Watch your hands: door types and the risk of infections in clinic waiting area

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Abstract. Patient safety in a healthcare environment is crucial. They are vulnerable to Healthcare Associated Infections (HAI) that can be gained through contact with a surface in the healthcare facility. Cleaning with disinfectant performed as the main procedure on the routine basis to cope with the infection contamination. However, the wider the surface that being cleaned also means the more usage of dangerous disinfectant being used. This is not very sustainable and put another risk for the patients. To minimise the problem, this paper aims to look at various types of doors design as part a non-critical surface in a healthcare facility with high interaction with the hands of both patients and healthcare workers. The study is conducted in the waiting area at a certain clinic in Depok. The waiting area becomes an essential aspect of this study because of its position as the primary circulation of patients. Four different types of door and how they interact with human are found in the clinic through observation and interview. In the end, this study findings can be used to consider door design in healthcare facilities because of its influence on people's behaviour and the risk of microbial spread.

Keywords: Door, Hand contact, Healthcare Associated Infection, Surface

1. Introduction

When entering healthcare environment, patient safety is at risk. They are exposed to the chance of getting Healthcare Associated Infections (HAI), an infection in which patients get while receiving medical care at healthcare environment. As the place to treat human body with different diseases and conditions, healthcare facilities are prone to microorganisms that could become serious threats to human health. HAI contributes to the addition of healthcare cost to treat the newly detected disease caused by infection [1]. Accordingly, it can depress patient satisfaction on their general healthcare experience.

Interventions on the cleaning routine and intensive infection control surveillance are found to have influential part in controlling the number HAI cases [2]. Although this may be true, there are still more studies needed to investigate the effect of healthcare facility design to prevent HAI transmission [3]. Cleaning strategy is impactful, but it is not the most sustainable way. Sustainable strategy to prevent HAI should be able to decrease the occurrence of microbial contamination in healthcare environment without posing risk to the patient, staff, and the environment.

Strategy to prevent HAI are mainly focus on the procedure and the products for cleaning. The normal procedure is to clean contaminated environmental surfaces with disinfectant on a routine basis

and when a patient has just been discharged from the room [4]. Objects that directly have contact with patient and healthcare workers become the main concern during this cleaning process. Generally, these objects are either being replaced or wiped meticulously using disinfectant. Albeit the high usage in hospital hygiene maintenance, disinfectant cannot fully prevent the occurrence of HAI.

Most cleaning products that are used in hospitals contain dangerous chemicals for human and the environment. Cleaning solutions accounts for air and water pollution and ecosystems damage [5]. Green cleaning is believed to be the more sustainable solution for HAI prevention method. It implements interdisciplinary and systematic approach through careful selection of cleaning products followed by conscious operational practice and building design [6]. As part of green cleaning approach, the practice of sustainable design contributes to improve patient outcomes, patient safety, patient satisfaction, and eventually increase productivity of staff and the healthcare system in general [7]. Rather than treating the already contaminated area with highly chemical cleaning products, preventing and minimizing the contaminated surface through design strategy could become the more sustainable solution to lower HAI cases.

This paper aims to take a closer look at doors as part of the healthcare facility with high interaction with the hands of both patients and healthcare workers. It takes place in a certain clinic in Depok. Data collection are done through physical observation, recorded by photographs and hand sketch. User interaction with doors and their surroundings in the waiting area of the clinic is observed three times in one month, for about 60 minutes in one visit. All observations are performed with regards to the users' privacy and discretion. Additional data is also gathered through interview with clinic's staff to gain information related to who and when the doors are being used. By looking in detail about the interaction between high touch objects and patients, the area of contamination in the surfaces of healthcare environment can be specifically determined. Therefore, the use of high chemical disinfectant to clean contaminated surfaces can be optimized. This strategy could potentially become a more sustainable way to prevent HAI.

2. Transmission of HAI through hand contact

Healthcare acquired infections (HAI) are transmitted through direct and indirect contact with contaminated surfaces. Direct contact occurs when the hand of healthcare worker touches patients without intermediator in between. As for indirect contact, it involves additional medium that is not part of the body of neither healthcare workers nor the patients. Usually, objects in healthcare environments are the mediator that facilitates the transmission of HAI. In the event of cross contamination of microorganism, hands are invariably involved in both direct and indirect contact because they are utilized for providing medical care.

Hands act as the main vehicle of infection transmission. Hand contact contributes in the transmission of microorganism by increasing the surface area and re-contaminating surfaces [8]. When the hands touch contaminated surface, the microorganism are transferred to the hand. Later, when the hand is being used to conduct other activity and contact other objects, the microorganism that move along on the hand surface continue to contaminate more surfaces. Hands become the vehicle that lead pathogens from the outside, point of entry, and to the patients or other surfaces inside the healthcare environment [9]. A study by WHO discovered that after the hand contact with contaminated environment, microorganisms can stay and survive on the hand for up to 60 minutes [10]. Contaminated areas can be duplicated quickly once there is contact with the hand that continue to engage in more contacts with more objects after the transfer of contamination.

A study suggests that the 25% reduction on the rate of infection associated with the improvement on the hand-hygiene practice in hospital [11]. Regardless that, the practice of hand washing is still highly dependent on the individual motivation and opportunity created by the built environment to support this habit. Compared to studies about the prevention of HAI through intervention of hand cleaning habit, studies that focus on the surface as the vehicle of infection transmission are less discussed. It is due to the difficulties in investigating the complicated process of pathogen transmission [12]. Rather than taking the clinical approach of pathogen transmission, this research will

focus on the prevention of contamination transfer from the physical attribute of objects and the contact with the hand. It investigates doors as objects within healthcare environments that are in frequent contact with hands.

Objects that are in frequent contact with the hands have higher chance of becoming the medium of infection transmission. Bed rails, bed table, and bed surface are considered high touch because they are frequently touched by healthcare workers during the delivery of medical treatment [13]. Being the surface that have higher touch rate, these objects are treated with extra attention on the cleaning procedures. However, there are other objects that do not necessarily have high engagement during medical treatment but receive less attention on the means of cleaning. Doors arguably have similar rate of touch but have relatively low engagement during medical treatment. Although present in most of the areas in healthcare environment, doors are cleaned less often compare to other objects that has higher engagement in medical treatment.

3. Geometry of doors in clinic waiting area

Some surfaces in healthcare environments are touched significantly higher than others. They are usually cleaned based on the level of criticality. A swabbing test on door knobs (22.76%) recorded has the greatest microbial contamination [14]. Nonetheless, doors handles are among the non-critical surface that needs particular attention.

Doors are present in all types of the healthcare facility and needed as access from one space to another. Operating the doors requires contact between the user's body—especially hands--and part of the door. Door part with the highest hand contact is the handle. Whilst door handle design may appear trivial at the design stage and largely ignored, it is one of many ''trivial'' design features that might silently undermine microbial transmission control [2]. There are many types of door handle; some require a mechanism to turn, rotate, push or pull depending on the design. To investigate the relation between users' hands with the doors, we will further investigate the physical properties of doors in a specific clinic waiting area located in Depok in the context of this study. The waiting area became our specific observation space because of its function as the central hub of the facility--the transition between outside and inside--where infection is likely to occur. The primary target of observation is the patients. As non-frequent users of the facility, they have less familiarity with the built environment, particularly the operation of doors. They mostly come to this clinic to receive treatments from general practitioners, dentist, and psychologist.

Figure 1. Four types of doors in the clinic

Different types of door required different gestural approach in accessing through them. The act of opening and entering the door highly depends on the geometry of the door and the movement of a human body. However, this observation will be focused on the hand as the main body parts that are

involved in the act of entering and exiting rooms through doors. The objective is to observe the user behaviour towards a different design of the doors as the critical point of contamination transmission.

The various doors that are included in these studies are located in the first and second floor of the clinic. The entrance door is not included because it always opened during the clinic operation hours. Thus, there is almost no contacted surface on that door. Generally, there are four different types of door in this clinic: single swing door with lever handle, single swing door with staff's modification, single swing door with metal plate, and the yellow sliding door. All of the doors are 240mm in height with slight differences in width. The doors are built with plywood with paint finish.

The first type is a single swing door with lever handle, which located in most area in the first floor and second floor. Next one has a lever handle with slight modification by the staff. The lever handle is covered with taped on the nose piece so it stays on the inner part of the door handle. It is treated that way so people only need to push the door to access the room as there is frequent activities going through the door that involve drugs distribution. They do not have to swing the handle downward as the mechanism to push the nose piece inside and open the door. For the single swing door used in toilets, it has flat rectangular metal plate on the push side and vertical handle on the pull side inside the toilet. The sliding door has vertical handle bar for people to hold while sliding the door to the side. There are 8 sliding doors on the first floor and 11 of them on the second floor. These doors connect the waiting area with examination room.

4. Interaction between doors and human body

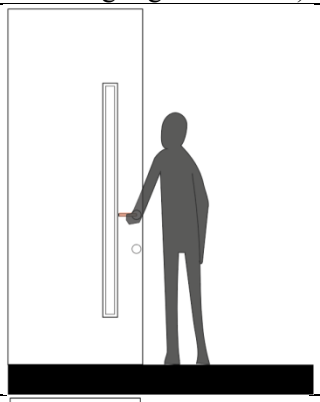
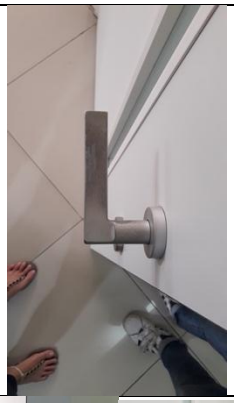
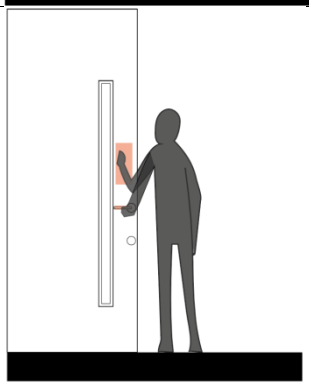
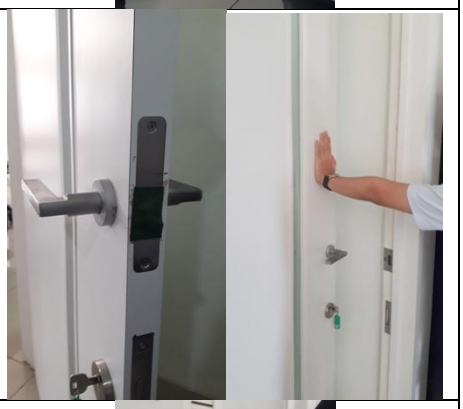
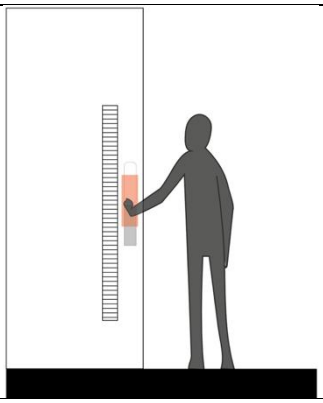
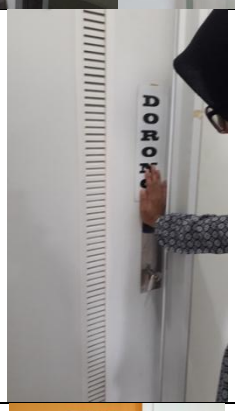
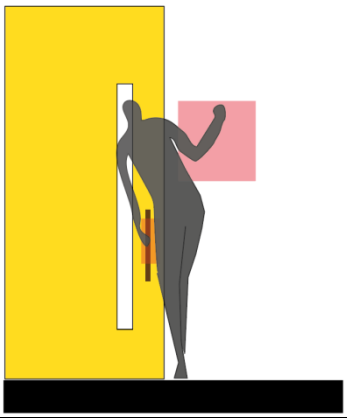
Considering the various types of opening and closing mechanism of each door, the interaction between human body and the doors are also different. Confronted with the size of the doors, their users are mostly Indonesian, with the average height of 158 cm for male and 147 cm for female [15]. Diagrams shown below are trying to map the contact area of the user of the doors—mainly patients; sometimes staff—and see the relation between door design and infection control.

Table 1 No.1 illustrates the first door type which its lever handle requires twisting mechanism in order to pull the nose part inside so the door can be opened. Because of that, user's hand should fully grab the handle, twist it downward, and then push or pull the door open. Such mechanism specifies the contacted surface area and minimize the possibility of contamination to spread. All users that we observed always only touch the handle bar. It also proved by the worn out looks of the handles, contrast with the clean door.

In the case of the swing door with covered knob (look at Table 1 No.2), it is generally easier for people to push rather than pull because they can use their body weight to give force towards the door. Because this type of door is connecting the waiting area with pharmacy area, user of these doors are staff. During the gesture of pushing the door, human hands generally form a flat open to distribute the force evenly throughout the palm. Based on the study, people intent to disregard the handle and instead directly touch the door surface to push the door forward. Thus, the area of contact becomes less concentrated on the handle part but wider on the leaf door. This condition differs on the pull side of the door which the same as the first type of the door. Hence, if contaminated hands touch it, the contamination is limited on the door handle. This finding aligns with the study conducted by Wojgani et al. that proof higher bacterial contamination of pull handles compare to push plates [2].

The third type of door design in this clinic is the single swing door with metal plate (look at Table 1 No.3). This flat rectangular metal plate used for the toilet door and can only be put for push-operated door. Although the push plate is intended to be the area where people lay their palm on, it does not stop the chance of contamination spread. Sometimes, people touch the door outside the rectangular plate. They tend to touch the instruction to push sign as it also hint where the plate should be.

Table 1. User Interaction with Several Doors in the Clinic

No.	Description	Illustration (Possible Contaminated Area Highlighted in Red)	On-Site Images
1	User Interaction with Single Swing Door with Lever Handle		
2	User Interaction with Modified Single Swing Door		
3	User Interaction with Single Swing Door with Metal Plate		
4	User Interaction with Yellow Sliding Door		

Unlike lever handle, vertical bar does not require twisting mechanism. People should just push or pull the handle to operate the door. Due to its verticality, people with different height grab the vertical bar on different height. Hence, the contacted area tends to be more spread compare to lever handle. As shown in Table 1 No.4, with sliding door, the user tends to keep some distance from the door and touch a wall next to the door. The area of the wall that they touch is on the opposite site of the door's opening and as tall as the user's shoulder. This specific hand gesture shown by most of the user used to hold a force of their body before move the door. Another gesture specific to sliding door is when the user-staff in particular-take a peek into the room. This position affects the wall next to the door in which a particular area around the reach of user hand became dirtier compared to other parts of the wall. It is also supported with the clear glass design on the door that create opportunity for people to peek inside. The human interaction with sliding door triggers more surface contact due to the possibility of interaction from both hands during the opening and closing operation. This can be seen from the hand marks on the wall beside the sliding doors at the clinic.

5. Conclusion

Maintaining hygiene in healthcare environment through cleaning is necessary. Although there are many guidelines for infection prevention and control on hand hygiene protocol being implemented in healthcare environments, some studies are failed to show direct correlation between improved hand hygiene and the reduction of HAI cases. Strict control on cleaning procedure is not the only solution to prevent HAI. The practicality of cleaning is debatable because some inanimate objects in healthcare environment have high rate of touch. With such high frequency of hand contact, objects like doors are not practical to be clean every time. There should be options in the design that can minimize the spread of contamination.

Different types of door design triggers different way of human interaction on operating it. Factors like door type, door handles, and direction of opening determine the surface of contaminated area. From the observation, it can be concluded that compare to other types of door, sliding door has the highest contaminated surface area. It expands from the door handle, door leaf, into the walls by the door. Among the various types of door handle, lever handle has the smallest surface area. The twisting mechanism causes more concentrated area of hand-contact. Lastly, regarding the side of door, the push side of the door tends to have bigger area of contact because of the nature of transferring force from the body through the palm during the mechanism of pushing the door.

Design of the healthcare environment has much influence on people’s behaviour and the risk of microbial spread. In the case of door design, some design has higher potential of microbial contamination due to the behaviour of operation by the user. Findings from this research can be used for consideration when deciding types of door design for healthcare environments. This paper can be referred to decide the highly contaminated parts of door at existing buildings. Therefore, the cleaning division can plan a more intense cleaning procedure on those parts with higher risk of bacterial contamination. This study is still lack of support from the microbiological proof. For further study, swab test should be incorporated into the research to further confirm the synthesis of highly contaminated parts of door in healthcare environments.

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