



DRINGEND ADVIES VAN DE HOGE GEZONDHEIDSRAAD nr. 9587

Gebruik van CT-scans als diagnostische methode in het kader van de Coronavirusepidemie in België

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I INLEIDING EN VRAAGSTELLING

Voor de derde keer in enkele decennia wordt de wereld geteisterd door een Coronavirusepidemie. In deze context is de vroegtijdige identificatie van patiënten met dit nieuwe virus, waartegen geen vaccin of specifieke behandeling bestaat, van het grootste belang om niet alleen een snelle behandeling van de betrokken personen mogelijk te maken, maar ook om adequate maatregelen te nemen om de verdere verspreiding van dit bijzonder besmettelijke virus te voorkomen.

Screening op Covid-19-ziekte en het virus SARS-CoV-2 dat ze veroorzaakt, wordt momenteel voornamelijk door middel van reverse-transcriptiepolymerasekettingreactie (RT-PCR) uitgevoerd. Echter, door een tekort aan sommige reagentia die noodzakelijk zijn om deze tests uit te voeren, moeten momenteel prioriteiten worden gesteld bij het uitvoeren van de gevraagde tests. Bovendien zijn er opmerkelijke verschillen in de literatuur m.b.t. de gevoeligheid van de RT-PCR-tests. Volgens verschillende studies die zijn uitgevoerd in China heeft RT-PCR namelijk een beperkte gevoeligheid van 60-70% (Bai et al. 2020, Ai et al. 2020, Fang et al., 2020, Kanne et al., 2020), terwijl andere studies, die vooral in de VS zijn uitgevoerd, een gevoeligheid van 95 tot 97% aangeven (Mossa-Basha et al. 2020).

Deze schaarste heeft aanleiding gegeven tot onderzoek naar alternatieve diagnostische procedures. Zo heeft de UNamur op 17 maart een nieuw procedé voorgesteld dat gebaseerd is op chemische tests die meer handmatige handelingen vereisen, maar die zonder de reagentia waaraan er een tekort is, kunnen worden uitgevoerd, en waarmee binnen 24 uur een betrouwbaar resultaat wordt verkregen.

De HGR heeft op basis van de recente literatuur onderzocht welke rol CT-scans **naast** de RT-PCR-tests kunnen spelen in de strijd tegen dit virus, op het vlak van de diagnose/triage en/of de follow-up van de Covid-19-diagnose.

Er werd ook een vragenlijst naar deskundigen in de radiologie in dit land gestuurd. Deze had betrekking op het huidige en potentiële gebruik van CT in de radiologieafdelingen.

Volgens een recente studie (Ai T. et al., 2020) heeft CT een gevoeligheid van 98% voor SARS-CoV-2-infecties. Deze studie had echter betrekking op een specifieke patiëntengroep, waarbij bijna 100 % klinisch positief was. Hierdoor is er dus een zekere selectiebias opgetreden, wat heeft bijgedragen tot de hoge score van CT. In deze studie werden ook het risico van vals-

¹ De Raad behoudt zich het recht voor om in dit document op elk moment kleine typografische verbeteringen aan te brengen. Verbeteringen die de betekenis wijzigen, worden echter automatisch in een erratum opgenomen. In dergelijk geval wordt een nieuwe versie van het advies uitgebracht.

positieve resultaten en de lagere specificiteit van de CT-scan vastgesteld. De CT-scan maakt het bovendien in sommige gevallen mogelijk om een SARS-CoV-2-infectie vroeger te identificeren dan met PCR, waarvan het resultaat later (de volgende dag of in de dagen daarna) positief kan worden. Deze vroegtijdigheid van CT-thorax ten opzichte van PCR staat echter ter discussie (Wang et al., 2020): de gevoeligheid ervan stijgt van 84% in de eerste 5 dagen tot maximum 99% tussen 6 en 11 dagen! In veel van de beschikbare studies heerst er onduidelijkheid over het tijdstip waarop de tests zijn uitgevoerd ten opzichte van het begin van de symptomen.

Er zijn ook aanwijzingen in de literatuur dat CT-scans anomalieën aan het licht hebben gebracht bij asymptomatische patiënten die dragers zijn van SARS-CoV-2 (Heshui 2020).

Andere studies (Xie X et al, 2020) melden dat het omgekeerde mogelijk is (negatieve CT-scans met positieve RT-PCR-tests), met opnieuw een mogelijke bias verbonden aan het gebruikte design (geen informatie over het tijdstip van aanvang van de symptomen).

Het is belangrijk op te merken dat sommige van deze artikelen op weinig gevallen betrekking hebben en dat de specificiteits- en gevoelighedscijfers met de nodige voorzichtigheid moeten worden geïnterpreteerd. Er bestaat immers geen perfecte diagnostische referentiestandaard ("gold standard") waartegen alle nieuwe diagnostische methodes qua gevoeligheid en specificiteit kunnen worden geëvalueerd.

Het neemt echter niet weg dat de CT zeer gevoelig is in het detecteren van letsels bij patiënten met ademhalingsmoeilijkheden, die geen, één of meerdere andere symptomen (koorts, neusloop, griepaal syndroom) vertonen. Anderzijds biedt een negatieve CT geen garantie voor "niet-Covid-19". Het is **dus belangrijk om CT-scans en RT-PCR te combineren**.

Een ander voordeel van het uitvoeren van CT-scans is de snelheid waarmee de resultaten van het onderzoek beschikbaar zijn.

Tot slot is het gebruik van CT bij de beoordeling van de ernst en de omvang van Covid-19-pneumonie vanzelfsprekend.

Naast de wetenschappelijke artikelen hebben sommige verenigingen onlangs aanbevelingen gepubliceerd waarvan wij het nuttig achten om deze onder uw aandacht te brengen.

Het gaat in de eerste plaats om het ACR (*American College of Radiology*), dat op 11 maart een zeer duidelijke aanbeveling heeft gedaan om CT niet in de eerste lijn te gebruiken en te reserveren voor gehospitaliseerde en symptomatische patiënten met specifieke klinische indicaties voor CT. Het standpunt van het ACR is gebaseerd op het feit dat de CT-resultaten niet specifiek zijn voor de Covid-19-ziekte en gelijkenissen vertonen met andere infecties. In zijn update van 22 maart voegt het ACR hier het volgende aan toe: "*As an interim measure, until more widespread COVID-19 testing is available, some medical practices are requesting chest CT to inform decisions on whether to test a patient for COVID-19, admit a patient or provide other treatment. The ACR strongly urges caution in taking this approach. A normal chest CT does not mean a person does not have COVID-19 infection - and an abnormal CT is not specific for COVID-19 diagnosis. A normal CT should not dissuade a patient from being quarantined or provided other clinically indicated treatment when otherwise medically appropriate. Clearly, locally constrained resources may be a factor in such decision making.*"

De Société Française de Radiologie (SFR) en de Belgische Vereniging voor Radiologie (BVR) hebben eveneens aanbevelingen in dezelfde zin gedaan. De BVR heeft haar aanbevelingen op 31 maart aangevuld met de volgende verduidelijking: "*When CT is used in specific indications for 'triage', this should always be followed by PCR testing*". De BVR adviseert ook dat radiologen actief zouden deelnemen aan de teams die beslissen over de patiëntenworkflow.

De BSTI (*British Society for Thoracic Imaging*) wijst erop dat als er een significante toename is van het aantal patiënten dat in het ziekenhuis wordt opgenomen, CT-scans kunnen worden gebruikt voor risicostratificatiedoeleinden.

Tot slot heeft een panel van Amerikaanse deskundigen (Mossa-Basha et al., 2020) een lijst van goede praktijken opgesteld om alle radiologieafdelingen voor te bereiden op het beheren van Covid-19. Deze verschillende aanbevelingen zijn opgenomen in de bijlage.

Hoewel de HGR geen specifieke vraag heeft gekregen, werden een aantal Belgische radiologen geraadpleegd om te anticiperen op een rampenscenario (epidemiepiek met massale toestroom van patiënten bij de spoeddiensten, tekort aan reagentia voor RT-PCR-tests), specifiek m.b.t. de identificatie en follow-up van patiënten die met SARS-CoV-2 geïnfecteerd zijn, met behulp van CT-scanners.

II AANBEVELINGEN

Kernboodschappen

- CT-thorax is zeer gevoelig in het opsporen van longletsels bij patiënten met Covid-19, zelfs bij pauci- of asymptomatische patiënten. Hij vertoont echter een lagere specificiteit (risico van vals-positieve resultaten).
- CT-scans dienen niet als massaal screeningsinstrument te worden gebruikt (algemene bevolking).
- CT-scans kunnen als triage-instrument worden gebruikt voor gehospitaliseerde patiënten die aan de hand van klinische criteria zijn geselecteerd (patiënten die klinisch zijn geïdentificeerd als mogelijk besmet met SARS-CoV-2, d.w.z. patiënten met ademhalingsklachten alsook bepaalde gevallen zoals patiënten die niet in staat zijn om te communiceren of risicofactoren vertonen), met het oog op risicostratificatie en de verdeling tussen Covid-19 vs. niet-Covid-19 ziekenhuiszones.
- De diagnose van Covid-19 met medische beeldvorming moet worden bevestigd met RT-PCR zolang dit mogelijk is en zeker in geval van een twijfelachtige diagnose
- Op uitzonderingen na dienen CT-scans momenteel niet als eerstelijns diagnostisch instrument voor SARS-CoV-2-infecties te worden gebruikt bij gehospitaliseerde, asymptomatische personen of personen met vermoede Covid-19 die niet in het ziekenhuis moeten worden opgenomen.
- Er wordt een CT-scan zonder contrast met geoptimaliseerde dosis (ALARA) uitgevoerd, indien mogelijk met een apart, aangewezen CT-scantoeestel in een aparte zaal op de spoedafdeling die is voorbehouden voor patiënten met een vermoede SARS-CoV-2-infectie.
- De HGR adviseert dat de radiologen zich trainen in het lezen van de beelden, volgens de aanbevelingen van de verenigingen voor radiologie.
- De HGR en de BVR adviseren dat de radiologen actief deelnemen aan de beslissingen omtrent de patiëntenworkflow.

1. Bepaling van het beste gebruik van de CT

De HGR bevestigt dat de aanpak van het ACR en de BVR terecht is en dat de CT-scan op dit moment niet als eerstelijns diagnostisch instrument moet worden gebruikt, maar moet worden voorbehouden voor patiënten die aan de hand van klinische criteria zijn geselecteerd.

Deze benadering is in lijn met die van de SFR (Société Française de Radiologie), die van oordeel is dat, hoewel de Chinese auteurs CT aanbevelen als eerste diagnostetechniek voor deze virusinfectie, "er momenteel geen aanbevelingen zijn voor het routinematische uitvoeren van CT-thorax, met name voor het screenen op Covid-19-infectie." (« il n'y a actuellement pas de recommandations quant à la réalisation

systématique d'un scanner thoracique, notamment à visée de dépistage de l'infection à Covid-19." Het is inderdaad riskant om vanuit China naar Europa te extrapoleren, vanwege de verschillen in de prevalentie van de ziekte en de in ons land gebruikte PCR-tests.

In het licht van de reacties van de deskundigen en in overleg met de BVR, adviseert de HGR dat ziekenhuizen zouden voorzien om CT-scans op te nemen in hun procedures voor de patiënten die klinisch zijn geïdentificeerd als mogelijk besmet met SARS-CoV-2 (patiënten met ademhalingsklachten) in situaties waarin er een tekort is aan PCR-tests. De CT-scan zou, samen met de klinische evaluatie, als snel triage-instrument gebruikt moeten worden voor de risicostratificatie en de verdeling tussen Covid-19 vs. niet-Covid-19 ziekenhuiszones. Bovendien kunnen de scanners als triage-instrument worden gebruikt wanneer het omwille van medische spoedgevallen of specifieke situaties waarin de patiënten verkeren (hypoxie, comorbiditeit, trauma, enz.) niet mogelijk is om de resultaten van de PCR-test af te wachten.

Daarnaast moet voorkomen worden dat patiënten met het virus die moeilijk hun klachten duidelijk kunnen maken (bejaarde patiënten met comorbiditeit, stroke patiënten, enz.), naar een "niet-Covid-19" zone worden gebracht. CT kan, in combinatie met de klinische symptomen, helpen om deze opdeling snel te maken.

Hoewel het onomstreden lijkt dat CT-thorax zeer gevoelig is in het opsporen van letsele bij patiënten met Covid-19, vertoont hij een lagere specificiteit - het risico dat Covid-19 verward wordt met andere aandoeningen is zeer reëel. Anderzijds biedt een negatieve CT geen garantie voor "niet-Covid-19". Het is dus belangrijk om CT-scans en RT-PCR te combineren. De diagnose van Covid-19 met medische beeldvorming moet worden bevestigd met RT-PCR zolang dit mogelijk is en zeker in geval van een twijfelachtige diagnose.

Een voordeel van het uitvoeren van CT-scans is de **snelheid** waarmee de resultaten van het onderzoek beschikbaar zijn.

In alle gevallen mag enkel gericht worden gescand bij ademhalingsklachten en bij verslechtering van het klinisch beeld, alsook bij aanwezigheid van bepaalde risicofactoren (cf. hierboven).

Heel onlangs heeft een multidisciplinair panel (radiologen, pneumologen, infectiologen...) van deskundigen in de zorgverlening aan Covid-19 patiënten uit 10 landen het nut van beeldvorming beoordeeld aan de hand van 3 scenario's die verschillende risicofactoren, werkstandigheden en beschikbare middelen voorstellen (Rubin et al. 2020). De aanbevelingen die hier worden gemaakt, komen in grote lijnen met die in dit advies.

Uiteraard is, zoals voor elk diagnostisch onderzoek, ook hier het optimalisatiebeginsel van toepassing, d.w.z. voldoende diagnostische kwaliteit met een zo laag mogelijke dosis (lage dosis CT-thorax zonder contrast, dosis geoptimaliseerd volgens het ALARA-beginsel ("As Low As Reasonably Achievable").

In dit stadium is er enkel ruimte voor RX-thorax in gevallen waarin er geen CT beschikbaar is en in de follow-up van patiënten in de intensieve zorgen of patiënten bij wie de klinische toestand achteruitgaat.

Verschillende Belgische centra adviseren om een CT-scan uit te voeren in geval van een RX-thorax (die eventueel om andere redenen werd uitgevoerd) die ofwel atypisch

is ofwel indicaties van Covid-19 vertoont (bilaterale infiltraties) of in geval van een normale RX-thorax met klinische discrepantie (auscultatie die bv. een longontsteking suggereert).

Patiënten zonder ademhalingsklachten kunnen in de meeste gevallen naar huis gaan en in quarantaine blijven.

De oorspronkelijke aanbeveling van de BVR, namelijk dat een eenvoudige RX-thorax niet thuis hoort bij het opsporen van Covid-19 (2020), blijft voor de werkgroep van de HGR van toepassing, hoewel de BVR ze als volgt heeft aangepast:

« *The use of chest radiographs in patients presenting with fever and respiratory complaints should be limited. Radiology departments that have a dedicated chest radiography unit, close to the emergency department or isolation wards, may consider this in certain cases as an alternative for CT. However, the same safety measures (as for CT) need to be taken into account* ». De geraadpleegde deskundigen leggen de nadruk op het risico van verspreiding van het virus.

In Groot-Brittannië staat RX-thorax echter nog steeds in de beslissingsboom van het verslag “Thoracic imaging in COVID-19 infection- Guidance for the reporting radiologist” van de BSTI (British Society of Thoracic Imaging) van 19 maart 2020.

2. Bescheratingsmaatregelen

De minimale aan te bevelen bescheratingsmaatregelen zijn:

Met betrekking tot de apparatuur en zalen:

- Aparte, aangewezen zaal op de spoedafdeling voor patiënten bij wie een SARS-CoV-2-infectie vermoed wordt;
- Apart, aangewezen CT-scantoezel voor verdachte of positieve patiënten (niet enkel voor CT-thorax, maar voor al het diagnostisch werk met deze patiënten), of zelfs mobiele CT-scan apparatuur buiten het ziekenhuis of op zijn minst aparte toegang tot de afdeling voor deze patiënten;
- Prioritering van één of meerdere CT-scantoezellen in geval van een toestroom van symptomatische patiënten;
- Voor ziekenhuizen met slechts één CT-scanner, Covid-19-patiënten clusteren door de onderzoeken na elkaar uit te voeren, met inachtneming van strikte hygiënemaatregelen;
- Uitstellen van niet-dringende onderzoeken om de voorrang te geven aan Covid-19-diagnoseonderzoeken en aan essentiële onderzoeken voor andere ernstige aandoeningen. De continuïteit van de zorg voor andere patiënten in een ernstige toestand moet gewaarborgd blijven;
- Het toestel ontsmetten vooraleer een nieuw onderzoek wordt uitgevoerd.
- Indien in de onderzoekszaal een aerosolvormende handeling wordt uitgevoerd, wordt een wachttijd aanbevolen die afhankelijk is van de luchttuitwisselingssnelheid (volgens het American College of Radiology : 1 uur);
- Bovendien worden dezelfde ontsmettingsmaatregelen, die sinds het begin van de epidemie in vergelijking met de gebruikelijke standaarden zijn aangescherpt, toegepast voor scantoezellen die niet aan Covid-19-patiënten zijn toegewezen.

Met betrekking tot het personeel en de patiënt:

- De gebruikelijke Covid-19 procedures wat betreft de preventieve maatregelen voor zowel de patiënt als het personeel (cf. https://epidemio.wiv-is.be/ID/Documents/Covid19/COVID-19_procedure_hospitals_NL.pdf) en in de mate van het mogelijke de *social distancing*-maatregelen naleven;
- Systematisch bescherming voorzien voor eerstelijnszorgverleners, ongeacht of al dan niet verdacht wordt dat de patiënt positief is voor SARS-CoV-2;
- Het personeel op voorhand verwittigen van de aankomst van de patiënt;
- Specifiek voor CT-scans:
 - Handschoenen uittrekken en handen ontsmetten tussen het installeren van de patiënt en het uitvoeren van het onderzoek aan de console;
 - Opnieuw de handen ontsmetten en handschoenen dragen alvorens terug te keren naar de patiënt om hem/haar uit het toestel te helpen.

3. Organisatie van de dienst radiologie

Het zeer recente artikel "Radiology Department Preparedness for COVID-19: Radiology Scientific Expert Panel" (Mossa-Basha et al., 2020) in de bijlage illustreert de strategieën en prioriteiten die in de radiologieafdelingen moeten worden geïmplementeerd. Deze kunnen worden aangepast aan de lokale situatie.

De HGR beveelt aan

- om, gezien de aanbeveling om alle niet-drangende onderzoeken te annuleren/uit te stellen, het team "CT-scan Covid-19-patiënten" te versterken met medisch technologen die beschikbaar zijn geworden en recent opgeleid zijn in CT's;
- om rotatie van artsen en personeel tussen verschillende installaties (op dezelfde site of op een andere site) te vermijden.

Voor ziekenhuizen waar dit mogelijk is:

- een aangewezen vervangscanner zou kunnen worden voorzien in geval van uitvallen van de "Covid-19-scanner".
- om verder te gaan dan een aparte, aangewezen scanner voor Covid-19-patiënten, zou met de leveranciers en het FANC moeten worden onderzocht of een mobile CT, buiten het ziekenhuis, mogelijk is;

De continuïteit van de dringende medische zorgen en beeldvorming moet worden verzekerd, ondanks de ingrijpende aanpassingen die zijn gemaakt in de diensten. Er moet per radiologische specialiteit een permanentie worden verzekerd.

Gezien de omvang van het werk, de risico's en de verwachte duur van epidemie in België, moet worden gewaakt op de veiligheid en het welzijn van het personeel - artsen, verpleegkundigen, technologen.

Tot slot adviseren de HGR en de BVR dat de radiologen actief deelnemen aan de beslissingen omtrent de patiëntenworkflow.

4. Opleiding voor radiologen in het lezen van de beelden

Radiologen in opleiding en studenten moeten eraan worden herinnerd dat CT-scans niet specifiek, maar wel gevoelig zijn. De afwijkingen variëren sterk, zoals bij alle virale pneumonieën het geval is.

De HGR adviseert dat de radiologen zich trainen in het lezen van de beelden, volgens de aanbevelingen van de verenigingen voor radiologie.

De Belgische Vereniging voor Radiologie beveelt radiologen aan om zich vertrouwd te maken met het beeld van Covid-19 gerelateerde letsets op CT-beelden, om ze ook op te kunnen sporen op CT-scans van de longen die om andere redenen worden gemaakt. Op haar website worden sprekende beelden ter beschikking gesteld. Uit het onderzoek van de eerste Belgische beelden lijkt er een overeenkomst te zijn met gevallen die in andere landen, met name China, zijn gepubliceerd.

De SFR heeft de CT-afwijkingen van de longen van patiënten met Covid-19 als volgt op haar website samengevat: "Het vroege CT-beeld toont perifere, subpleurale, niet gesystematiseerde matglas-opaciteit, met een asymmetrisch multifocaal karakter, en een variabele omvang, beperkt tot kleine infracentrimetrische of grotere bereiken. Er zijn over het algemeen geen nodules, adenopathieën of pleurale effusie. Dit kan evolueren naar aspecten van georganiseerde longontsteking, en klinisch ernstige vormen worden gekenmerkt door uitgebreide alveolaire verdichtingen." (*« L'aspect tomodensitométrique précoce est celui d'opacités en verre dépoli de siège périphérique, sous-pleural, non systématisées, avec un caractère multifocal asymétrique, et une étendue variable, limitée à de petites plages infracentrimétriques ou plus étendues. Il n'y a en règle générale pas de nodules, d'adénopathies ou d'épanchement pleural. L'évolution peut se faire vers des aspects de pneumonie organisée, et les formes graves cliniquement se caractérisent par des condensations alvéolaires étendues ».*).

Aan de andere kant heeft het tijdschrift Radiology de ontvangen artikelen online ter beschikking gezet, evenals een catalogus met beelden, die via deze link toegankelijk is: <https://pubs.rsna.org/2019-nCoV#images>

De BSTI heeft een geanonimiseerde en vrij toegankelijke beeldvormingsdatabase (https://bit.ly/BSTICovid19_Teaching_Library) online beschikbaar gemaakt, waarmee scans van patiënten met een bevestigde of vermoede SARS-CoV-2-infectie, kunnen worden gedeeld en geraadpleegd. Het doel is om een richtsnoer te bieden voor het toekomstige beheer van de Covid-19-epidemie en nationale protocollen en om clinici een hulpmiddel ter beschikking te stellen om gevallen van SARS-CoV-2-infectie nauwkeuriger te kunnen identificeren en te diagnosticeren.

Het verslag "Thoracic imaging in COVID-19 infection- Guidance for the reporting radiologist" van de BSTI geeft ook een beschrijving en classificatie van de patronen die kunnen gezien worden en hun betrouwbaarheidsinterval.

Tot slot is het van fundamenteel belang dat de resultaten onverwijd schriftelijk aan de voorschrijver of aan de persoon die voor de patiënt verantwoordelijk is, worden meegedeeld. De SFR en de BVR stellen voorbeelden voor een gestructureerd verslag ter beschikking (zie bijlagen).

III METHODOLOGIE

De voorzitters van het domein Ioniserende Stralingen hebben de nodige expertises bepaald. Op basis hiervan werd een *ad-hoc*werkgroep opgericht met deskundigen in de volgende disciplines: radiologie, stralingsbescherming, radiobiologie, medische stralingsfysica.

Het advies berust op een overzicht van de wetenschappelijke literatuur, zowel uit wetenschappelijke tijdschriften als uit rapporten van nationale en internationale organisaties die in deze materie bevoegd zijn (*peer-reviewed*), alsook op het oordeel van de experten.

Gezien de uitzonderlijke omstandigheden verbonden aan de Covid-19-crisis, werd het advies na goedkeuring door de werkgroep enkel door het Bureau gevalideerd.

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V SAMENSTELLING VAN DE WERKGROEP

De samenstelling van het Bureau en het College alsook de lijst met de bij KB benoemde experten is beschikbaar op de website van de HGR: [wie zijn we?](#).

Al de experten hebben **op persoonlijke titel** aan de werkgroep deelgenomen. Hun algemene belangenverklaringen alsook die van de leden van het Bureau en het College kunnen worden geraadpleegd op de website van de HGR ([belangenconflicten](#)).

De volgende deskundigen werden per mail geraadpleegd. Deze aanbevelingen, die dringend per brief werden verleend, werden opgesteld op basis van hun antwoorden. Het werk werd gecoördineerd door **Marie-Thérèse Hoornaert** en **Patrick Smeesters** en het wetenschappelijk secretariaat werd waargenomen door Evelyn Hantson en Sandrine Everaert.

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De volgende arts-thoraxradiologen, wetenschappelijk deskundigen bij de BVR, werden gehoord:

GOSSELIN Robert	Radiologie	UZ Gent, BVR
SNOECKX Annemie	Radiologie	UZA, BVR

VI BIJLAGEN

- Bijlage 0a: CSS : Utilisation du CT-scan comme méthode de diagnostic / triage du Covid-19
- Bijlage 0b : HGR : Gebruik van CT-scans als diagnostische / triagemethode voor Covid-19
- Bijlage 1: ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection
- Bijlage 2a: Société Française de Radiologie : Epidémie de Covid-19 : ce que les radiologues doivent savoir. 5 mars 2020.
- Bijlage 2b : Société Française de Radiologie : Epidémie de Covid-19 : POINT SUR L'IMAGERIE. 12 mars 2020.
- Bijlage 2c : Société Française de Radiologie : Epidémie de Covid-19 : POINT SUR L'IMAGERIE. 14 mars 2020.
- Bijlage 2d : Société Française de Radiologie : Exemple compte-rendu type Covid-19
- Bijlage 3 : BSTI – British Society of Thoracic Imaging. Thoracic Imaging in COVID-19 Imaging – Guidance for the Reporting Radiologist
- Bijlage 4a: BSR – Belgian Society of Radiology: COVID-19 info from BSR. Guidelines for imaging in COVID-19. 14 mars 2020.
- Bijlagen 4b en c: BSR – Belgian Society of Radiology: template to report CT in COVID cases. Maart 2020.
- Bijlage 5: Mahmud Mossa-Basha, Carolyn C. Meltzer, Danny C Kim, Michael J Tuite, K. Pallav Kolli, Bien Soo Tan. Radiology Department Preparedness for COVID-19: Radiology Scientific Expert Panel. Radiology, 16/3/2020.

Utilisation du CT-scan comme méthode de diagnostic/triage du Covid-19



Messages-clés

- Le CT scan thoracique présente une **grande sensibilité** dans la détection de lésions pulmonaires chez les patients atteints de Covid-19, même pauci- ou asymptomatiques, mais sa spécificité est moins avantageuse (risque de faux positifs).
- Le CT-scan ne doit pas être utilisé comme outil de dépistage massif (population générale).
- Le CT-scan peut être utilisé, comme outil de triage, chez des patients hospitalisés sélectionnés **sur base clinique** (patients identifiés cliniquement comme potentiellement infectés par le SARS-CoV-2, c.-à-d. patients avec plaintes respiratoires, ainsi que dans certaines situations comme des patients incapables de communiquer ou présentant des facteurs de risque), à des fins de répartition entre zones hospitalières Covid – non-Covid et de stratification du risque.
- Le diagnostic Covid-19 par imagerie doit être confirmé par RT-PCR tant que la situation le permet et dans tous les cas de diagnostic douteux.
- Sauf exception, le CT-scan ne doit pour l'instant pas être utilisé en première ligne pour le diagnostic de l'infection par le SARS-CoV-2 chez des personnes asymptomatiques hospitalisées ou chez les personnes suspectes de Covid mais ne nécessitant pas d'hospitalisation.
- Le CT-scan sera réalisé sans contraste avec optimisation de la dose (ALARA), si possible avec un CT dédié et dans une salle dédiée aux urgences pour les patients suspectés d'être infectés par le SARS-CoV-2.
- Le CSS recommande que les radiologues se forment à la lecture des images, en suivant les recommandations émises par les sociétés de radiologie.
- Le CSS et la SBR recommandent que les radiologues participent activement aux décisions concernant le workflow patient.

Gebruik van CT-scans als diagnostische/triagemethode voor Covid-19



Kernboodschappen

- CT-thorax is zeer gevoelig in het opsporen van longletsels bij patiënten met Covid-19, zelfs bij pauci- of asymptomatische patiënten. Hij vertoont echter een lagere specificiteit (risico van vals-positieve resultaten).
- CT-scans dienen niet als massaal screeningsinstrument te worden gebruikt (algemene bevolking).
- CT-scans kunnen, als triage-instrument, worden gebruikt voor gehospitaliseerde patiënten die aan de hand van klinische criteria zijn geselecteerd (patiënten die klinisch zijn geïdentificeerd als mogelijk besmet met SARS-CoV-2, d.w.z. patiënten met ademhalingsklachten alsook bepaalde gevallen zoals patiënten die niet in staat zijn om te communiceren of risicofactoren vertonen), met het oog op risicostratificatie en de verdeling tussen Covid-19 vs. niet-Covid-19 ziekenhuiszones.
- De diagnose van Covid-19 met medische beeldvorming moet worden bevestigd met RT-PCR zolang dit mogelijk is en zeker in geval van een twijfelachtige diagnose.
- Op uitzonderingen na dienen CT-scans momenteel niet als eerstelijns diagnostisch instrument voor SARS-CoV-2-infecties te worden gebruikt bij gehospitaliseerde, asymptomatische personen of personen met vermoede Covid-19 die niet in het ziekenhuis moeten worden opgenomen.
- Er wordt een CT-scan zonder contrast met geoptimaliseerde dosis (ALARA) uitgevoerd, indien mogelijk met een apart, aangewezen CT-scantoeestel in een aparte zaal op de spoedafdeling die is voorbehouden voor patiënten met een vermoede SARS-CoV-2-infectie.
- De HGR adviseert dat de radiologen zich trainen in het lezen van de beelden, volgens de aanbevelingen van de verenigingen voor radiologie.
- De HGR en de BVR adviseren dat de radiologen actief deelnemen aan de beslissingen omtrent de patiëntenworkflow.

March 11, 2020

ACR Recommendations for the use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection

 [Recommend](#) [Bookmark](#)**UPDATED MARCH 22, 2020**

As COVID-19 spreads in the U.S., there is growing interest in the role and appropriateness of chest radiographs (CXR) and computed tomography (CT) for the screening, diagnosis and management of patients with suspected or known COVID-19 infection. Contributing to this interest are limited availability of viral testing kits to date, concern for test sensitivity from earlier reports in China, and the growing number of publications describing the CXR and CT appearance in the setting of known or suspected COVID-19 infection.

To date, most of the radiologic data comes from China. Some studies suggest that chest CT in particular may be positive in the setting of a negative test. **We want to emphasize that knowledge of this new condition is rapidly evolving, and not all of the published and publicly available information is complete or up-to-date.**

Key goals for the U.S. health care system in response to the COVID-19 outbreak are to reduce morbidity and mortality, minimize disease transmission, protect health care personnel, and preserve health care system functioning.

The ACR believes that the following factors should be considered regarding the use of imaging for suspected or known COVID-19 infection:

- The Centers for Disease Control (CDC) does not currently recommend CXR or CT to diagnose COVID-19. Viral testing remains the only specific method of diagnosis. Confirmation with the viral test is required, even if radiologic findings are suggestive of COVID-19 on CXR or CT.
- For the initial diagnostic testing for suspected COVID-19 infection, the CDC recommends collecting and testing specimens from the upper respiratory tract (nasopharyngeal AND oropharyngeal swabs) or from the lower respiratory tract when available for viral testing.
- **Generally, the findings on chest imaging in COVID-19 are not specific, and overlap with other infections**, including influenza, H1N1, SARS and MERS. Being in the midst of the current flu season with a much higher prevalence of influenza in the U.S. than COVID-19, further limits the specificity of CT.
- The current [ACR Appropriateness Criteria® statement on Acute Respiratory Illness](#) , last updated in 2018 states that chest CT is “Usually Not Appropriate.”
- A [review from the Cochrane Database of Systematic Reviews on chest radiographs for acute lower respiratory tract infections](#) concluded that CXR did not improve clinical outcomes (duration of illness) for patients with lower respiratory tract infection; the review included two randomized trials comparing use of CXRs to no CXRs in acute lower respiratory tract infections for children and adults.

Additionally, there are issues related to infection control in health care facilities, including the use of imaging equipment:

- Primary care and other medical providers are attempting to limit visits of patients with suspected influenza or COVID-19 to health care facilities, to minimize the risk of spreading infection. The CDC has also asked that patients and visitors to health

CSS9587 - Ann1: ACR Recommendations

care facilities be screened for symptoms of acute respiratory illness, be asked to wear a surgical mask and be evaluated in a private room with the door closed.

- In addition to environmental cleaning and decontamination of rooms occupied by a patient with suspected or known COVID-19 infection by thorough cleaning of surfaces by someone wearing proper protective equipment, air-flow within fixed radiography or CT scanner rooms should be considered before imaging the next patient. Ventilation is an important consideration for the control of airborne transmission in health care facilities ↗
(<https://www.cdc.gov/infectioncontrol/guidelines/environmental/background/air.html#c2c>). Depending on the air exchange rates, rooms may need to be unavailable for approximately 1 hour after imaging infected patients; air circulation rooms can be tested.
- These measures to eliminate contamination for subsequent patients may reduce access to imaging suites, leading potentially to substantial problems for patient care.

Based on these concerns, the ACR recommends:

- CT should not be used to screen for or as a first-line test to diagnose COVID-19
- CT should be used sparingly and reserved for hospitalized, symptomatic patients with specific clinical indications for CT. Appropriate infection control procedures should be followed before scanning subsequent patients.
- Facilities may consider deploying portable radiography units in ambulatory care facilities for use when CXRs are considered medically necessary. The surfaces of these machines can be easily cleaned, avoiding the need to bring patients into radiography rooms.
- Radiologists should familiarize themselves with the CT appearance of COVID-19 infection in order to be able to identify findings consistent with infection in patients imaged for other reasons.
- (Updated March 22, 2020) As an interim measure, until more widespread COVID-19 testing is available, some medical practices are requesting chest CT to inform decisions on whether to test a patient for COVID-19, admit a patient or provide other treatment. The ACR strongly urges caution in taking this approach. A normal chest CT does not mean a person does not have COVID-19 infection - and an abnormal CT is not specific for COVID-19 diagnosis. A normal CT should not dissuade a patient from being quarantined or provided other clinically indicated treatment when otherwise medically appropriate. Clearly, locally constrained resources may be a factor in such decision making.

Recommended Resources:

Centers for Disease Control:

- American College of Radiology - COVID-19 Radiology-Specific Resources (<https://www.acr.org/Clinical-Resources/COVID-19-Radiology-Resources>) ↗ (<https://www.cdc.gov/coronavirus/2019-ncov/index.html>)
- General information and situation updates □ (<https://www.cdc.gov/coronavirus/2019-ncov/index.html>)
- Information for health care professionals □ (<https://www.cdc.gov/coronavirus/2019-nCoV/hcp/index.html>)

Radiologic articles and collections:

- Journal of the American College of Radiology (JACR) – Coronavirus (COVID-19) Outbreak: What the Department of Radiology Should Know ↗ ([https://www.jacr.org/article/S1546-1440\(20\)30150-2/fulltext](https://www.jacr.org/article/S1546-1440(20)30150-2/fulltext))
- Radiology and Radiology: Cardiothoracic Imaging – Special Focus: COVID-19 □ (<https://pubs.rsna.org/2019-nCoV>)
- American Journal of Roentgenology (AJR) – Coronavirus Disease (COVID-19) □ (<https://www.ajronline.org/topic/cov19>)



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Épidémie de Covid-19 : ce que les radiologues doivent savoir

Fin décembre 2019, l'organisation mondiale de la santé (OMS) a été informée par les autorités chinoises de cas groupés de pneumonie dans la région du Hubei en Chine, en lien avec la fréquentation d'un marché d'animaux dans la ville de Wuhan. Un nouveau coronavirus, SARS-CoV2 a été identifié comme agent causal de cette maladie, appelée Covid-19. Lors de la rédaction de cette Newsletter, le 5 Mars 2020, le nombre de cas mondiaux atteint 93 076, tandis que 285 cas ont été confirmés en France, dont 4 décédés.

Cette épidémie a généré la publication rapide de plusieurs articles radiologiques, décrivant les aspects tomodensitométriques de l'atteinte pulmonaire qui fait la gravité de cette infection, avec une mortalité estimée 7 à 10 fois supérieure à celle de la grippe.

Quels sont les informations essentielles ?

1- **L'aspect tomodensitométrique précoce est** celui d'opacités en verre dépoli de siège périphérique, sous-pleural, non systématisées (Figure), avec un caractère multifocal asymétrique, et une étendue variable, limitée à de petites plages infracentimétriques ou plus étendues. Il n'y a en règle pas de nodules, d'adénopathies ou d'épanchement pleural. L'évolution peut se faire vers des aspects de pneumonie organisée, et les formes graves cliniquement se caractérisent par des condensations alvéolaires étendues. La revue *Radiology* a mis en ligne les articles reçus ainsi qu'un catalogue d'images, accessible sur ce lien : <https://pubs.rsna.org/2019-nCoV#images>

2- **Deux publications dans *Radiology*** (1,2), dont la plus large regroupe 1014 cas, font état d'une sensibilité supérieure du scanner par rapport à la recherche d'ARN viral par RT-PCR, qui reste cependant la technique de référence, mais qui peut se positiver de façon retardée par rapport aux premiers signes radiologiques. Par ailleurs, il est démontré que des sujets asymptomatiques au plan respiratoire peuvent présenter des anomalies tomodensitométriques analogues à celles des patients ayant la forme commune, non grave, de l'atteinte respiratoire. Sur la base de ces résultats, les auteurs chinois recommandent la réalisation première d'un scanner pour dépister l'infection virale. **Les différences quant à la prévalence de la maladie et la sensibilité des tests PCR utilisés en France rendent hasardeuse toute transposition.** Il n'y a actuellement pas de recommandations quant à la réalisation systématique d'un scanner thoracique, notamment à visée de dépistage de l'infection à Covid-19.

3- **S'il est décidé de réaliser une imagerie tomodensitométrique**, pour les manipulateurs sont celles actuellement recommandées pour l'ensemble des soignants prenant en charge les patients suspects: friction des mains avec produit hydro-alcoolique (PHA), surblouse à manches longues à usage unique, masque chirurgical, charlotte, lunettes de protection à usage unique, gants à usage unique. Le patient doit porter un masque chirurgical et effectuer une friction des mains au PHA. Selon les dernières recommandations, le port des masques filtrants FFP2 est actuellement réservé aux seuls personnels hospitaliers en contact étroit et prolongé avec des cas confirmés (soins intensifs).

Le scanner thoracique doit être réalisé sans injection, en coupe fines, avec un niveau de dose optimisé.

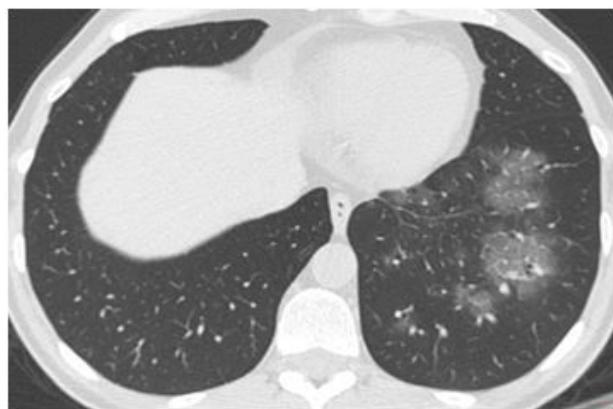
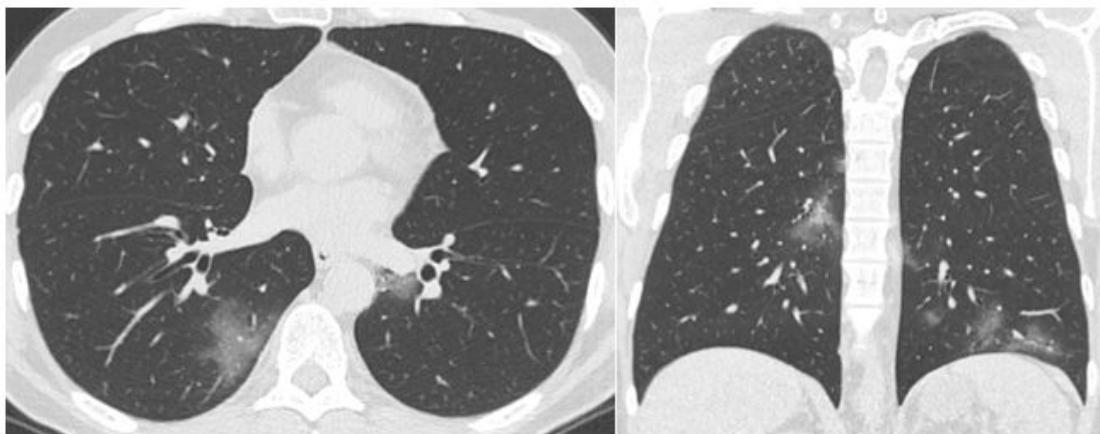
Un bio-nettoyage du scanner doit être ensuite réalisé selon les recommandations des services d'hygiène (Septalkan pour les surfaces, Anios Oxy'floor pour les sols).

La société d'imagerie thoracique communiquera, via cette Newsletter, toute nouvelle donnée susceptible de modifier nos pratiques vis-à-vis de cette épidémie.

Marie-Pierre Revel et Mathieu Lederlin
Société d'Imagerie Thoracique - SIT

Références

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Opacités en verre dépoli, bilatérales, asymétriques, à prédominance basale, correspondant à une infection prouvée à Covid-19 chez un patient de 53 ans exposé au coronavirus après un voyage en zone épidémique



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Epidémie de Covid-19 : POINT SUR L'IMAGERIE

La France est actuellement en situation épidémique de stade 2 vis-à-vis du SARS-CoV-2, et la sollicitation des structures radiologiques, qu'elles soient hospitalières ou non, devient plus importante.

Cette montée en charge nécessite de clarifier le rôle de l'imagerie dans ce contexte épidémique

Quelles sont les indications d'imagerie et quel type d'examen réaliser ?

1. Il n'y a pas de place pour la radiographie thoracique, si une imagerie est indiquée, il faut réaliser un scanner.
2. Chez des patients sans gravité clinique ni co-morbidités, pour lesquels il existe une hésitation diagnostique entre pneumopathie bactérienne ou bien atteinte Covid-19, les arguments cliniques (foyer auscultatoire, douleur thoracique) et biologiques (hyperleucocytose) doivent prévaloir, et une PCR peut être indiquée en cas de fièvre résistant à l'antibiothérapie, plutôt que la prescription d'une imagerie.
3. Il n'y a actuellement pas d'indication à réaliser un scanner thoracique à des fins de dépistage chez des patients sans signes de gravité et sans comorbidités.
4. La réalisation d'un scanner thoracique sans injection en coupes fines est actuellement indiquée chez les patients ayant un diagnostic suspecté ou confirmé et des signes de gravité clinique (dyspnée, désaturation...) initiaux ou secondaires relevant d'une prise en charge hospitalière. Elle peut également se concevoir chez des patients suspects avec co morbidités, en attente des résultats de PCR, ou bien en première ligne si les délais et disponibilité de PCR deviennent limitants, ce qui semble se profiler.
5. Chez les patients Covid-19 positifs en soins intensifs et réanimation, présentant une aggravation, l'examen tomodensitométrique doit rechercher une aggravation des lésions avec évolution vers un tableau de SDRA, mais également un pneumothorax sous ventilation ou bien une complication thrombo-embolique et doit donc être réalisé avec injection.

Quelles précautions prendre pour les manipulateurs et radiologues ?

S'il est décidé de réaliser une imagerie tomodensitométrique, les mesures à prendre sont celles actuellement recommandées pour l'ensemble des soignants prenant en charge les patients suspects :

- Le patient : doit porter un masque chirurgical et effectuer une friction des mains au PHA.
- Les médecins et manipulateurs :
 - Friction des mains avec produit hydro-alcoolique (PHA), masque chirurgical.
 - Si nécessité d'installer le patient sur la table d'examen et/ou de le perfuser :
 - Surblouse à manches longues, charlotte et gants à usage unique.
 - Idéalement, lunettes protectrices réutilisables après désinfection.
 - Le port des masques filtrants FFP2 est réservé aux seuls personnels hospitaliers en contact étroit et prolongé avec des cas confirmés (soins intensifs ou nécessité d'un geste de radiologie interventionnelle).

- Un bio-nettoyage du scanner doit être ensuite réalisé selon les recommandations des services d'hygiène (FB spray ou tout autre détergent désinfectant pour les surfaces, Anios Oxy'floor pour les sols).

Les patients doivent venir accompagnés (isolement contact), en tenue permettant une installation directe sur la table de scanner sans déshabillage.

Le service de Radiologie doit être prévenu en amont, pour organisation évitant l'attente au milieu d'autres patients.

Des circuits spécifiques doivent être mis en place, avec selon l'affluence et le nombre de scanners disponibles, des horaires dédiés sur un scanner ou un scanner totalement dédié à cette activité.

NB : Pour les échographies des patients hospitalisés, il est préférable de les réaliser au lit avec un échographe portatif, pour limiter les allées et venues.

Quels sont les aspects tomodensitométriques rencontrés ?

Ils sont illustrés à partir de ces quelques cas cliniques commentés. [Voir les cas cliniques](#)

Il s'agit essentiellement de plages de verre dépoli non systématisées à prédominance sous pleurale, et à un stade plus tardif de condensation alvéolaire. Il n'y a en règle pas d'excavation, de nodules, de masses. Les micronodules bronchiolaires, les adénopathies médiastinales et épanchements pleuraux sont rares, en sachant que des épanchements sont possibles en cas de décompensation cardiaque.

Pr REVEL, Pr LEDERLIN, Pr BRILLET, Pr KHALIL
pour la Société d'Imagerie Thoracique - SIT



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Epidémie de Covid-19 : POINT SUR L'IMAGERIE

Le contexte épidémique de Covid-19 entraîne une affluence de patients aux urgences de nos hôpitaux.

La société d'Imagerie Thoracique tient à rappeler que l'imagerie validée en cas de suspicion de pneumonie Covid-19 **est le scanner thoracique, indiqué en cas de signes de sévérité (désaturation) ainsi que chez les patients fragiles, avec comorbidités**. Il n'est pas actuellement utilisé comme test de dépistage systématique, ce qui pourrait évoluer. Il peut être négatif dans les 3 premiers jours des symptômes.

La **radiographie thoracique standard est non indiquée pour explorer les suspicions** de pneumonie Covid-19 car non sensible pour la détection des opacités en verre dépoli, faussement rassurante voire trompeuse. Elle conserve ses autres indications (suspicion de pneumothorax, d'OAP...).

Sa sur prescription entraîne une surcharge d'activité et une désorganisation de nos services de radiologie allant à l'encontre de l'efficience requise par la situation épidémique actuelle.

Devant un tableau suggérant une infection respiratoire basse, le contexte actuel doit faire préférer la réalisation d'un scanner thoracique sans injection en faible dose, plus discriminant, les signes tomodensitométriques de l'atteinte virale étant différent de ceux des pneumonies bactériennes.

Pr MP REVEL , Pr A KHALIL, Pr PY BRILLET, Pr M LEDERLIN, Pr G FERRETTI, Dr L CASSAGNES,
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[Se désabonner](#)

INDICATION:

Bilan d'une suspicion d'infection par SARS Cov2 (Covid19)

TECHNIQUE:

Acquisition hélicoïdale millimétrique **sans injection** sur le thorax

PDL : (mGy.cm)

Bio-nettoyage du scanner à l'aide d'un détergent-désinfectant pour les surfaces au décours de la réalisation de l'examen, selon les recommandations des services d'hygiène

RESULTATS:

Anomalies évocatrices de CoV19 :

Opacités en verre dépoli

Aspect : en plage / nodulaire

Condensations

Aspect : en bande / nodulaire

Crazy paving (réticulations au sein du verre dépoli)

Topographie lésionnelle globale :

Sous pleurale/ mixte /centrale

Prédominance inférieure : oui/non

Etendue des anomalies

Degré d'atteinte :

absent /minime (<10%)/modéré (10-25%)/étendu (25-50%) / sévère (>50%) / critique >75%

Signes négatifs :

Absence de micronodulation centrolobulaire.

Absence de condensation systématisée.

Absence de sécrétions endobronchiques.

Par ailleurs :

Absence d'anomalie du parenchyme pulmonaire sous-jacent.

Arbre trachéo-bronchique sans particularité.

Absence de masse ou de nodule pulmonaire suspect.

Absence d'adénomégalie médiastino-hilaire.

Absence d'épanchement pleuropéricardique notable.

Absence d'anomalie notable sur les coupes abdominales hautes.

Absence de lésion osseuse.

CONCLUSION:

Scanner typique/ compatible/ non évocateur de COVID-19

Atteinte : minime/ modérée/ étendue/ sévère /critique

Absence d'anomalie parenchymateuse, ce qui n'exclut pas une infection COVID-19 dans les 3 premiers jours d'apparition des symptômes



Thoracic Imaging in COVID-19 Infection

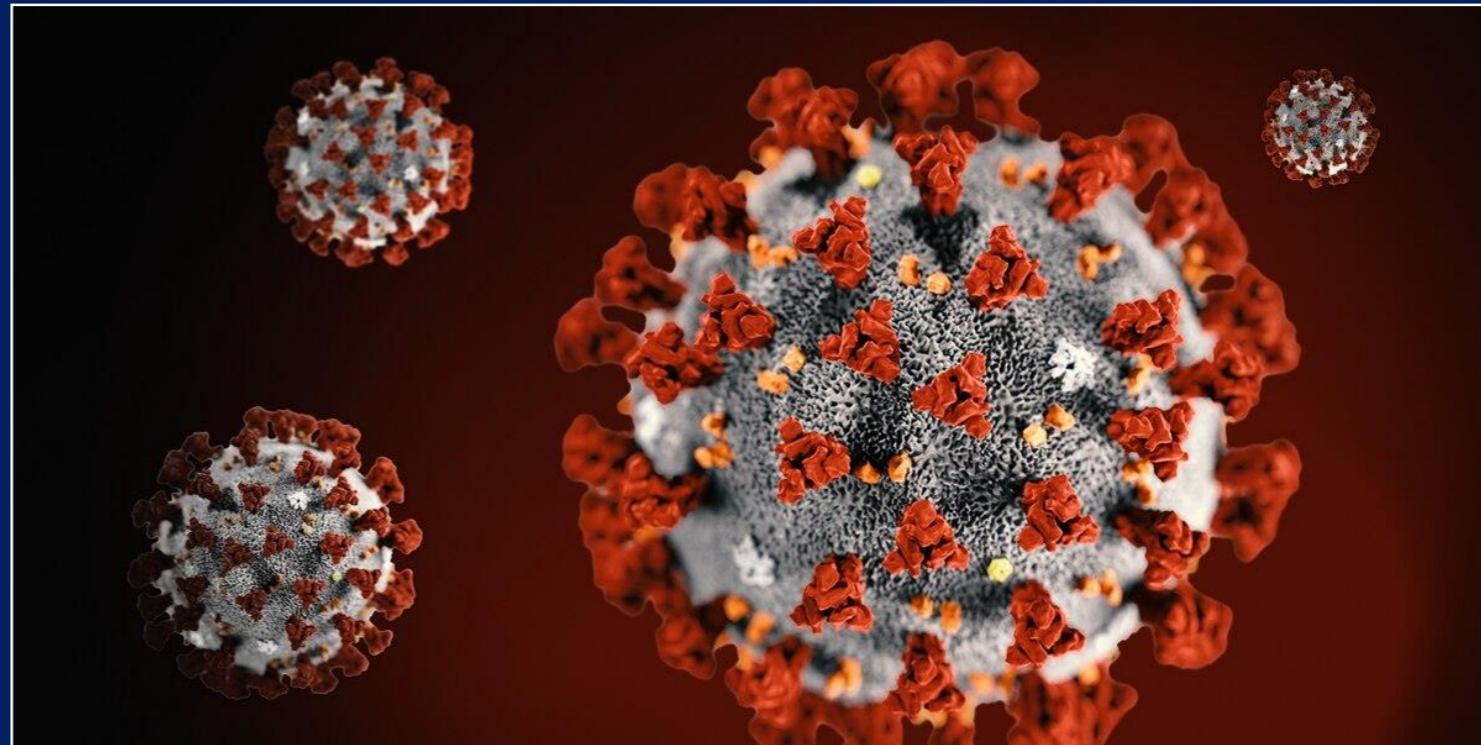
Guidance for the Reporting Radiologist
British Society of Thoracic Imaging

Version 2
16th March 2020



Background COVID-19

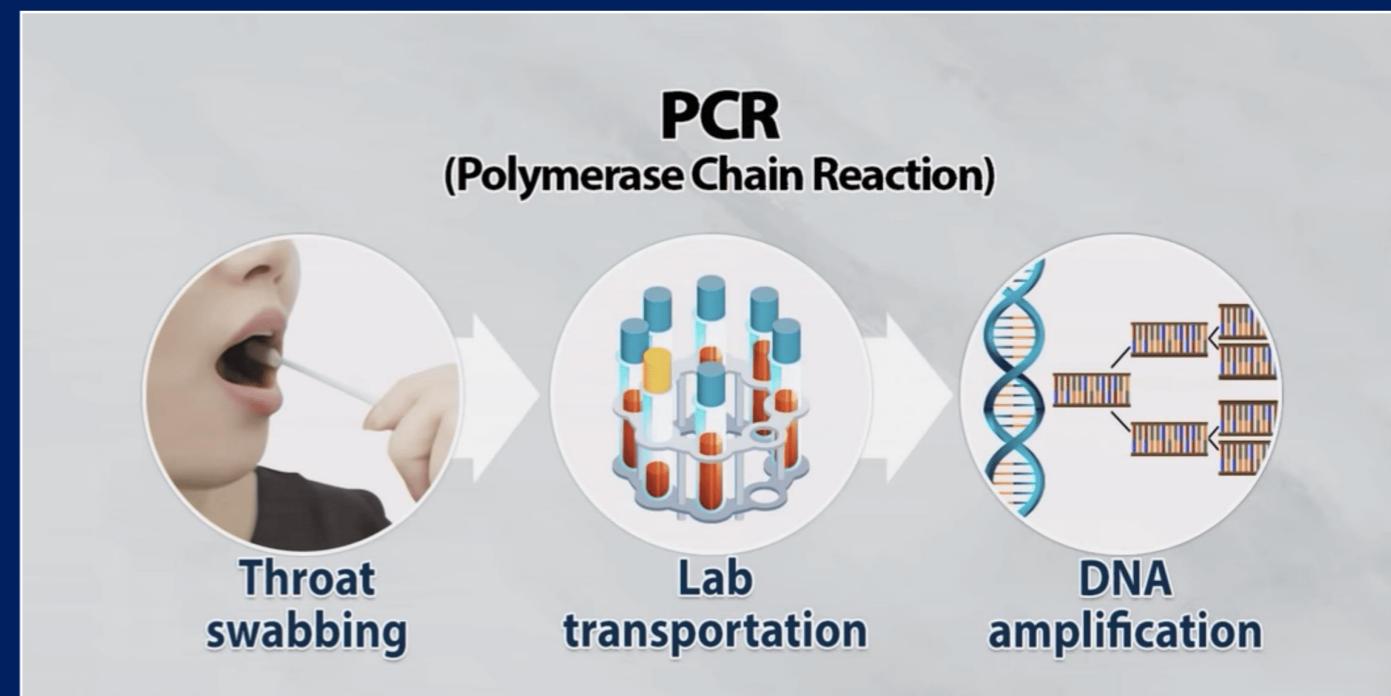
- First cases Wuhan City China
December 2019
- Large outbreak Northern Italy
February 2020
- First UK cases seen February
2020
- WHO Pandemic March 2020



PCR



- Throat swab
- Concern re availability
- When the demand increases processing times may significantly increase
- China - ran out of PCR testing kits so implemented CT scanning as a diagnostic tool
- PCR sensitivity 60-70% and can give a false negative result initially
- Retesting patients - precipitates further delays in turnaround of PCR results





Departmental Protocols

Standard operating procedures should be developed locally based around:

- Minimising risk to staff
- Infection control
- Portable CXR
- Standard departmental CXR
- Transferring patient to and from the Radiology department
- CT scanning & deep cleaning





Imaging Requests

Sufficient Information needs documenting on all Imaging referrals

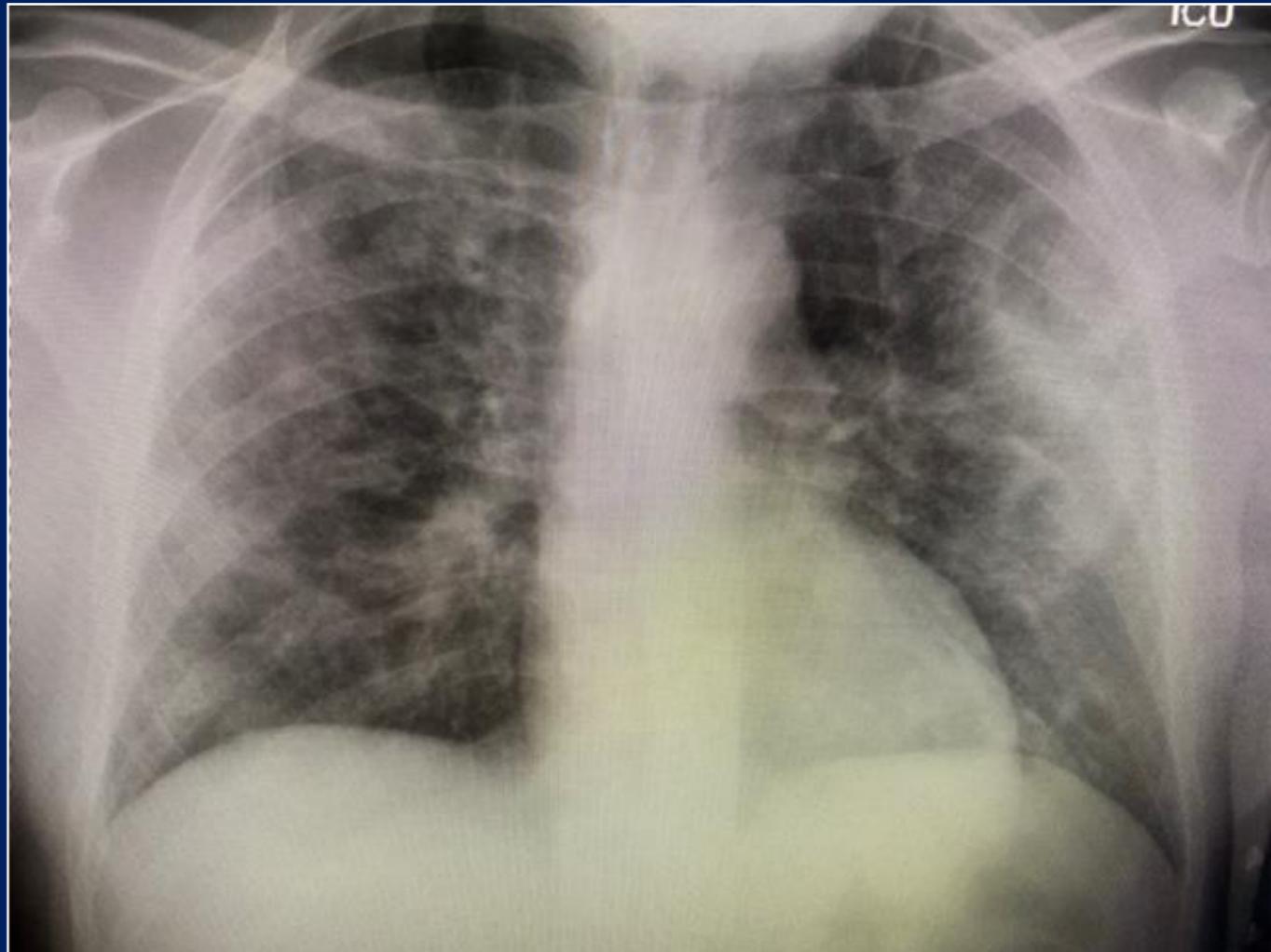
Departments should work with local clinicians to ensure relevant clinical information on all imaging requests

- Suspicion of COVID-19
- Infection risk - impacts on how, where and when patients are imaged
- Raised WCC / lymphopaenia - usually present in COVID-19
- CRP - unusual to be COVID-19 +ve if CRP is normal
- Relevant respiratory history
- Smoking history

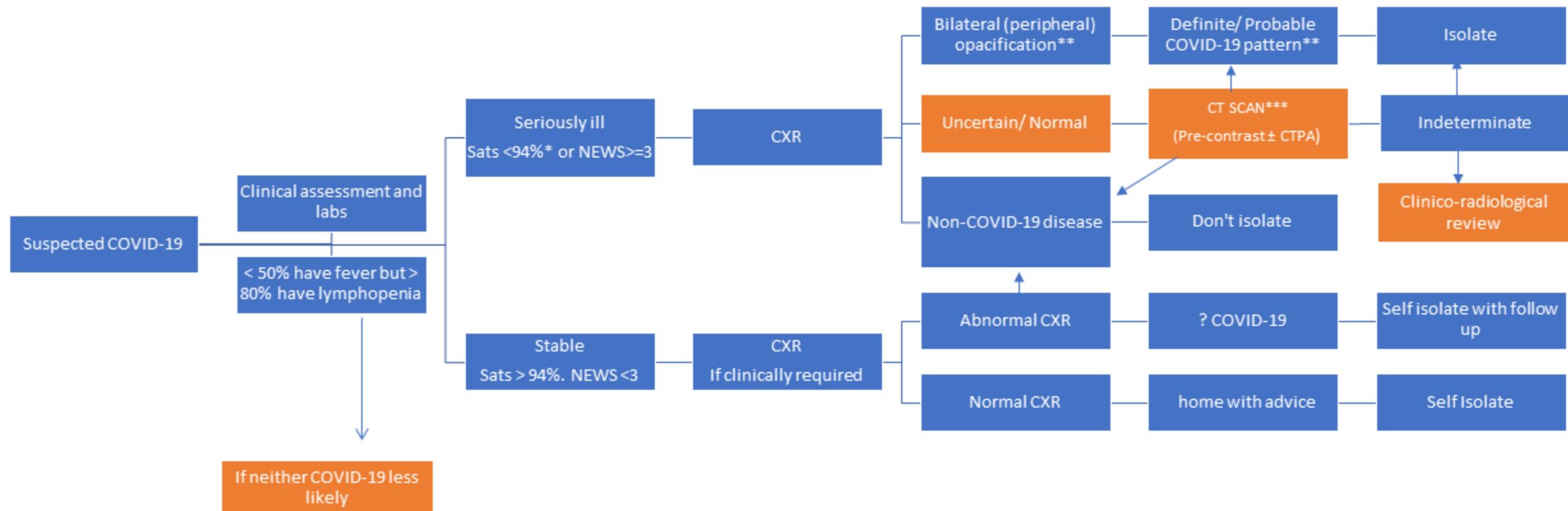
Imaging



- No role for CT imaging in the **diagnosis** of COVID-19 unless the patient is **seriously ill OR if PCR unavailable**
- Imaging (CXR & CT) may guide individual patient **management decisions**, deal with **complications** or looking for an **alternative diagnosis**



Radiology decision tool for suspected COVID-19



*94% unless known COPD in which case ≤90%

** Unsuspected/ unexpected cases may be incidentally discovered on CXR/ CT at this stage; should be reviewed in the context of clinical suspicion as to likelihood of COVID-19.

***Classic and Indeterminate CTs should be scored either: 'mild' or 'moderate/severe'

Please upload all COVID 19 cases to BSTI database: <https://www.bsti.org.uk/training-and-education/covid-19-bsti-imaging-database/>



CT patterns

Pattern	Description
CLASSIC COVID-19 <i>(100% confidence for COVID)</i>	<p>Lower lobe predominant, peripheral predominant, multiple, bilateral* foci of GGO</p> <ul style="list-style-type: none"> ± • Crazy-paving • Peripheral consolidation** • Air bronchograms • Reverse halo/ perilobular pattern**
PROBABLE COVID-19 <i>(71-99% confidence for COVID)</i>	<ul style="list-style-type: none"> • Lower lobe predominant mix of bronchocentric and peripheral consolidation • Reverse halo/ perilobular pattern** • GGO scarce
INDETERMINATE <i>(<70% confidence for COVID)</i>	<ul style="list-style-type: none"> • Does not fit into definite, probable or Non-Covid • Manifests above patterns, but the clinical context is wrong, or suggests an alternative diagnosis (e.g. an interstitial lung disease in a connective tissue disease setting)
NON-COVID <i>(70% confidence for alternative)</i>	<ul style="list-style-type: none"> • Lobar pneumonia • Cavitating infections • Tree-in bud/ centrilobular nodularity • Lymphadenopathy, effusions • Established pulmonary fibrosis

*>1 lesion, but could still be unilateral; usually but not universally bilateral¹

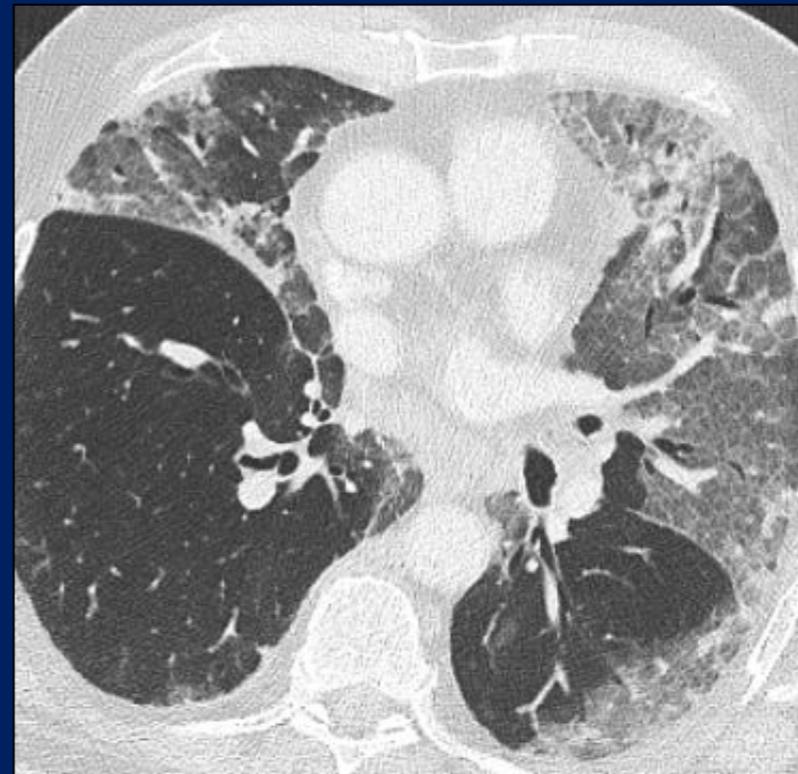
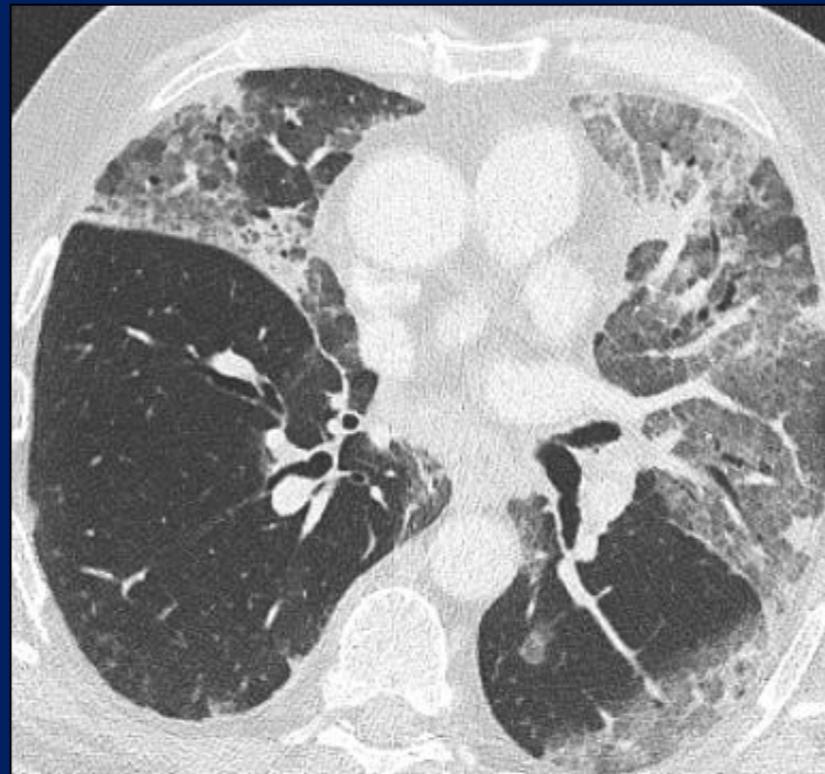
**i.e. organising pneumonia patterns

EXAMPLES

- The following examples are from recent UK cases
- Note that the clinical suspicion is **IMPERATIVE**
- Without the suspicion, the radiology is non-specific and could easily represent so many other processes

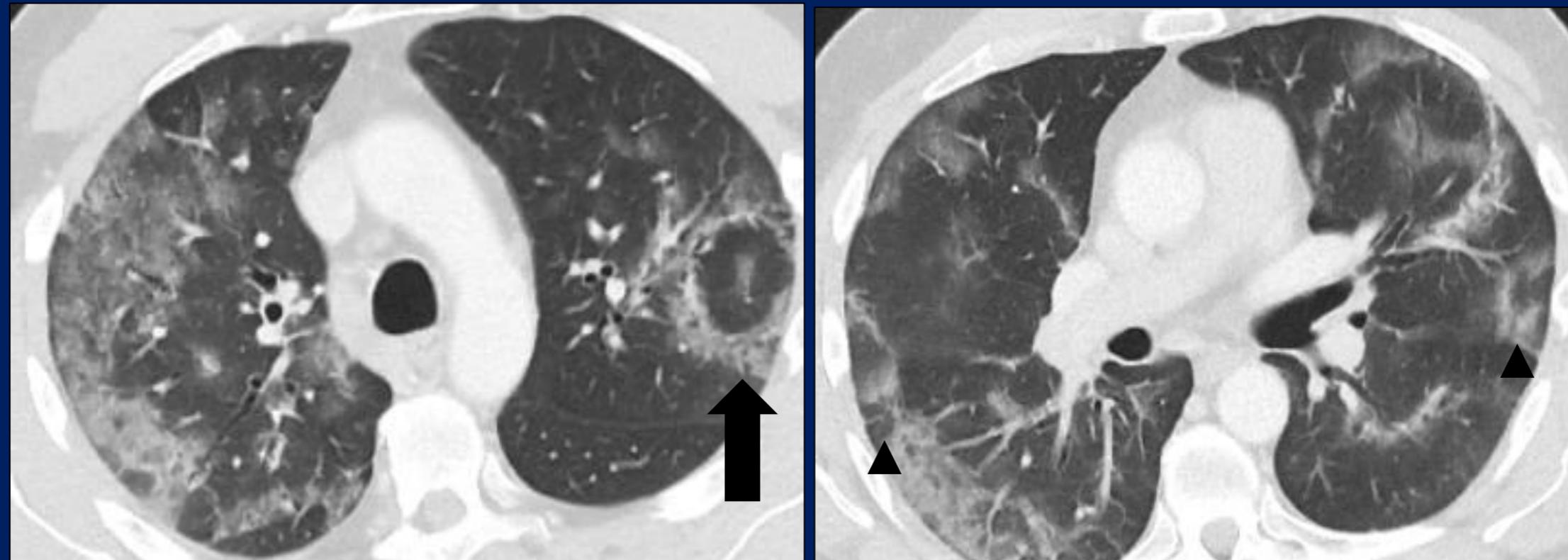
CLASSIC COVID19

Crazy-paving and consolidation



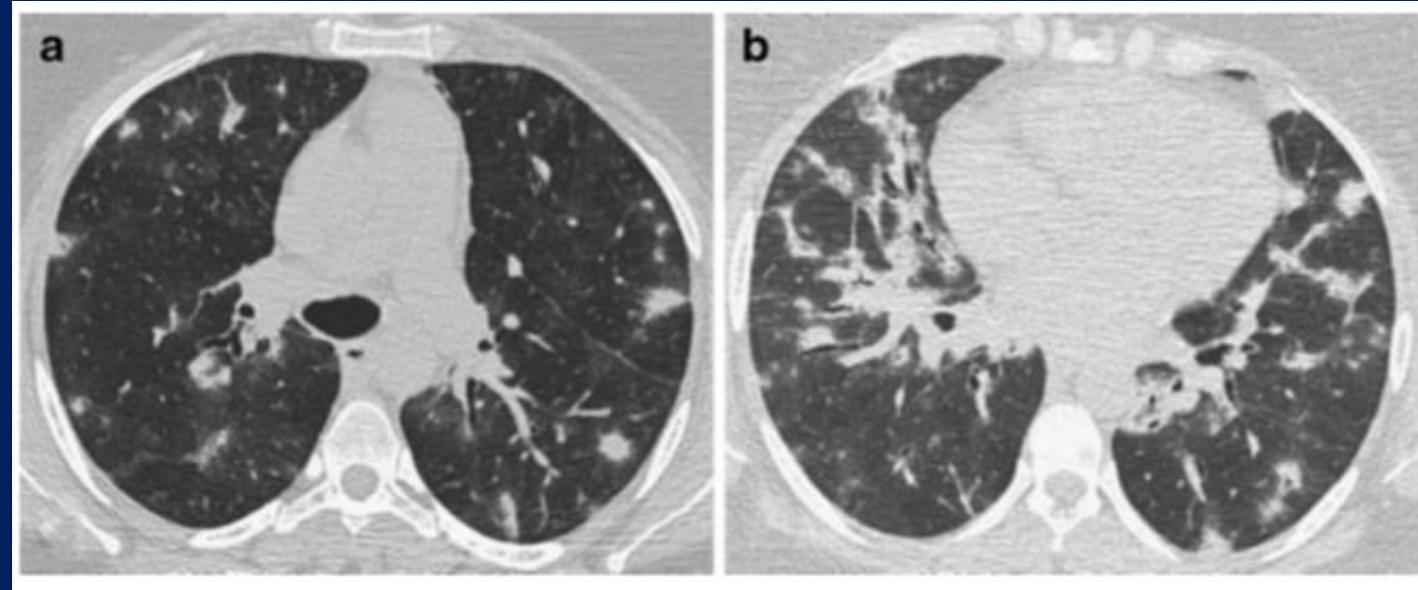
CLASSIC COVID19

GGO, reverse halo and perilobular

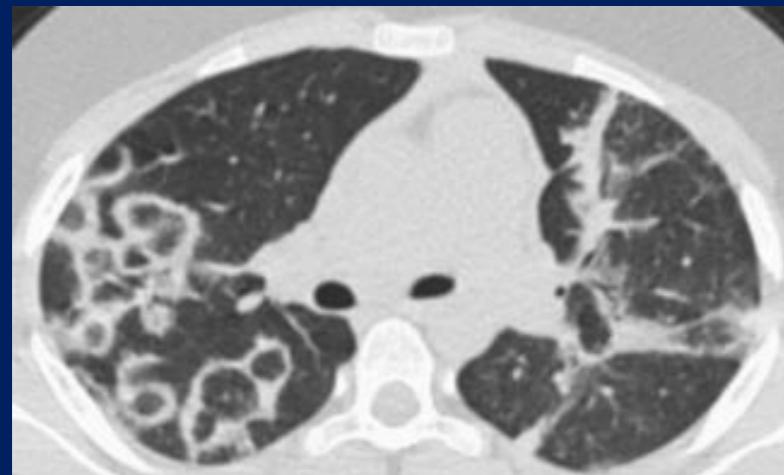


Reverse halo (arrow) and Perilobular opacities (arrowheads) are a sign of organising pneumonia

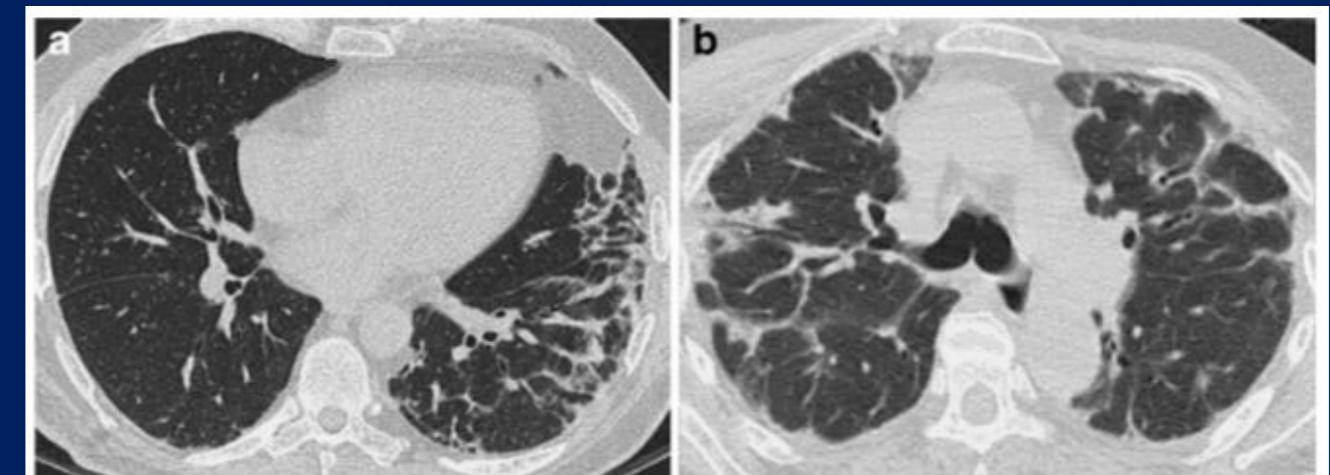
Organising pneumonia patterns



Bronchocentric consolidation and irregular nodules



Reverse halo pattern



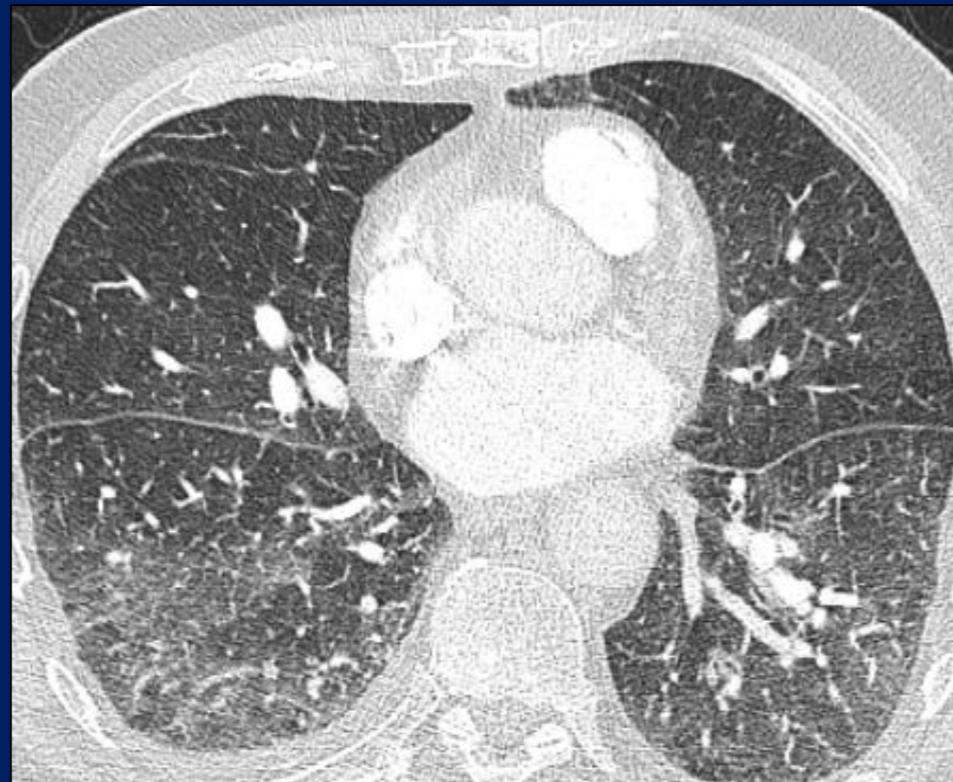
Perilobular pattern
“fuzzy arcades”

PROBABLE COVID19

Bronchocentric and nodular organising pneumonia
patterns, air bronchogram, but no GGO



INDETERMINATE COVID19 GGO ?from contrast and/or dependent



Needs clinic-radiology review. Fever, CRP and especially a **lymphopaenia**, would make COVID19 more likely

NON-COVID19



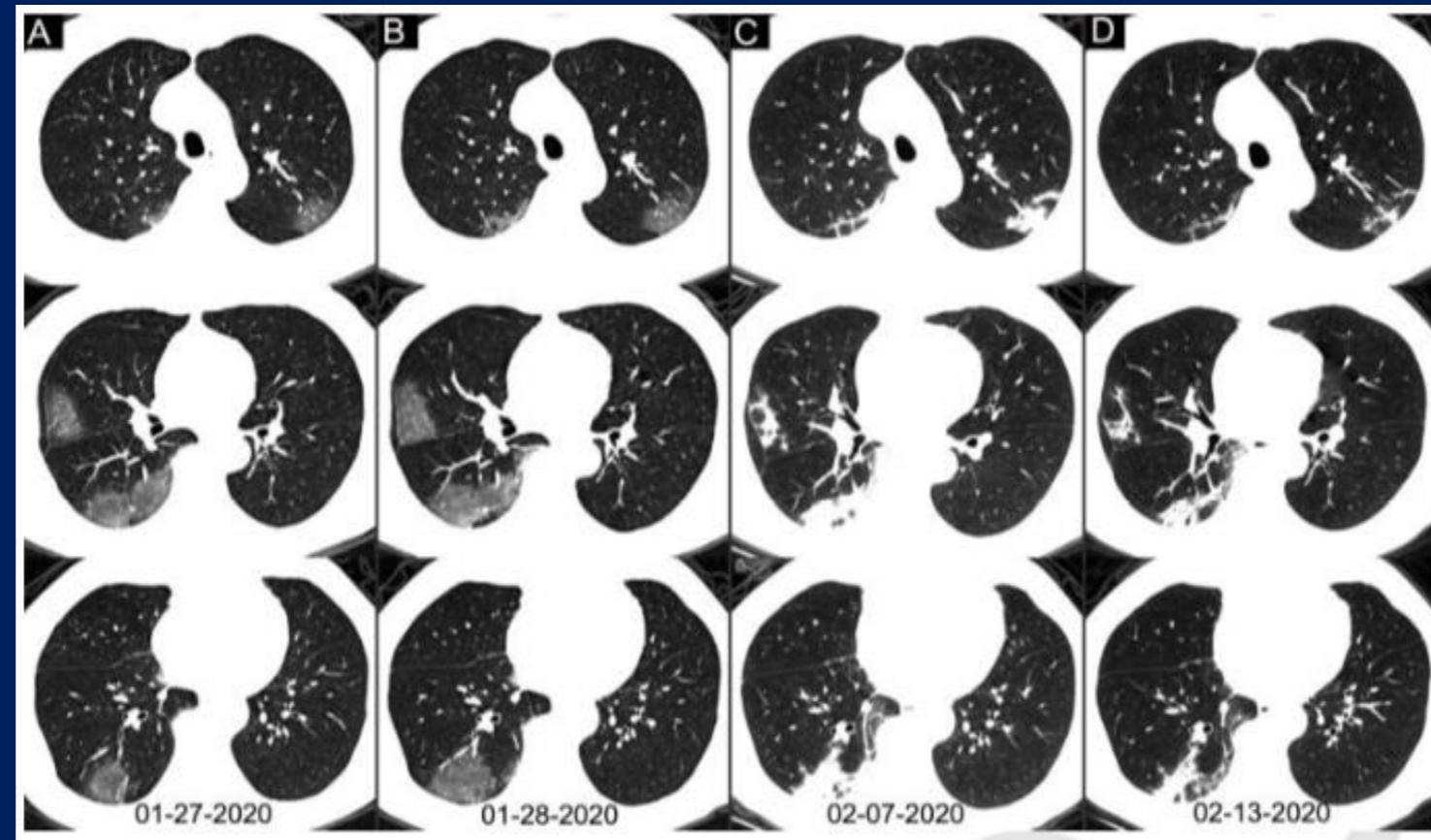
0.6mm lung recon



8mm MIP lung recon

Burkitt's lymphoma, pancytopenic. febrile 5 days with diarrhoea.
tree in bud (MIPs useful) and acinar- COVID negative (initial swab)

Serial change

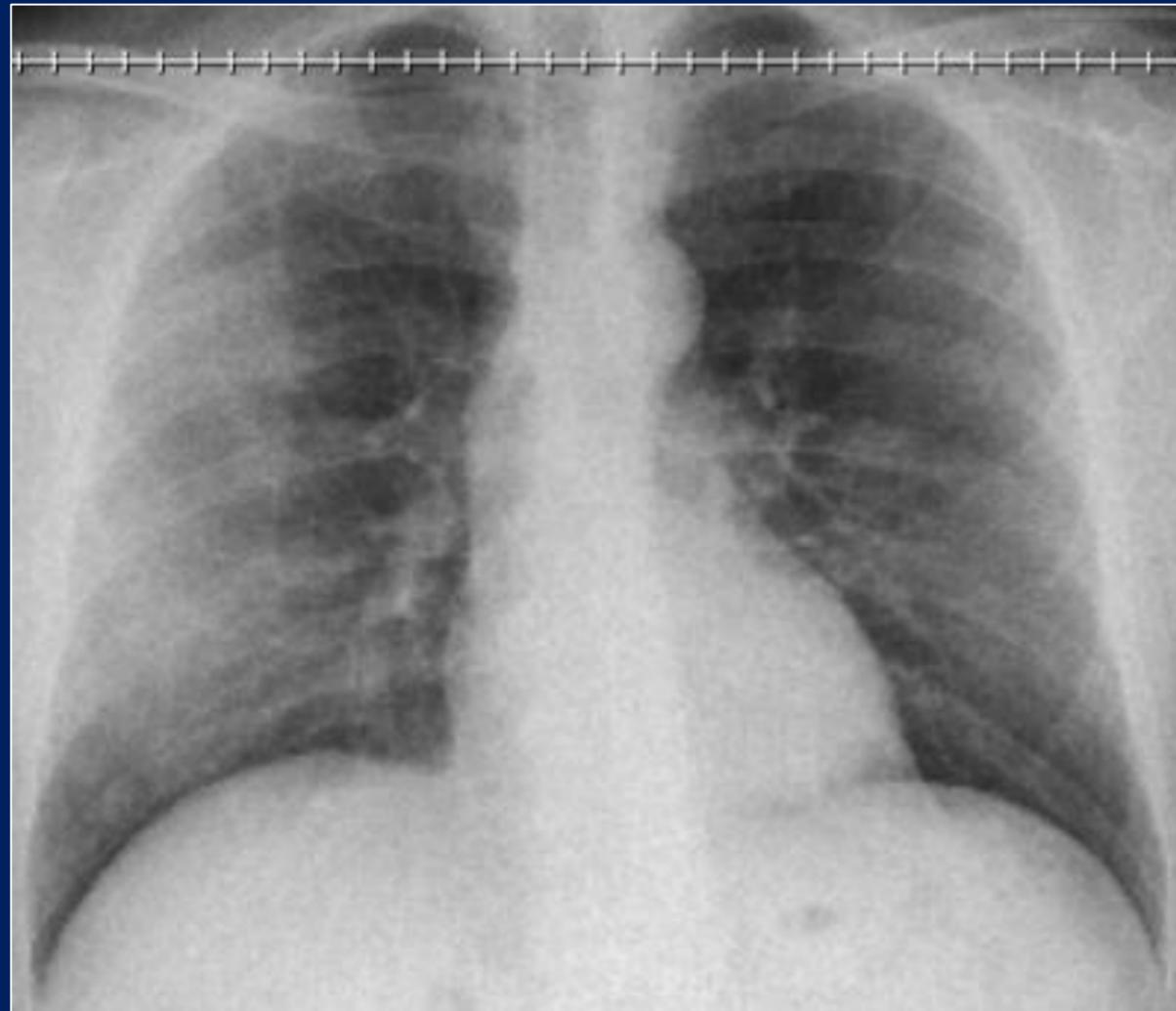


Chest CT images of a 62-year-old man with fever for 2 weeks, and dyspnea for 1 day. Negative results of RT-PCR assay for the SARS-CoV-2 using a swab samples were obtained on February 3 and 11, 2020, respectively. (column A) Chest CT with multiple axial images shows multiple ground-glass opacities in the bilateral lungs. (column B) Chest CT with multiple axial images shows enlarged multiple ground-glass opacities. (column C) Chest CT with multiple axial images shows the progression of the disease from ground-glass opacities to multifocal organizing consolidation. (D column) chest CT with multiple axial images shows partial absorption of the organizing consolidation.

*Ai et al. Radiology. 2020 Feb
26:200642. doi:
10.1148/radiol.2020200642.*



CXR categorisation



CLASSIC
Bilateral peripheral
air-space disease

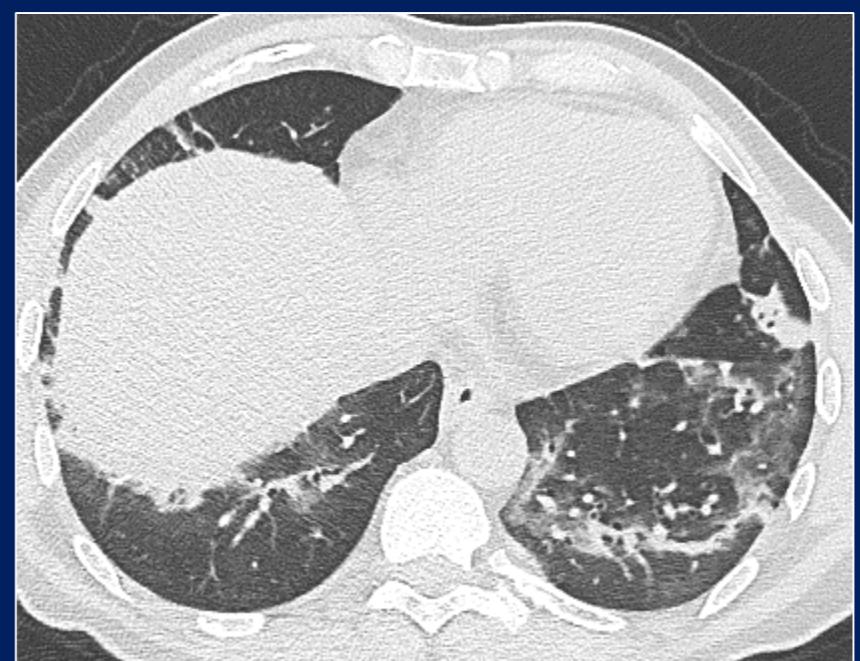
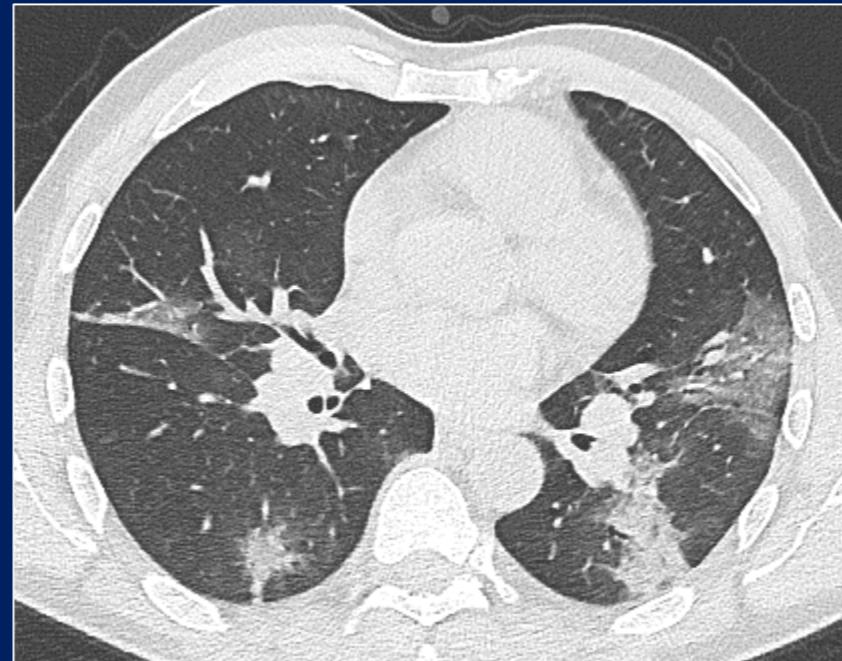
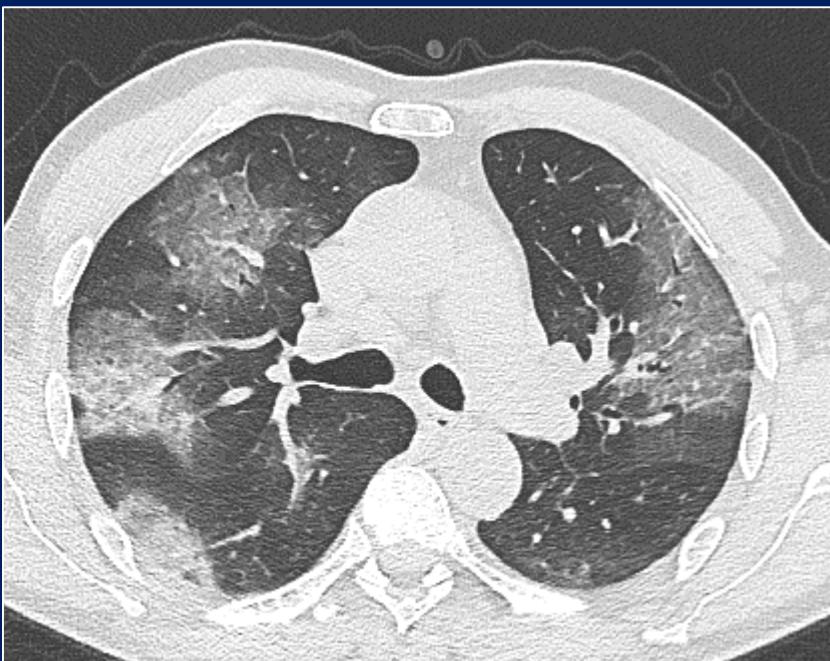


Unhelpful/
INDETERMINATE
Poor quality film



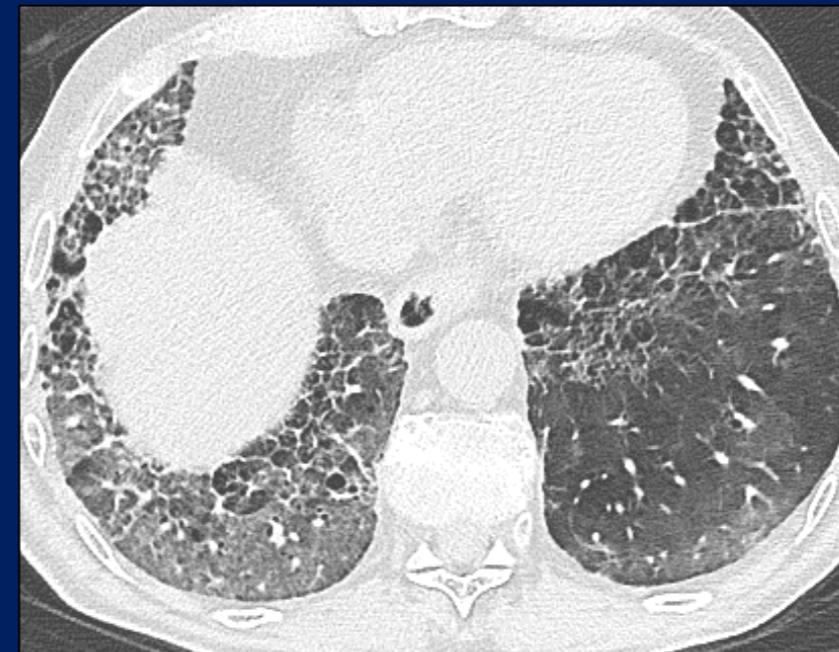
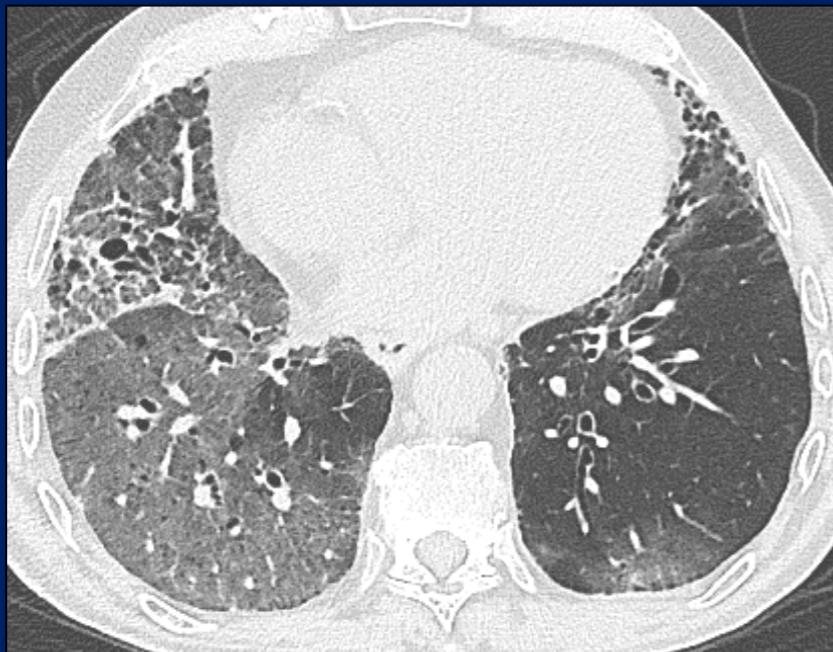
CLASSIC COVID-19

- Peripheral ground-glass opacities
- Crazy paving may be present
- Organising pneumonia



INDETERMINATE for COVID-19

- Ground-glass / patchy / non peripheral changes
- Fibrosis with ground glass
- Complex patterns

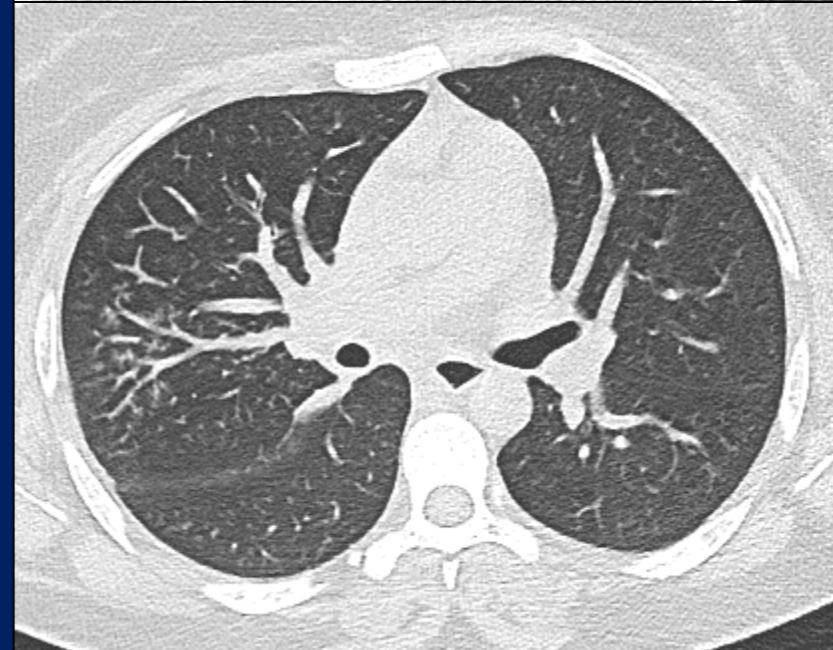
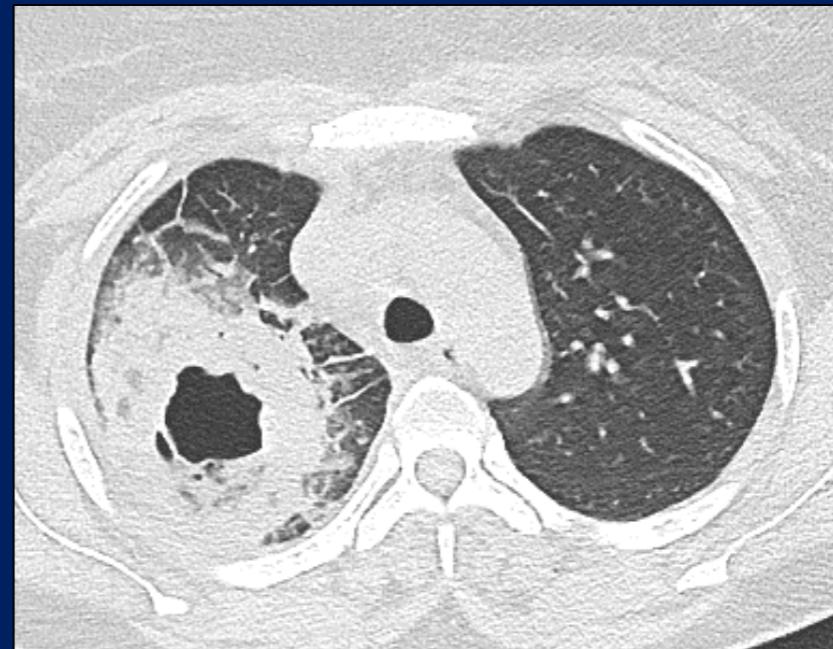




NON COVID19

The following would be unusual in COVID -19 infection:

- Lobar pneumonia
- Cavitating infections
- Tree-in bud changes
- Effusion(s)

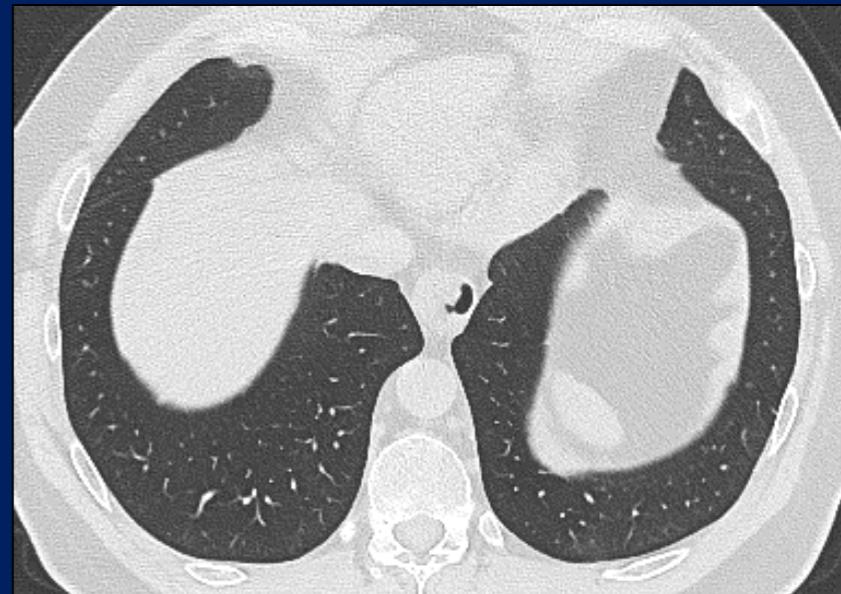
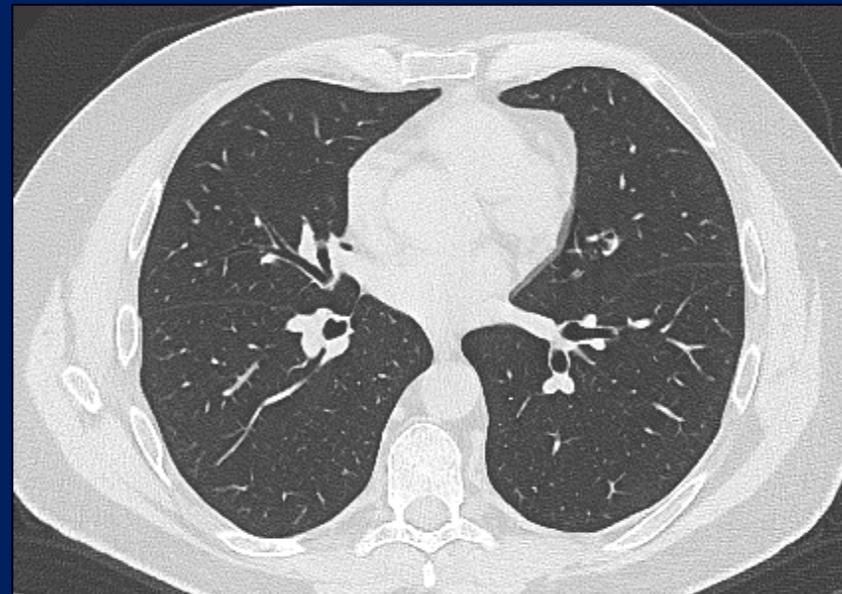
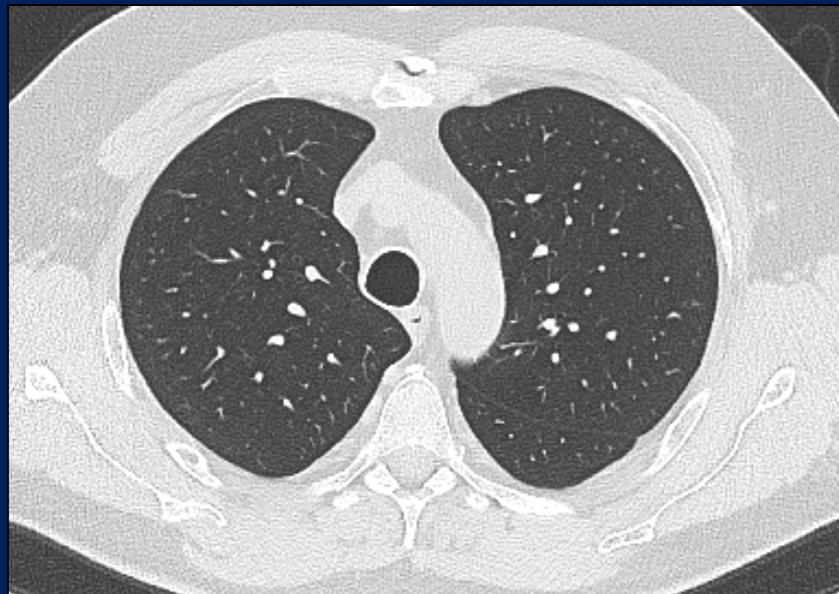


Differentiating abnormalities in the presence of underlying emphysema or interstitial lung disease maybe difficult



Normal

- It is important to remember that a normal CT can be seen in early COVID-19 infection



CT pattern and quantifying disease

Radiology	Parenchymal lung changes	Severity
Classic/Probable/Indeterminate	Up to 3 focal abnormalities 3cm in max diameter	Mild
	More than 3 focal abnormalities or max diameter >3cm	Moderate / Severe*

* The difference between moderate and severe is subjective and will likely differ between reporters.
This should be used in conjunction with clinical assessment.

CT pattern and quantifying disease (2)

Radiology in probable COVID-19		Severity
Pure ground glass opacities	Up to 3 focal abnormalities < 3cm in max diameter	Mild
Pure ground glass opacities	More than 3 focal abnormalities or max diameter >3cm	Moderate / Severe*
Focal ground glass opacities mixed with early consolidation		Moderate / Severe*
Diffuse ground glass opacities or consolidation with signs of architectural distortion		Severe

* The difference between moderate and severe is subjective and will likely differ between reporters.
This should be used in conjunction with clinical assessment.



BSTI: CT reporting proforma: COVID-19



Pre-existing lung findings

Emphysema none / mild / moderate / severe

Fibrosis none / mild / moderate / severe

Findings

Normal

Classic/Probable COVID-19

Predominant pattern: Bilateral, basal, GGO/ Crazy-Paving / Peripheral consolidation / Reverse halo / Perilobular

Other patterns:

Indeterminate for COVID-19

Does not fit Classic or Non-COVID-19 patterns or clinical context

Non-peripheral GGO / Complex / Unilateral / Other

Non-COVID-19

Lobar pneumonia / Cavitation / Tree-in-bud / Centrilobular nodules / Lymphadenopathy / effusion(s)

Other patterns

Disease Distribution

Upper	Middle	Lower	Random
-------	--------	-------	--------

Central 2/3	Peripheral 1/3
-------------	----------------

Bronchocentric (y/n)

Other findings

Conclusion

1. Normal Correlate with RT-PCR as CT can be normal in early infection

2. Classic/Probable COVID-19 infection

CT severity score

Mild Pure GGO, ≤3 focal abnormalities and all ≤3 cm

Mod/Severe Pure GGO, >3 focal abnormalities or >3 cm max diameter, consolidation, architectural distortion

3. Indeterminate for COVID-19 infection

CT severity score

Mild ≤3 focal abnormalities and all ≤3 cm max diameter

Mod/Severe >3 focal abnormalities or >3 cm max diameter

4. Non-COVID-19

Correlate with RT-PCR

Codes for RIS searches: CVCT0 = Normal CVCT1 = Classic/probable CVCT2 = Indeterminate CVCT3 = Non-COVID-19

Please consider case upload to https://bit.ly/BSTICovid19_Database



BSTI COVID-19 CXR Report Proforma

Findings

Normal

COVID-19 not excluded. Correlated with RT-PCR

Classic/Probable COVID-19

Lower lobe and peripheral predominant multiple opacities that are bilateral (>> unilateral)

Indeterminate for COVID-19

Does not fit Classic or Non-COVID-19 descriptors

Non-COVID-19

Pneumothorax / Lobar pneumonia / Pleural effusion(s) / Pulmonary oedema

Other

Quantifying disease

Mild / Moderate / Severe

Other findings

Codes for subsequent Radiology Information System search:

CVCX0 = Normal CVCX1 = Classic CVCX2 = Indeterminate CVCX3 = Non-COVID-19

Please consider case upload to https://bit.ly/BSTICovid19_Database



Scenarios to consider

- Incidental or unexpected finding on CXR. Clear advice needs to be given to radiographers regarding who to contact and what to do next in such a situation
- Dealing with unexpected findings on CT e.g. abnormal lung bases on CT abdomen & pelvis
- Workforce planning: departmental cover and on call provisions in the case of staff absence
- Unexpected findings on GP CXR suggesting Covid 19: based on clinical scenario – if patient not significantly ill as per suggested algorithm = mention classic/probable Covid infection, for self-isolation and clinical re-review where appropriate.



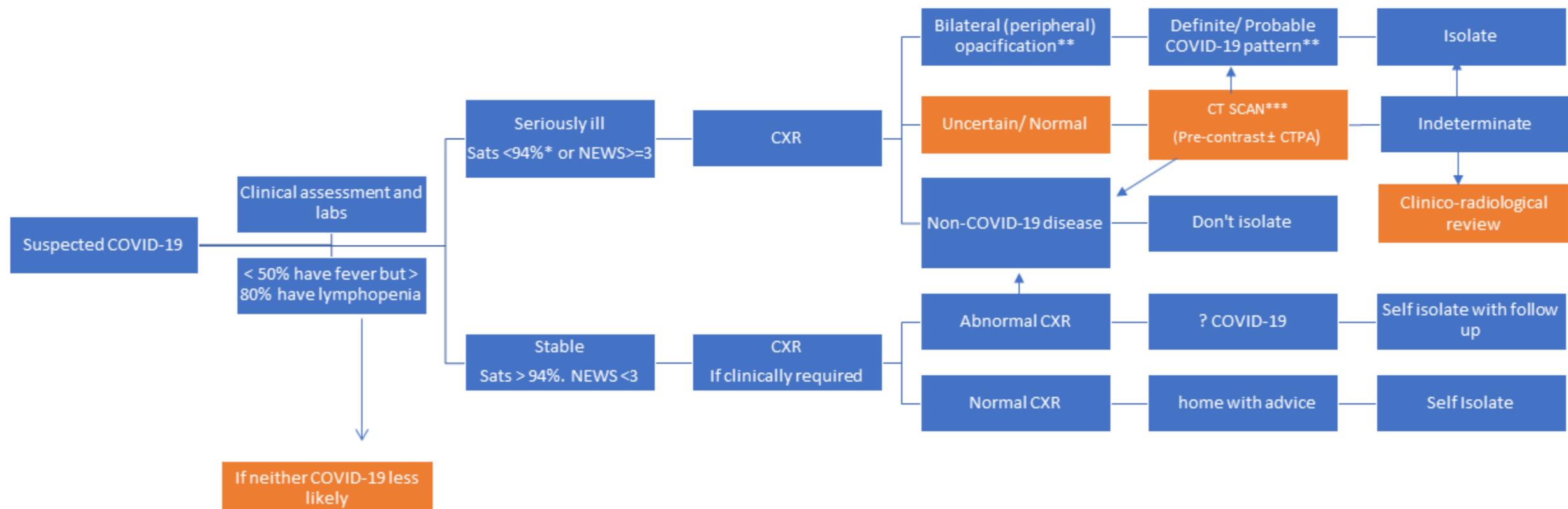
Case Database

- Refer a case https://bit.ly/BSTICovid19_Database
- Teaching Library https://bit.ly/BSTICOVID19_Teaching_Library
- Updates can be found on www.bsti.org.uk or via our Facebook (@BSTImaging) or Twitter (@BSTImaging) feeds.



The BSTI would like to thank Prof Nicola Sverzellati and his team in Parma Italy for sharing information and images.

Radiology decision tool for suspected COVID-19



*94% unless known COPD in which case ≤90%

**** Unsuspected/ unexpected cases may be incidentally discovered on CXR/ CT at this stage; should be reviewed in the context of clinical suspicion as to likelihood of COVID-19.**

***Classic and Indeterminate CTs should be scored either: 'mild' or 'moderate/severe'

Please upload all COVID 19 cases to BSTI database: <https://www bsti.org.uk/training-and-education/covid-19-bsti-imaging-database/>

COVID-19 info from the BSR

March 14 2020.

From the BSR Board, Scientific Council and BSR Chest Section.

Concerning COVID-19

1/Guidelines as to the hygienic measures for limiting virus spread in imaging departments are at the discretion of the authorities and subject to local decisions. The BSR cannot supply exact guidelines also due to the rapidly changing circumstances.

2/Guidelines how to organize Imaging Departments and their throughput/appropriateness are also subject to local hospital/network and authority decisions.

3/Guidelines for imaging in COVID-19 are supplied below.

The ACR, SFR and FOD have published very useful information on their websites.

Concerning point 3:

Typical indications for imaging

Imaging of COVID-19 patients (proven or 'possible') is only needed when there are clinical implications.

- CT should NOT be used as screening tool to replace laboratory testing for COVID-19
- If imaging is needed and patients can be transferred to the radiology department: unenhanced CT is the preferred imaging technique. There is no place for chest radiographs.
- Follow-up imaging of patients who are admitted to the Intensive Care unit or specialized units in isolation: portable radiography
- Patients who have a clinical suspicion of COVID-19 but cannot be tested (due to shortage of testing) and who are advised to go home: no need for imaging, no chest radiographs, no CT.
- Patients who are hospitalized and tested COVID-19 positive with no clinical deterioration: no imaging
- Patients who are hospitalized and tested COVID-19 positive with clinical deterioration:
 - o In general: unenhanced CT, thin section
 - o When there are comorbidities, hemoptysis, suspicion of pulmonary embolism, possibility of other pathology (pleural, pericardial, ...) etc.: IV contrast may be needed. This needs to be discussed with the treating clinician on a case per case basis.
- Patients who are hospitalized and tested COVID-19 negative but who have a clinical suspicion of possible COVID-19 infection: should be handled with the same

precautions as COVID-19 positive patients. Imaging only indicated in case of therapeutic consequences.

- In very specific conditions, CT can be considered to confirm or exclude COVID-19 infection. For example patients who need hemodialysis or need to be transferred to other centres (handicapped patients, specific treatment,). If patients have negative testing but high clinical suspicion, a negative CT may be used to confirm low likelihood of infection and patients can be transferred safely. These cases should be the exception and should be discussed on a case per case basis with the treating physician.
- Follow-up imaging studies in patients who are clinically improving is not indicated.
- There is currently no evidence to perform a CT at the end of treatment.
- If COVID-19 positive patients need an ultrasound: this should be preferably done bedside.

CT-imaging features:

Radiologists should familiarize themselves with the CT appearance of COVID-19 infection, in order to be able to identify possible COVID-19 related infection on imaging studies performed for other reasons. See cases. https://www.bsr-web.be/docs/Imaging_Coronavirus_BSR_chest.pdf. Preliminary data show that findings in Belgian patients are similar to cases published in literature (mainly Chinese population)

Parenchyme pulmonaire

- Lobe supérieur droit :
 - o "verre dépoli" / dallage fou / consolidation
- Lobe moyen droit
 - o "verre dépoli" / dallage fou / consolidation
- Lobe inférieur droit
 - o "verre dépoli" / dallage fou / consolidation
- Lobe supérieur gauche
 - o "verre dépoli" / dallage fou / consolidation
- Lobe inférieur gauche
 - o "verre dépoli" / dallage fou / consolidation
- Distribution : périphérique / central / périphérique et central
- à caractère flou/ou à limites nettes
- Signe du halo inversé / signe du halo présent
- Bandes et lignes curvillignes sous pleurales : présents / absents
- Dilatation vasculaire : présent / non présent
- Présence de nodules de type "tree-in-bud" / micronodules : (décrire si présents)
- Maladie pulmonaire sous-jacente (décrire si présente)
- Signes secondaires : (Décrire si présents)

Anomalies thoracique

- Thyroïde : sans particularités / (description des anomalies)
- Médiastin et hiles pulmonaires : pas d'adénopathies / (description des anomalies)
- Trachée et arbre bronchique : sans particularités / (description des anomalies)
- Cœur et vaisseaux sanguins :
 - o Taille du cœur : normale /(description des anomalies)
 - o Péricarde : quantité physiologique/quantité pathologique
 - o Aorte : Détails / (description des anomalies)
 - o Signes de surcharge : aucun signe de surcharge / (description des anomalies)
 - o (Embolie pulmonaire : présente/absente)
- Plèvre :
 - o Epanchement de la cavité pleurale à droite : absente/présent (limité/modéré/important)
 - o Epanchement de la cavité pleurale à gauche : absente/présent (limité/modéré/important)
- Devices externes (décrire si présents)

Divers :

- Abdomen supérieur : particularités / (à détailler)
- Os : particularités / (à détailler)

Conclusion :

- Résultats normaux, aucun argument TDM pour l'infection par COVID-19.
- Anomalies TDM, non typiques d'infection par Covid-19.
- Anomalies TDM atypiques, mais dans lesquelles une infection à Covid-19 doit être évoquée dans le diagnostic différentiel.
- Anomalies TDM, typiques de l'infection à Covid-19.
- Autres anomalies importantes : (à décrire si présentes)

Facultatif*.

- Score CT pour évaluer l'étendue du parenchyme pulmonaire affecté, avec évaluation par lobe. % de personnes touchées. 5 points par lobe, soit 25 au total.

0% : 0 point

< 5% : 1 point

5-25% : 2 points

25-50% : 3 points

50-75% : 4 points

Longparenchym

- Rechter bovenkwab:
 - o matglas / crazy paving / consolidatie
- Rechter middenkwab
 - o matglas / crazy paving / consolidatie
- Rechter onderkwab
 - o matglas / crazy paving / consolidatie
- Linker bovenkwab
 - o matglas / crazy paving / consolidatie
- Linker onderkwab
 - o matglas / crazy paving / consolidatie
- Distributie afwijkingen: perifeer / centraal / perifeer en centraal
- Scherp/onscherp gedemarkeerd
- Reversed halo sign / halo sign aanwezig
- Subpleurale banden en strengen: aanwezig/afwezig
- Vasculaire verdikking: aanwezig/niet aanwezig
- Tree-in-bud afwijkingen / noduli: (beschrijf zo aanwezig)
- Onderliggend longlijden (beschrijf zo aanwezig)
- Nevenbevindingen: (beschrijf zo aanwezig)

Bevindingen thoracaal

- Schildklier: geen bijzonderheden / (beschrijving afwijkingen)
- Mediastinum en longhili: geen vergrote klieren / (beschrijving afwijkingen)
- Trachea en bronchiaalboom: geen bijzonderheden / (beschrijving afwijkingen)
- Hart en bloedvaten:
 - o Hartgrootte: normaal / (beschrijving afwijkingen)
 - o Pericardvocht: fysiologische hoeveelheid/pathologische hoeveelheid
 - o Aorta: geen bijzonderheden / (beschrijving afwijkingen)
 - o Overvulling: geen tekenen van overvulling / (beschrijving afwijkingen)
 - o (Longembolie: geen/zo afwijkend beschrijf)
- Pleura:
 - o Pleuravocht rechts: afwezig/aanwezig (beperkt/matig/uitgesproken)
 - o Pleuravocht links: afwezig/aanwezig (beperkt/matig/uitgesproken)
- Supportmateriaal (beschrijf zo aanwezig)

Overig:

- Bovenbuik: geen bijzonderheden / (beschrijving afwijkingen)
- Skelet: geen bijzonderheden / (beschrijving afwijkingen)

Conclusie:

- Normale bevindingen, geen argumenten voor infectie.
- Infectieuze afwijkingen, niet typisch verdacht voor Covid-19 infectie.
- Infectieuze afwijkingen welke relatief atypisch zijn, doch waarbij ook een Covid-19 infectie tot de differentiaal diagnose behoort.
- Infectieuze afwijkingen, typisch voor Covid-19 infectie.

- Overige significante afwijkingen: (beschrijf zo aanwezig)

Optioneel*

- CT score ter evaluatie van de uitgebreidheid van het aangetaste longparenchym, met evaluatie per kwab. % aangetast. 5 punten per kwab, 25 in totaal.
 - 0%: 0 punten
 - < 5%: 1 punt
 - 5-25%: 2 punten
 - 25-50%: 3 punten
 - 50-75%: 4 punten
 - >75%: 5 punten
- Globale inschatting uitgebreidheid parenchymafwijkingen ten opzichte van het totale longvolume: <5% / 5-25% / 25-<50% / 50-<75% / >75%

*deze scores kunnen de clinicus een idee geven van de uitgebreidheid van het aangetaste longparenchym, maar zijn niet gevalideerd

Radiology Department Preparedness for COVID-19: *Radiology* Scientific Expert Panel

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The Coronavirus Disease 2019 (COVID-19) pandemic began in December 2019 in Wuhan, China. The outbreak is due to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection (1). Approximately 81,000 patients have been infected in China (2). Although infection rates are said to be controlled in China through severe public health measures, Italy (more than 10,000 cases) and Iran (more than 8000 cases) have seen exponential increases in the number of infected individuals.

Other than China, Italy, and Iran, most countries have had approximately 2 months to prepare their responses to the COVID-19 pandemic. These responses are led by public health authorities of national governments in coordination with local governments and hospitals. Due to the nature of the emergency in China, chest CT findings (eg, peripheral ground-glass infiltrates and/or organizing pneumonia) temporarily became part of official diagnostic criteria of COVID-19 as a surrogate for viral nucleic acid testing (1). With improved disease understanding, chest CT findings are no longer part of the diagnostic criteria for COVID-19. Instead, at present, the focus of most radiology departments outside of China has shifted from diagnostic capability to *preparedness*.

Radiology preparedness is a set of policies and procedures directly applicable to imaging departments designed (a) to achieve sufficient capacity for continued operation during a health care emergency of unprecedented proportions, (b) to support the care of patients with COVID-19, and (c) to maintain radiologic diagnostic and interventional support for the entirety of the hospital and health system.

Because of varying infection control policies (both nationally and regionally), steps for radiology preparedness for COVID-19 will vary between institutions and clinics. The *Radiology* Editorial Board has assembled a team of radiologists who are active in coordination, development, and implementation of radiology preparedness policies for COVID-19. Their policies have been developed in conjunction with top infection control experts at their respective world-class healthcare systems. In the sections below, each panel member describes their department's top priorities for COVID-19 preparedness in their environment. The Editorial Board hopes that readers may find one or more the highlighted healthcare systems to be similar to their own, providing impetus for action or confirmation of your current preparedness activities.

See also summary Tables 1-2 and Figures 1-2 for further resources.

University of Washington Medicine (UW)

UW is a major metropolitan medical system, with three major urban medical centers and many outpatient clinics and imaging centers spread across Western Washington, at the epicenter of the COVID-19 outbreak in the United States. There have been more than 267 cases of COVID-19 and 24 deaths in Washington state, including approximately 18 patients with confirmed COVID-19 hospitalized at our institutions as of this writing. There is a substantial Asian population that exists in Seattle, including many professionals and students that frequently travel to China and other high infection rate regions. The largest risk remains in older patient populations, as 71% of patients infected in Washington state are over 50 years of age and 57% are over 60 years of age.

Radiology leadership has helped in development of policies and guidelines relating to COVID-19 in areas of patient screening, spread precautions and patient triage in coordination with the hospital leadership. Radiology leadership has worked with input from our department membership, especially operations leaders and chest imagers to develop screening-specific guidelines.

Top Priorities in Our Environment for COVID-19 Preparedness

- 1. Early detection and limiting exposure of healthcare workers, employees and patients,** especially critically ill patients. The hospitals have implemented screeners at all hospital entrances to check those coming in for symptoms that could be related to SARS-CoV-2 infection or with risk factors related to travel or exposure. The radiology front desk serves as a screening site, with similar screening to that performed at the hospital front door. Patients who present with respiratory symptoms who are undergoing outpatient imaging or procedures have their studies canceled and are asked to follow up with their primary care physician. For inpatients with suspected or confirmed COVID-19, all nonemergent imaging and procedures are delayed until diagnosis is confirmed and they recover from their illness and are considered noncontagious.
- 2. Use of radiography and chest CT.** Despite reports from China (3) and initial concerns from the United States Centers for Disease Control regarding unreliable test performance (4), our current RT-PCR for SARS-CoV-2 viral nucleic acid is estimated to have a sensitivity of 95%-97%. Our lab also has a turnaround time of less than 1 day, making RT-PCR an easy, accurate, and less resource-intensive examination. Our lab has been performing more than 500 tests per day, covering our system but also other regional systems, with approximately 10% positive results. Inconclusive results are seen in a small subset, which are then sent for confirmation to Washington state labs.

Sensitivity and specificity of chest CT for COVID-19 are reported to range from 80%-90% and 60%-70%, respectively (3, 5). Thus, imaging is reserved for those cases where it will impact patient management and is clinically indicated or to evaluate for unrelated urgent/emergent indications. This is typically in cases where an alternative diagnosis is being ruled out or being

considered for acute symptom worsening. In our current workflow and with the accuracy and rapidity of the RT-PCR testing, there is no need for immediate CT imaging. In addition, if symptom worsening is thought to be secondary to COVID-19, imaging would not change management, as current treatment consists of oxygen and supportive care.

When possible, imaging is performed at sites with less foot traffic and with fewer critically ill patients in that area to avoid secondary patient and staff exposure. Considerations are also being made to implement a containment zipper (a room isolation tarp barrier with a zipper for room access) to separate the control area from the CT scanner room. Imaging is performed in the imaging center nearest to the patient and, if possible, at the ambulatory clinic. This approach limits the transit of contagious patients and potential exposure of others. When possible, portable imaging is performed (both portable x-rays and portable CT in patient rooms) to limit equipment, room, and hallway decontamination requirements.

3. Imaging in COVID-19 patients who are suspected positive or RT-PCR positive. For these patients, droplet precaution is employed. Patients are masked during imaging and procedures. Deep cleaning of the room is performed after each patient. Air exchange processes are not employed due to patient masking. After imaging, the room downtime is typically between 30 minutes to 1 hour for room decontamination and passive air exchange. Airborne precautions are reserved for those patients who are critically ill or are undergoing aerosol-generating procedures (bronchoscopy, intubation, nebulization, or open suction). Ventilated patients are not an airborne precaution, as the system is considered a closed system. The decision to remove patients from isolation is determined by hospital infection control staff. Those staff members consider RT-PCR results, imaging findings, clinical characteristics, potential exposures, and risk factors and comorbidities into their decision making.

4. Staff protection. Our hospital systems in coordination with the state have worked to reduce the need to bring patients to major hospitals and clinics. This will help protect our vulnerable patient population and university employees. Harborview Medical Center instituted a team of physicians and nurses that go out to SARS-CoV-2 suspected patient homes to perform testing and evaluation. In coordination with the Seattle Flu Study and Gates Foundation, University of Washington has begun issuing SARS-CoV-2 testing kits for home use. UW Medical Center Northwest Hospital has implemented drive-thru testing for University employees who are symptomatic. The University has placed a moratorium on travel for all employees for 1 month.

5. Maintenance of radiology department operations. In radiology, we have focused on providing the ability for radiology faculty to work from home if needed for isolation. For those that are not suspected of having been exposed or infected but are concerned about potential exposures, we have created radiology outposts and isolated reading rooms across our enterprise, including single station reading rooms in our hospitals as well as in our outpatient imaging centers. Staff that do not need to be on-site and who can work remotely (eg, including coders, billers and schedulers) are directed to work from home. The majority of hospital staff-related meetings now use video conferencing rather than having in-person attendance. For

those meetings that cannot be virtual, a determination of the necessity of the meeting is made by department leadership and those determined as nonessential are cancelled.

Emory University School of Medicine, Atlanta, Georgia

Emory is a large urban, academic, research-oriented healthcare system with 10 affiliated hospitals and extensive outpatient facilities covering an urban sprawl of more than 6.5 million persons in the greater Atlanta area. Atlanta is also home to the world's busiest airport and the Centers for Disease Control and Prevention (CDC).

Emory Healthcare has central coordination for COVID-19 preparedness, including *daily* leadership teleconferences; maintenance of a central stockpile of N-95 masks and other personal protective equipment; policy alignment with CDC, employee health, and infection control personnel. In the radiology department, we are holding regular meetings of the departmental leadership, including division directors and healthcare staff to plan for workforce integrity and the health of our staff. We also work closely with the Emory Office of Critical Event Preparedness and Response to ensure communication between our Emergency Department and the Radiology Department's Division of Emergency and Trauma Imaging. Email notifications, leader calls, and redistribution of the department's disaster preparedness escalation policy are the main modes of communication.

Top Priorities in Our Environment for COVID-19 Preparedness

- 1. Ensuring the health of our workforce so that we can best care for our patients.**
- 2. Planning for sufficient staffing to cover our clinical needs.**

Quarantine of clinical radiologists, staff, and trainees following travel to Level 3 countries and/or following exposure to patients with proven or suspected COVID-19 have the potential to quickly overburden our ability to adequately staff critical services. We are working to rapidly obtain and deploy additional home workstations so that asymptomatic radiologists can work from home. While this approach does not help procedural services, it can decompress diagnostic interpretations and provide back up for surge capacity.

- 3. Arranging for surge potential should the healthcare system be taxed** by increased volume of patients and associated imaging needs.
- 4. Contamination of CT scanners is major concern.** CT equipment may be out of commission for several hours for cleaning. Should a patient presenting atypically and/or not triggering suspicion for COVID-19 be scanned, the potential for additional patient and radiology staff exposure is heightened.

Other workforce considerations. The many spring radiology meetings are important venues for professional satisfaction, networking, and sharing meaningful scientific and educational material. With the prospect of major conferences being canceled we are finding opportunities for faculty and trainees to present their work locally to colleagues. During this period our colleagues have significant concerns about the safety of their families and school and daycare closings can impact their ability to get to the hospital.

New York University Langone Health (NYU), New York, NY

NYU is a large academic health care center in New York City. The catchment area includes the tri-state region of New York, New Jersey, and Connecticut. With three large airports serving the area, there is a large volume of domestic and international people traffic. Currently, New York has the second the greatest number of COVID-19 cases in the United States. On March 7, 2020, the governor of New York, Andrew Cuomo, declared a state of emergency for New York State.

At our institution, guidelines are distributed from the institutional leadership and then implemented by individual departments, including radiology.

Top Priorities in Our Environment for COVID-19 Preparedness

1. COVID-19 crisis management team.

A dedicated team from radiology leadership was charged with overseeing the departmental preparedness for COVID-19. A vertical communication network was established to coordinate the activities of four hospitals and multiple ambulatory care offices that comprise our department. Department directors and site managers participated in regular conference calls to standardize the protocols for patient care and operational workflow. The crisis management team share institutional news and sources of information to inform the department leaders. The crisis management team serves as a centralized resource to answer questions and address concerns from individual sites and department members.

2. Implementing protocols for patients with known or suspected COVID-19 exposure

Institutional directives for patient care protocols were adapted to the radiology environment. For outpatients, patients who schedule imaging examinations are screened for pertinent symptoms, travel history and exposure to individuals with known COVID-19. Based upon these answers, patients are scheduled for their imaging examinations or directed to the Virtual Urgent Care program or the Emergency Department. At radiology reception areas, patients are screened for symptoms of fever and cough. Initially, patients with travel history to countries with widespread transmission or contact with individuals with known COVID-19 were identified and consult calls were placed to the institution's Infection Prevention and Control (IPC) team to determine the need for patient testing and whether the patient will be

transferred to the emergency department or discharged home. Subsequently, as evidence of community spread of COVID-19 appeared in our geographic area, the threshold for calling the IPC team has been lowered with increased emphasis on patient symptoms. For these high-risk patients, the need to perform the scheduled imaging examination was determined by the relative urgency of the examination for patient care management.

In the hospital and emergency department (ED) setting, patients have usually already been identified as known or suspected COVID-19 patients and imaging examinations are provided as clinically warranted.

3. Reducing potential transmission from known or suspected COVID-19 patients

The guiding principle to reduce potential transmission from known or suspected COVID-19 patients is *source control*. In the ambulatory care setting, a patient presenting with fever and cough is immediately given a mask and directed to an isolation room for further screening and consultation with the IPC team. Healthcare providers who perform this additional screening wear personal protective equipment (PPE) including gloves, mask, and eye-shield. If the scheduled imaging examination is ultimately performed, the healthcare providers, such as the technologist and nurse, wear the same PPE and may wear a gown if there is the potential for close or direct contact with the patient. A *census of the other patients and staff in the practice at the time of the patient visit is logged* so that they may be contacted should the patient test positive for COVID-19.

In the hospital and ED setting, patients have usually already been identified as known or suspected COVID-19 patients. A dedicated portable x-ray machine was assigned to image only these patients. If additional advanced imaging examinations are required, the radiology staff wears the necessary PPE and the room is cleaned and disinfected according to hospital protocols.

4. Reducing potential exposure for department members

In order to minimize risk and potential for exposure, travel restrictions were instituted for all employees of our organization. All domestic and international work-related travel and business/academic attendance at meetings, conferences, and similar events were banned for a temporary time period. Large group gatherings were discouraged.

In our department, a significant number of the clinical faculty already have home workstations as part of our clinical wellness program. Prior to the travel ban, radiologists returning from high risk areas were asked to self-quarantine and interpret cases from home. With the possibility of increasing COVID-19 related quarantines involving the clinical faculty, additional home workstations have been ordered to provide quarantined clinical faculty the ability to work from home to meet the clinical demand.

With the increased usage of PPE and the concern for shortages, our institution implemented conservation measures to ensure that supplies are available for radiology staff

and patients who required them. In addition, allocation of PPE has been centralized within our hospital. PPE is distributed to areas of our department based upon clinical need.

University of Wisconsin Hospital

The University of Wisconsin hospital is a 675-bed academic hospital in Madison, WI. Our catchment area is a population of about 600,000 people. The main risk factor in our area is the international nature of our university and area businesses. There are 44,000 students at the University of Wisconsin – Madison, many do a semester abroad; the university research programs thrive on international outreach. Madison is home to Epic Systems; under normal conditions, 4000 employees traveled weekly to work in hospitals throughout the United States and internationally.

At the time of writing, the University of Wisconsin hospital has had one patient diagnosed with COVID-19. None of the hospital personnel in contact with the patient developed symptoms or positive real-time reverse transcriptase polymerase chain reaction (RT-PCR) for viral nucleic acid.

Our radiology department response is closely coordinated with our hospital infection control team. Hospital infection control personnel have had in-person meetings with our radiography technologists and have given tutorials on infection control procedures for respiratory infections. The hospital infection response workgroup sends out daily emails to all employees. Our department's Senior Director attends daily hospital COVID-19 command center briefings and meets daily with the radiology Vice Chair of Operations. Department modality managers have policies and procedures developed several years ago to deal with patients who might have EBOLA; existing policies were reviewed, and staff were updated.

For the faculty radiologists, our hospital infection response workgroup had our department create a back-up call schedule. The purpose is to cover faculty who become ill or are quarantined. Each radiology section has responsibility for sick-coverage for their daily clinical services and on-call staffing; individual radiology specialty areas have created back-up call schedules. Almost all radiologists have home PACS workstations; use of remote interpretation has been incorporated into our department's response plan.

Top Priorities in Our Environment for COVID-19 Preparedness

- 1. Insure all department employees are aware of and are performing recommended infection control protocols.** This applies not only to interacting with patients but also with fellow employees and working on shared workstations.
- 2. Arrange infection control tutorials led by hospital infection control experts.** Time has been allocated for hospital infection control experts to provide in person tutorials and provide

information required protocols for interaction with patients who may have COVID-19. Seminars by our Infection control personal have also been arranged with our CT, ultrasound and interventional technologists. These individuals are anticipated to be on the front lines in interaction with patients with suspected COVID-19 infection.

3. Develop a detailed operational plan for a new, separate urgent care site for COVID-19.

In the case of severe community outbreak, hospital infection control staff may take steps to provide care for COVID-19 patients in a separate facility away from our main hospital. We have developed a plan to equip and staff the site with a portable x-ray machine using strict infection control procedures.

4. Review and practice protocols for decontaminating imaging rooms after caring for a COVID-19 patient. This includes a 1 hour downtime for passive air exchange.

5. Work to better define the role of CT and 2-view chest x-rays in patients with COVID-19.

While multiple publications in RADIOLOGY and other major journals have described COVID-19 findings on chest CT, the vast majority of patients have been from China. In that environment, lack of RT-PCR test kits, remarkable influxes of patients required detecting and staging of COVID-19 disease patterns with chest CT. The applicability of those results to our environment is not yet known.

6. Continue sharing information with all department employees, including open discussions on ramp-up of stricter infection control procedures if needed. This includes having faculty work from their home PACS or sections splitting their faculty and fellows into separate reading sites, having residents attend conferences remotely from their reading rooms so they do not gather in one location, and having technologists work from one location and not rotate between health care facilities.

University of California San Francisco (UCSF)

UCSF is a tertiary-quaternary, 1000 bed urban referral academic center. San Francisco is an international crossroads and one of the earlier sites of disease in the United States.

The prevalence of COVID-19 cases in our institution's catchment area has increased rapidly over the last two weeks. UCSF has instituted a Hospital Incident Command System (HICS) structure to guide decisions and practice. The institution has shifted its strategy from containment to risk-mitigation in view of the size of the outbreak and the documented community spread of infection. Until internal laboratory testing had been developed, confirmatory RT-PCR testing represented a significant bottleneck in patient triage.

The response of our radiology department is coordinated with health system leadership, including radiology planning and strategy at the health system level. Policies are developed at

the health system level, including stay-at-home and return-to-work, faculty travel, and procedures for safe transport, respiratory isolation and treatment of suspected or confirmed COVID-19 patients. We have developed Radiology-specific guidelines for safe imaging of Patients Under Investigation (PUI) with CT and x-ray, contingency staffing planning and reducing risk of nosocomial spread.

Top Priorities in Our Environment for COVID-19 Preparedness

- 1. Identification of patients at risk for having COVID-19.** Patient screening is now undertaken at the time of radiology exam scheduling and in all outpatient imaging settings. Additionally, all patients and visitors are screened at the entrance to clinic buildings and hospitals. Respiratory clinics equipped with portable x-ray units have been established at each of our 3 main hospital sites. Ambulatory patients who screen positive for possible COVID-19 illness are redirected to one of these respiratory clinics for further evaluation.
- 2. Development of standard operating procedures for safe imaging of patients with suspected or known COVID-19.** (see figures) At UCSF, CT is not considered a screening examination for COVID-19. A multidisciplinary team of experts, including thoracic radiologists, is developing a guideline for use of CT imaging in patients with known or suspected disease. Standard operating procedures for safely imaging patients with portable x-ray units and for imaging patients with CT when necessary have been developed, ensuring that all team members are aware of patients' isolation status and that clinical and imaging teams provide coordinated high-level care in a safe and efficient manner.
- 3. Staff education regarding COVID-19 prevention.** Education of radiology staff regarding stay-at-home policies and infection prevention techniques, such as handwashing and regular cleaning of fomites, was an early focus in our department.
- 4. Personal protective equipment (PPE) availability and education for health-care workers.** Our department has worked with health system leadership to ensure adequate supplies of necessary PPE. Staff and faculty champions were recruited and serve to educate and reinforce appropriate donning and doffing techniques for PPE.
- 5. Implementation of “social distancing” strategies for staff, trainees, and faculty.** All large staff gatherings (e.g. radiology grand rounds) have been cancelled. We have aimed to decrease foot traffic in radiology reading rooms by encouraging remote consultations by video and telephone rather than in-person. Recurring departmental meetings and multiple clinical conferences have been moved to video conferencing. We are exploring strategies to allow diagnostic radiologists to work from home and developing guidance for when this is appropriate.
- 6. Planning for a potential surge of patients:** A surge in patients with known or suspected COVID-19 illness will require re-allocation of resources. Illness or factors such as school closing

may deplete our physician and staff workforce. We have developed contingency plans for maintenance of our clinical activities and staffing in such cases.

In order to maintain hospital bed availability, schedules for interventional radiology and neurointerventional radiology have been frozen (no additional patient slots) for two weeks for procedures that require patients to have overnight observation or hospitalization.

Singapore General Hospital (SGH)

SGH is a 1773-bed academic tertiary hospital in the city center of Singapore. SGH has one million patient visits annually. Singapore is an international travel hub. The first COVID-19 patient in Singapore was diagnosed in SGH on 23 January 2020. As of March 12, 2020, there were 187 confirmed cases of COVID-19 in Singapore.

The activities for infection control in the radiology department are highly coordinated with our institution-wide infection control staff. We have separate imaging facilities for inpatients and outpatients and negative air pressure rooms for radiography, ultrasonography, CT, and MRI to cater for patients with infection control risks.

Even prior to the COVID-19 outbreak, radiology had an infection control committee that included infectious disease (ID) physicians. In addition, there is an institutional disease outbreak task force that includes several members from radiology leadership, as there is acknowledgement that radiology is a key component in an outbreak situation (2).

At the present time, the national strategy for COVID-19 is that of containment. Our institutional strategy is to minimize any possibility of in-hospital transmission and to achieve zero health care worker transmission to ensure a safe environment for both patients and staff.

Top Priorities for Radiology for the Control of COVID-19 in Our Environment

1. Ensure sustainable radiology operations. Our goal is to ensure that every staff member is competent with standard infection control practices and use of appropriate personal protection equipment. At the present time, our priority now is to ensure continuous and consistent practice to avoid staff fatigue or complacency that can otherwise easily result in lapses in infection control. Daily audits of infection control procedures are conducted.

We have allocated staff into hybrid teams working in separate physical locations to avoid large numbers of radiology staff members being subject to quarantine. Meetings are conducted via electronic platforms to avoid congregation. Staff are encouraged to practice social distancing. Imaging equipment status is tracked daily to ensure adequate imaging capacity.

2. Monitor and respond to rapid changes in the COVID-19 pandemic. Our existing radiology management structure was too large and cumbersome to effectively respond to the rapid scenario changes. We constituted a smaller radiology disease outbreak task force, incorporating faculty with experience in intense operations (eg, colleagues who have held senior positions in the armed forces). This task force meets daily (eg, 20 minutes each morning) to assess overnight incidents and anticipated changes during the day.

Radiology has inserted itself into our infectious disease clinical team due to the key role of imaging in timely diagnosis as well as infection control (nosocomial infection related to imaging tests). The radiology task force actively disseminates information to all staff members via electronic means (eg, website, emails, text messaging).

3. Long range planning for COVID-19: a new norm for radiology operations. At seven weeks of the COVID-19 outbreak, we have minimized in-hospital transmission. Due to the global spread of COVID-19, we are looking at new norms of practice. Our goal is to inculcate an ongoing culture of infection control practice embraced by all staff members. We are re-thinking how radiology can deliver optimal imaging and treatment while reducing unnecessary movement and congregation of patients within our hospital environment. Teleconsultation and electronic smart appointment applications and counselling are being fast tracked for implementation and will have far reaching impact on our future practice.

Table 1: Relationship between the healthcare institution and radiology department in relationship to the COVID-19 pandemic

<input type="checkbox"/> Central coordination for COVID-19 preparedness for messaging between hospital infection control and the radiology department
<input type="checkbox"/> Screening (standardized questionnaire) for COVID-19 prior to patient examinations, at the time of scheduling, hospital entrances and at radiology front desks
<input type="checkbox"/> Rapid isolation of patients with suspicion of COVID-19 at screening
<input type="checkbox"/> Training of all employees to follow infection control protocols and to use personal protective equipment (PPE)
<input type="checkbox"/> Centralization of PPE supplies to prevent shortages, distributed based on clinical need
<input type="checkbox"/> Restricted travel for staff for all domestic and international work –related activities
<input type="checkbox"/> Use of video-conferencing for hospital/ health system staff meetings.

Table 2: Radiology Preparedness for COVID-19 pandemic

<input type="checkbox"/> Implementation of standard operating procedures for radiological imaging and procedures for patients with known or suspected COVID-19 exposure
<input type="checkbox"/> Imaging only for those COVID-19 patients where imaging will impact management
<input type="checkbox"/> Performance of imaging at locations with less foot traffic and with fewer critically ill patients. When possible, portable imaging is performed
<input type="checkbox"/> Standardized hospital protocols for decontaminating imaging rooms, especially CT scanners, after caring for a COVID-19 patient
<input type="checkbox"/> Improving capability for remote interpretations (home, other sites) in the case of staff isolation or patient surge

Figure 1. Tip sheet posted at the radiology front desk. All front desk locations have been equipped with isolation packets containing instructions for staff roles, N95 masks, gowns (University of California, San Francisco)

An outbreak of respiratory illnesses associated with a novel coronavirus called SARS-CoV-2 was first identified in Wuhan City, Hubei Province, China. The disease caused by this virus has been named coronavirus disease 19 (COVID-19) and cases have been identified in a growing number of other international locations, including the United States.

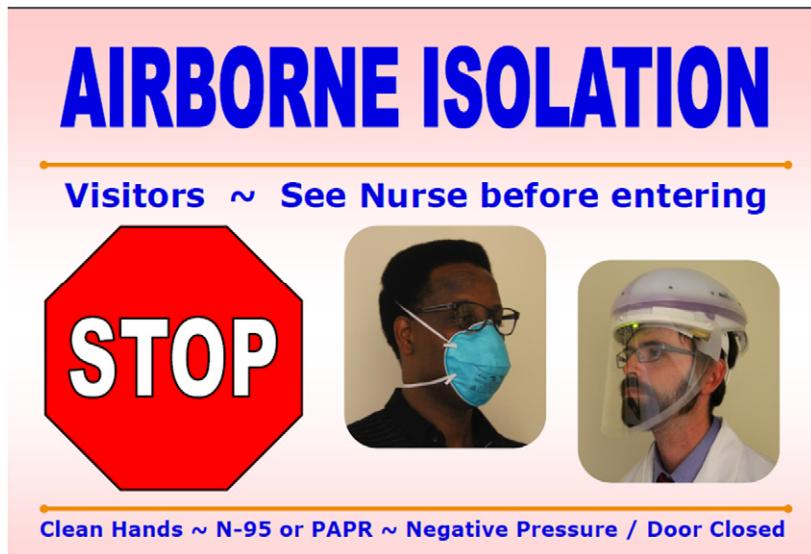
All Radiology front desk reception areas are screening outpatients asking standardized questions. These are hard stop questions before registration is completed. The current CDC criteria for Persons Under Investigation include:

Clinical Features	&	Epidemiologic Risk
Fever or signs/symptoms of lower respiratory illness (e.g. cough or shortness of breath)	AND	Any person, including health care workers, who has had close contact with a laboratory-confirmed COVID-19 patient within 14 days of symptom onset
Fever and signs/symptoms of a lower respiratory illness (e.g., cough or shortness of breath) requiring hospitalization	AND	A history of travel from the affected geographic areas below within 14 days of symptom onset <ul style="list-style-type: none"> • China • Iran • Italy • Japan • South Korea
Fever with severe acute lower respiratory illness (e.g., pneumonia, ARDS) requiring hospitalization and without alternative explanatory diagnosis (e.g., influenza)	AND	No source of exposure has been identified

If a patient presents with fever or cough and meets the criteria above:

- 1) Ask the patient to put on a **surgical** mask and place the patient as quickly as possible into an Airborne Infection Isolation (negative pressure) room in the ED or at least a private exam room. **Keep the door closed.**
- 2) Institute Airborne and Contact isolation plus eye protection—all healthcare personnel entering the patient's room should be wearing either an N95 respirator with eye protection (goggles or a face shield) or PAPR, a gown, and gloves.
- 3) Consider sending a nasopharyngeal swab for routine respiratory viral panel testing to evaluate for community respiratory viral infections (e.g., influenza).
- 4) Immediately contact Hospital Epidemiology and Infection Prevention (HEIP): phone numbers: XXXX including after-hours numbers.

Figure 2. All radiology sites with rooms that can be used as isolation rooms are identified with appropriate signage.



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