CHEST CT SCAN

RECOMMENDATION

We suggest against the routine use of CT scan for diagnosing COVID-19 among suspected patients with COVID-19 presenting at the emergency department if RT-PCR testing is readily available with timely results. *(Very low quality of evidence; Conditional recommendation).*

If RT-PCR test is not available, we suggest using non-contrast chest CT scan for symptomatic patients suspected of having COVID-19 to guide early triage and management under the following conditions *(Very low quality of evidence; Conditional recommendation)*:

- Mild COVID-19 patients who are at risk for progression
- Moderate to severe COVID-19 patients

EVIDENCE SUMMARY

Should CT scan be used to diagnose COVID-19 infection among suspected patients?

Evidence Reviewers: Myzelle Anne J. Infantado, PTRP, MSc (cand.), Cary Amiel G. Villanueva, MD, & Howell Henrian G Bayona, MSc

Key Findings

There is very low-quality evidence from 42 observational studies on the use of CT scans in diagnosing COVID-19 infection. Uncertainty arises mainly from unclear reporting of the threshold and variations in reporting of CT scan findings. Heterogeneity across studies was also substantial. The sensitivity ranged from 84.3 to 90.3%, and the specificity ranged from 74.2 to 83.9%.

Introduction

Computed tomography (CT) scans utilize a computer to combine two-dimensional X-ray images and convert them into three-dimensional ones. Images are produced by this non-invasive, highly specialized equipment and interpreted by radiologists [1]. It has become the standard of care in diagnosing and assessing various pulmonary conditions to optimize therapeutic management [2]. Different characteristics of CT features that guide clinical pathway are different degrees of ground-glass opacities with and/or without crazy-paving sign, multifocal organizing pneumonia, and layer distortion in peripheral distribution, as reported in one review [3].

CT scans have been used in the COVID-19 pandemic more frequently when there was still limited RT-PCR to diagnose COVID-19 infection. It provides images of lung conditions when there is high clinical suspicion of COVID-19 [1]. CT scans also are relatively faster and cheaper than RT-PCR

tests in the early period of pandemic [4]. It was also reported to have higher sensitivity (94%, 95% CI 91% to 96%; I^2=95%) in initial studies compared with RT-PCR (89%, 95% CI 81% to 94%) [5].

Review Methods

We searched several electronic databases (MEDLINE through PubMed, Cochrane CENTRAL) and preprint servers (medRxiv, bioRxiv, ChinaXiv) until March 25, 2021, using the following keywords in free text and MeSH terms: suspect, probable, healthcare worker, coronavirus, NCOV, COVID-19, SARS-Cov-2, CT Scan, CAT Scan, radiograph, RT-PCR, polymerase chain reaction. We also searched trial registries (ClinicalTrials.gov, WHO ICTRP, ChiCTR) on March 26, 2021, for ongoing clinical studies.

To assess and determine the studies to be included in this evidence review, we set a priori the following inclusion criteria: (1) suspected or probable cases of COVID-19, (2) available data to construct a 2x2 contingency table for diagnostic accuracy, (3) used CT scan as index test and RT-PCR as the reference standard. We set our exclusion criteria: (1) confirmed cases of COVID-19 at the beginning of the study and (2) case series, case reports, case-control studies.

We appraised the studies using the QUADAS-2 tool and extracted the data from the included studies. Measures of diagnostic accuracy such as sensitivity and specificity values were pooled using STATA version 14. When applicable, we performed subgroup analysis based on (1) criteria of abnormality from CT findings, and (2) population (i.e., symptomatic vs. asymptomatic, outpatient or in-patient, and age group).

Results

Characteristics of Included Studies

Types of studies

Evidence for this review came from 42 observational studies (40 cohort, 2 cross-sectional) involving a total of 16,187 patients. These studies were included in nine systematic reviews and meta-analyses on the same topic except for one additional cohort study published on January 27, 2021. The Cochrane systematic review [1] was the most comprehensive of these reviews. All 42 studies focused on the diagnostic performance of CT scan, while a few (5/42) reported the prevalence of most discriminative features that can be found in CT scan among patients tested positive with COVID-19 in RT-PCR tests.

Participants

Twenty-nine (70%) studies included only adult participants, while 13 (30%) studies reported both adults and children. All participants were suspected of having COVID-19. Thirty-three (79%) studies involved only symptomatic (at least having one of the symptoms such as fever, cough, or dyspnea) patients, 11 (26%) studies involved both symptomatic and asymptomatic patients (i.e., without clinical suspicion of COVID-19), and 8 (19%) studies did not explicitly state participant's symptom status. Twenty-three (55%) studies included patients admitted to an emergency department.

Index test and definition of imaging test positivity

The majority of the studies were not able to describe the type of CT used, but some reported using plain chest CT (n=12) and low dose CT (n=6). Some studies reported using CT Scans from GE Medical, Philips, Siemens, or Canon Medical. Studies used different scoring systems for

determining positive results in CT scans (e.g., British Society Thoracic Imaging COVID-19 reporting template, RSNA classification, CO-RADS scoring). Nine studies included in the meta-analysis evaluated CT findings and used the CO-RADS scoring system to define index test positivity.

One study [6] that compared chest CT and chest X-ray (CXR) indirectly concluded that both imaging tests have similar specificity when used among suspected patients with COVID-19 presenting at the emergency department. However, the sensitivity of chest CT (85%; 95% CI 79% to 90%) was significantly higher than CXR (56%; 95% CI 54% to 65%).

Reference standard
All studies used RT-PCR as the reference standard for the diagnosis of COVID-19. The time interval between the index test and reference varied from less than or equal to 24 hours [7-14] to 2 to 7 days [4, 15-25].

Risk of bias assessment
The risk of bias was moderate to high in the selection of patients, index test, reference standard, and flow and timing. One common finding among these studies is they included all participants who are suspected with COVID-19 and underwent both tests, but they were not able to describe if both CT scan and RT-PCR were part of the standard of care upon admission or CT scan was used only in severe symptomatic cases that may not reflect the target population. Sixteen or 42% of the studies could not pre-specify or have unclear reporting of the threshold used. In terms of the reference standard, 33 studies (79%) failed to report if assessors had no previous knowledge of index tests or reference standard results. However, in this comparison, it may be presented as low risk of bias since the RT-PCR test does not rely on any assessor's judgment to determine positivity and is the current gold standard in diagnosing COVID-19 infection. Nineteen studies (45%) also did not specify the time interval between CT scan and RT PCR testing.

Overall quality of evidence
The GRADE quality of the body of evidence for CT scans for COVID-19 diagnosis was rated very low *(Appendix 4)* due to serious risk of bias and very serious inconsistency.

Typical CT Imaging Features
Six studies reported the prevalence of prominent features found in CT images of COVID-19 patients' thoracic area (Table 1) [7,12,18,26-28]. All studies described a CT image of lungs having ground-glass opacity (GGO), with peripheral distribution, posterior, bilateral, and multilobe lesions, subpleural involvement, and small vessel enlargement.

Table 1. COVID-19 CT image features from different studies

Study	GGO	Peripheral distribution	Posterior involvement	Subpleural involvement	Bilateral involvement	Multilobe involvement	Vessel dilatation
Aslan[7]	69.2%	74.3%	74.3%	41.6%	-	-	-
Caruso[12]	100%	89%	93%	-	-	93%	89%
Giannitto[18]	93%	79%	-	-	93%	93%	-
Li[26]	69%	-	-	77%	-	-	93%
Luo (1)[27]	90%	97%	100%	-	-	-	-
Luo (2)[28]	39%	-	-	-	84.3%	-	-

Diagnostic Accuracy

Based on 42 studies (n = 8143) the pooled sensitivity was estimated at 87.6% (95% CI 84.3, 90.3%) while the pooled specificity (n = 8049) was 79.5% (95% CI 74.2, 83.9%). These observational studies had substantial heterogeneity in both pooled sensitivity (I^2 = 93.80) and specificity values (I^2 = 96.5). Subgroup analyses based on population and index tests were not possible due to lack of granularity in data in most studies (i.e., adult and children, non-contrast vs. contrast). We performed subgroup analyses based on the presence of symptoms and difference in test interval between RT-PCR and CT scan and definition for index test positivity.

Table 2. Accuracy of CT scan stratified by potential sources of heterogeneity

Subgroup	Studies (Sample size)	Sensitivity (95% CI)	I^2	Specificity (95% CI)	I^2
Population					
Symptomatic	27 (11554)	51% (43 – 59%)	97.4%	67% (54 – 78%)	93.7%
Mixed [a]	6 (2482)	45% (30 – 60%)	96.7%	64% (38 – 84%)	95.4%
Timing					
≤ 24 hrs	9 (1865)	55% (44 – 66%)	95.0%	67% (50 – 81%)	81.5%
> 24 hrs (up to 7 days)	11 (8623)	85% (76 – 91%)	96.8%	75% (62 – 85%)	98.4%
Index test positivity [b]					
Radiologist impression	13 (7000)	90% (85 – 94%)	n/a	77% (67 – 85%)	n/a
Formal scoring system	23 (6805)	86% (81 – 89%)	n/a	80% (75 – 84%)	n/a

[a] both asymptomatic and symptomatic; [b] adopted from the meta-analysis[1]

Table 2 shows that the sensitivity of CT scan is poor (51%) even when used among symptomatic patients with a clinical suspicion of COVID-19. Its sensitivity is also poor when used within 24 hours from symptom onset, making it less preferable than RT-PCR in emergency settings. Using either a radiologist's interpretation or a formal scoring system to determine test positivity seemed to have no difference in terms of diagnostic accuracy.

Recommendations from Other Groups

The American College of Radiology [29] (March 2020) does not recommend using chest CT to screen or diagnose COVID-19. They only recommend it for monitoring hospitalized patients when needed management.

In WHO guidelines [30] (June 2020), they suggest not using chest imaging for the diagnostic work-up of symptomatic patients with suspected COVID-19 when RT-PCR testing is available with timely results. However, they also suggest using chest imaging for the diagnostic work-up of COVID-19 when RT-PCR testing is (1) not available, (2) available but with delayed results, and (3) has negative results but with clinical suspicion of COVID-19. Although it has been recognized that chest CT has relatively high sensitivity and low specificity and can be useful in monitoring pulmonary diseases, the absence of radiological findings indicative of pneumonia still does not rule out viral infection. Chest radiography, compared with chest CT scan, is also considered because of (1) low cost, (2) low radiation doses, and (3) portability, and (4) convenience in monitoring disease progression.

The Center for Disease Control [31] (February 2021) also recognized that chest CT alone is not recommended in diagnosing COVID-19 because of the imaging pattern found in pneumonias caused by other infections.

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Appendix 1. Characteristics of Included Studies

Study ID	Design	Setting	Population	Sample Size	Index test	Index Test Interpretation	Reference standard	Outcomes
Mirahmadizadeh 2021 [32]	CS	Iran, ED	● Suspected COVID-19 ● Adults	54	Chest CT scan (unclear) Brand/Manufacturer: NR	Abnormal CT vs normal CT (n=17) Abnormal (n=37) - GGO (23) (Sn 67.9%, Sp 53.8%) - Consolidation (28) (Sn 35.7%, Sp 65.4%)	RT-PCR Oropharyngeal and nasopharyngeal (not reported number on swab type)	Dx performance
Ai 2020 [4]	RC	China, unclear	● Suspected patients with COVID ● Adults	1014	Chest CT Scan (slice thickness, 10mm) B/M: uCT 780 (United imaging, Shanghai china), Optima 660 (GE healthcare chicago)	CT findings by radiologists Chest CT scan positive: GGO, consolidation, reticulation and/or thickened interlobular septa (nodules) and lesion distribution	RT-PCR No details on swab	Dx perf
Aslan 2020 [7]	RC	Turkey, ED	● Suspected patients, symptomatic ● Hospitalized (6 days)	306	Chest CT (non-contrast, low dose)	CT findings by two experienced radiologists Radiological evidence of COVID-19 pneumonia (GGO, GGO+consolidation, consolidation, distribution, number of lobes and segment affected by GGO)	RT PCR twice , no details on swab	● Dx perf ● CT findings in covid19 patients
Barbosa 2020 [33]	RC	Brazil, ED	● Suspected patients with COVID19 ● Adults, cancer patients ● All symptomatic (6 days)	91	Chest CT	CT findings read by two experienced radiologist RSNA classification (typical, indeterminate, atypical, negative)	RT PCR, no details on swab	● Dx perf
Bellini 2020 [15]	RC	Italy,ED	● Suspected cases of COVID19 ● Symptomatic (at least 1: fever, cough, dyspnea) ● Children and adults	572	Chest CT (non-contrast) B/M: CT Scanner	CT findings read by radiologists Classified using CO-RADS (2, 3,4,5) Used (>/4)	RTPCR twice in some (other clinical signs on follow up) NP, OP swab	● Dx perf ● Validity of CO-RADS
Besutti 2020 [16]	CS	Italy,ED	● Suspected patients with COVID-19 ● Symptomatic ● Adults and some children	696	Chest CT (non-contrast, slice thickness 2.5mm) B/M: Siemens, Philips, GE Healthcare Test at admission	CT findings read by radiologist. Definition: a structured report about probability of COVID19 pneumonia (radiologist impression – highly suggestive)	RT PCR once or twice in some NP, OP No details on swab	● Dx perf

Borakati 2020 [6]	RC	UK, ED	● Suspected cases ● Symptomatic or asymptomatic	302	Chest CT (non-contrast,IV contrast)	CT findings read by radiologist, Definition: British Society of Throacic ImagingI template 0,1,2,3 — 3: classic findings of COVID-19 (peripheral GGO)	RT PCR once, twice in some No details on swab	● Dx perf
Cartocci 2020 [11]	RC	Italy, ED	● Suspected COVID-19 ● Symptomatic (at least 1: fever, cough, dyspnea), admitted ● Adults	314	Chest CT (slice thickness, 1.0mm) Brand: Siemens SOMATOM Sensation, Germany)	CT findings read by radiologist Definition: classification system by Simpson, typical CT pattern, possible CT pattern, inconsistent CT pattern, negative for pneumonia	RT PCR once, twice in some No details on swab	Dx perf
Caruso 2020 [12]	PC	Italy; ED	● Suspected COVID19 ● Symptomatic, (at least 1: fever, cough, dyspnea), admitted ● Adults	158	Chest CT (non-contrast) Brand: GE Medical	CT findings read by radiologist Definition: pneumonia (GGO, multlobar, bilateral distribution, oosterior involvement) (>90% prevalence)	RT PCR twice as necessary NP, OP	● Dx perf ● CT findings
Debray 2020 [34]	RC	France; ED, ID	● Suspected COVID19 ● Unclear symptom status ● Adults, including with comorbidities	241	Chest CT (non-contrast)	CT findings by 6 radiologists, emergency physicians Definition: evocative; multifocal GGO, being nodular or not, crazy-paving with or without consolidations, with a bilateral, peripheral or mixed distribution and involvement of the posterior zones	RT PCR once, twice in some No details on swab	● Dx perf ● Reliability of CT findings
Deng 2020 [35]	RC	China, Unclear	● Suspected COVID19 ● Symptomatic ● Adults and children	587	Chest CT (high res)	CT findings by radiologist Definition: Any of the following: - GGO - Thickened blood vessels - Thickened bronchial shadows passing through - With or without localized lobular septal grid thickening - Single or multiple real shadows - Re-exam 3-5 days later showed original GGo or consolidation range	RT PCR once No details on swab	Dx perf
De Smet 2020 [36]	PC	Belgium, unclear	● Suspected COVID-19 ● Symptomatic (WHO def) and asymptomatic (without clinical suspicion but admitted for other medical emergencies)	859	Chest CT	CT findings by _____ Definition: CO-RADS (2,3,4,5) ■ CO-RADS 5	RT PCR No details on swab	● Dx perf of CT using CO-RADS in symptomatic and asymptomatic

			• Adults and children • Admitted					
Dofferhoff 2020 [37]	PC	Netherlands, ED	• Suspected COVID19 • Symptomatic (fever, dyspnea, cough) or asymptomatic	312	Chest CT (low dose)	CT findings by _____ Definition: CO-RADS (2,3,4,5)	RT PCR once, twice in some No details on swab	Dx perf
Ducray 2020 [38]	RC	France, ED	• Suspected COVID19 • Symptomatic or asymptomatic • Adults	694	Chest CT (IV contrast) B/M: Philips Siemens GE Canon Medical systems	CT findings by radiologist Definition: CT classification surely COVID+ (peripheral, bilateral or multifocal GGO + consolidations or crazy paving,reversed halo sign or subpleural bands of consolidations), possible COVID+, COVID-	RT PCR once, twice in some No details on swab	• Dx perf • Compare the delay in reporting
Falaschi 2020 [17]	RC	Italy, ED	• Suspected COVID-19 • Symptomatic • Adults	773	Chest CT (non-contrast, slice thickness 1mm) Brand: Philips	CT findings by radiologist Definition: STR/ACR/RSNA (typical and indeterminate features)	RT PCR once, twice in some Nasopharyngeal	• Dx perf
Fonsi 2020 [39]	PC	Italy, ED	• Suspected COVID-19 • Symptomatic • Adults	63	Chest CT (non-contrast)	CT findings by **radiologist** Definition: GGOs, consolidation, a mixed GGO and consolidation, single or multiple solid nodules surrounded by GGOs; focal or multifocal distribution, GGO and consolidation location; multilobe involvement, a bilateral distribution; interlobular septal thickening, an air bronchogram; the presence of cavitation; bronchial wall thickening; bronchiectasis, mediastinal lymph node enlargement; pleural effusion and pericardial effusion	RT PCR once, twice in some No details on swab	• Dx perf (LUS, CT scan)
Fujioka 2020 [40]	RC	Japan, Unclear	• Suspected COVID19 • Symptomatic • Adults	154	Chest CT Brand: Siemens Done within first 2 hours of admission	CT findings by radiologist Definition: CO-RADS (2,3,4,5)	RT PCR once, twice in some No details on swab	• Dx perf of CT using CO-RADS
Gezer 2020 [41]	RC	Turkey, Pandemic clinic	• Suspected COVID19 • Symptomatic (at least one: fever, cough, dyspnea) • Adults	222	Chest CT (non-contrast) Brand: Philips	CT findings by radiologist Unclear definition of positive diagnosis on CT (typical chest CT findings were not clearly specified)	RT PCR and other clinical signs and imaging tests No details on swab	• Dx perf of CT
Giannitto 2020 [18]	RC	Italy, ED	• Suspected COVID-19 • Symptomatic (fever coigh and dyspnea)	68	Chest CT (non-contrast) Brand; Philips	CT findings by radiologist Definition: classification system: suspected COVID-19 pneumonia, non-COVID-19 pneumonia, negative CT	RT PCR twice, if necessary NP, BA (preferred)	• Dx perf of CT in patients with moderate or high

			• Adults					pretest probability of COVID-19 • Describe imaging features of COVID-19
Gietama 2020 [8]	PC	Netherlands, ED	• Suspected COVID-19 • Symptomatic (not including those who need immediate intubation) • Adults including those with comorbidities	193	Chest CT (non-contrast) Brand: GE Medical	CT findings by resident Definition: standardized imaging reporting system (typical for COVID-19, equivocal, non COVID19	RT PCR once, twice in some No details on swab	Dx perf of CT
Guillo 2020 [19]	RC	France, ED	• Suspected COVID-19 • Symptomatic • Adults	214	Chest CT (non-contrast except for patients for whom pulmonary embolism was suspected as alternative diagnosis of COVID-19 pneumonia after clinical ax and D-dimer dosage) Brand: Siemens	CT findings by resident Definition: structured report about probability of COVID-19 pneumonia based on the presence of GGOs, with or without crazy paving pattern, isolated or admixed with perilobular or linear consolidation, their peripheral or central distribution	RT PCR once, twice in some No details on swab	• Dx perf of CT • Poor prognostic factors
He 2020 [10]	RC	China, Unclear	• Suspected COVID-19 • Unclear symptom status • Adults and children	82	Chest CT (non-conrtast, high resolution	CT findings by radiologist Definition: GGO with or without consolidation, crazy paving pattern, peripheral and diffuse distribution and bilateral/multilobular involvement	RT PCR once, twice in some NP, OP, EA, BA	Dx perf
Hermans 2020 [9]	PC	Netherlands, ED	• Suspected COVID19 • Symptomatic or asymptomatic • Adults only (>/ 18yo)	319	Chest CT Brand: canon, Philips, siemens	CT findings by radiologist Definition: CO-RADS (2, 3,4,5)	RT PCR once No details on swab	Dx perf
Hernigou 2020 [42]	RC	Belgium, ED	• Suspected COVID-19 • Symptomatic or asymptomatic • Adults (with dx of fx or trauma, nondeferrable elective tx)	47	Chest CT (low dose)	CT findings by at least two radiologists Definition: unclear	RT PCR once, twice in some No details on swab	Dx perf
Herpe 2020 [20]	PC	France, Unclear	• Suspected COVID-19 • Symptomatic	4824	Chest CT	CT findings by experienced radiologist	RT PCR once, twice in some	Dx perf

			• Adults and children			Definition: bilateral GGO with peripheral distribution, biltateral paving appearance with intralobular thickening, reverse halo sign, or other signs compatible with organizing pneumonia	No details on swab	
Korevaar 2020 [13]	RC	Netherlands, ED	• Suspected COVID-19 • Symptomatic • Adults	239	Chest CT (low dose)	CT findings by radiologist Definition for positive diagnosis on CT: CO-RADS (2,3,4,5)	RT PCR once, twice in some No details on swab	Dx perf using CO-RADS
Krdzalic 2020 [21]	RC	Netherlands, Unclear	• Suspected COVID-19 • Symptomatic • Adults	56	Chest CT	CT findings by radiologist Definition: CO-RADS (3)	RT PCR twice, if necessary NP, OP	Dx perf
Kuzan 2020 [22]	RC	Turkey, ED	• Suspected COVID-19 • Symptomatic (any of the ff:fever • Adults	120	Chest CT (non-contrast) Brand: Canon	CT findings by radiologist Definition: BSTI version 2 (classic COVID 19)	RT PCR twice if necessary No details on swab	Dx perf
Li 2020 [26]	RC	China, Unclear	• Suspected COVID-19 • Symptomatic • Adults	92	Chest CT Brand: GE, Philips	CT findings by radiologist Definition: specific scoring criteria based on literature findings (higher score means high risk) Subpleural distribution	RT PCR No details on swab	Dx perf CT findings prevalence
Luo 2020a [27]	RC	China, Unclear	• Suspected COVID-19 • Symptomatic • Adults (excluding pregnant)	73	Chest CT (ST 1mm) Brand: Siemens, GE	CT findings by radiologist Definition: scoring system was developed (with scores from -4 to +7)	RT PCR twice No details on swab	Dx perf CT findings prevalence
Luo 2020b [28]	RC	China, Unclear	• Suspected COVID-19 • Unclear symptom status • Adults	140	Chest CT (ST 1mm) Brand: Philips, Siemens	CT findings by radiologist Definition: unclear	RT PCR No details on swab	Dx perf CT findings prevalence
Mei 2020 [43]	RC	USA, Unclear	• Suspected COVID-19 • Symptomatic or asymptomatic • Children and adults	905	Chest CT NR	CT findings by radiologist Definition: Unclear	RT PCR twice if necessary No details on swab	Dx perf of CT plus AI
MM Santos 2020 [23]	RC	Brazil, ED	• Suspected COVID-19 • Symptomatic • Children and adults	75	Chest CT Brand: GE	CT findings by radiologist Definition: RSNA classification (CT typical appearance – COVID19)	RT PCR No details on swab	Dx perf
Narinx 2020 [44]	RC	Belgium, ED	• Suspected COVID-19 • Symptomatic	90	Chest CT (low dose)	CT findings by radiologist	RT PCR NP	Dx perf

			• Adults and children (unclear)		Brand: Siemens	Definition: Scored as suggestive for or inconsistent with COVID19 infection beased on the presence of clinical manifestations by Ng and Shi 2020		
Patel 2020 [45]	PC	USA, ED	• Suspected COVID19 • Symptomatic • Adults and children	317	Chest CT (high res)	CT findings by: radiologist Definition for positive diagnosis on CT: scoring system; consistent with multifocal pneumonia (C1)l indeterminate for multifocal pneumonia (C3)	RT PCR once, twice in some NP, OP	Dx perf
Peng 2020 [46]	RC	China, Unclear	• Suspected COVID-19 • Asymptomatic or symptomatic • Children	72	Chest CT	CT findings by: radiologist Definition: GGO, consolidations, with surrounding halo sign, nodules, residual fibre strip, lymphadenopathy	RT PCR No details on swab	Dx perf
Prokop 2020 [24]	RC	Netherlands, ED	• Suspected COVID-19 • Symptomatic • Adults and children	105	Chest CT	CT findings by radiologist Definition for positive diagnosis on CT: CO-RADS (2,3,4,5)	RT PCR once or twice in some No details on swab	Dx perf using CO-RADS
Schulze-Hagen 2020 [14]	PC	Germany, ED	• Suspected COVID-19 • Symptomatic • Adults	191	Chest CT (low dose)	CT findings by radiologist Definition: CO-RADS (3)	RT PCR once, twice in some NP	Dx perf using CO-RADS
Song 2020a [25]	RC	China, Unclear	• Suspected COVID-19 • Symptomatic • Adults	211	Chest CT	CT findings by _____ Definition: diagnosis of viral pneumonia accdg to: multiple bilateral, ill-defined GGOs or mixed consolidation with diffuse peripheral distribution or bilateral pulmonary consolidation	RT PCR twice NP, OP	Dx perf
Steuwe 2020 [47]	RC	Germany, Unclear	• Suspected COVID-19 • Symptomatic • Adults	105	Chest CT (low dose)	CT findings by _____ Definition: unclear based on typical COVID-19 findings reported by Salehi et al	RT PCR once, twice in some NP, OP	Dx perf
Wang 2020 [48]	-	China, Unclear	• Suspected COVID-19 • Symptomatic or asymptomatic • Adults and Children	190	Chest CT	CT findings by _____ Definition: standardized imaging reporting system: infectious disease, viral pneumonia is highy likely (class 1), infectious lesions, VP (class 2), IL, pathogens to be investigated (class3), infectious lesions 4	RT PCR twice if necessary	Dx perf
Xiong 2020 [49]	-	China, inpatient	• Suspected COVID-19 • Unclear symptom status • Children and adults	47	Chest CT	CT findings by radiologist Definition:subpleural GGO without pleural effusion, bronchial changes or lymphadenopathy	RTPCR	Dx perf

Appendix 2. Summary of Findings

Study	Disease Prevalence	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio
Mirahmadizadeh 2021 [32]	55.93%	66.67%	42.31%	1.16	0.79
Ai 2020 [4]	59.27%	96.51%	25.42%	1.29	0.14
Aslan 2020 [7]	81.70%	90.40%	64.29%	2.53	0.15
Barbosa 2020 [33]	9.23%	92.00%	16.67%	1.1	0.48
Bellini 2020 [15]	24.83%	56.34%	82.33%	3.19	0.53
Besutti 2020 [16]	85.63%	73.49%	84.00%	4.59	0.32
Borakati 2020 [6]	63.25%	84.82%	50.45%	1.71	0.3
Cartocci 2020 [11]	51.59%	90.74%	84.21%	5.75	0.11
Caruso 2020 [12]	39.24%	96.77%	56.25%	2.21	0.06
Debray 2020 [34]	66.39%	75.00%	95.06%	15.19	0.26
Deng 2020 [35]	73.76%	97.69%	53.90%	2.12	0.04
De Smet 2020[36]	41.68%	77.93%	93.41%	11.83	0.24
Dofferhoff 2020[37]	49.36%	88.31%	77.22%	3.88	0.15
Ducray 2020 [38]	41.35%	90.24%	87.96%	7.5	0.11
Falaschi 2020 [17]	59.77%	90.69%	78.78%	4.27	0.12
Fonsi 2020 [39]	95.69%	99.29%	89.47%	9.43	0.01
Fujioka 2020 [40]	49.35%	75.00%	87.18%	5.85	0.29
Gezer 2020 [41]	44.14%	93.88%	95.97%	23.28	0.06
Giannitto 2020 [18]	29.41%	70.00%	79.17%	3.36	0.38
Gietama 2020 [8]	10.00%	89.16%	68.18%	2.8	0.16
Guillo 2020 [19]	60.28%	79.84%	87.06%	6.17	0.23
He 2020 [10]	41.46%	76.47%	95.83%	18.35	0.25
Hermans 2020 [9]	41.69%	90.23%	88.17%	7.63	0.11
Hernigou 2020 [42]	34.04%	81.25%	93.55%	12.59	0.2
Herpe 2020 [20]	46.62%	88.88%	79.61%	4.36	0.14
Korevaar 2020 [13]	52.72%	92.86%	77.88%	4.2	0.09
Krdzalic 2020 [21]	50%	89.29%	75.00%	3.57	0.14
Kuzan 2020[22]	57.50%	69.57%	58.82%	1.69	0.52
Li 2020 [26]	46.74	97.67%	61.22%	2.52	0.04
Luo 2020a [27]	41.10%	86.67%	67.44%	2.66	0.2
Luo 2020b [28]	55.71%	89.74%	88.71%	7.95	0.12
Mei 2020 [43]	46.30%	65.39%	91.98%	8.15	0.38
MM Santos 2020 [23]	48.00%	83.33%	97.44%	32.5	0.17
Narinx 2020 [44]	16.67%	80.00%	86.67%	6	0.23
Patel 2020 [45]	50.79%	77.64%	73.72%	2.95	0.3
Peng 2020 [46]	54.17%	71.79%	60.61%	1.82	0.47
Prokop 2020 [24]	50.48%	81.13%	90.38%	8.44	0.21

Schulze-Hagen 2020 [14]	36.13%	94.20%	86.89%	7.18	0.07
Song 2020a [25]	52.61%	97.30%	45.00%	1.77	0.06
Steuwe 2020 [47]	18.10%	100.00%	77.91%	4.53	0
Wang 2020 [48]	35.80%	96.55%	36.54%	1.52	0.09
Xiong 2020 [49]	42.55%	95.00%	70.37%	3.21	0.07

Appendix 3: Forest Plots

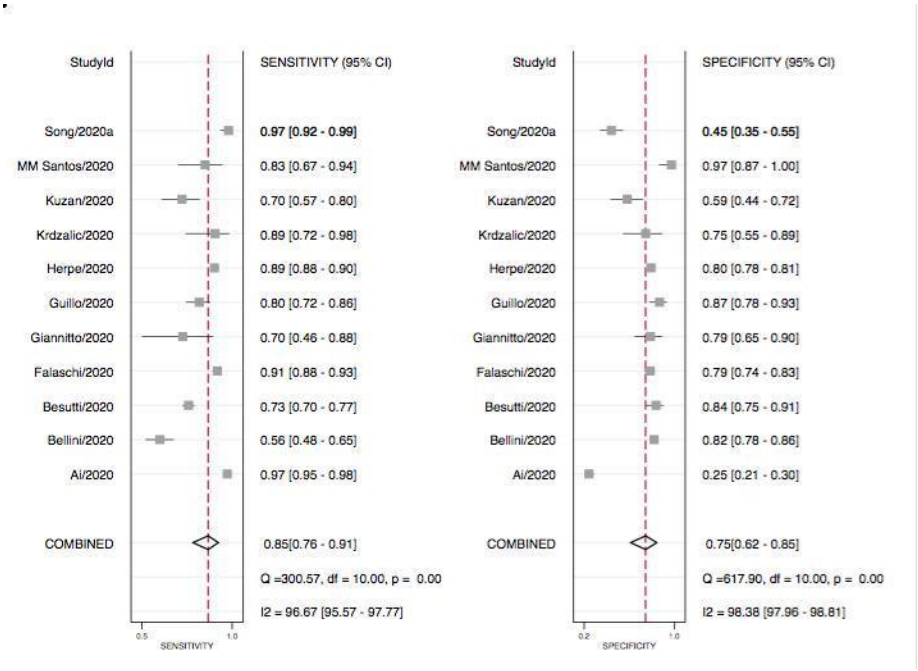

Figure 1a. Forest plot of diagnostic performance of CT Scan compared with RT-PCR, with an interval between tests of 2-7 days

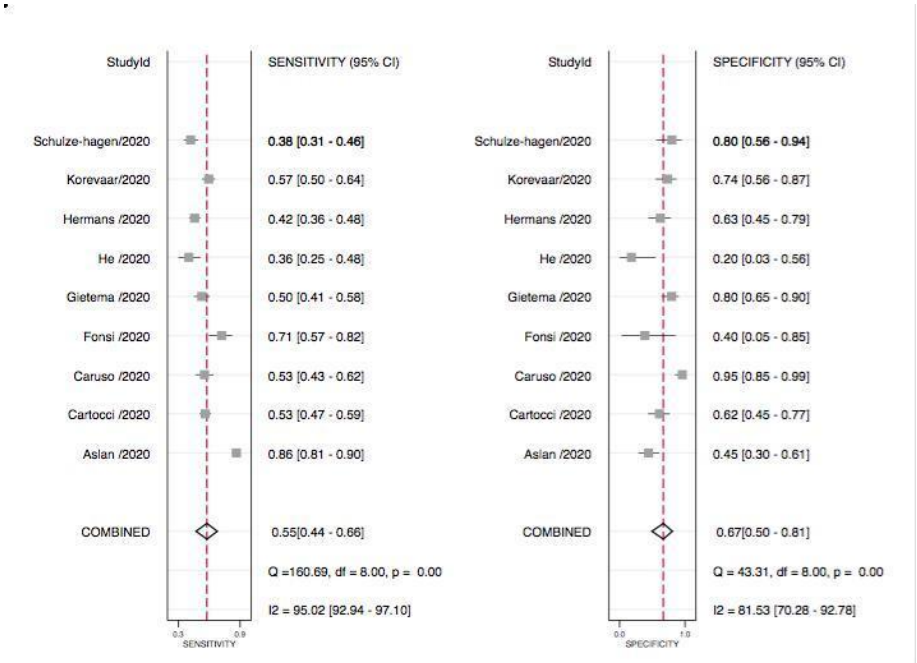

Figure 1b. Forest plot of diagnostic performance of CT Scan compared with RT-PCR, with an interval between tests of less than or equal to 24 hours

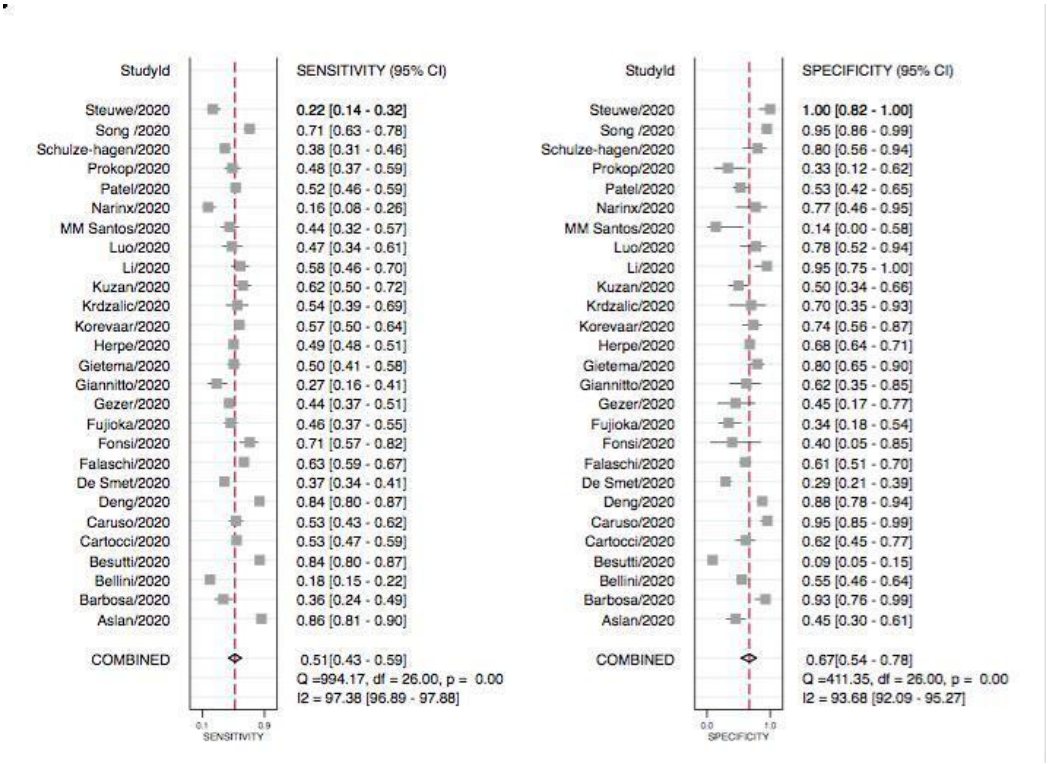

Figure 2a. Forest plot of diagnostic performance of CT Scan compared with RT-PCR among symptomatic patients

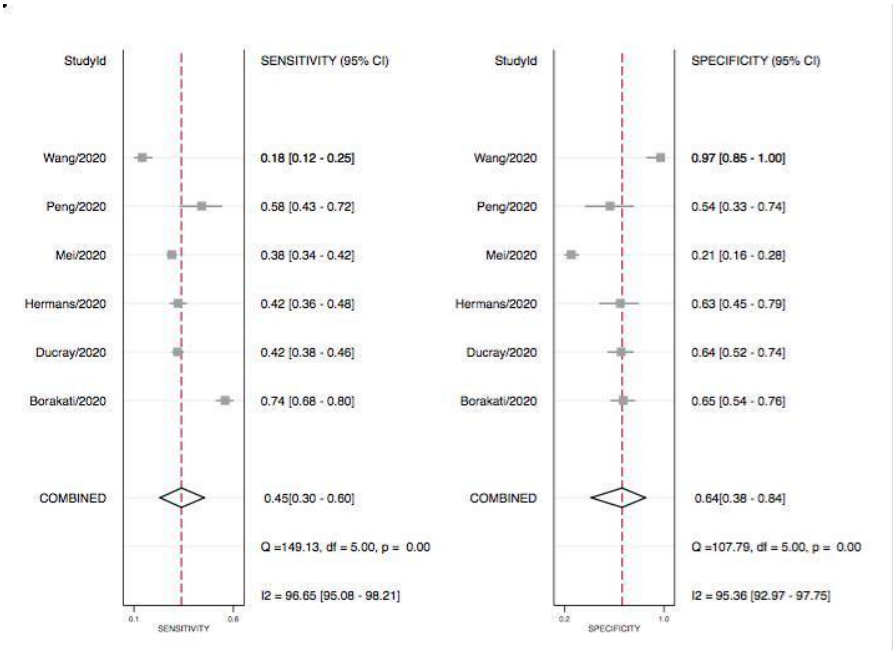

Figure 2b. Forest plot of diagnostic performance of CT Scan compared with RT-PCR among mixed symptomatic and asymptomatic patients

Appendix 4: GRADE Evidence Profile

Question: Should CT scan be used to diagnose COVID-19 infection in suspected patients?

Sensitivity	0.88 (95% CI: 0.84 to 0.90)
Specificity	0.80 (95% CI: 0.74 to 0.84)

Prevalences	0.27%	0.46%	3.04%

Outcome	№ of studies (№ of patients)	Study design	Factors that may decrease certainty of evidence					Effect per 1,000 patients tested			Test accuracy CoE
			Risk of bias	Indirectness	Inconsistency	Imprecision	Publication bias	pre-test probability of 0.27%	pre-test probability of 0.46%	pre-test probability of 3.04%	
True positives (patients with COVID-19 infection)	42 studies 8143 patients	cross-sectional (cohort type accuracy study)	serious [a]	not serious	very serious [b]	not serious	none	2 (2 to 2)	4 (4 to 4)	27 (26 to 27)	⨁◯◯◯ VERY LOW
False negatives (patients incorrectly classified as not having COVID-19 infection)								1 (1 to 1)	1 (1 to 1)	3 (3 to 4)	
True negatives (patients without COVID-19 infection)	42 studies 8049 patients	cross-sectional (cohort type accuracy study)	serious [a]	not serious	very serious [b]	not serious	none	793 (740 to 837)	791 (739 to 835)	771 (719 to 813)	⨁◯◯◯ VERY LOW
False positives (patients incorrectly classified as having COVID-19 infection)								204 (160 to 257)	204 (160 to 256)	199 (157 to 251)	

Explanations

a. cut-offs were unclear, different reporting system; unclear appropriate exclusion criteria for the population, failure to report pre-specified threshold of the index test, unclear blinding of outcome assessors in index test or reference standard, lack of transparent reporting of the time interval between index test and reference standard)

b. heterogeneity across studies is very high (>90%)