Practice guideline

Pre-operative work-up for COVID-19 infection in asymptomatic patients scheduled for surgery under general anesthesia

Leidraad

Pre-operatieve diagnostiek naar COVID-19 bij asymptomatische patiënten ingepland voor chirurgie onder algehele anesthesie

Disclaimer
This practice guideline is drafted to address the need for advice about pre-operative COVID-19 screening in asymptomatic patients. The utility of COVID-19 screening in asymptomatic patients is highly dependent on the background prevalence of SARS-CoV-2 infection among the tested population. Due to the acute and dynamic nature of the pandemic and the lack of accurate estimates of COVID-19 prevalence among the Dutch population, it is rather difficult to generalize the expected results of the proposed screening for the entire country. Therefore, hospitals may deviate from this practice guideline based on a locally-formulated multidisciplinary statement if they observe a low rate of COVID-19 infection within their community and hospital populations.
The committee will prospectively collect data on the performed nasopharyngeal swabs and chest CTs. If these results show that the proposed strategy has no or limited value, the practice guideline will be changed. For the next few weeks, there will be a weekly evaluation by the committee to evaluate the obtained results.

Introduction
The SARS-CoV-2 pandemic has rapidly altered the practice of medicine globally and in the Netherlands. This practice guideline was initiated by the Dutch Surgical Association (NVvH) and drafted by relevant medical specialists' associations under the auspices of the Dutch Association of Medical Specialists (FMS), and is a preliminary guide for how to perform a pre-operative COVID-19 workup for asymptomatic patients who are awaiting elective or emergency surgery under general anesthesia.

This practice guideline specifically concerns patients who are asymptomatic based on a thorough history of present illness (no shortness of breath, cough, rhinorrhea, anosmia, etc) and without signs of fever or hypoxia on physical exam. When patients show any signs of infection, they should be considered as COVID-19 suspect and treated accordingly, thus not based on this guideline.

The aim of this practice guideline is to provide a flowchart for the pre-operative workup of asymptomatic patients awaiting surgery under general anesthesia with the best available current evidence-base, while acknowledging the limitations of this knowledge base and minimizing the risks of unnecessary radiologic diagnostic tests.

Methods
A multidisciplinary working group was formed with representatives from surgery, radiology, pulmonary medicine, infectious diseases and microbiology. The databases [Medline (via OVID) and Embase (via Embase.com)] were searched with relevant search terms until March 25, 2020. The detailed search strategy is depicted in Appendix 1. Both scientific literature and clinical considerations formed the flowchart.

Summary of the literature

COVID-19 has a median incubation time of 5 days with a range of 1 to 14 days (Wu, 2020). Following this incubation period, patients can develop mild to moderate symptoms, with clinical deterioration and severe disease usually occurring 5-10 days after symptom onset (Wu, 2020; Guan, 2020; Chan, 2020). This means that patients who are initially asymptomatic or mildly symptomatic can subsequently develop moderate to severe COVID-19 disease, placing them at significant risk for adverse post-operative outcomes (NHvH webinar, 2020; Kluytmans, 2020; Aminian, 2020).
Comorbidities that are common to surgical populations, including hypertension, cardiovascular disease, COPD, asthma, and malignancies also place patients at significantly higher risk of severe COVID-19 disease (Yang, 2020; Zou, 2020). Effective screening of patients is therefore necessary to prevent post-operative development of severe COVID-19 disease in a vulnerable patient population.

In addition to the risk that COVID-19 poses to patients, COVID-19 may also pose a risk to health care workers and other hospitalized patients who are vulnerable to adverse COVID-19 outcomes. The understanding of this disease is rapidly evolving, and much remains unknown about the transmission of disease. However, growing evidence shows that, in contrast to SARS-CoV-1 and MERS, a significant proportion of COVID-19 infections may be asymptomatic to mildly symptomatic, and that these individuals shed SARS-CoV-2 and are capable of infecting other individuals who can subsequently develop severe disease (Wei, 2020; Qian, 2020; Du, 2020; Kimball, 2020; Kluytmans van den Bergh, 2020; Chan, 2020; Rothe, 2020; Moriary, 2020; Hu, 2020; Li R, 2020). Serial evaluation of SARS-CoV-2 viral load in the nasopharynx also show highest levels of infectious viral shedding early in the disease, just prior to or at onset of symptomatology (To, 2020; Zou, 2020, Wolfel, 2020).

These data suggest that asymptomatic/mildly symptomatic SARS-CoV-2 patients pose a realistic risk to health-care workers, particularly during intubation procedures and surgical procedures which can result in aerosolization of virus, and to other vulnerable hospitalized patients, through droplet and contact transmission in health-care settings. Transmission risks for asymptomatic to mildly symptomatic patients are therefore of significantly higher consequence in the hospital compared to the community setting.

Identification of asymptomatic and mildly symptomatic SARS-CoV-2 patients is challenging and sensitivity and specificity of existing and new diagnostics are rapidly evolving. Nasopharyngeal swabs for SARS-CoV2 in symptomatic patients are prone to sampling error and have demonstrated diminished sensitivity in comparison to chest CT (Ai, 2020, Fang 2020). One study reported similar sensitivity for PCR and CT (Xie, 2020). Interpretation of these studies, however, is limited by suboptimal reference tests and selection bias. It is likely that PCR sensitivity is higher in earlier stages of disease when shedding peaks and that patients with severe disease have higher viral loads than those with asymptomatic/mild disease (Liu Y, 2020, Wolfel R, 2020). A relatively large proportion of asymptomatic, PCR+ patients appear to have changes on pulmonary CT. 12 of 19 (63%) asymptomatic patients reported CT abnormalities in a Chinese cohort and 44 of 82 (54%) asymptomatic patients from the Diamond Princess cruise ship in Japan had CT changes (vs 80% of symptomatic patients) (Hu, 2020; Inui, 2020). Another study reported that 4 out of 10 asymptomatic patients (40%) showed CT abnormalities (Wang Y, 2020). These data are limited by confirmation bias, however they also suggest that CT may be a useful but under-characterized adjunct to PCR in peri-operative screening of asymptomatic patients with pulmonary involvement.

Conclusion

COVID-19 screening in asymptomatic surgery patients is important for three main reasons:

1. Patients may be in the incubation period of a COVID-19 infection and subsequently develop COVID-19 post-operatively, placing them at risk for adverse post-operative outcomes.

2. Patients may be asymptomatic/mildly symptomatic carriers and shedders of SARS-CoV-2 and place hospital workers at risk, particularly during intubation and aerosolizing procedures.

3. Patients may be asymptomatic/mildly symptomatic carriers and shedders of SARS-CoV-2 and place other hospitalized patients at risk, who are often in higher age groups with co-morbidities and at higher risk of severe COVID-19 disease.

Considerations

The committee advises that all adult patients requiring a surgical procedure under general anesthesia undergo pre-operative screening for COVID-19 infection through the use of SARS-CoV-2 PCR of a deep nasopharyngeal swab in conjunction with a low-dose chest CT (without iv contrast).

In general, the utility of CT scans for pre-operative screening is dependent upon the local background prevalence of COVID-19 disease. This data is currently lacking and therefore we are unable to determine a minimum rate of infections among the population or health care workers which could guide us in deciding when testing every patient scheduled for surgery would be beneficial. Currently, there is a clear difference in prevalence of SARS-CoV-2 in different parts of the Netherlands. The rapid changes in prevalence rates of COVID-19 during the spread of SARS-CoV-2 makes adjustment for known prevalence in recommendations challenging.

The risks of false positive and false negative findings on findings on CT scan, exposure of pre-operative patients to potentially contaminative environment of the CT room, and radiation exposure must be weighed against the risk of missing COVID-19 infections for patients, health care workers, and hospitalized patients. If low-dose CT is applied with a low dose radiation protocol on a modern CT scanner, it has a low radiation exposure of less than 5 mSv. There is no need for use of iv contrast which eliminates contrast allergy issues and risk of renal damage.

Elective patients

The committee advises to test elective patients within 48 hours prior to surgery in an outpatient clinic setting. One may consider starting with PCR testing and withholding a chest CT only if the PCR is positive for a COVID-19 infection. However, this might have severe logistical implications (patients need to visit the hospital repeatedly) and joint testing of PCR and CT may be a more desirable and practical approach, depending on the local situation.

In addition, we strongly recommend advising patients to comply with general directions regarding social distancing as stated by the government since this will likely lower the risk for COVID-19 disease at the time of operation.

Semi-acute patients

In semi-acute patients (those whose surgery can be postponed for more than 24 hours) who are admitted to the hospital, one can choose to start with PCR testing and cancel chest CT in SARS-CoV-2 PCR+ patients.

Acute patients

In acute patients (those who need surgery immediately) PCR testing will, in contrast to a chest CT, not provide a test result before the surgical procedure will be executed. However, it is deemed valuable to

know PCR status for the postoperative phase, in continuing or ceasing contact and droplet precautions. Therefore, we advise, also in acute patients, to perform PCR testing in conjunction to chest CT. Of course, chest CT should only be performed in acute situations if the clinical condition of the patient is stable enough to undergo this procedure.
One should realize that a CO-RADS 1-2 chest CT in an asymptomatic patient does not fully exclude a COVID-19 infection in these patients and careful treatment according to local protocol remains imminent. If history of present illness is not possible (i.e. trauma-patient in severe condition) or there is minimal doubt regarding symptoms, it is advisable to consider the patient COVID-19 positive and take precautions accordingly.

The committee does recognize that hospitals may differ in their access to testing resources (like PCR test availability or CT capacity), however, in the committee's opinion, peri-operative COVID-19 infections should be minimized as much as possible. If new evidence appears indicating that a more restrictive policy is justified, the committee will adjust the current standpoint.

Should patients with COVID-19 be identified with PCR or chest CT, the committee advises to delay elective surgery for at least 2 weeks in quarantine and to consider alternatives to surgery for (semi-)acute surgery if at all possible. Should surgery proceed in a COVID-19 patient, then appropriate peri-operative and operative hospital infectious disease / strict personal protective equipment (PPE) precautions should be used.

Pregnant women
The committee refers to the guideline which is currently crafted by the Dutch Association of Gynaecologists.

Children
In children avoidance of CT is wanted. The committee advises the use of PCR in these patients whenever possible and avoiding the use of low-dose CT.

Availability of PPE resources
In developing the recommendation, the committee has also weighed the limited availability of PPE in formulating recommendations. Currently, the limited availability of PPE in the Netherlands makes other solutions, such as increased use of isolation of patients and more general use of PPE, not possible in the evolving pandemic.

CO-RADS
The CO-RADS grading system as proposed by the Dutch Society of Radiology, should reflect the impression of the reporting radiologist's level of suspicion on CT imaging characteristics alone (without clinical parameters) (COVID working group of the Dutch Radiological Society, 2020). This score is based on international CT findings in COVID-19 patients. However, the score is not validated nor properly tested in asymptomatic populations. It is likely that an increasing number of false positive CO-RADS 3 scores will be seen in populations with a low pretest probability of COVID-19 and in patients without symptoms. Therefore, the working group advises to discuss CO-RADS 3 patients in a multidisciplinary team to determine the level of precautions. This multidisciplinary team should ideally include the respective surgeon, pulmonary physician, microbiologist, infectious disease specialist and radiologist.

The COVID working group of the Dutch Radiological Society advises to scan asymptomatic patients on a non-COVID CT scanner, if one has the availability of a dedicated COVID-CT scan.

In addition, it is likely that an increasing number of false negative CT scores (CO-RADS 1 > 2) will be seen in patients without symptoms, as CT scans can be negative within the first days of the disease

(Bernheim, 2020) or in patients without lung involvement. Hence, chest CT should be performed in addition to nasopharyngeal SARS-CoV-2 PCR testing.

Table 1. CO-RADS level of suspicion COVID-19 infection (COVID working group of the Dutch Radiological Society, 2020)

	Chance of COVID-19	**CT findings**
CO-RADS 1	Very low	Normal or non-infectious abnormalities
CO-RADS 2	Low	Abnormalities consistent with infections other than COVID-19
CO-RADS 3	Unsure	Unclear whether COVID-19 is present
CO-RADS 4	High	Abnormalities suspicious for COVID-19
CO-RADS 5	Very high	Typical COVID-19

Policy after postponed surgery due to a positive test result
Should a patient have a positive nasopharyngeal swab or chest CT test result, the committee recommends postponing surgery for 14 days. If the patient remains asymptomatic in these 14 days, the committee recommends that the patient be considered negative and not undergo new testing.

Policy in case of repeat surgery
The committee advises testing a patient only once in case multiple surgeries within a short period of time is needed.

Legitimacy of the practice guideline
In developing the recommendations, the committee recognizes that there is currently insufficient evidence and an urgent need for more information about the utility of CT and PCR in pre-operative screening. There is a parallel multi-center coordinated study to evaluate the utility of these diagnostics in identifying asymptomatic COVID-19 positive patients and this data will be used to re-evaluate the current guideline within one month's time.

Recommendations/Aanbevelingen

Adults
The committee advises to perform diagnostic testing in adult patients prior to a surgical procedure under general anesthesia for COVID-19 infection using a deep nasopharyngeal swab for SARS-CoV-2 PCR testing as well as a low-dose chest CT without contrast (see flowchart).

Children
The committee advises to perform diagnostic testing in pediatric patients prior to a surgical procedure under general anesthesia for COVID-19 infection using a deep nasopharyngeal swab for SARS-CoV-2 PCR testing. The committee advises against the use of low-dose CT.

Volwassenen
De commissie adviseert om bij volwassenen die een operatie onder algehele anesthesie ondergaan preoperatief onderzoek naar de mogelijke aanwezigheid van een COVID-19 infectie te verrichten door een diepe nasopharyngeale swab voor SARS-CoV-2 PCR en low-dose CT-thorax zonder contrast (zie flowchart).

Kinderen
De commissie adviseert om bij kinderen die een operatie onder algehele anesthesie ondergaan preoperatief onderzoek naar de mogelijke aanwezigheid van een COVID-19 infectie te verrichten door een diepe nasopharyngeale swab voor SARS-CoV-2 PCR.

Disclaimer 2

All associations involved have taken the greatest possible care in formulating the content of this Practice Guideline. Nevertheless, they accept no liability for any inaccuracies in this document, for any damages or for other consequences arising from or related to the use of this Practice Guideline.

Working group

dr. R. Bakx, pediatric surgeon at Amsterdam UMC, location AMC and chairman of the guideline committee of the Dutch Surgical Association, on behalf of the Dutch Surgical Association
Prof. dr. M.I. van Berge Henegouwen, surgeon at Amsterdam UMC, location AMC, on behalf of the Dutch Surgical Association
Prof. dr. M.A. Boermeester, surgeon at Amsterdam UMC, location AMC, on behalf of the Dutch Surgical Association
dr. M. Brink, radiologist at Radboud UMC, on behalf of the Dutch Radiological Society
dr. S.S. Gisbertz, surgeon at Amsterdam UMC, location VUmc, on behalf of the Dutch Surgical Association
dr. V. Harris, internist-infectious disease specialist at Amsterdam UMC, location AMC, on behalf of the Dutch Society for Internal Medicine: Infectious disease
dr. J.L. Murk, physician-microbiologist at ETZ Elisabeth, on behalf of Dutch Association of Medical Microbioloy
dr. G.D. Nossent, pulmonary physician, on behalf of the Dutch Association of Physicians in Lung Disease and Tuberculosis.
Prof. dr. J.M. Prins, internist-infectious disease specialist at Amsterdam UMC, location AMC, on behalf of the Dutch Society for Internal Medicine: Infectious disease
Prof. dr. M. Prokop, radiologist at Radboud UMC, on behalf of the Dutch Radiological Society
dr. J. Quarles, radiologist at Haaglanden MC, on behalf of the Dutch Radiological Society

With support of:

dr. J. Buddeke, advisor Knowledge Institute of Medical Specialists
drs. M. Oerbekke, advisor Knowledge Institute of Medical Specialists

Literature:

Aminian, A., Safari, S., Razeghian-Jahromi, A., Ghorbari, M., Delaney, C.P. (2020) COVID-19 Outbreak and Surgical Practice: Unexpected Fatality in Perioperative Period. Annals of Surgery

Bao, L., Deng, W., Gao, H., Xiao, C., Liu, J., Xue, J., ... & Qi, F. (2020). Reinfection could not occur in SARS-CoV-2 infected rhesus macaques. bioRxiv.

Bernheim, A., Mei, X., Huang, M., Yang, Y., Fayad, Z. A., Zhang, N., ... & Li, S. (2020). Chest CT findings in coronavirus disease-19 (COVID-19): relationship to duration of infection. Radiology, 200463.

Chan, J. F. W., Yuan, S., Kok, K. H., To, K. K. W., Chu, H., Yang, J., ... & Tsoi, H. W. (2020). A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. The Lancet, 395(10223), 514-523.

Du, Z., Xu, X., Wu, Y., Wang, L., Cowling, B. J., & Meyers, L. A. (2020). The serial interval of COVID-19 from publicly reported confirmed cases. medRxiv.Guan, W. J., Ni, Z. Y., Hu, Y., Liang, W. H., Ou, C. Q., He, J. X., ... & Du, B. (2020). Clinical characteristics of coronavirus disease 2019 in China. New England Journal of Medicine.

Guan, W. J., Ni, Z. Y., Hu, Y., Liang, W. H., Ou, C. Q., He, J. X., ... & Du, B. (2020). Clinical characteristics of coronavirus disease 2019 in China. New England Journal of Medicine.

Hu, Z., Song, C., Xu, C., Jin, G., Chen, Y., Xu, X., ... & Wang, J. (2020). Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. Science China Life Sciences, 1-6.

Inui, S., Fujikawa, A., Jitsu, M., Kunishima, N., Watanabe, S., Suzuki, Y., Umeda, S., Uwabe, Y. (2020). Chest CT Findings in Cases from the Cruise Ship "Diamond Princess" with Coronavirus Disease 2019 (COVID-19) Radiology: Cardiothoracic Imaging 2(2), e200110.
https://dx.doi.org/10.1148/ryct.2020200110

Kimball, A. (2020). Asymptomatic and Presymptomatic SARS-CoV-2 Infections in Residents of a Long-Term Care Skilled Nursing Facility—King County, Washington, March 2020. *MMWR. Morbidity and Mortality Weekly Report*, *69*.

Kluytmans- van den Bergh M, Buiting A, Pas S, Bentvelsen R, Van den Bijlaardt W, Van Oudheusden A, Van Rijen M, Verweij J, Koopmans M, Kluytmans J. (2020). SARS-CoV-2 infection in 86 healthcare workers in two Dutch hospitals in March 2020: a cross-sectional study with short-term follow-up. Available at: https://www.medrxiv.org/content/10.1101/2020.03.23.20041913v1

Li, R., Pei, S., Chen, B., Song, Y., Zhang, T., Yang, W., & Shaman, J. (2020). Substantial undocumented infection facilitates the rapid dissemination of novel coronavirus (SARS-CoV2). Science.

Liu, Y., Yan, L. M., Wan, L., Xiang, T. X., Le, A., Liu, J. M., ... & Zhang, W. (2020). Viral dynamics in mild and severe cases of COVID-19. The Lancet Infectious Diseases.

Mizumoto, K., Kagaya, K., Zarebski, A., & Chowell, G. (2020). Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. *Eurosurveillance*, *25*(10).

Moriarty, L., Plucinski, M., Marston, B., Kurbatova, E., Knust, B., Murray, ….& Richards, J. (2020). Public Health Responses to COVID-19 Outbreaks on Cruise Ships — Worldwide, February–March 2020 MMWR. Morbidity and Mortality Weekly Report 69(12) Available at: https://dx.doi.org/10.15585/mmwr.mm6912e3

COVID working group of the Dutch Radiological Society (2020) COVID-19 CORADS classification. https://www.radiologen.nl/nieuws/handreiking-standaardverslag-ct-thorax-covid-19

Okba, N., Marcel A. Müller, M., Li, W., Wang, C., GeurtsvanKessel, GH., …& Haagmans B. SARS-CoV-2 specific antibody responses in COVID-19 patients. Preprint unpublished. Available at: https://www.medrxiv.org/content/10.1101/2020.03.18.20038059v1.full.pdf

Oral communications from Italian surgeons, webinar NVvH march 20th and 24th 2020

Qian, G., Yang, N., Ma, A. H. Y., Wang, L., Li, G., Chen, X., & Chen, X. (2020). A COVID-19 Transmission within a family cluster by presymptomatic infectors in China. *Clinical Infectious Diseases*.

Rothe, C., Schunk, M., Sothmann, P., Bretzel, G., Froeschl, G., Wallrauch, C., ... & Seilmaier, M. (2020). Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. New England Journal of Medicine.

To, K., Tsang, O., Leung, W., Tam, A., Wu, T., Lung, D., ….. & Yuen, K. (2020). Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study The Lancet Infectious Diseases. Available at https://dx.doi.org/10.1016/s1473-3099(20)30196-1

Wei WE, Li Z, Chiew CJ, Yong SE, Toh MP, Lee VJ. Presymptomatic Transmission of SARS-CoV-2 — Singapore, January 23–March 16, 2020. MMWR Morb Mortal Wkly Rep. ePub: 1 April 2020. DOI: http://dx.doi.org/10.15585/mmwr.mm6914e1external icon

Wolfel R et al, Virological assessment of hospitalized cases of coronavirus disease 2019 , https://www.medrxiv.org/content/10.1101/2020.03.05.20030502v1.full.pdf

Wu, Z., & McGoogan, J. M. (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. Jama.

Xie, X., Zhong, Z., Zhao, W., Zheng, C., Wang, F., & Liu, J. (2020). Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiology, 200343.

Yang, J., Zheng, Y., Gou, X., Pu, K., Chen, Z., Guo, Q., ... & Zhou, Y. (2020). Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: a systematic review and meta-analysis. International Journal of Infectious Diseases.

Zhou, F., Yu, T., Du, R., Fan, G., Liu, Y., Liu, Z., ... & Guan, L. (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet.

Zou, L., Ruan, F., Huang, M., Liang, L., Huang, H., Hong, Z., ... & Guo, Q. (2020). SARS-CoV-2 viral load in upper respiratory specimens of infected patients. New England Journal of Medicine, 382(12), 1177-1179.

Appendix 1

Search	Query	Items found
#23	Search **#22 AND #17**	166
#22	Search **((coronavirus*[tiab] OR corona virus*[tiab] OR pneumonia virus*[tiab] OR cov[tiab] OR ncov[tiab]) AND (outbreak[tiab] OR wuhan[tiab])) OR covid19[tiab] OR "covid 19"[tiab] OR ((coronavirus*[tiab] OR corona virus*[tiab]) AND 2019[tiab]) OR "sars cov 2"[tiab] OR sars2[tiab] OR new coronavirus*[tiab] OR new corona virus*[tiab] OR "ncov 2019"[tiab] OR "sars coronavirus 2"[tiab] OR "sars corona virus 2"[tiab] OR "severe acute respiratory syndrome cov 2"[tiab] OR "severe acute respiratory syndrome cov2"[tiab]** Filters: **Publication date from 2019/12/01**	1576
#21	Search **((coronavirus*[tiab] OR corona virus*[tiab] OR pneumonia virus*[tiab] OR cov[tiab] OR ncov[tiab]) AND (outbreak[tiab] OR wuhan[tiab])) OR covid19[tiab] OR "covid 19"[tiab] OR ((coronavirus*[tiab] OR corona virus*[tiab]) AND 2019[tiab]) OR "sars cov 2"[tiab] OR sars2[tiab] OR new coronavirus*[tiab] OR new corona virus*[tiab] OR "ncov 2019"[tiab] OR "sars coronavirus 2"[tiab] OR "sars corona virus 2"[tiab] OR "severe acute respiratory syndrome cov 2"[tiab] OR "severe acute respiratory syndrome cov2"[tiab]**	2552
#20	Search **#18 AND #19**	326
#19	Search **"Sensitivity and Specificity"[MeSH] OR specificit*[tw] OR screening[tw] OR accura*[tw] OR reference value*[tw] OR false positive[tw] OR false negative[tw] OR predictive value*[tw] OR roc[tw] OR likelyhood*[tw] OR likelihood*[tw]**	2690072
#18	Search **#1 AND #17**	1534
#17	Search **#10 OR #12 OR #11 OR #16**	1184792
#16	Search **"Polymerase Chain Reaction"[Mesh] OR polymerase chain reaction[tiab] OR pcr[tiab]**	815485
#12	Search **("Tomography, X-Ray Computed"[Mesh] OR computed tomograph*[tiab] OR ct[tiab] OR cts[tiab] OR cat scan*[tiab] OR computer assisted tomograph*[tiab] OR computerized tomograph*[tiab] OR computerised tomograph*[tiab] OR computed x ray tomograph*[tiab] OR computed xray tomograph*[tiab]) AND (“Thorax”[Mesh] OR thorax[tiab] OR thorac*[tiab] OR chest[tiab])**	71470
#11	Search **(Ultrasonography"[Mesh] OR "diagnostic imaging"[Subheading] OR ultraso*[tiab] OR sonograph*[tiab] OR echograph*[tiab] OR echocardiograph*[tiab] OR echotomograph*[tiab]) AND (“Thorax”[Mesh] OR thorax[tiab] OR thorac*[tiab] OR chest[tiab])**	352018
#10	Search **"Radiography, Thoracic"[Mesh] OR “X-thorax”[tiab] OR thoracic radiograph*[tiab]**	39381
#1	Search **"Severe Acute Respiratory Syndrome"[Mesh] OR "SARS Virus"[Mesh] OR "COVID-19"[Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept] OR 2019ncov[tiab] OR 2019 ncov[tiab] OR novel coronavirus*[tiab] OR novel corona virus*[tiab] OR ((coronavirus*[tiab] OR corona virus*[tiab] OR pneumonia virus*[tiab] OR cov[tiab] OR ncov[tiab]) AND (outbreak[tiab] OR wuhan[tiab])) OR covid19[tiab] OR covid 19[tiab] OR ((coronavirus*[tiab] OR corona virus*[tiab]) AND 2019[tiab]) OR sars*[tiab] OR new coronavirus*[tiab] OR new corona virus*[tiab] OR ncov 2019[tiab] OR “sars corona virus”[tiab] OR “sars-like cov”[tiab] OR “sars-like coronavirus”[tiab] OR sars-related cov[tiab] OR sars-related coronavirus[tiab] OR sarsr-cov[tiab] OR “severe acute**	13402

Search	Query	Items found
	respiratory syndrome-like coronavirus”[tiab] OR “severe acute respiratory syndrome-related coronavirus[tiab] OR hcov-sars[tiab] OR human sars coronavirus[tiab] OR sars cov[tiab] OR sars associated coronavirus”[tiab] OR sars coronavirus[tiab] OR sars virus[tiab] OR sars-cov[tiab] OR sars-associated coronavirus[tiab] OR severe acute respiratory syndrome coronavirus[tiab] OR severe acute respiratory syndrome virus[tiab] OR mers coronavir*[tiab] OR mers vir*[tiab] OR mers-cov[tiab] OR middle east respiratory syndrome coronavir*[tiab] OR severe acute respiratory infection*[tiab]	

Pregnant women
are excluded from this flowchart and underlying practice guideline

Children 0 -16

Acute surgery
Perform PCR. If test result is not available before surgery: consider patient COVID-19 positive.

Semi-acute
Perform PCR. Schedule when outcome is known within 2 day window.

Elective
Perform PCR 2 days before surgery and schedule when needed and possible.

In special cases or circumstances (such as Diaphragmatic Hernia surgery on the NICU) follow local protocols, multidisciplinary consultation and common sense.

CO-RADS 1: Very low
CO-RADS 2: Low
CO-RADS 3: Uncertain
CO-RADS 4: High
CO-RADS 5: Very high

Preoperative work up on COVID-19 infection in asymptomatic patients (based on history taken and presence of fever or hypoxia) scheduled for surgery under general anesthesia

Elective surgery
Limited postponement possible (e.g. oncology patients)

<48 hours pre-surgery in outpatient clinic:
PCR testing and chest CT

One may consider starting with PCR testing and withholding a chest CT only if the PCR is positive for a COVID-19 infection.[1]

PCR test results?[2] Chest CT results?

PCR negative and CT CO-RADS 1-3

CO-RADS classification

CO-RADS 1-2

Consider patient non infected

Standard care

CO-RADS 3

Diagnosis uncertain

Discuss patient in a multidisciplinary team[4] Postpone surgery with 2 weeks if possible

PCR positive and/or CT CO-RADS 4-5

Consider patient infected Consult COVID-19 treating physician

Discuss alternative options (postponement with 2 weeks, other treatment) or take necessary precautions if surgery cannot be postponed for > 14 days[3]

Semi-acute surgery
Surgery required >24 hours & <7 days

PCR test results?[1] [2] Chest CT results?

PCR negative and CT CO-RADS 1-3

CO-RADS classification

CO-RADS 1-2

Consider patient non infected

Standard care

CO-RADS 3

Diagnosis uncertain

Discuss patient in a multidisciplinary team[4] Postpone surgery with 2 weeks if possible

PCR positive and/or CT CO-RADS 4-5

Consider patient infected Consult COVID-19 treating physician

Discuss alternative options (postponement with 2 weeks, other treatment) or take necessary precautions if surgery cannot be postponed[3]

Acute surgery

Perform PCR testing + chest CT

Consider patient positive if chest CT is not possible due to urgency of disease

COVID-19 status based on chest CT, if PCR test result is not yet available

CO-RADS 1-2

Consider patient non infected

Standard care

CO-RADS 3

Diagnosis uncertain

Discuss patient in a multidisciplinary team if possible[4] Otherwise, consider patient positive till PCR is negative

CO-RADS 4-5

Consider patient infected Consult COVID-19 treating physician

Take necessary precautions[3]

Postoperative result of PCR positive in CO-RADS 1-2 patients: consider patient positive and upscale precautions. [3]

Postoperative result of PCR negative in CO-RADS 3 patients: consider patient negative and downscale precautions if possible.

In other situations: no need for management change.

[1] One may consider starting with PCR testing and withholding a chest CT only if the PCR is positive for a COVID-19 infection.
However, this might have severe logistical implications (patients need to visit the hospital repeatedly) and joint testing of PCR and CT may be a more desirable and practical approach.

[2] PCR: nasopharyngeal PCR

[3] Necessary precautions: implement peri-operative and operative hospital infectious disease precautions according to local protocols.

[4] Multidisciplinary team i.e. including a surgeon, anesthesiologist, radiologist, pulmonary physician, microbiologist and infectious disease specialist, if possible.

Federatie Medisch Specialisten

With support provided by the Knowledge Institute of the Federation of Medical Specialists