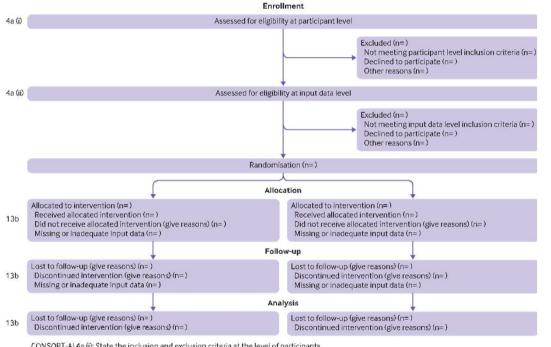
Title and abstract

CONSORT-AI 1a,b (i) Elaboration: Indicate that the intervention involves artificial intelligence/machine learning in the title and/or abstract and specify the type of model.

CONSORT-AI 1a,b (ii) Elaboration: State the <u>intended use</u> of the AI intervention within the trial in the title and/or abstract.

Introduction

CONSORT-AI 2a (i) Extension: Explain the <u>intended use</u> for the AI intervention <u>in the context of the</u> <u>clinical pathway</u>, including its purpose and its <u>intended users</u> (such as healthcare professionals, patients, public).



CONSORT-XI

Methods

CONSORT-AI 4a (i) Elaboration: State the inclusion and exclusion criteria at the level of participants.

CONSORT-AI 4a (ii) Extension: State the inclusion and exclusion criteria at the level of the input data.

CONSORT-AI 4a (i): State the inclusion and exclusion criteria at the level of participants CONSORT-AI 4a (ii): State the inclusion and exclusion criteria at the level of the input data CONSORT 13b (core CONSORT item): For each group, losses and exclusions after randomisation, together with reasons

CONSORT-XI

Methods

CONSORT-AI 4b Extension: Describe how the AI intervention was <u>integrated</u> into the trial setting, including any onsite or offsite requirements.

CONSORT-AI 5 (i) Extension: State which <u>version</u> of the AI algorithm was used.

CONSORT-AI 5 (ii) Extension: Describe how the input data were acquired and selected for the AI intervention.

CONSORT-AI 5 (iii) Extension: Describe how <u>poor quality</u> or <u>unavailable input data</u> were assessed and handled.

CONSORT-AI 5 (iv) Extension: Specify whether there was <u>human-AI interaction</u> in the handling of the input data, and what level of expertise was required of users.



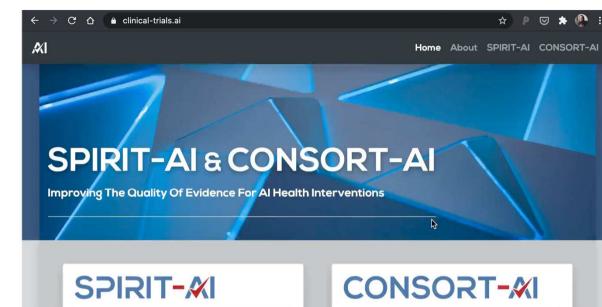
Results

CONSORT-AI 19 Extension: Describe results of any analysis of performance <u>errors</u> and how errors were identified, where applicable. If no such analysis was planned or done, explain why not.

Other information

CONSORT-AI 25 Extension: State whether and how the AI intervention and/or its code can be <u>accessed</u>, including any restrictions to access or re-use.





Reporting Guidelines for Clinical Trial Protocols for Interventions Involving Artificial Intelligence

The SPIRIT-AI Extension

Reporting Guidelines for Clinical Trial Reports for Interventions Involving Artificial Intelligence

The CONSORT-AI Extension

The SPIRIT-AI and CONSORT-AI initiative is an international collaborative effort to improve the transparency and completeness of reporting of clinical trials evaluating interventions involving artificial intelligence (AI). SPIRIT-AI stands for Standard Protocol Items: Recommendations for Interventional Trials - Artificial Intelligence and CONSORT-AI stands for (Consolidated Standards of Reporting Trials - Artificial Intelligence).

The SPIRIT-AI and CONSORT-AI statements are extensions to the SPIRIT 2013 and CONSORT 2010 reporting guidelines for

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Privacy Policy

naturemedicine

Guidelines for clinical trial protocols for

interventions involving artificial intelligence:

medicine

the SPIRIT-AI extension

THELANCET Digital Health

Guidelines for clinical trial protocols for interventions involving artificial intelligence: the SPIRIT-AI extension

s-Artificial Intelligence) extension is a new reporting guideline for conscar to an Al component. It was developed in parallel with its companion statem with the Constant of Reporting Triple, Artificial Intelligence. Both wideling

ment aims to improve the completeness of clinical trial protocol reporting by providir

b) 3 now items that were considered sufficiently important for clinical this periods of AU to a second s

way sum-parent examination of new interventions. More recently, there has been a growing recognition involving artificial intelligence (AI) need to indergo riporoas, prospective evaluation to dem et on health outcomes. The SPIRTFAI ISlandard Protocol Items: Recommendations for Intervential Intelligence extension is a new reporting multiplication for initial trial association schedule.

Introduction (clinical trial protocol is an essential document produced sy study investigators detailing a priori the rationals investigators detailing a priori the rationals investigators detailing a triori the rationals investigators detailing a priori the rationals investigators detailing a priori the rationals investigators detailing a triori the rationals investigators detailing a priori the rationals investigators details and a second second second second ratio and the rational second second second second second ratio and the ratio and the ratio and the ratio ratio and ratio and the ratio and the ratio and the ratio ratio and the ratio ratio and the ratio ratio and the ratio ratio and the ratio ratio and the ratio

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RESEARCH METHODS AND REPORTING CHEN ACCESS Guidelines for clinical trial protocols for interventions involving (I) Check for updates artificial intelligence: the SPIRIT-AI Extension Samantha Cruz Rivera, ¹² Xiaoxuan Liu; ^{2,9,6,6} An Wen Chan,⁷ Alastair K Denniston; ^{12,0,4,9} Melanie J Colvert, ^{12,4,9,10,11} On behalf of the SPIRIT-AI and CONSORT-A: Working Group The SPIRIT 2013 (The Standard Protocol investigators provide clear descriptions of the Al intervention, including or the atticle. Genespondance to: A Conceitor, walls to of refamiliation a

Items: Recommendations for Interventional Trials) statement aims to instructions and skills required for use. improve the completeness of clinical the setting in which the Al intervention trial protocol reporting, by providing evidence-based recommendations for will be integrated, considerations around the handling of input and output data, the human-Al interaction the minimum set of items to be addressed. This guidance has been and analysis of error cases. instrumental in promoting transparent evaluation of new interventions. More SPIRIT-AI will help promote recently, there is a growing recognition that interventions involving artificial intelligence need to undergo rigorous, their impact on health outcomes.

transparency and completeness for clinical trial protocols for Al prospective evaluation to demonstrate and peer-reviewers, as well as the general readership, to understand, interpret and critically appraise the The SPIRIT-AI extension is a new reporting guideline for clinical trials design and risk of bias for a planned

clinical trial.

interventions. Its use will assist editors

RESEARCH METHODS AND REPORTING

The two reporting guidelines for clinical trial protocols and reports

September 2020

were published in September 2020 in Nature Medicine, The Lancet Digital Health and The BMJ.

Samantha Cruz Rivera¹²³, Xiaoxuan Liu^{® XAA2}, An-Wen Chan^a, Alastair K. Denniston^{® XAAA} Melanie J. Calvert^{® (XXAAAN)}, The SPIRIT-AI and CONSORT-AI Working Group⁺, SPIRIT-AI a CONSORT-AI Steering Group and SPIRIT-AI and CONSORT-AI Consensus Group

CONSENSUS STATEM

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CONSENSUS STATEMENT

Reporting guidelines for clinical trial reports for interventions involving artificial intelligence: the **CONSORT-AI** extension

Xiaoxuan Liu^{12,3,45}, Samantha Cruz Rivera^{5,67}, David Moher^{(3,69}, Melanie J. Calvert^{(3,4,4,7}) Alastair K. Denniston 23.4.5.4.32 and The SPIRIT-AI and CONSORT-AI Working Group*

CONSORT 2010 statement provides minimum guidelines for reporting randomized trials. Its widespre-temental in ensuring transporters in the evaluation of new interventions. More recently, there has been a to the state of the statement of ensuring guidelines for clinical trial products SPRIFA (Statement of Reporting Train-Artificial Institu-ent clinical trials and the clinical trial products SPRIFA (Statement of Products) (Statement and the statement of the s a defense for diska for personals PRPT AI (Scharder Person) flexes becommendation for bleves flexes and the semantic set in barry and the set of the se

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Reporting guidelines for clinical trial reports for interventions 🍾 🌒 involving artificial intelligence: the CONSORT-AI extension oa

ment provides minimum guidelines for reporting randomised trials. Its widespread use towards has been instrumental in ensuring transparency in the evaluation of new interventions. More recently, there has a growing recognition that interventions involving artificial intelligence (AI) need to undergo rigorous, proop evaluation to demonstrate insect on health outcomes. The CONSORTA (Cannollated Standards of Res-volution) to the construction of the standards of the construction of the constructio evaluation to dominantize impact no health noticenses. The COMSOFTAI (Committational Standards of Reporting Theorem 2019) and the standard standard standard standards and the standard standards of Reporting Theorem 2019 and the standard standard standard standards and the standard standards and the Standard Testand Testa Reconstruction for Interventional Table-Articla Intelligence, footh quadration starter and and quadratic starter and the standard starter and the starter of the starter of the starter and and the starter objects the CONSURTAL extension includes 11 core immu that were considered unificiantly important time terms that the should be notifiedly speech in addition in the over CONSURT 210 lines. CONSURTAL 10 constraints and the should be notifiedly speech and addition in the over CONSURT 210 lines, and for some the wering in which the A bit intervention is integrated, the handling of impact and negroup of the A1 time the human-A1 distribution of an analysis of error cases. CONSURTAL 2014 lines are every and completeness in reporting (field) at this flat A1 interventions. It will avoid colour add per reviewers the general modeling is a understand, intervention and object of error cases. CONSURTAL 2014 lines 1014 lines just the general modeling is a understand, intervention and error the quality of distingt and to lide lines just the general modeling is a understand, intervention and the general modeling term in the general modeling term of the source and of the lines of the source of the source of the source and of the lines of the source of t

siled trials (RCIA) are considered the experimental design for providing eri-traperimental design for providing eri-that most recent AI and/es are inadequately re-defined an intervention." That and ensuing providing publicless do not fully legately reported, have the potential to potential sources of bias specific to AI systems, have devidens. dand exper-

COMPANY OF ACCESS Reporting guidelines for clinical trial reports for interventions involving artificial intelligence: the CONSORT-AI Extension () Check for updates Xiaoxuan Liu, ^{1,2,3,45} Samantha Cruz Rivera,^{3,6} David Moher,^{1,8} Melanie J Calvert,⁴ Alastair K Denniston, ^{1,2,4,5,5,12} On behalf of the SPIRIT-AI and CONSORT-AI Working Group The CONSORT 2010 (Consolidated intervention, including instructions and for sumbered affilelists see e of the article. skills required for use, the setting in Standards of Reporting Trials) statement provides minimum which the Al intervention is integrated guidelines for reporting randomised the handling of inputs and outputs of trials. Its widespread use has been the Al intervention, the human-Al interaction and providing analysis of instrumental in ensuring transparency when evaluating new interventions. error cases. Accepted: 4 August 2020 More recently, there has been a CONSORT-AI will help promote growing recognition that interventions transparency and completeness in reporting clinical trials for Al to undergo rigorous, prospective evaluation to demonstrate impact on interventions. It will assist editors and peer-reviewers, as well as the general health outcomes. readership, to understand, interpret The CONSORT-AI extension is a new reporting guideline for clinical trials and critically appraise the quality of clinical trial design and risk of bias in evaluating interventions with an Al component. It was developed in the reported outcomes. parallel with its companion statement

SPIRIT-AI CONSORT-M





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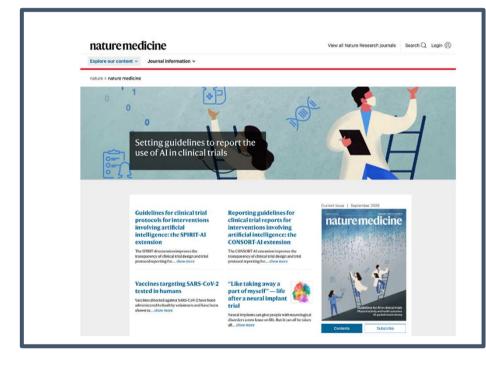
SPIRIT-AI & CONSORT-AI Consensus Group:

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Impact - will it make a difference?

Endorsed by journals



Welcomed by regulatory experts

FDA

M. Khair ElZarrad - Deputy Director. Office of Medical Policy - CDER. U.S. FDA:

"Developing a framework that helps facilitate and encourage transparency for the use of AI in clinical trials is important to advancing the field in general, and to establishing trust in AI-based tools and approaches."

MHRA

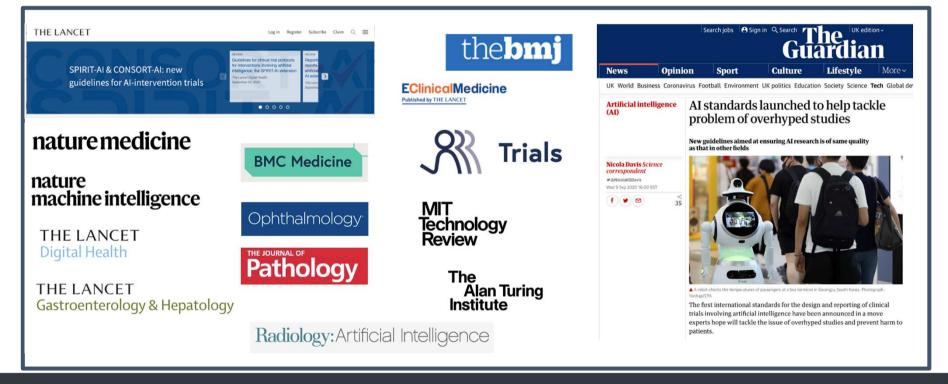
Dr **Maria Beatrice Panico**, Medicines and Healthcare products Regulatory Agency (MHRA):

'The SPIRIT(AI) and CONSORT(AI) initiatives will contribute to the safe and scientifically sound development of artificial intelligence in the context of clinical trials'



Impact - will it make a difference?

Widespread coverage - an opportunity to explain why this matters



Impact - future work

Recognising that many studies in the field of AI are not RCTs

<i>Editorial</i> Table 1. Summary of Guidelines for Artificial Intelligence Studies						
Development and validation pl	hase					
STARD AI ¹⁴	Diagnosis	Diagnostic accuracy study	Testing the diagnostic accuracy of an AI system	In development		
TRIPOD ML ¹⁵	Diagnosis or prognosis	Studies developing, validating, or updating a prediction model	Development, validation, or updating of an AI system, or a combination thereof	In development		
Testing and regulatory phase						
They nearly		Randomized trial (report)	Randomized trial report, results for the effectiveness of an AI system	Published online September 9, 2020, in the British Medical Journal, Lancet Digital Health, and Nature Medicine		
SPIRIT AI ⁷	Any health intervention	Randomized trial (protocol)	Randomized trial protocol for testing the effectiveness of an AI system	Published online September 9, 2020, in the British Medical Journal, Lancet Digital Health, and Nature Medicine		



Campbell et al Reporting guidelines for Artificial Intelligence in Medical Research. https://doi.org/10.1016/j.ophtha.2020.09.009



SPIRIT-&I CONSORT-&I