# TELE-ICU IN PROTECTING HEALTH-CARE WORKERS AND PATIENTS FROM SARS-COV-2 IN HANOI, VIETNAM

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*COVID-19 has been declared as a pandemic since March 2020. Since healthcare workers and patients in isolation have a high risk of being infected, hospitals in countries affected by COVID-19 are facing challenges in protecting their healthcare workers to response to the increased demand of health services while maintaining quality of care for their patients. This study described the deployment of a Tele-ICU system in screening process for COVID-19 at Hanoi Medical University Hospital. The screening processes of SARS-CoV-2 for two illustrative cases admitted to the Emergency Department (i.e., one patient received Tele-ICU and the other did not) were described and compared. The screening process with Tele-ICU or without Tele-ICU allowed similar access to specialists but less specialists were exposed to COVID-19 with Tele-ICU using. The study concludes that Tele-ICU could be effective in reducing exposure to COVID-19 for health workers during the pandemic.*

**Keywords: Covid-19, SARS-CoV-2, healthcare provider protection, Hanoi Medical University Hospital, Viet Nam**

## I. INTRODUCTION

The newly-discovered Coronavirus disease (COVID-19, SARS-CoV-2) has been recognized as a pandemic by World Health Organization1. Healthcare workers are at high risk of infection as one out of ten COVID-19 cases are reported in healthcare workers.[2] This could affect the responsiveness of healthcare services in countries that are heavily affected by COVID-19. For instance, in China, more than 3300 medical staff have been infected as of early March 2020 and by the end of February at least 22 people died.[3] Therefore, it has been the highest priority that healthcare workers use recommended barrier precautions, such as masks, gloves, gowns, and eyewear, during the care of all patients with respiratory symptom4. Furthermore, it became more challenging in screening and prevention for both healthcare workers and patients when there are undiagnosed but infected patients, with clinically mild symptoms or atypical presentations 5 and the virus can be transmitted before symptoms appeared in infected patients.[6]

Health workers are at high risk of exposure to SARS-CoV-2 virus. As of May 10th, 2020, Vietnam was initially successful in disease prevention when there were only 288 COVID-19 cases.[7] The initial success of Vietnam has been due to the early response of the Vietnamese Government and the health sector. The consequences of delayed recognition of a patient with COVID-19 are

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*Received: 26/05/2020*
*Accepted: 11/06/2020*

significant. The COVID-19 prevention strategy has been different in each country; the number of COVID-19 infections has not spread widely in Vietnam, one reason being a commitment to contact tracing of people with exposure to a case of COVID-19. Making good use of epidemiological information of suspected cases helped Vietnam save valuable time in controlling the spread of COVID-198. In the early response to COVID-19 in Vietnam, hospitals tried to keep people with suspected COVID-19 separate from patients with other complaints. As reducing direct contact with patients while ensuring the quality of medical examination and treatment becomes an urgent requirement, tele-ICU can become a useful solution to minimizing contact risk of healthcare workers during the era of the COVID-19 pandemic. Hanoi Medical University Hospital decided to apply Tele-ICU in March 2020 in the emergency department, a system for exchanging medical information from hospital critical care units to another via electronic communications.

In this article, we described the deployment of the Tele-ICU system at the hospital and its role in preventing SARS-CoV-2 infection for healthcare workers and patients.

## II. METHODS

### 1. Study design and patients

This case study described two illustrative suspected COVID-19 cases admitted to the Emergency Department in March 2020. We compared diagnosis and treatment processes of the two patients; one was treated via the tele-ICU system and the other had usual care. The study was approved by the Hanoi Medical University Institutional Ethical Review Board.

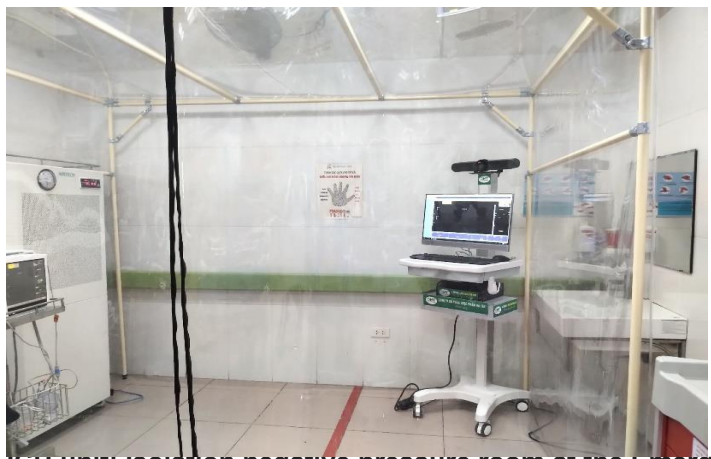
### 2. Study setting

The Hanoi Medical University Hospital has 34 departments, 600 beds, more than 800 employees and 2,500 outpatients daily. The hospital has 12 operating rooms, 50 ventilators, 02 machines of continuous veno-venous hemofiltration and 02 Hemodialysis machines, 01 extracorporeal membrane oxygenation system. The Emergency Department has a capacity of 46 beds, including 10 critical care beds. On average, the Emergency Department had 22,000 patients annually.

### 3. Tele-ICU equipment and system

The Tele-ICU system was deployed in the Emergency Department in March 2020 in response to COVID-19. The system consists of two main components, including the Tele-ICU command center and the Tele-ICU units. Tele-ICU command center (Picture 1) has a dedicated software system to monitor and support patient data analysis at the units and audiovisual communication tools to support diagnosis and treatment.


Tele-ICU units comprise of emergency resuscitation equipment such as ventilators, monitors, tests, imaging and connecting software, real-time patient's data transmission to the command center (Picture 1). Two Tele-ICU units are located at the two negative pressure rooms (Picture 2). The third Tele-ICU unit is an isolated room for COVID-19 patients after intervention (Picture 3).



**Picture 2. Tele-ICU unit: isolation negative pressure room at the Emergency Department.**

## III. RESULTS

### 1. Process of screening SARS-CoV 2 at Hanoi Medical University Hospital

Figure 1 describes the process of welcoming and screening patients on admission. All patients with suspected symptoms such as cough, fever, fatigue, dyspnea, productive cough and epidemiological factors must follow this procedure. Patients with a mild clinical presentation may not initially require hospitalization and they will be consulted for self-isolation at home. However, patients with risk factors for severe illness need to be monitored closely, then they will be considered to refer to the national hospital for tropical diseases for examination and COVID-19 confirmation.

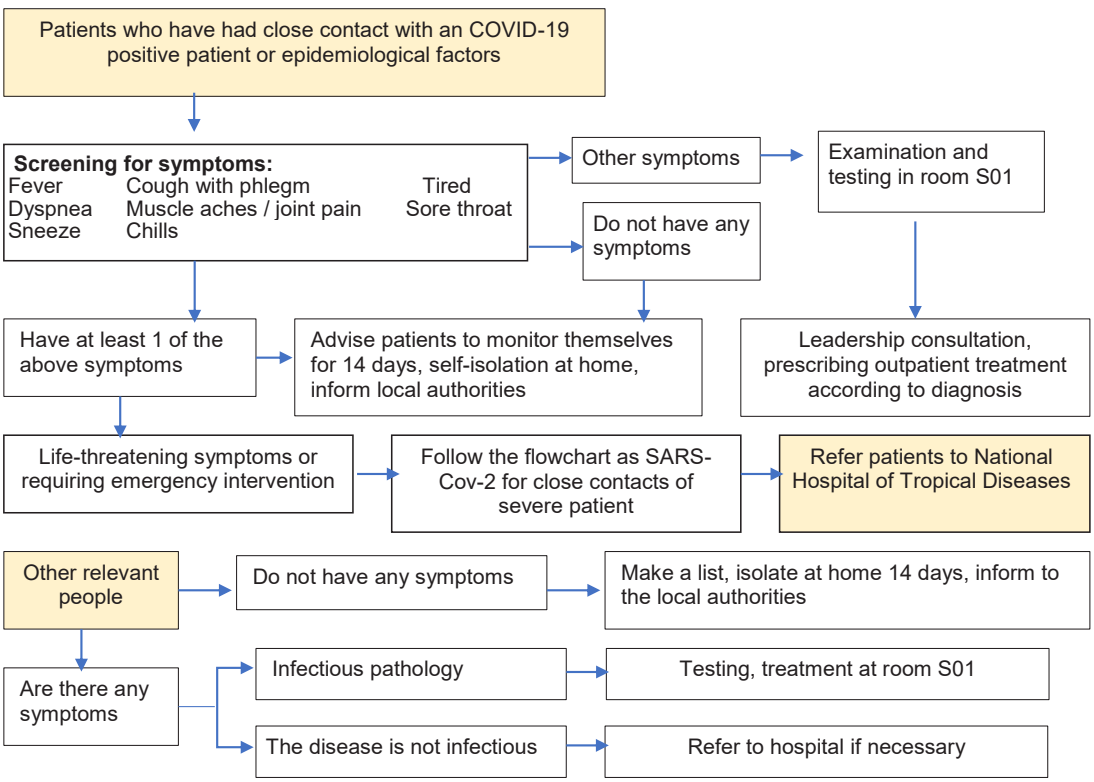



**Figure 1. Flowchart for screening patients**

Cases with suspected symptoms and epidemiological factors, with health problems requiring emergency treatment, would follow the procedure described in Figure 2. After the intervention, if the result of the COVID-19 test is positive and the condition of patient is stable, the patient will be transferred to the National Hospital for Tropical Diseases. Patients who need follow-up after the intervention will be referred to the intensive care unit for COVID-19 patients. The intervention for COVID-19 or suspected COVID-19 patients was performed at one of two negative pressure intervention rooms.

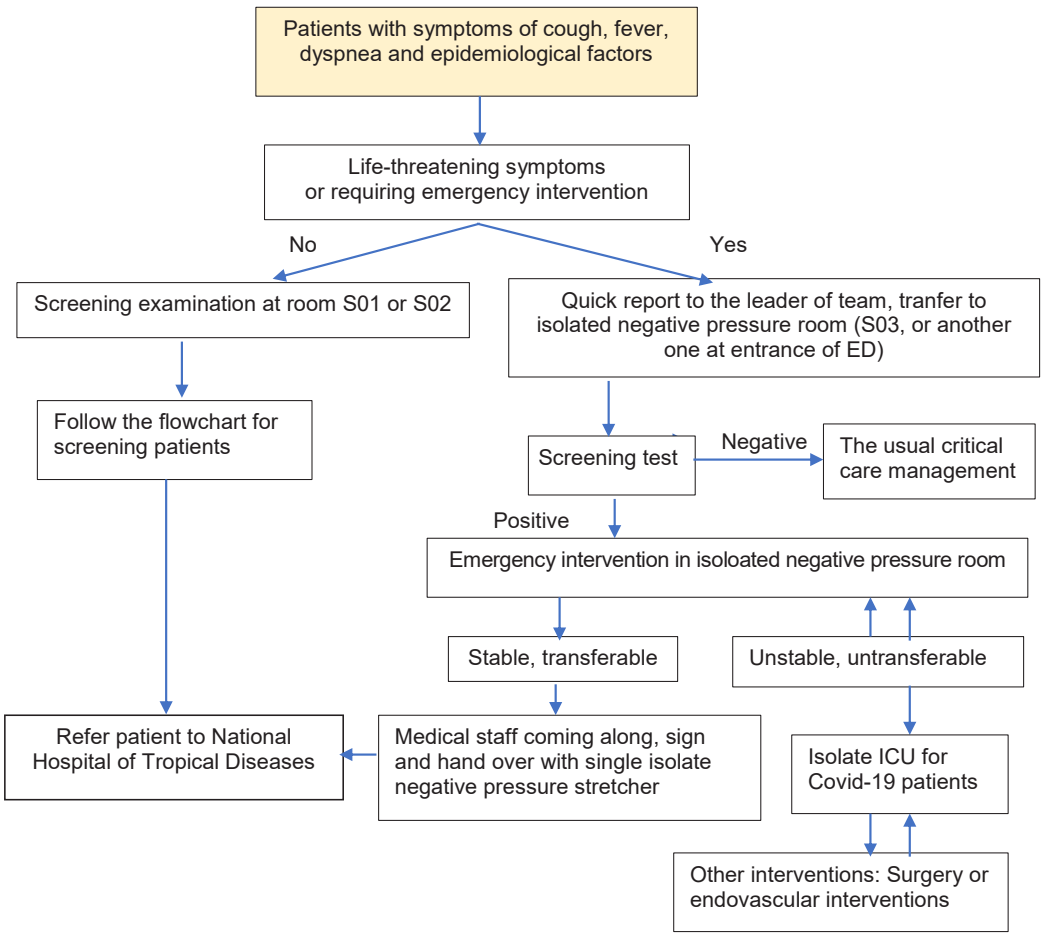
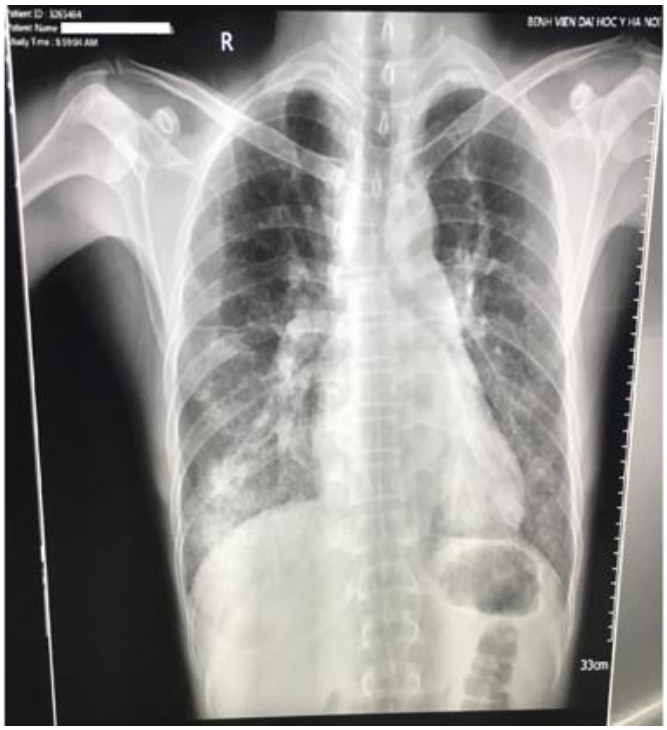



**Figure 2. Emergency care and intervention for patients suspected to be infected with SARS-CoV2**

**2. A suspected COVID-19 patient receiving usual screening, diagnosis and treatment procedures**

A 34-year-old male worker was admitted to the Emergency Department on March 20, 2020, with fever and dyspnea, accompanied with coughing for 2 days. Initial examination showed a respiratory rate of 32 breaths per minute, oxygen saturation of 92% while the patient was receiving supplemental oxygen through a mask at a rate of ten liters per minute, blood pressure of 120/70 mmHg, and the temperature was 37.6°C. Breath sounds decreased throughout the lower lung fields with fine crackles but no wheezing. Chest X-ray showed significant diffuse bilateral coalescent opacities, and no enlargement of the heart (Picture 5). The electrocardiogram showed sinus tachycardia of 132 beats per minute, non ST-segment elevation, and a QTc of 450 ms. Nucleic acid tests of a nasopharyngeal swab for influenza A and B viruses and respiratory syncytial virus were negative.




**Picture 4. Chest X-ray at admission of patient experiencing usual care procedures**

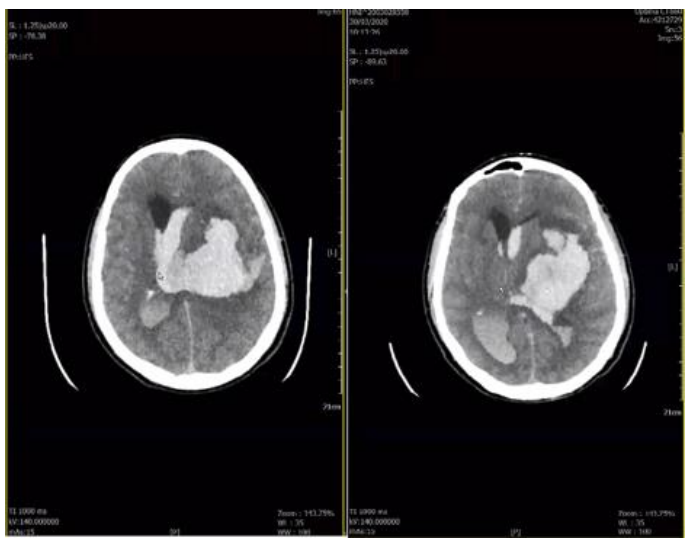
The patient received treatment in an isolated negative pressure room in the Emergency Department. When symptoms became more severe, two doctors and two nurses with personal protective equipment (PPE) applied intubation and set mechanical ventilation. His blood test showed the white-cell count of 24,650 per microliter (reference range of 4000 to 10,000), with a neutrophil count of 87.5%, pro BNP higher than 18510 ng/ml, Troponin T of 152 ng/L, Pro calcitonin of 0.512, pH = 7.47; pCO2 = 27.1mm Hg; pO2 = 59.9 mm Hg, FiO2 = 60% HCO3 = 195; lactate = 2.6mmol/L; creatinine = 62 umol/l. He was diagnosed with myocarditis and severe pneumonia with Acute Respiratory Distress Syndrome but no rule out of SARS CoV-2. Because Tele-ICU had not been applied by the time of this admission, different specialists, including an intensivist, a cardiologist and infectious doctors and nurses with PPE had to come to the isolated area to examine the patient. Transthoracic echocardiogram revealed left atrium dilation with mitral valve regurgitation, left ventricular ejection fraction of 60%, apical ventricular reduced movement, and a trace (7 mm) pericardial effusion. Finally, the patient was diagnosed with severe pneumonia and acute myocarditis. The patient checked with RT-PCR for SAR-CoV-2 and had negative result.

**3. A suspected COVID-19 patient receiving Tele-ICU services for screening, diagnosis and treatment**

A 51-year-old male security guard was unconscious at admission to the Emergency Department on March 30, 2020. His co-worker found him on the floor and called emergency services. The patient was transferred to the Emergency Department by a medical ambulance without his family members and he had no medical history. The patient was immediately transferred to an isolated negative

pressure room. Initial examination showed a blood pressure of 190/100 mmHg, a heart rate of 101 beats per minute, the oxygen saturation of 98% while air room, Glasgow coma score of 6 points, pupils were equally dilated at 4 mm with weak light reflex, and glucose test of 8.0 mmol/l.

Only one doctor of the Emergency Department and one nurse with PPE performed intubation for patients in order to minimize the number of health workers in the isolation room. Then, the doctor informed the Radiology center to prepare the computed tomography scan for the patient. The scan revealed large cerebral hemorrhage and ventricles, midline shift and subalpine herniation. A neurologist, a neurosurgeon, and a radiologist were invited to the Tele-ICU command center to have a video examination with the help of the emergency doctors in the isolated area. The patient was also checked with RT-PCR for SAR-CoV-2 and had negative result.



**Picture 5. Large cerebral hemorrhage and ventricles and subalpine herniation of the patient receiving Tele-ICU services**

Table 1 compares the number of health workers participating in emergency treatment with and without the use of Tele-ICU. Without the use of Tele-ICU, all 05 health workers were at risk of exposure to SARS-CoV-2 and they needed to be isolated while waiting for the patient's RT-PCR test results. With Tele-ICU, only 2 out of 5 participants who consulted and treated the patient were at risk with SARS-CoV-2.

**Table 1. Comparison of the two admitted patients with and without use of Tele-ICU services**

| | **Case 1 (without Tele-ICU)** | **Case 2 (with Tele-ICU)** |
|---|---|---|
| Patient's condition when admitted hospital | Myocarditis and differential diagnosed severe pneumonia with acute respiratory distress syndrome | Unconciousness, without family members, without past medical history |
| Process of care | Immediately put into isolation negative pressure room, needed to rule out of SARS CoV-2 | Immediately put into isolation negative pressure room, needed to rule out of SARS CoV-2 |

| | Case 1 (without Tele-ICU) | Case 2 (with Tele-ICU) |
|---|---|---|
| Health workers involed | 01 Emergency physician and 02 nurses<br>1 senior cardiologist, 1 heart untrasound cardiologist, exposed to potential Covid-19 | 01 Emergency physician and 01 nurse: Exposed<br>And 01 neurologist and 01 neuro-surgeon, 01 radiologist were non-exposed to potential Covid-19 |

## IV. DISCUSSIONS

*The examination procedure and Tele-ICU system protect health workers and patients in the emergency department*

In order to prevent COVID-19 cross-infection in hospitals, the Vietnamese Ministry of Health, as well as the health sector of many countries around the world have instructed hospital isolation, recommending the application of telemedicine technologies to protect medical staff and patients.[9,10] To respond to this strategy, the Hanoi Medical University Hospital has arranged a separate flow for patients from the gate to the registration desk or isolation room for registration and screening. This helps to mitigate the contact of healthcare workers with suspected SARS-CoV-2 patients as well as protected for patients among themselves.

Tele-ICU can provide convenient access to patients without the risk of exposure in the period of COVID-19 pandemic. Tele-ICU delivers technology-enabled care from a remote command center. This system provides on-demand, two-way, audiovisual communication between isolated room and the tele-ICU center. Additionally, it can access electronic medical records, telemetry, and imaging systems for data retrieval and documentation, help doctors with risk stratification and decision support. Tele-ICU as a step to improve the quality of health care has shown statistically significant improvement in the adult ICU patients' outcomes, which lead to lesser mortality rate, readmission rate, hospital-acquired pressure ulcer rate, discharge against medical advice rate, and shorter length of stay.[11] The focus of preventing COVID-19 infection is reducing contact. Using patient monitoring on central work stations to monitor vitality and other treatment parameters may also reduce exposure.[12]

When examining suspected Sars-cov 2 infected patients, infectious specialists and epidemiologists can speak directly to patients through video conferencing system. In the isolation negative pressure room, only one nurse and one doctor entered to contact the patient directly.

Intra-hospital COVID-19 infection is an issue that needs to be addressed, not only to prevent infection for health workers but also to protect other patients being treated. A previous study found that the SARS-CoV-2 virus could be spread patient-to-patient in the hospital, and at least 4 patients were infected in the same ward of the hospital in Wuhan.[13] The patients admitted to the ICU are usually older and have a greater number of comorbid conditions than those not admitted to the ICU. If exposed to COVID-19, they are at higher risk of infection and will have poorer outcomes.[14] Tele-ICU helps doctors in classifying patients with risk factors, to avoid placing people at risk of COVID-19 infection in the same ward with other patients.

*Difficulties in deploying Tele-ICU*

Clinicians are often unwilling to use Tele-ICU

because they may not be knowledgeable and aware of Tele-ICU and are reluctant to attend training courses to master the technology.[15] In relation to Tele-ICU acceptance, a systematic review indicated that before implementation, 67% of ICU staff believed that Tele-ICU coverage would facilitate collaboration with intensivists. After implementation, communication between the ICU and Tele-ICU was rated good or very good by 94% of tele intensivists and by 98% of bedside physicians.[16] We did not face provider resistance when we implemented this Tele-ICU system; clinicians of Hanoi Medical University Hospital were willing to use this system. The reason may be that we applied this technology in the context of health systems in many countries facing the COVID-19 crisis. In addition, the Tele-ICU system allows connecting between experts of different specialties inside and outside the hospital. This can save time and limit the movement of both patients and doctors during the outbreak of COVID-19 pandemic. During the global COVID-19 crisis, personnel of all hospitals, including caregivers, support staff, administration, and preparedness teams, all will be stressed by work overload and high risk of infection, minimizing the risk of infection is very important.

*Tele-ICU saves resources for COVID-19 prevention*

As the pandemic accelerates, management of PPE for health workers is a key concern. Many countries had a shortage of masks, gowns, gloves, and other PPE for doctors, nurses, and other medical staff. This situation occurs when the supply is insufficient globally. So single-use equipment needs to be saved as much as possible in order to maintain operation for a long time. Tele-ICU can help avoid unnecessary equipment because doctor does not need direct contact face to face with the patient. In fact, when applying Tele-ICU, we use less consumables to protect employees than usual.

Moreover, if patients are admitted to the hospital with serious conditions, patients are immediately taken to an isolation room and followed the screening process, which means that the hospital will limit the number of health workers involved in managing this case. Health workers will take vital survival and respiratory assistance if necessary while awaiting further action. According to Vietnamese regulations, all close contacts with people infected COVID-19 or those suspected of having COVID-19 infection must be isolated. Therefore, all health workers of the emergency department who had the close direct contact with these patients when they were admitted to the hospital have been quarantined while waiting for the results of the SARS-Cov2 test. This means that they cannot provide health care service during this time.

The limitations of tele-ICU were remained at the time and budget. Tele-ICU innovation can be costly and take weeks to be delivered and installed. That timeline isn't conducive to control the COVID-19 in some hotspots. In addition, the Tele-ICU system requires doctors and nurses who need time to be trained and acquainted. Sometimes using technology is challenging for clinicians.

## V. CONCLUSIONS

Tele- ICU could be considered as an intervention in hospitals in response to COVID-19 pandemic to reduce exposure to COVID-19 for healthcare workers. The application of Tele-ICU could help mitigate the amount of in-person interactions without restriction to connection with different specialists for intensive care in emergency departments. A standard set of outcomes and evalutation of the impacts of Tele-ICU in future research are warranted.

We would like to thank to Hanoi Medical University Hospital, The Infomed Vietnam Company, Physsicians and all staff of Emergency and Intensive care Department of HMUH and all patients who have helped us to complete this study.

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