Development of In-Hospital Infection Management Using IoT.

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Abstract

As one of the countermeasures against infection at medical institutions, thorough hand hygiene is extremely important. In Japan, these controls are not sufficient. In order to do this management, it is necessary to track the hand washing situation. *Therefore, we decided to monitor the condition of hand washing by utilizing IoT.* Since there are environments where we can use IoT in our hospital, we decided to follow up using these environments. *As a result, it is possible to collect data continuously for 24 hours, 365 days, and evaluate infection risk based on data.* In addition, our hospital can also obtain location information on smartphone, so we can also track work. We are considering support for medical staff by utilizing smart devices.

Keywords:
Hand Hygiene, Infection Control, Medical Staff

Introduction

The World Health Organization (WHO) created hand hygiene guidelines in 2009. It saught compliance with hand hygiene at five timing. However, in the announcement of the Japan Society for Environmental Infections in 2017, our hand hygiene compliance rate is 38% on average, which is lower than much of the world, and the occurrence rate of resistant bacteria is very high compared to the Northern Europe such as Sweden. For this reason, we consider it necessary to reduce the infection rate.

Nurses who have many contact opportunities with patients are actively engaged in nosocomial infection prevention. They always carry disinfectants and maintain cleanliness of fingers, are cooperative in countermeasures against nosocomial infections, and the compliance rate of hand hygiene is higher than other medical treatments It shows a high price compared with the person. However, medical personnel other than doctors and nurses do not adequately comply with the WHO hand hygiene guidelines and are low consciousness.

Since Internet of Things (IoT) devices using Bluetooth and others can be used cheaply, the use of radio wave networks has begun to spread to solve medical problem problems. In our hospital, we can also use it for patient observation, and the positioning of medical staff is possible in the whole hospital as well. Using this kind of communication environment, we attempt to solve the problem of nosocomial infection control using hand hygiene disinfectant with IoT.

By visualizing the present state of hand hygiene using IoT and supplementing the management of infection control by utilizing the collected data, it is believed to lead to the creation of a safer medical environment. In addition, by evaluating hand hygiene for each medical doctor and giving feedback to individuals of medical personnel in real time, if there is a risk, educational effect can be obtained, and expectation can be expected for habitualization of behavior change of handicap and hand hygiene. Furthermore, we decided to aim for a method to use on a daily basis with smartphones and others.

Methods

In our hospital, we are strengthening the use of wireless communication as part of promoting medical ICT. Therefore, communication such as Bluetooth and ZigBee can be used. We have created and installed modules so that these communications can be used in hospitals. The configuration of the IoT gateway module is for converting from communication such as Bluetooth, Zigbee etc. to a Wifi connection to Wi-Fi. (Figure 1)

We developed this IoT gataway to acquire data and location information including alarms from medical devices and various sensors. We have already installed 1,500 IoT gataways in the hospital. In addition to this device, the staff distributes the smartphone as an extension, so this smartphone is used for location detection and personal identification.
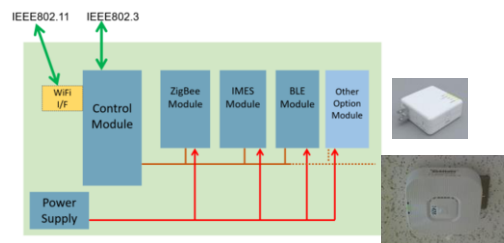

Figure 1 − Structure of IoT Hateway

We use a combination of smartphones and IoTgateway to detect medical staff locations. As a positioning method, Bluetooth low energy (BLE) beacon is performed by position calculation from multiple RSSI radio wave intensity measurements. In order to detect hand hygiene, it is necessary to detect the operating state of the disinfectant. For this reason, we created a mechanism to output a signal when the disinfectant was operated (Figure 2).

Figure 2 − Disinfection Pump Operation Detection Sensor

By combining the staff's flow line and disinfection pump operation, it is possible to detect the hand disinfection situation. In this way, it is possible to detect the hand disinfection situation at the time of entering the area or approaching the patient. By collecting these data continuously, it is possible to measure the required hand hygiene performance.

Results

In this system, positions and flow lines of staff are acquired with accuracy of approximately one meter (Figure 3). For this reason, we are making it possible to receive multiple BLE beacons at any location.
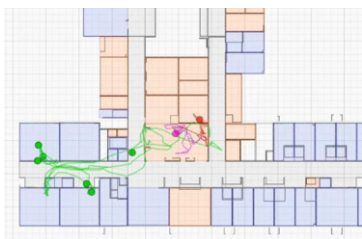

Figure 3 − Acquisition of Position and Flow Line of Staff

The fixed disinfection pump maps the coordinates of the installation position, and the carried disinfection pump is made to correspond to the person. Timing is determined by matching the operation signal of the disinfection pump with the position information. As a result, continuous measurement is possible , and it is possible to present collected hand hygiene data.

One result is the measurement result of the ICU. The status of hand hygiene compliance when entering the ICU and entering the patient area was (94.5%, 21.3%) by nurses (37 people), (64.3%, 12.5%) by anesthesiologists (5 people), (28.0%, 13.5%) by cardiac surgeons(6 person), (48.0%, 15.7%) by circulatory physicians (1 person),   (100%, 18.2%) by physiotherapists (1 person), (100%, 100%) by nurse assistants (6 persons).

This is an ICU situation, but similar measurements are possible in hospital wards. By feedback the results of hand hygiene measurement, the hand hygiene action of the medical staff has improved. However, we believe that infection control is an inadequate condition.

Discussion

With this method, the compliance rate of hand hygiene can be measured steadily. However, simply presenting this compliance rate is insufficient for continuous improvement. Although there are advantages in terms of visualization of compliance status, there are many cases where it is limited to presenting data. In order to make this improvement, we need to develop a method that reflects our actual behavior. we think that real-time assistance should be provided in important situations for infection control.

Conclusions

By using this method, it is possible to measure the behavior of medial staff in real time, so it is necessary to consider a method to utilize this result. In our hospital, one staff member uses smartphones, so we believe that hand hygiene can be improved by adding a mechanism to notify warnings when hand hygiene is needed. In the future, we will consider implementation with smartphone notification function. We plan to develop from the location of the medical staff's smartphone to a system that can provide appropriate assistance notifications. This method can be used in the same way as patient monitoring in the future, so it can be used together with these devices. We are also considering combining it with the sensor used in the nurse call system. In such a combination, we believe that this method is widely available.

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