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Original Article

Evaluation of a combination protocol of CT-first triage and active telemedicine methods by a selected team tackling COVID-19: An experimental research study

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ABSTRACT

Background: Many health care workers around the world tackled with COVID-19, however sadly, the infection of many medical care workers were reported. To reduce the risk of infection, we launched selected team (Team COVID) of non-specialists and brought in active telemedicine method and computed tomography (CT)-first protocol. We describe our actual practice and the health status of medical doctors dealing with COVID-19 patients.
Methods: Between April 17, 2020 and May 24, 2020, 10 doctors worked with COVID-19 patients as part of Team COVID. The Team COVID doctors used a CT-first triage protocol for outpatients and telemedicine for inpatients and outpatients. We evaluated paired serum-specific antibodies for SARS-CoV-2 at the initial and end of the study duration and PCR results for SARS-CoV-2 at the end of the study duration. Furthermore, 36-item short-form of the Medical Outcome Study Questionnaire (SF-36) at the beginning and end of the study period were evaluated.
Results: Ten doctors worked as Team COVID: seven internal medicine doctors and three surgeons. During the study period, Team COVID treated 165 individuals in the outpatient clinic and isolated hospitalized patients for 315 person-days. There were no positive results of serum-specific antibody testing and PCR testing for SARS-CoV-2 in Team COVID doctors. Furthermore, the SF-36 showed no deterioration in physical and mental QOL status. No in-hospital infection occurred during the study period.
Conclusions: The Team COVID fulfilled the treatment using the active telemedicine and CT-first triage protocol without in hospital infection and excess stress. The combination strategy seems acceptable for both the protection and stress relief among the medical staff.

Abbreviations: CO-RADS, coronavirus disease 2019 reporting and data system; COVID-19, coronavirus disease 2019; CT, computed tomography; ELISA, enzyme linked immunosorbent assay; MCS, Mental Component Summary; PCR, polymerase chain reaction; PCS, Physical Component Summary; PPE, personal protective equipment; QOL, quality of life; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SF-36, 36-item short form of the medical outcome study questionnaire.

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Introduction

Coronavirus disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has affected more than 7.8 million individuals and has caused more than 0.43 million deaths to date [1]. The second and third waves of COVID-19 infection are expected. The pandemic of COVID-19 is one of the greatest human challenges facing healthcare systems on a global scale in this century [2,3]. In Italy, 20% of all infectious persons were medical care workers [4]. To prevent outbreaks of COVID-19 in hospitals, the adequate use of disposable personal protective equipment (PPE) is recommended [5]. Additionally, it is advisable to separate services for patients suspected of COVID-19 [6,7].

To maintain the healthcare capacity and quality in emergency situations, health management of healthcare workers is one of the most important requirements [8]. In the COVID-19 pandemic, because of the absence of a vaccine, rapid testing, and standard treatment, healthcare workers have been subjected to immense physical and psychological stress [9]. Especially, in emergency situations such as the COVID-19 pandemic, an urgent response team comprising different specialties often tackles triage and treatment [10,11]. In general, these urgent response teams face more stress than ordinary medical workers because they deal with unfamiliar diseases and are at risk of infection themselves. In order to practice adequate medical care, standard triage and treatment protocols are essential. At the same time, in order to sustain the teams, provision of medication and appropriate protection measures for healthcare workers is crucial [10].

A reasonable and reliable protocol for reducing contact with COVID-19 patients is important for both patients and healthcare workers. Therefore, several triage protocols and telemedicine methods for triage of COVID-19 patients have been reported [12–14]. The triage using present history and radiological features has been found to shorten the diagnostic duration and help narrow down the suspected patients [15]. Additionally, telemedicine using current technology promotes contactless medical care [16]. Therefore, we incorporated the combination protocol of triaging method and telemedicine in our hospital.

Here, we describe our actual practice including selected team formation and the combination protocol. Additionally, the health status of medical doctors dealing with COVID-19 patients was assessed. In this study, we aimed to assess the sustainability of healthcare systems in emergency situations by examining our combination protocol of triaging method and telemedicine in terms of infectivity and mental health.

Material and methods

Study design and setting

This study is a single-center experimental study that evaluated medical doctors at Yokohama City University Hospital, prospectively registered between April 17, 2020 and May 15, 2020.

Yokohama is the second largest city in Japan after Tokyo; COVID-19 has affected 17.502 individuals and caused 890 deaths in Japan as of June 15, 2020 [17]. In Yokohama City University Hospital, a tertiary-level hospital in Yokohama, we treated COVID-19 patients, who were affected by the outbreak in the "Diamond Princess" cruise ship in Yokohama Bay from February 2020 [18–20]. A selected team (Team COVID) was launched to treat patients with moderate-to-severe COVID-19 symptoms and identify suspected COVID-19 patients to prevent the spread of infection to in-hospital patients and medical staff. The Team COVID doctors were engaged in the outpatient clinic and treated in-hospital patients suspected of having COVID-19 in 24-h rotations. In our hospital, a protocol that used computed tomography (CT) as the first-line examination, i.e., "CT-first triage protocol [16]" was adopted for the management of suspected COVID-19 patients. Additionally, we adopted the active telemedicine method for both outpatients and inpatients.

Ethical approval and study registration

The Institutional Review Board at Yokohama City University Hospital approved this study (approval number B200400091). Written consent for participation in this prospective study was obtained from all the participants. This study has been registered in the University hospital Medical Information Network (UMIN) Clinical Trials Registry as UMIN000040129.

Participants

Team COVID consisted of 10 doctors (mainly selected from the Department of Internal Medicine and Surgery), all of whom were included this study.

We analyzed the following baseline characteristics: age, sex, specialties, history of overseas travel from January 2020 to April 2020, contact history with COVID-19 patient, and serum-specific level of SARS-CoV-2 antibody.

Active telemedicine method

In the outpatient clinic, suspected COVID-19 patients were guided to a temporary tent (Fig. 1A). In the temporary tent, there were intercoms (VL-SE25K, Panasonic Corporation, Osaka, Japan) connected to the emergency room (Fig. 1B). Nurses and doctors took the medical interview and observed the patient situation through the intercom. If a patient visited our hospital by his/her own car, the nurses and doctors communicated with the patient using a mobile phone, with the patient seated in the car.

When treating inpatients, doctors took rounds using room cameras (DH-IPC-HDBW1220EN-S-0280B, Dahua Technology Co., Ltd, Hangzhou, China) and nurse call phones (PLAIMH NICSS, Carecom Co., Ltd, Tokyo, Japan) (Fig. 1C and D). Only when the patents required direct medical examination or the patient's status changed, the doctors entered the isolation room (Fig. 1E) donning PPE.

CT-first triage protocol

We previously reported the efficacy of the CT-first protocol for triage [15]. In brief, patients complaining of COVID-19 symptoms were instructed to visit the fever outpatient clinic of the emergency room. These patients were isolated from other patients and treated as suspected COVID-19 patients. The nurse of a fever outpatient clinic is equipped with PPE and briefly checks the patients' vital signs and history. Chest CT was performed. Patients suspected of COVID-19 were separated from other patients on traffic lines and elevators to the CT room. Every CT feature was interpreted immediately by specialized radiologists and COVID-19 team doctors; the patients were classified into five categories according to the COVID-19 Reporting and Data System (CO-RADS) [20]. According to the CO-RADS score and patient history, patients were separated into a "COVID-19 suspected" group or a "COVID-19 less likely" group. In the COVID-19-suspected group, the isolation and PPE support continued until the polymerase chain reaction (PCR) test showed negative results.

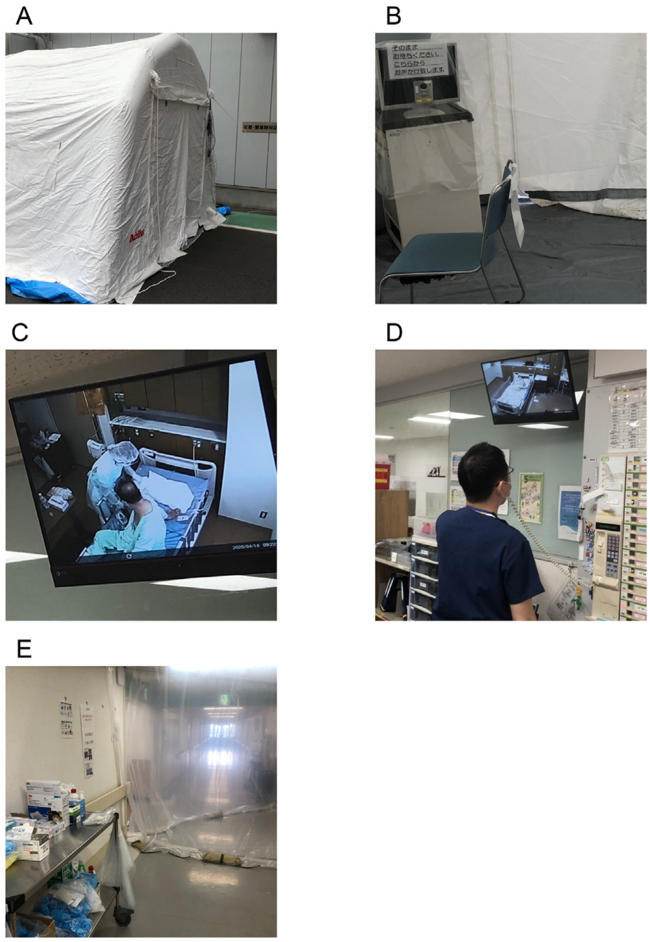

Fig. 1. Active telemedicine method for COVID-19 suspected patients.
The applications for the active telemedicine method were shown. (A) The temporary tent for the feverish outpatients. (B) The intercom in the temporary tent. The intercom connected outpatient and medical staff without contact. (C) The room camera of isolating inpatient. (D) The medical question through the nurse call phone. (E) The isolating inpatient area.

Calculation

Outcome

We evaluated the number of inpatients and outpatients treated by Team COVID. We also evaluated paired serum-specific antibodies for SARS-CoV-2 at the initial and end of the study duration and PCR results for SARS-CoV-2 at the end of the study duration. Furthermore, we evaluated the responses to the 36-item short-form of the Medical Outcome Study Questionnaire (SF-36) at the beginning and end of the study period. SF-36 can evaluate the physical and mental quality of life (QOL) as 2 Physical Component Summary (PCS) and 2 Mental Component Summary (MCS) [21,22].

Detection of COVID-19 genomic RNA and serological test for COVID-19 antibody

The detection of COVID-19 genomic RNA was performed according to the Manual for the Detection of Pathogen 2019-nCoV Ver.2.6 [23] provided by National institute of infectious disease in Japan. Nasal swab samples were obtained using Flocked Nasopharyngeal Swab (COPAN, City). The RNA extraction was performed from 140 μl sample using QIAamp Viral RNA Mini Kit (QIAGEN, City) according to the manufacture's protocol. The final elution was performed with 60 μl of elution buffer in the kit, and five μl of the RNA extraction was used for the reaction of Real Time quantitative PCR (RT-qPCR). The RT-qPCR Reaction Mix was prepared with TaqMan Fast Virus 1-Step Master Mix (Thermo Fisher Scientific, City) and Primer/Probe N2 (2019-nCoV) (TAKARA, City, japan) according to the manufacture's protocol. The sequences of the primers were shown in the supplementary Table 1. Denature and anneal/extend steps were repeated 45 cycles. Absolutely quantified artificial synthetic template RNA was used as positive control, whereas the well that contain no template RNA was used as negative control. According to the Manual [23], the assay was considered valid when the assay meets the following criteria; the 50 copies/well of template RNA was successfully detected before 40 cycles. (b) The nonspecific amplification was not detected in the well with no template RNA until 45 cycles. The sample that was detected the amplification of COVID-19 genomic RNA before 40 cycles was determined as positive for COVID-19 in this study.

We previously reported the methodology of serological testing [24,25]. In brief, enzyme linked immunosorbent assay (ELISA) was performed to detect and quantify anti–SARS-CoV-2 antibodies in plasma. We used n coronavirus-N-terminally truncated nucleocapsid protein as the antigen. In serological test, cut-off of COVID-19 antibody positive was over 0.45.

Table 1
Participants characteristics.

		Team COVID
	Number	10
	Age	33.8 ± 6.5
	Sex (male, female)	9, 1
	Internal medicine	7
Specialty	Surgery	3
	Infection	0
History of overseas		0
Rich contact with COVID-19		0

Abbreviations: COVID-19: coronavirus disease 2019.

Statistical analysis

The results are presented as means for the quantitative data and as frequencies (percentage) for categorical data. The Mann–Whitney *U* test was used for continuous data. A p value <0.05 was considered statistically significant. All statistical analyses were performed using JMP® 15 (SAS Institute Inc., Cary, NC, USA).

Results

Participant characteristics

Between April 17, 2020 and May 15, 2020, 10 doctors worked with COVID-19 patients as part of Team COVID: seven internal medicine doctors and three surgeons. There was no infection specialist; however, the infection specialist supervised the activities of Team COVID. The mean age was 33.8 ± 6.5 years, and nine doctors were male in Team COVID. There was no history of travel abroad before the study period (from January 2020 to April 2020) (Table 1).

Number of outpatients and inpatients treated by the Team COVID

During the study period, 165 individuals visited the outpatient clinic. Thirty-eight patients suspected of COVID-19 were hospitalized, and a total of 12 patients were finally diagnosed with COVID-19 (Fig. 2). Team COVID members treated isolated hospitalized patients for 315 person-days.

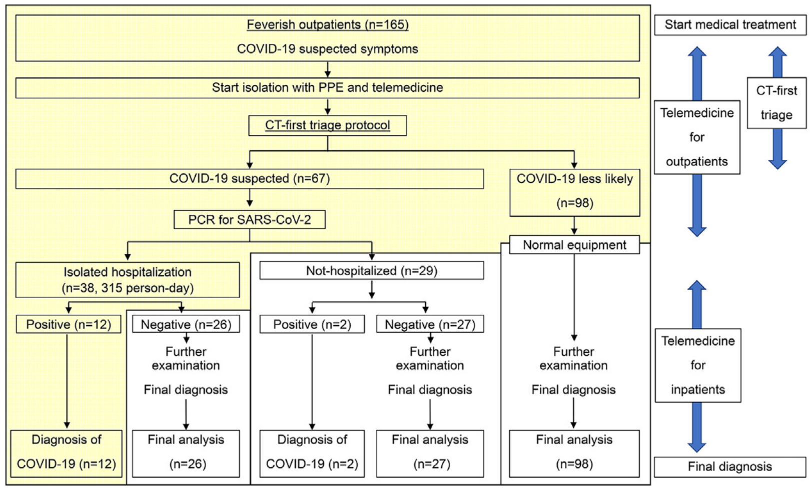

Fig. 2. Activities of Team COVID.
The overview of activities of Team COVID according to combination protocol of CT-first triage protocol and telemedicine method. The yellow area means isolating duration, requiring personal protective equipment. During the isolating duration, active telemedicine was applied for coronavirus disease 2019 (COVID-19) suspected or confirmed patients. The CVID-19 less likely group was treated normal equipment and finally diagnosed with further examinations. The needs for hospitalization of COVID-19 suspected group were judged personally according to their severity. The patients negative for polymerase chain reaction (PCR) for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were treated normal equipment and finally diagnosed with further examinations.

Table 2
Outcomes of participants.

	Initial of study period	End of study period	
Serological test for COVID-19 antibody (absorbance, positive: n, %)	0.22 ± 0.16 (n = 0, 0.0%)	0.21 ± 0.15 (n = 0, 0.0%)	
PCR test (positive: n)		positive: none	
SF-36 2PCS*	53.9 ± 3.6	54.2 ± 3.8	$p = 0.94$
SF-36 2MCS*	56.8 ± 7.5	56.5 ± 8.1	$p = 0.91$

In serological test, cut off of COVID-19 antibody positive is over 0.45.
Abbreviations: COVID-19: Coronavirus disease 2019, PCR: Polymerase chain reaction, SF-36: 36-item short form of the medical outcome study questionnaire, MCS: Mental Component Summary, PCS: Physical Component Summary.

The results of serological antibody for SARS-CoV-2 and PCR test, physical and mental status in the Team COVID doctors

Serum-specific antibody testing showed no positive results for the doctors during the study period both in team COVID. The absorbance values of the ELISA of Team COVID were 0.22 ± 0.16 at initial and 0.21 ± 0.15 at the end of study period. PCR testing for SARS-CoV-2 at the end of the study period did not show any positive results. It means there no COVID-19 infection during study period. Furthermore, the SF-36 showed no deterioration in physical and mental QOL status (Table 2). The 2PCS score of Team COVID were 53.9 ± 3.6 at initial and 54.2 ± 3.8 at the end of study period ($p = 0.94$). The 2MCS score of Team COVID were 56.8 ± 7.5 at initial and 56.5 ± 8.1 at the end of study period ($p = 0.91$). There were no statistically significant differences between initial and end of QOL score evaluated with SF36 both 2PCS and 2MCS within the Team COVID. With the use of the combination protocol of CT-first triage and active telemedicine, no in-hospital infection occurred during the study period.

Discussion

In this study, we demonstrated Team COVID activities and our actual practice of the combination protocol using CT-first triage and active telemedicine for COVID-19 patients. In our experience, with the combination protocol, the Team COVID carried out adequate treatments and there were no cases of COVID-19 infections in Team COVID. Furthermore, Team COVID members showed stable QOL score evaluated with the SF-36 questionnaire. We previously reported the efficacy of the CT-first triage protocol for patients suspected of COVID-19 [15]. Therefore, our combination protocol of the CT-first triage and active telemedicine seems permissible for both management of patients and protection of healthcare workers.

In Yokohama City University, the selected team called Team COVID was launched to tackle COVID-19. These emergency response teams consisted of non-specialist and worked in emergency situations [10]. Recently, when the MARS and SARS outbreaks spread in Asia, several emergency teams were launched in the high-risk area [26,27]. These teams are useful for minimizing the influence on general healthcare capacity and increasing the number of staff trained in unfamiliar diseases. In our hospital, Team COVID doctors covered the COVID-19 suspected or confirmed patients fully, therefore, the other doctors were able to maintain the quality and capacity of the usual medication. Furthermore, because the Team COVID doctors were limited number, the treatment protocol was easy to establish and update for all members. In our experience, Team COVID members were not infected during the study period. The team formation may have advantage to maintain the appropriate infection protection.

However, high stress is a matter of concern for these team members [28,29]. There were several evidences of health care workers tackling COVID-19 to face the high risk of infection and receive strong stress leading poor QOL [4,9]. In this study, we confirmed that the physical and mental QOL score did not drop in Team COVID. We emphasize that the Team COVID carried out appropriate triage, examination, and treatment following the combination protocol of CT-first triage and active telemedicine without excessive stress. Therefore, the appropriate protocol maintained the QOL of health care workers tackling COVID-19, and this combination protocol may potentially contribute to overcome the demerits of emergency team formations.

Telemedicine is attracting attention for overcoming infectious diseases [16]. Several new technologies have been reported, such as remote diagnostic technology using artificial intelligence and telemedicine, for triage systems [30]. Robotic technology for remote medical systems is also reported to help medical systems tackle COVID-19 [31]. These technologies are promising, as they have the potential for improving the safety of the medical staff.

However, these innovative technologies are too expensive and taking too long time for installation globally. In our hospital, quick and cheap installable methods for telemedicine were adopted. That is intercom which can be bought all over the world for housing inexpensively. Furthermore, we used what already existed, such as patient's cellar phone, nurse call phone, and room camera. Therefore, our method is adoptable for all over the world quickly. At the same time, because of the rapid worsening of COVID-19 [32], making quick decisions on direct medical examination is a crucial requirement.

There are some limitations to our study. First, this study was based on a single-center experience. The number of patients positive on PCR for SARS-CoV-2 was limited to our hospital. Our hospital is a tertiary-level hospital in Yokohama, and a high-quality backup system has been established in our hospital. This study had some biases. The medical protocol of the hospital depends on the medical resources of the hospital. An additional validation study is needed to confirm our conclusion. Second, the number of participants was limited, the study period was short, and the gender differences were biased, so additional studies will be needed to yield concrete evidence and confirm our findings.

Conclusions

In conclusion, we have demonstrated the real-world activities of the Team COVID selected from non-specialist. The combination protocol of CT-first triage and active telemedicine seems realistic and acceptable for both the protection and stress relief among the medical staff tackling COVID-19. Our encouraging findings may help improve the safety of the medical staff tackling COVID-19 and support healthcare systems in dealing with COVID-19.

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Competing interests

None declared.

Ethical approval

Not required.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jiph.2021.08.016.

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