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Surveillance of the infection prevention and control practices of healthcare workers by an infection control surveillance-working group and a team of infection control coordinators during the COVID-19 pandemic

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\textbf{A B S T R A C T}

\textbf{Background:} During the ongoing coronavirus disease (COVID-19) pandemic, hospitals have strengthened their guidelines on infection prevention and control (IPC), and a rigorous adherence to these guidelines is crucial. An infection control surveillance-working group (ICS-WG) and infection control coordinators (ICCs) team were created to monitor the IPC practices of the healthcare workers (HCWs) in a regional hospital in Korea. This study analyzed the surveillance results and aimed to identify what IPC practices needed improvement.

\textbf{Methods:} During phase 1 (March to April 2020), the ICS-WG performed random audits, recorded incidences of improper IPC practices, and provided advice to the violators. During phase 2 (April to July), the ICCs inspected the hospital units and proposed practical ideas about IPC. The surveillance and proposals targeted the following practices: patient screening, usage of personal protective equipment (PPE), hand and respiratory hygiene, equipment reprocessing, environmental cleaning, management of medical waste, and social distancing.

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Introduction

The pandemic of coronavirus disease 2019 (COVID-19) is ongoing, and the World Health Organisation (WHO) has warned that this crisis will not end soon [1,2]. In Korea, the first case of COVID-19 was reported on January 20, 2020. The infection rate overwhelmed the country in February and March but then started to decrease [3]. However, incidence spikes followed by cluster infections have been constantly occurring. As of October 17, there had been 25,698 cases, with 455 deaths [4].

Hospitals are high-risk environments for nosocomial exposure and infection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the coronavirus that causes COVID-19 [5,6]. There is increasing evidence that individuals with COVID-19 who are either asymptomatic or exhibit mild non-specific symptoms, such as fever or cough, are highly contagious. These patients may introduce the virus to hospitals, thereby causing clusters of nosocomial infection [7,8]. To minimize the risk of SARS-CoV-2 exposure and nosocomial infection, hospitals have strengthened their guidelines on infection prevention and control (IPC) practices [9–11]. Rigorous adherence to these guidelines is crucial to maintain the standards of IPC practices at high levels, and surveillance alongside continuous training of healthcare workers (HCWs) greatly contributes to this end.

This study presents the activities of the infection control surveillance-working group (ICS-WG) and the infection control coordinators (ICCs)’s team at Eunpyeong St. Mary’s Hospital, Seoul, Korea. The two programs were created during the COVID-19 pandemic to reinforce the monitoring on IPC practices. This hospital is a regional referral hospital and generally hosts a considerable number of patients immunocompromised due to organ transplantation, hematologic diseases, or chemotherapy. With the outbreak of COVID-19, Eunpyeong St. Mary’s Hospital was also designated as COVID-19 testing and treatment hospital. Consequently, the hospital established guidelines on the following categories of IPC practices: patient screening and triage, personal protective equipment (PPE) usage, hand and respiratory hygiene, equipment reprocessing, environmental cleaning, management of medical waste, and social distancing. These guidelines were notified to all the HCWs of the hospital. The ICS-WG and ICCs were assigned to monitor the IPC practices of the HCWs, particularly for any improper IPC practice that is in violation of the guidelines.

Although many studies have recently reported on experiences with IPC practices against COVID-19, systematically analyzed data are limited. This study assessed the observations of the ICS-WG and ICCs on the IPC practices of the HCWs in a regional referral hospital during the pandemic and aimed to determine which practice is the most challenging to execute in compliance with the guidelines and thus needs improvement. The results will be useful in providing the HCWs with feedback and proper training on IPC practices, and in establishing IPC strategies at other healthcare facilities.

Methods

Checklist

A detailed checklist was developed to maintain adherence to proper IPC practice and distributed to the managers of the hospital units or teams, who shared it with their members. This checklist, which reflected the guidelines issued by the Korea Disease Control and Prevention Agency [12], is presented in Table 1. The ICS-WG or ICC monitored for the presence of the required elements, the performance of HCWs, and evidence of IPC practices including the body temperature checking note and HCW’s working note. The following presents criteria for compliance briefly (no or incomplete presentation/performance was considered as noncompliant).

- Patient Screening and Triage
  - Present completely (e.g.: posters, hand sanitizer, triage, isolation room) was considered as compliant.
  - Performed completely (e.g.: checking body temperature) was considered as compliant
- PPE usage of HCW
  - Present completely (e.g.: prepared PPE, room for PPE doffing, instruction poster) was considered as compliant.
  - Performed completely (e.g.: wearing PPE, providing surgical mask) was considered as compliant.
- Hand and respiratory hygiene
  - Present completely (e.g.: poster, sanitizer, all of people wearing facial mask) was considered as compliant.
- Equipment Reprocessing
  - Present completely (e.g.: manual for cleaning equipment, disinfectant) was considered as compliant.
  - Performed completely (e.g.: wearing PPE during cleaning equipment) was considered as compliant.
- Environmental cleaning
  - Performed completely (e.g.: cleaning), was considered as compliant.
- Management of medical waste
  - Present (e.g.: container for medical waste) in necessary places, was considered as compliant.
  - Present completely (e.g.: disposal vinyl bags are placed in container, not overfilled, lid is closed), was considered as compliant.
  - Performed completely (wearing of specified PPE during handling, segregated properly—not mixed with nonmedical waste), was considered as compliant.
- Social distancing
  - Present completely (e.g.: poster, social distancing), was considered as compliant.

Results: In phase 1, of the 127 violations observed, most (32.3%) corresponded to hand and respiratory hygiene. In phase 2, the highest proportion of violation per category was observed in the management of medical waste (37.8%); among these, a higher proportion of violation (71.4%) was observed in the collection of medical waste. Of the 106 proposals made by the ICCs, the most addressed practice was patient screening (28.3%). No case of nosocomial infection was reported during the study period.

Conclusion: Adherence to proper hand and respiratory hygiene was inadequate at the early stage of the COVID-19 pandemic. The results indicate that more attention and further training are needed for the management of medical waste, particularly medical waste collection, and that continuous upgrading of the strategies for patient screening is essential. These results will be useful in helping other healthcare facilities to establish their IPC strategies.
Table 1
Checklists for infection control and prevention in the COVID-19 pandemic.

| Category                  | Details |
|---------------------------|---------|
| Patient Screening         | Triage is prepared to detect symptomatic patients |
|                           | Alerts (signs or posters) are shown with instructions for patients with fever or symptoms of respiratory infection |
|                           | Patients with fever or respiratory infection symptoms are urgently reported to health professionals |
|                           | Isolation rooms are prepared for patients found to have fever or respiratory infection symptoms |
|                           | Hand sanitizer is prepared in triage |
|                           | Body temperature of patients' caregivers is checked twice a day |
|                           | Surgical masks are provided to HCWs |
|                           | All of the HCWs are wearing surgical mask |
|                           | HCWs who are likely to be exposed to COVID-19 are wearing N95 mask |
|                           | Seal check is performed when donning an N95 mask |
|                           | HCWs involved in procedures producing respiratory droplets or body fluids wear goggles or face shields |
|                           | HCWs involved in procedures producing respiratory droplets, body fluids or blood wear gowns |
|                           | HCWs who may touch blood or body fluid wear gloves |
| PPE for HCW               | Gloves are changed if different procedures start or contact with an infectious agent takes place, even if the same patient |
|                           | Gloves are changed for every patient |
|                           | Room for donning PPE is prepared |
|                           | PPE is discarded as soon as donning |
|                           | PPE is ready for use at all times |
|                           | Instructions on how to don and doff PPE is posted |
|                           | PPE is prepared for code apple announcement |
| Hand and respiratory hygiene | Informing respiratory etiquette is posted  |
|                           | All of the patients and visitors are wearing facial masks |
|                           | Hand sanitizer is available in waiting places of patients and visitors |
|                           | Specified PPE is worn when cleaning equipment |
| Equipment Reprocessing    | A Manual for cleaning equipment is prepared |
|                           | Component, concentration, manufactured date and expiration date are marked in disinfectants |
|                           | Disinfectants are well sealed and kept appropriately |
|                           | Cleaning is done as scheduled |
|                           | There is no dirt on furniture, lights or equipment |
| Environmental Cleaning     | Isolation room for patients with fever or respiratory symptoms are cleaned after use |
|                           | Cleaning starts from clean areas to dirty areas |
|                           | Cloths for cleaning are checked |
|                           | Floors are cleaned well |
| Disposal of Medical Waste | Container for medical waste disposal is prepared |
|                           | Disposal vinyl bags are placed in containers for medical waste and removed before full |
|                           | Specified PPE is worn when handling containers for medical waste |
| Social distancing         | Post alerts on social distancing |
|                           | Social distancing is maintained |

COVID-19, coronavirus disease-2019; PPE, personal protective equipment; HCW, healthcare worker.

Study setting

This observational study was undertaken at Eunpyeong St. Mary's Hospital, a university affiliated hospital, which serves as a major medical facility in northwest Seoul, the capital city of Korea. This hospital has 808 beds including 60–70 beds dedicated to critical care units, emergency medical center, and facilities for organ and bone marrow transplantation. The hospital has approximately 2500 employees (doctors, nurses, support personnel, administrative staff, aides, etc.), and daily handles 2000–3000 outpatients, and 500–650 inpatients.

The hospital has an infection control unit comprised of three infectious disease (ID) physicians and five infection control nurses (ICNs), which is mandatory under the law. To reinforce the inspection of IPC practices performed by HCWs during COVID-19 pandemics, the temporary inspection group, ICS-WG and ICC, were created. The ICS-WG comprised 12 health professionals (five doctors, two dentists, three nurses, one laboratory technician, and one medical engineer). Three ID physicians and one ICN nurse concurrently served at the infection control unit of the hospital. The other two doctors, one nurse, and one laboratory technician concurrently served at the quality improvement unit, while the rest were those that had interest in infection control. Since the hospital building proved to be too large for the frequent ICS-WG audit of every site, the ICCs were introduced to support the functioning of the ICS-WG. The 46 nursing units and clinical support units’ managers were designated as ICCs; their roles coincided with those of infection control link nurses. The function of the ICCs was to maintain high standards of IPC practices in their units, and they reported their IPC practices surveillances to the ICS-WG.

Study design and period

During the early stage of the pandemic—from March 9, 2020 to April 5, 2020 (phase 1)—the ICS-WG staff conducted surveillance in the hospital daily or 2–3 times a week, and the audited site was randomly selected. The surveillance focused on improper IPC practices based on the checklist, and the involved HCWs were advised (Fig. 1).

During phase 2 (April 6, 2020 to July 31, 2020), the ICCs conducted surveillance on the IPC practices at their units once every 2–4 weeks. Additionally, two ICCs were paired to audit their counter partner’s units. The ICCs assessed the adherence of the HCWs to the guidelines on IPC practices and identified the incidences of proper and improper IPC practices according to the checklist. Monitoring of the ICCs’ team members own units (self-surveillance) corresponded to approximately half of the total surveillance while the rest were monitoring undertaken at designated pair’s units. In addition, since the guidelines may not necessarily cover all the different situations that may arise in clinical settings, the ICCs were also allowed to propose new ideas for challenging matters about IPC. The ICCs reported their surveillance results and proposals to the ICS-WG via presentations on PowerPoint (Microsoft Corporation, Redmond, Washington) and in writing through an intra-hospital messenger program (Fig. 1). The ICS-WG considered the matters and proposals raised by the ICCs
and provided relevant advice to the ICCs. Subsequently, the ICS-WG reported the new ideas suggested by the ICCs to the hospital executives for their implementation in IPC practices.

As this was a descriptive study based on data regarding IPC, ethical approval was not required under the guidelines of the Institutional Review Board of Eunpyeong St. Mary's Hospital (waiver application number: PC20EISI0126).

**Data analysis**

During phase 1, the incidences of noncompliance with the guidelines were recorded for all the IPC categories, and the distribution by each IPC category was assessed. During phase 2, the proportion of compliance and noncompliance per category among the total inspections were evaluated. In addition, the distribution of each category addressed in the proposals made by the ICCs was evaluated.

Descriptive statistics and frequency distributions were generated for all variables. Fisher’s exact test or the chi-square test was performed to compare the incidence or proportions of the variables. All the statistical analyses were performed using IBM SPSS Statistics for Windows, version 23 (IBM Corp., Armonk, NY, USA). P < 0.05 was considered statistically significant.

**Results**

During phase 1, a total of 127 incidences of noncompliance with the IPC guidelines were observed by the ICS-WG. The distribution of each IPC category incidences were as follows: patient screening and triage (22/127; 17.3%), PPE usage of the HCWs (20/127; 15.7%), hand and respiratory hygiene (41/127; 32.3%), equipment reprocessing (23/127; 18.1%), environmental cleaning (17/123; 13.4%); management of medical waste, 0%; and social distancing (4/123, 3.1%) (Fig. 2). Most of the violations were related to the category of ‘hand and respiratory hygiene’ (P < 0.001).

Fig. 3 summarises the number of inspections made by the ICCs during phase 2 for each category (638 inspections in total). The results were as follows: 77 patient screening and triage inspections made, 20.8% identified noncompliance with the guidelines; 118 PPE usage of the HCWs inspections identified 14.4% noncompliance; 118 hand and respiratory hygiene inspections identified 22.0% noncompliance; 75 equipment reprocessing inspections identified 8.0% noncompliance; 153 environmental cleaning inspections identified 11.1% noncompliance; 37 management of medical waste inspections identified 37.8% noncompliance; and 60 social distancing inspections identified 21.7% noncompliance. The highest proportion of violation was observed in the category of ‘management of medical waste’ (P < 0.05).

Table 2 presents the surveillance report on management of medical waste in detail. The results on noncompliance are as follow: preparation of containers in necessary places, 10 inspections were made, 10% noncompliance; checking on collection such as dis-
positional vinyl bag placement, removal before full, lid is closed, 14 inspections were made, 71.4% noncompliance; wearing specified PPE when handling container, segregated properly–not mixed with nonmedical waste, 13 inspections were made, 30% noncompliance. The highest violation was observed in the collection category ($P < 0.05$).

Fig. 4 demonstrates the distributions of the IPC categories among the 106 proposals made by the ICCs as follows: Patient screening and triage (30/106; 28.3%), PPE usage of the HCWs (8/106; 7.5%), hand and respiratory hygiene (16/106; 15.1%), equipment reprocessing (13/106, 12.3%), environmental cleaning (17/106; 16%), management of medical waste (12/106; 11.3%), and social distancing (10/106; 9.4%). The category of ‘patient screening and triage’ showed the highest proportion ($P < 0.05$).

Fig. 5 demonstrates the weekly number of COVID-19 tests (polymerase chain reaction testing) performed for patients with symptoms consistent with COVID-19 (in the wards, at the outdoor COVID-19 screening clinic, and at the emergency medical center) and weekly positive results. It also shows the numbers of inpatients undergoing COVID-19 treatment at the study site, during the study period. Of 4735 tests performed, 104 were positive (positive rate: 2.2%). The hospital had in total; 25 new hospitalizations due to COVID-19. The number of days hospitalized varied between patients from 3 to 68 days, and the number of inpatients for COVID-19 treatment varied from 2 to 7 every week. None of the nosocomial transmission cases were reported among patients and HCWs during the study period.

Discussion

The results of this study showed that, during phase 1, the most frequent (32.3%) noncompliance with the IPC guidelines were related to hand and respiratory hygiene practices. In other words, these practices appear to be the most improperly performed IPC practices in a hospital setting during the early stage of the COVID-19 pandemic. Additionally, during phase 1, the ICS-WG often identified patients or visitors without any or properly worn facial masks. Thus, it seems that the awareness of the usage of facial masks was not high during the early stage of the COVID-19 pandemic. During phase 2, the highest proportion (37.8%) of noncompliance observed was related to the management of medical waste compared with other IPC categories. The overall high proportions of compliance in IPC categories during phase 2 indicate that the HCWs were careful about IPC practices, except for the management of medical waste. Among the management of medical waste items, the highest proportion (71.4%) of noncompliance was observed with the collection of medical waste (Table 2). ICCs found cases of overflowed bins or their lids being opened. The containers for medical waste disposal are foot operated; however there were cases of faults with the pedal or arbitrarily fixed to open, for convenience (not needing to pedal every time). In the observation of the preparation of containers for medical waste disposal in necessary places (e.g., inpatient wards, outpatient clinics), 10% noncompliance was identified. In the observation of handling (PPE worn when handling, medical waste segregated properly (not mixed with nonmedical waste)), 30% noncompliance was identified. It seemed that the preparation or handling of containers by the HCWs was important and was considered to have a high risk of contamination, whereas the collection of medical waste was less important, with a low risk of contamination. However, overfilling can lead to contaminated surfaces in the environment where SARS-CoV-2 could survive for more than 5 days and could be the medium of transmission [13]. The faults with the pedals or the arbitrary opening of the containers could lead to touching of the containers. These behaviors increase the risk of contamination with SARS-CoV-2, particularly in the wards where COVID-19 patients are hospitalized and places where COVID-19 testing is performed [14]. Further education is needed to increase awareness on the collection of medical waste.

In the proposals made by the ICCs, the most frequently addressed IPC category was ‘patient screening and triage’ (28.3%). The high frequency of this category may reflect the specific situations that arise in hospital settings. All patients and visitors are to undergo screening upon arrival at the hospital, and those with symptoms consistent with COVID-19 or who had travelled in the last 14 days to any area subject to the hospital’s own COVID-19 Travel Order are then guided to the outdoor COVID-19 screening clinic instead of being allowed to enter the hospital building. However, some of these cases end up inside the building. Such cases can occur due to various reasons, such as misinformation by the patients or missed screening due to patients’ surge. The ICCs proposed practical solutions to cover various situations, such as updating the questionnaire used at the first point of entry, restriction of visitors, increasing the number of staff at the entrance, and making more rooms available to be designated as isolation rooms. The distribution of the IPC categories among the ICC proposals calls for particular attention on the patient screening and triage at Eunpyeong St. Mary’s Hospital. This result also indicates that the guidelines for this category should be periodically updated depending on the needs of each hospital and the dynamics of COVID-19 cases.

Despite the risk of nosocomial infection, hospitals have to maintain their medical services, and thus enforcement of IPC practices is crucial. The results of the descriptive study presented here suggest that implementation of an ICS-WG or ICC program at health care facilities can be highly beneficial in strengthening compliance with proper IPC practices.

During the study period, the hospital constantly had inpatient undergoing treatment for COVID-19 and the positive rate for COVID-19 testing (104/4735; 2.2%) was higher than the nation-
wide positive rate of 0.5% [15,16]. However, no case of nosocomial infection was reported during the study period.

During the COVID-19 pandemic, it has become clear that more ID physicians and ICNs are needed in Korea as well as other countries. This need seems to be higher in developing countries, small cities, or non-hospital healthcare facilities [17,18]. In many countries, including Korea, infection control units with an ID physician and ICN are mandatory for hospitals [19]. However, during the COVID-19 pandemic, infection control units should constantly revise their programs and implement updated strategies in the hospital according to the newly issued governmental policies to accommodate the dynamics of COVID-19. It is virtually impossible to rely on these units for monitoring the IPC practices throughout the hospital. In this study, most of the members of the ICS-WG and ICCs were not ID physicians or ICNs but performed their surveillance using a checklist. For the ICS-WG and ICCs to be effective, not all of their members need to be ID physicians or ICNs as long as they know the essential steps of IPC practices and there is interactive communication among ICCs, ICS-WG, and hospital executives. An ideal ICS-WG member or ICC should be enthusiastic, keen, and with a special interest in infection control [19].

Reporting through PowerPoint presentations was also helpful. Recently, self-checklists have increasingly been used in monitoring IPC practices, but a check mark is used to record compliance, rather than a parameter that grades the performance [20,21]. PowerPoint presentations explicitly describe a situation and can include photographs of any case of noncompliance, thereby increasing the efficacy of the ICCs in their surveillance. Additionally, these presentations enabled making effective proposals and were useful in creating an interactive environment with eagerness to devise constructive strategies.

Although this study had the above-mentioned merits, it also had some limitations. First, this was a single-center study, and a limited number of observations were made during the two study phases. Thus, it is unknown whether the observations made during the inspections reflect routine IPC practices. Second, our observations may have been focused on the inspector’s interests. For example, during phase 1, no violations regarding the management of medical waste were observed. During phase 2, a smaller number of inspections on management of medical waste was made. It seems that commonly seen IPC practices, such as PPE usage, patient screening and requiring all patients and visitors to the hospital to wear masks, were regarded as more urgent. The observations pertinent to the management of medical waste were far less likely to be made by the ICS-WG of ICCs. Third, the ICCs inspected their own units (regarded as self-reporting). The ICCs also conducted surveillance on the pair’s unit, although whether an unannounced inspection should be conducted was not fixed and was dependent on the ICC’s decision. This exercise may have resulted in false negatives in the identification of violations. Increasing the frequency of observations or fixing an unannounced surveillance on the pair’s unit was not enforced because of the concern that the ICCs may be overburdened since they also had routine responsibilities as HCWs. Fourth, the study period was relatively short. Although the ICS-WG and ICCs are still operating, it is paramount to share experiences and strategies as soon as possible during a pandemic. Thus, a short study period was inevitable.

In conclusion, the results of this study indicate the need for awareness and further training of HCWs on the management of medical waste, particularly collection of waste, at Eunpyeong St. Mary’s Hospital. In addition, it is essential to update the guidelines on patient screening and triage periodically. This study also demonstrated that the hand and respiratory hygiene practices were inadequate during the early stage of the COVID-19 pandemic. The findings of this study will be useful in providing feedback to the HCWs at Eunpyeong St. Mary’s Hospital and in the future training of these personnel. The results can also serve as reference data for other healthcare facilities in formulating their own IPC strategies. We believe that implementation of ICS-WG and ICC programs, and an interactive environment where results are presented via PowerPoint and proposing new ideas, could be useful in improving IPC practices to protect from nosocomial infections, thereby maintaining routine medical services of the healthcare facility.

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**Competing interests**

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