

# Primarna perkutana koronarna intervencija u okolnostima pandemije COVID-19

## Primary Percutaneous Coronary Intervention during the COVID-19 Pandemic

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### Svjetska iskustva

Pandemija virusa COVID-19 izniman je izazov nacionalnim zdravstvenim sustavima. S obzirom na osobine virusa, kao što je njegova virulentnost, tj. mogućnost širenja zaraze u asimptomatskoj fazi, brzo širenje u zatvorenim prostorima, poglavito u zdravstvenim ustanovama i patogenost, tj. velik broj bolesnika koji zahtijevaju bolničko liječenje te relativno visok udio bolesnika koji zahtijeva intenzivnu skrb, u zemljama s većim razmjerom epidemije kapaciteti kritične skrbi zauzeti su gotovo potpuno bolesnicima s infekcijom COVID-19. Obuzdavanje epidemije zahtijeva rigorozne mjere u općoj populaciji, no još i agresivnije unutar zdravstvenih sustava.

U zbrinjavanju bolesnika s indikacijom za primarnu perkutanu koronarnu intervenciju (pPCI) mogu nam pomoći iskustva kolega iz Kine, kao i iz Italije i Slovenije, zemalja čiji su zdravstveni sustavi organizirani približno slično našem. Zeng *i sur.* u pismu uredniku objavljenom u časopisu *Intensive Care Medicine* prikazuju postupnik za liječenje akutnoga koronarnog sindroma u bolesnika oboljelih ili suspektih na COVID-19<sup>1</sup>. U takvih bolesnika s akutnim infarktomiokarda s elevacijom ST-segmenta u EKG-u (STEMI) kao reperfuzijska metoda preferira fibrinoliza, a perkutana koronarna intervencije (PCI) samo u bolesnika nakon neuspjele fibrinolize, i to samo u onih s blagom pneumonijom ili kontraindikacijom za fibrinolizu. Drugim riječima, korist intervencijskoga zahvata mora znatno nadilaziti rizik od širenja infekcije. U akutnome koronarnom sindromu bez elevacije ST-segmenta (NSTEMI), PCI se preporučuje nakon izlječenja pneumonije, odnosno respiracijske infekcije koju je uzrokovao COVID-19. Međutim, stajališta se zapadnih autora razlikuju u usporedbi s kineskima. Welt i

### Global experiences

The COVID-19 virus pandemic represents a massive challenge to national healthcare systems. Given the characteristics of the virus, such as its virulence, i.e. its ability to spread infection in the asymptomatic phase, its rapid spread in enclosed environments, especially in healthcare institutions, and its pathogenicity, i.e. the high number of patients who require hospital treatment and the relatively high ratio of patients that require intensive care, critical care capacities in countries with large-scale epidemics of the virus have been almost completely occupied by patients with COVID-19 infection. Controlling the epidemic requires rigorous measures in the general population but even more aggressive measure within the healthcare system.

Care for patients with indications for primary percutaneous coronary intervention (pPCI) can be facilitated by experiences from our colleagues in China as well as Italy and Slovenia as being countries in which the organization of the healthcare system is similar to ours. Zeng *et al* published a letter to the Editor in the *Intensive Care Medicine* journal describing the protocol for the treatment of acute coronary syndrome in patients positive for COVID-19 or suspected to have the virus<sup>1</sup>. Fibrinolysis was reported to be the preferred reperfusion method in such patients with acute myocardial infarction ST elevation (STEMI) on the ECG, with percutaneous coronary intervention (PCI) used only in patients after failed fibrinolysis, and even then only in those with mild pneumonia or contraindications for fibrinolysis. In other words, the benefits of the interventional procedure must significantly outweigh the risk of spreading the infection. In non-ST-segment elevation myocardial infarction (NSTEMI), PCI is recommended after curing the pneumonia, i.e. the respiratory system

sur. u JACC-u komentiraju preporuke kineskih autora iz perspektive zdravstvenog sustava sa široko dostupnom pPCI te sugeriraju liberalniji pristup, odnosno ne odustaju od pružanja optimalne reperfuzijske strategije unatoč organizacijskim problemima<sup>2</sup>. Predlažu razmatranje fibrinolize kao terapije izbora u stabilnih bolesnika s aktivnom infekcijom koju uzrokuje COVID-19 (bez detaljnijeg razlaganja), međutim, preporučuju individualnu procjenu koristi od intervencijskoga zahvata s obzirom na rizik od izlaganja osoblja izvoru infekcije. Naglasak stavljaju na zaštitu osoblja tijekom PCI-ja osobnom zaštitnom opremom, uključujući i N95 maske, kombinezone, naočale ili štitnike za lice. Nakon završetka intervencije potrebni su temeljito čišćenje i dezinfekcija laboratorija za kateterizaciju, pogotovo uzimajući u obzir činjenicu da su gotovo bez iznimke takvi laboratoriji opremljeni običnim sustavima ventilacije, a ne, nažalost, sustavima s negativnim tlakom. Autori predlažu ranu intubaciju prije PCI-ja u okviru odjela / u sklopu kritične skrbi, ako postoji indikacija, radi izbjegavanja postupaka s generiranjem aerosola unutar laboratorija.

U izravnoj komunikaciji s kolegama iz Slovenije (Univerzitetni klinični center Ljubljana) saznajemo kako bolesnici sa sumnjom na COVID-19 ondje nisu uskraćeni za pPCI. Takvim se bolesnicima odmah pri dolasku u laboratorij uzima bris za dokaz infekcije, pPCI se provodi uz sve zaštitne mjere, a bolesnik vrijeme do prispjeća nalaza provodi u „sivoj zoni“ (izolirani prostor, moguće i u okviru laboratorija, ali uz obvezan nadzor primjeren akutnom koronarnom sindromu). Bolesnici koji zahtijevaju mehaničku cirkulacijsku potporu nalaz brisa čekaju u izoliranom dijelu intenzivne skrbi. Daljnji postupak s bolesnikom ovisi o nalazu, a odluka se donosi timski, posebno za pojedinoga bolesnika, ovisno o kadrovskim i prostornim mogućnostima, uz sve mjere najveće moguće zaštite od prijenosa infekcije na medicinsko osoblje i ostale bolesnike.

## Trenutačno stanje Hrvatske mreže primarne perkutane koronarne intervencije

U telefonskoj anketi provedenoj među voditeljima intervencijskih laboratorija u Hrvatskoj koji su uključeni u Hrvatsku mrežu pPCI<sup>3</sup>, saznali smo da svi laboratoriji za kateterizaciju srca izvan područja Zagreba i središnje Hrvatske nastavljaju s uobičajenim radom za bolesnike s akutnim koronarnim sindromom, uz znatnu ili potpunu redukciju elektivnog programa. Slično se odnosi i na Kliniku Magdalena. Većina je laboratorija uvela i provodi prethodno spomenute postupnike koje su preporučili inozemni autori, a neki od kolega su se potužili na početni nedostatak specifične zaštitne opreme za liječenje COVID-19 bolesnika, te edukaciju za njezino korištenje.

U laboratorijima za kateterizaciju srca grada Zagreba i središnje Hrvatske stanje, osim zbog pandemije zaraze virusom COVID-19, dodatno je komplicirano potresom od 22. ožujka 2020. Klinički bolnički centar (KBC) Zagreb je, radi izolacije većeg broja liječnika i medicinskih sestara, tijekom dva tjedna morao reducirati svoj intervencijski program na bolesnike s NSTEMI-jem koji se izravno hospitaliziraju, dok se pPCI za bolesnike sa STEMI-jem do 27. ožujka 2020. godine praktički nije provodila, osobito ne za bolesnike iz pripadajućih županija. Sada se stanje promijenilo i KBC Zagreb se vratio u Hrvatsku mrežu pPCI preuzevši, osim svoga područja odgovornosti, i bolesnike koji su gravitirali KB Dubrava. Budući da je Klinička bolnica (KB) Dubrava, uz Kliniku za infektivne bole-

infection caused by COVID-19. However, opinions of Western authors differ in comparison with Chinese authors. Welt *et al* commented on the recommendations of the Chinese authors in JACC from the perspective of a healthcare system with widely available pPCI and suggested a more liberal approach, i.e. they do not recommend giving up on providing optimal reperfusion strategy despite organizational issues<sup>2</sup>. They suggest considering fibrinolysis as the therapy of choice in stable patients with active COVID-19 infection (without further elaboration), but they recommend individual assessment of the benefits of the procedure given the risk of exposing healthcare personnel to infection. They emphasize protection of healthcare workers during PCI procedures using protective gear that includes N95 masks, coveralls, and goggles or face shields. After the intervention is complete the cardiac catheterization lab should be thoroughly disinfected, especially considering that such labs are unfortunately almost always equipped only with normal ventilation systems without negative pressure capability. The authors suggest that early intubation should be performed in the ward/critical care before the PCI procedure, and if indicated to avoid procedures that generate aerosols in the laboratory.

Direct communication with colleagues from the Ljubljana University Medical Centre showed their patients suspected to have COVID-19 were not denied pPCI. A swab was taken from these patients as soon as they arrived at the lab, pPCI was performed with all the protective measures against infection, and the patient remained in the “grey zone” (an isolated area, possibly as part of the lab, but with monitoring appropriate for coronary syndrome) until arrival of the test results. Patients who required mechanical circulatory support waited for the swab results in an isolated part of the intensive care unit. Further patient procedures depend on the swab results, and the decision is made as a team and individually for each patient based on available personnel and hospital capacity, while applying all the possible measures to protect hospital staff and other patients from infection.

## The current state of the Croatian Primary Percutaneous Coronary Interventions Network

Heads of laboratories included in the Croatian Primary Percutaneous Coronary Interventions Network were polled by phone<sup>3</sup>, showing that all cardiac catheterization labs outside Zagreb and central Croatia are continuing normal treatment for patients with acute coronary syndrome but with significant or complete reduction of the elective program. The situation is also similar at the Magdalena Clinic for Cardiovascular Diseases. Most labs have introduced and implemented the previously mentioned protocols recommended by foreign authors, but some colleagues have complained about the initial lack of specific protective gear for treating patients with COVID-19 and the lack of education on its use.

In addition to the COVID-19 pandemic, the situation in cardiac catheterization labs in Zagreb was further complicated by the earthquake that took place on March 22, 2020. Due to having to place a number of physicians and nurses in isolation, the University Hospital Centre (UHC) Zagreb was forced to reduce its intervention program to directly hospitalized patients with NSTEMI for a period of two weeks, whereas pPCI was practically no longer conducted for STEMI patients until March 27, 2020, especially from the relevant counties. The situation has now changed and the UHC Zagreb has returned to the Croatian pPCI Network taking over both its own patients and the patients who gravitate to the University Hospital (UH) Dubrava. Given that the UH Dubrava has, along with the Zagreb University Hos-

sti, strateški određena kao centar za zbrinjavanje bolesnika zaraženih virusom COVID-19, ta ustanova nekoliko tjedana nije bila u mogućnosti pružati usluge PCI-ja. Prema posljednjim informacijama u skladu s odlukom Ministarstva zdravstva, KB Dubrava je predviđena za hospitalizaciju COVID-19 pozitivnih bolesnika koji imaju respiratorne tegobe ili druge internističke, kirurške ili neurološke bolesti koje zahtijevaju hospitalizaciju. U skladu s time i kolege kardiolozi iz te ustanove spremni su pružiti hitnu PCI za sve bolesnike iz Zagreba i sjeverozapadne Hrvatske za koje se procijeni da je indicirano takvo liječenje, a pozitivni su na COVID-19. Laboratorij Kliničkog bolničkog centra Sestara milosrdnica u takvim je okolnostima privremeno preuzeo hitno intervencijsko liječenje svih bolesnika koji gravitiraju KBC-u Zagreb i KB-u Dubrava te područja koje pokriva KBC Sestara milosrdnica, kako iz grada Zagreba, tako i pripadajućih županija. Nažalost, potres od 22. ožujka 2020. znatno je oštetio zgradu u kojoj se nalazi Laboratorij za kateterizaciju srca KBC-a Sestara milosrdnica. Nakon preliminarnoga statičkog pregleda istog dana Laboratorij je stavljen izvan funkcije zbog opasnosti od urušavanja, no definitivni građevinski pregled od 25. ožujka 2020. dopustio je nastavak rada u ovim prostorima te se ovaj centar vraća razini aktivnosti otprije potresa. Od 22. do 25. ožujka ove godine sve bolesnike sa STEMI-jem i hemodinamski nestabilnim NSTEMI-jem za koje su nadležne prije navedene tri ustanove te one iz vlastite zone odgovornosti Grada Zagreba i Zagrebačke županije zbrinjavao je KB Sveti Duh prema sustavu „24/7“, a Laboratorij za kateterizaciju srca KB-a Merkur preuzeo je bolesnike s NSTEMI-jem iz KBC-a Sestara milosrdnica i drugih ustanova s kojima ima uobičajenu suradnju, ali samo tijekom radnoga vremena. Od 25. ožujka 2020. i ova se dva centra vraćaju svojim uobičajenim aktivnostima u sklopu intervencijskog liječenja akutnog koronarnog sindroma. Pomoć u zbrinjavanju bolesnika s akutnim infarktom miokarda sustavom „24/7“ ponudili su Županijska bolnica Čakovec (osobito županijama Varaždinskoj i Koprivničko-križevačkoj) i Klinika Magdalena, a pomoć u skladu sa svojim mogućnostima ponudila je i Specijalna bolnica Agram.

Daljnja dinamička reorganizacija rada i nadležnosti umnogome će ovisiti o dinamici širenja epidemije, materijalnim i ljudskim resursima potrebnim za njezino liječenje te o rješavanju problema u radu laboratorijâ za kateterizaciju srca spomenutih zagrebačkih kliničkih ustanova. Napominjemo da stručna društva, kao što je i Hrvatsko kardiološko društvo, imaju savjetodavnu ulogu u ovakvim situacijama, a da konačne odluke donose Ministarstvo zdravstva Republike Hrvatske i ravnateljstva odgovarajućih zdravstvenih ustanova. O svim budućim promjenama u funkcioniranju Hrvatske mreže primarne PCI kardiološka će zajednica biti pravodobno obaviještena.

## Zaključak i preporuke za daljnji rad

Ono što možemo zaključiti u skladu s dosadašnjim iskustvima tijekom pandemije COVID-19 jest potreba racionalnog odabira bolesnika za intervencijsko kardiološko liječenje, nužna nabava svih potrebnih zaštitnih sredstava i njihova propisna uporaba od članove kardioloških timova koji rade s inficiranim ili potencijalno inficiranim bolesnicima, izrada postupnika za rad s tim bolesnicima u laboratoriju za kateterizaciju srca i nakon intervencije, te formiranje djelatnih i pričuvnih kardioloških timova koji osiguravaju neprekidni rad u slučaju infekcije ili suspektne infekcije članova trenutačno djelatnoga tima.

pital for Infectious Diseases, been strategically selected as the care center for patients COVID-19, that institution was unable to provide PCI services for several weeks. According to the latest information, in accordance with the decision of the Ministry of Health, UH Dubrava is scheduled for hospitalization of COVID-19 positive patients who have respiratory problems or other internal, surgical or neurological diseases requiring hospitalization. Accordingly, cardiologists from that institution, are ready to provide emergency PCI for all patients from Zagreb and northwestern Croatia who are estimated to have indication for such treatment and are positive for COVID-19. Given the circumstances, the Laboratory at the UHC "Sestre milosrdnice" has temporarily taken over emergency interventional treatment for all patients who gravitate towards the UHC Zagreb and UH Dubrava as well as the area covered by the UHC "Sestre milosrdnice" itself, both in Zagreb and other counties. Unfortunately, the earthquake of March 22 severely damaged the building that houses the Cardiac Catheterization Lab of the UHC "Sestre milosrdnice". The lab was closed due to danger of building collapse after a preliminary building safety inspection on the day of the earthquake, but a conclusive building safety inspection on March 25 approved commencement of work in the building and the center was returned to pre-earthquake levels of activity. Between March 22 and March 25 this year, all patients with STEMI and hemodynamically unstable NSTEMI for whom these three institutions were responsible as well as patients under the responsibility of the city of Zagreb and the Zagreb County were treated at the UH "Sveti Duh" under the 24/7 system, whereas the Cardiac Catheterization Laboratory at the UH "Merkur" took over patients with NSTEMI from the UHC "Sestre milosrdnice" as well as from other institutions with which it has established cooperation, but only during regular working hours. Since March 25 these two centers returned to regular activity regarding interventional treatment of acute coronary syndrome. Help in caring for patients with acute myocardial infarction under the 24/7 system was also offered by the Čakovec County Hospital (especially to the Varaždin County and Koprivnica-Križevci County) and the Magdalena Clinic, and the Agram Special Hospital also offered to help within its means.

Further dynamic reorganization of activity and jurisdiction will be greatly dependent on the dynamics of the epidemic and its spread, the material resources and personnel required for its treatment, and on resolving the issues in the work of the cardiac catheterization labs of the aforementioned clinical institutions in Zagreb. We would like to note that professional societies like the Croatian Cardiac Society have an advisory role in such situations and that final decisions are made by the Ministry of Health of the Republic of Croatia and the directors of the relevant healthcare institutions. The cardiological community will receive timely notifications on all future changes in the functioning of the Croatian pPCI Network.

## Conclusion and recommendations for further activity

The conclusions we can draw based on experiences with the COVID-19 pandemic so far are the necessity of rationally selecting patients for interventional cardiological treatment, acquisition of all necessary protective gear and their proper use by cardiological teams working with infected or potentially infected patients, creating protocols for working with these patients in cardiac catheterization labs and after intervention,

Do daljnijega preporučujemo da se svi bolesnici suspekti na infekciju virusom COVID-19 odmah testiraju te da im se, kao i bolesnicima pozitivnima na COVID-19, omogući pPCI samo u slučaju STEMI-ja te hemodinamske nestabilnosti u NSTEMI-ju. Uvjet za hitnu intervenciju u takvih bolesnika jest primjerena zaštita osoblja u laboratoriju za kateterizaciju srca te ostaloga osoblja koje će doći u kontakt s takvim bolesnikom. Do prispjeća nalaza testiranja na COVID-19 takvog bolesnika treba intenzivno monitorirati i liječiti u izoliranom okružju, a cjelokupno osoblje u kontaktu s bolesnikom mora biti optimalno zaštićeno. Ako je bolesnik pozitivan na COVID-19, premješta se u COVID-bolnicu, a, ako je negativan, prima se u intenzivnu skrb za kardiološke bolesnike nadležne bolnice (slika 1 i slika 2).

U slučaju STEMI-ja i nemogućnosti pPCI-ja u gore spomenutim uvjetima, treba primijeniti fibrinolizu prema postojećim smjernicama<sup>4</sup>, kao alternativu pPCI-ju. Vjerojatno će, zbog rizika od infekcije, za većinu bolesnika pozitivnih na COVID-19, ali i na COVID-19 suspektih bolesnika, fibrinoliza biti metoda izbora, posebice ako hitna PCI zahtijeva prijevoz iz županijske bolnice u centar za PCI.

U slučaju neuspjele fibrinolize, dolazi u obzir tzv. *Rescue PCI*, nakon čega se, u pravilu, takav bolesnik premješta u bolnicu za liječenje zaraženih virusom COVID-19.

Bolesnici suspekti ili pozitivni na COVID-19 s akutnim koronarnim sindromom i indikacijom za mehaničku potporu trebaju se liječiti u izoliranom prostoru koronarne jedinice ili laboratorija za kateterizaciju srca, uz primjerenu zaštitu me-

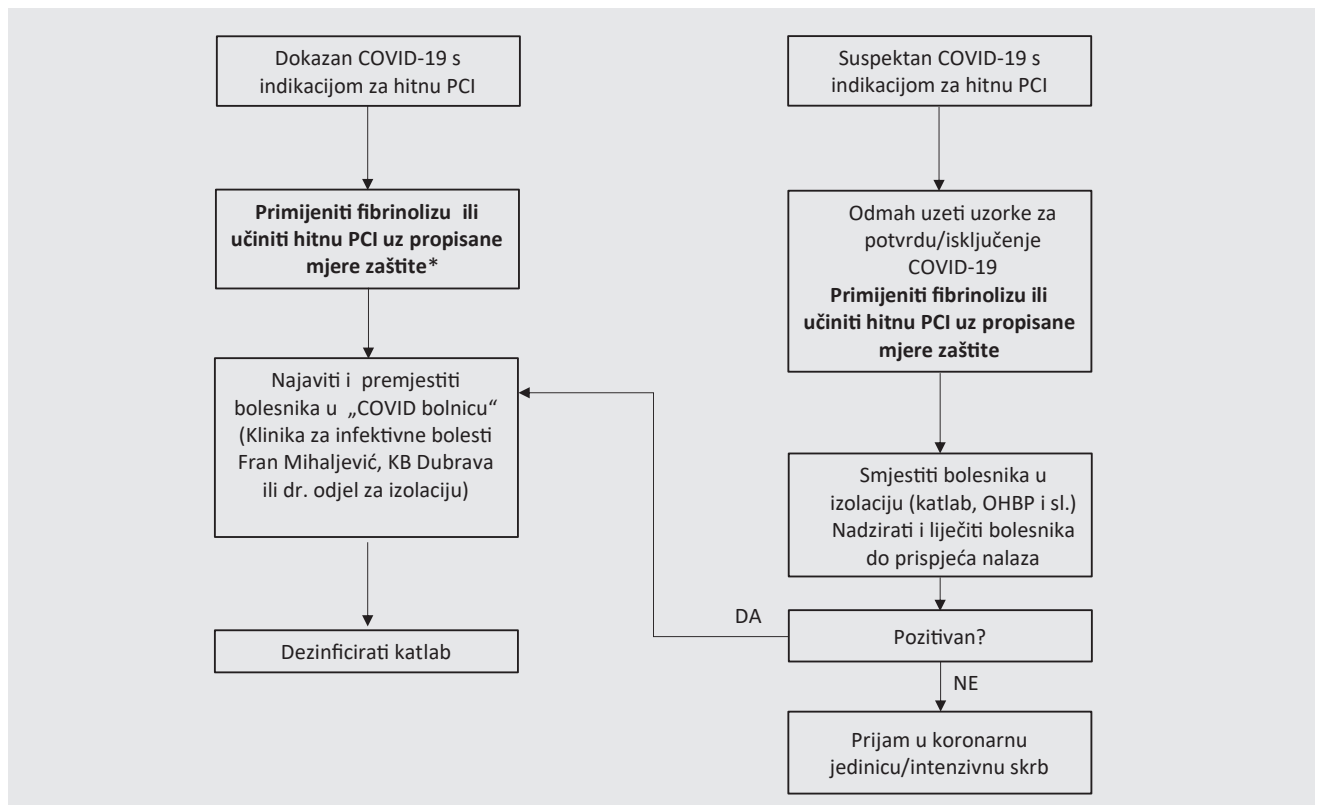
and forming both active and reserve cardiological teams that guarantee uninterrupted work in case of infection or suspected infection among members of the currently active team.

Until further notice, we recommend that all patients with suspected COVID-19 infection are tested immediately and that they, along with patients positive for COVID-19, receive pPCI only in case of STEMI or hemodynamical instability in NSTEMI. The precondition for emergency interventions in such patients is adequate protection for the staff of the cardiac catheterization lab as well as other personnel that will be in contact with these patients. Until the test results for COVID-19 arrive, these patients should be closely monitored and treated in an isolated environment, and the whole staff in contact with the patient must be optimally protected. If the patient is positive for COVID-19, they are to be transferred to a COVID hospital, and if the patient is negative they should be transferred to intensive cardiac care at the appropriate hospital (Figure 1, Figure 2).

In case of STEMI and pPCI being impossible to perform under the conditions described above, fibrinolysis should be applied according to current guidelines<sup>4</sup> as an alternative to pPCI. Due to the risk of infection, it is likely that fibrinolysis will be the therapy of choice for most patients positive for COVID-19 but also for those in whom infection is suspected, especially if emergency PCI requires transport from the county hospital to a PCI center.

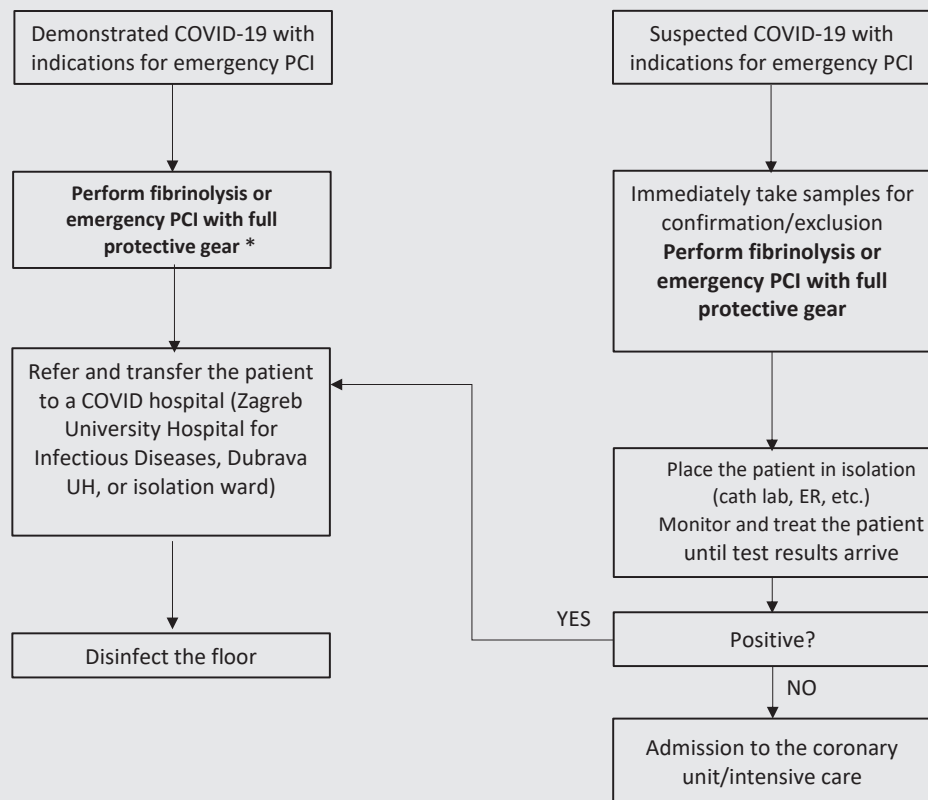
In case of unsuccessful fibrinolysis, rescue PCI can be considered, after which the patient is generally transferred to a COVID hospital.

Patients with suspected COVID-19 infection or those positive for the virus who are suffering from acute coronary syndrome and have indication for mechanical support should be treated in



**SLIKA / FIGURE 1.** Postupnik za hitnu perkutanu koronarnu intervenciju u bolesnika pozitivnih ili suspektih na infekciju virusom COVID-19. \*Klinička bolnica Dubrava za Zagreb i sjeverozapadnu Hrvatsku  
 PCI – perkutana koronarna intervencija; KB – klinička bolnica; katlab – laboratorij za kateterizaciju; OHBP = objedinjeni hitni bolnički prijam.





**FIGURE 2. Protocol for emergency percutaneous intervention in patients positive or suspected of COVID-19 infection. \*University Hospital Dubrava for Zagreb and northwestern Croatia**

PCI = percutaneous coronary intervention; UH = University Hospital; cath lab = cardiac catheterization lab; ER = emergency room.

dicinskog osoblja. U slučaju pozitivnog nalaza, nakon postavljanja mehaničke potpore, pacijent se po mogućnosti premješta u bolnicu za liječenje zaraženih virusom COVID-19, a, u suprotnome, nastavlja se liječiti u postojećoj bolnici.

Bolesnici s NSTEMI-jem trebaju se zbrinjavati u bolnicama u koje se primaju prema teritorijalnoj raspodjeli. Indikacija za invazivnu obradu postavlja se individualno, ovisno o riziku, odnosno težini bolesti i u dogovoru s nadležnim intervencijskim centrom. Bolesnici sa sumnjom ili dokazanom infekcijom virusom COVID-19 razmatraju se za invazivno liječenje samo u slučaju hemodinamske nestabilnosti ili refraktornosti simptoma na medikamentnu terapiju. PCI i postintervencijski tijek moraju se provesti pod prethodno navedenim uvjetima i preporukama za STEMI. Ostali bolesnici s NSTEMI-jem liječe se konzervativno, do negativizacije testa na COVID-19.

**Naposljetku, potrebno je naglasiti da u skladu sa stanjem bolesnika, procjenom odnosa koristi od PCI i rizika prijenosa infekcije te mogućnostima primjerene zaštite medicinskog osoblja i ostalih bolesnika, odluku o akutnom intervencijskom liječenju individualno, sa svim ovlastima i odgovornošću treba donositi kardiološki tim uključen u liječenje pojedinoga bolesnika.**

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an isolated area of the coronary care unit or the cardiac catheterization lab, with appropriate protective measures for medical staff. If the test is positive, the patient should be transferred to a COVID hospital after introduction of mechanical support and should be treated in the current hospital if transport is not possible.

Patients with NSTEMI should be treated in hospitals to which they belong according to territorial division. Indications for invasive procedures are to be established individually, based on risk and disease severity and in consultation with the responsible interventional center. Patients with established or suspected COVID-19 infection should be considered for invasive treatment only in case of hemodynamic instability or symptoms refractory to medication therapy. PCI and postinterventional care should be performed under the conditions and recommendations for STEMI that have been described above. Other patients with NSTEMI should be treated conservatively until they are negative for COVID-19.

**Finally, it should be emphasized that the decision on applying acute interventional treatment should be based on the condition of the patient, estimated benefit from PCI and infection risk, and the availability of appropriate protection for medical staff and other patients, and should be made individually for every patient and under full authority and responsibility of the interventional team responsible for their treatment.**

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