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# Knowledge and Practice of Hand Hygiene Among Hospitalized Patients in a Tertiary General Hospital in China and Their Attitudes: A Cross-Sectional Survey

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**Abstract**

**Objectives:** We aimed to gain a better understanding of patients' practice of hand hygiene and their knowledge and attitudes.

**Design:** A Cross-Sectional Survey.

**Setting:** A 3500-bed university-affiliated medical hospital in China.

**Participants:** Inpatients and their family members or caregivers.

**Methods:** An anonymous, self-reported questionnaire were used to collect data.

**Results:** Of the 310 respondents, 47.4% had received hand hygiene education, and 13.5% had a completing understanding of hand hygiene. A majority of patients believed that handwashing was important for disease recovery, and that it could prevent infection development. A total of 62.3% of patients washed their hands less than 5 times a day and 49.0% spent less than 1 minute every time. With regards to the seven steps of handwashing, 96.45% of the respondents adhered to the first step (washing the palms), but only 20.6% adhered to the fifth step (thumbs) and 17.7% to the sixth step (fingertips). Most respondents washed their hands only when visibly dirty. Few patients washed their hands before drinking fluids, and before and after interacting with visitors. hand hygiene compliance was lower among ICU patients than medical patients.

**Conclusions:** Hand hygiene is considered important by most patients. However, the levels of knowledge and compliance are unsatisfactory. Multifaceted and dedicated efforts are needed to improve patient hand hygiene compliance.

**Keywords:** Patient hand hygiene, Inpatient, Health care-associated infection, China

**Strengths and limitations of this study**

- We measured the hand hygiene knowledge, attitude, and performance from the prospects of patient view.
- We desiged the questionnaire combines both WHO and CDC patient hand hygiene related policies.
- A stratified random sampling method was used in order to make the sample representative.
- This is a single-center cross-sectional survey, our results may not be applicable to all other institutions.
- There is a need for further observational studies including quantitative hand bacterial cultures to verify the results of this study.

## INTRODUCTION

Health care-associated infections (HCAIs) are major risk factors for the development of sepsis,[1] which affects more than 30 million patients every year, worldwide, leading to 6 million potential deaths.[2] Both the Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) consider hand hygiene (HH) to be the most important factor in the prevention of HCAIs and the spread of pathogens.[3,4] The practice of effective HH plays a key role in the prevention of healthcare-associated sepsis.[5] Great efforts have been made to improve the performance of "My 5 moments for hand hygiene" among healthcare workers (HCWs), and this has had a global improvement. However, the role of patient hand hygiene (PHH) has been underestimated. Emerging evidence suggests that most infections occur as a result of bacteria present within a patient's own flora as well as bacteria present on surfaces within the healthcare environment;[6-8] therefore, the adequate practice of PHH could decrease pathogen transmission and the risk of HCAIs.[9] However, few studies have investigated PHH in China, with some of them focusing on the role of patients as monitors or auditors in the improvement of HCW HH compliance.[10] Thus, the purpose of this cross-sectional study was to investigate inpatient knowledge, as well as the attitudes towards and practice of PHH during hospital stay, and to characterize and identify the factors influencing practice compliance. The results may contribute to the design of more successful PHH promotion strategies.

In this study, PHH was defined as HH practices performed by a patient on his or her own hands, including handwashing, and the use of alcohol-based hand rubs (ABHRs) and disinfecting wipes.[9] In certain situations, this care may have to be provided to patients by professional caregivers or family members.

## METHODS

This cross-sectional, single-center study was performed at a 3500-bed university-affiliated medical hospital between November 2017 and December 2017. The study was approved by the hospital's institutional review board (No. 201708955).

### Participants

The study was conducted in 71 clinical wards, including the departments of internal medicine, surgery, obstetrics and gynecology, pediatrics and infectious diseases, and intensive care units (ICUs). Outpatient wards, operating rooms, psychiatric wards, isolation wards, and emergency rooms were excluded.

Patients were enrolled through a random sampling method using a random number table. Firstly, data on the number of beds in each ward were obtained from the hospital management department, and a total of 3,000 of these beds met our inclusion criteria in terms of ward type. Secondly, according to the largest sample size formula of simple random sampling, with values of $\Pi = 0.5$, $\alpha = 0.05$, and $\delta = 0.05$, a total sample size of 385 was obtained. After correction, the required sample size was 342, but taking into consideration a no-response rate of 10%, a total of

376 patients were required. Finally, patients from each ward were randomly selected using an 8:1 proportion.

Hospitalized patients who provided verbal informed consent and agreed to voluntarily participate in this study were included. Exclusion criteria were: patients with an admission time less than 24 hours, patients who did not return to their bed due to surgery or transfer to the ICU, and those with mental status changes. Family members or caregivers were enrolled in the case of patients with impaired consciousness, who were critically ill, or who were under the age of 14 years. Only family members who stayed with the patients in the wards for more than 1 day were enrolled. Visitors, friends, and family members who had only short visits with the patients were excluded. The nurses who were in charge of the eligible patients were selected.

**Questionnaires**

In this study, the survey instrument was a self-designed structured questionnaire that was based on "When should you wash your hands" released by the CDC in 2016,[11] and the "Standard for hand hygiene for health care workers in health care settings" issued by the National Health Commission of the People's Republic of China in 2009.[12] Experts from the Department of Infectious Diseases were also consulted in this regard. The questionnaire comprised two parts. The first part was designed to allow for the primary nurse to assess the elicited patient disease information, such as diagnosis, whether surgery was performed, or if there was any infection during the hospital stay.

The second part pertaining to PHH was designed for patients and their families or caregivers, and comprises 4 sections. Section 1 pertained to patients' demographic data, including ward type, bed number, place of residence, income, and number of hospitalizations. Section 2 pertained to caregiver information, such as if the respondent is a family member or caregiver, his/her relationship with the patient, length of hospital stay, education, and occupation. Section 3 addressed PHH knowledge and attitudes, while Section 4 evaluated patients' practice of HH, including handwashing moments, steps, number of wash times daily, minutes taken every time, and ways in which hands were dried. The PHH moments were scaled as 'seldom', 'sometimes', 'often', and 'always'. 'Not applicable' was selected for those who reported that they did not perform the procedure and therefore did not encounter that moment.

**Implementation**

The survey was conducted by eight research assistants, all of whom were team members who participated in all study meetings and discussions, who had knowledge on HH and its association with HCAI, and who had received unified training on how to fill out the questionnaire. The research assistants first obtained approval from the head nurses in the study wards, and then distributed questionnaires to the participants and provided instructions. The purpose of the study was explained to the respondents and informed verbal consent was obtained before investigation. Participants were informed that the questionnaire content would not involve invasive measurements or invade privacy, and would not cause injury to the body or mind. All

eligible patients and their families/caregivers were informed that participation in the study was voluntarily, and that refusal to participate or withdrawal from the study at any point for any reason would not influence medical decisions. The participants were assured that their information would only be used for research and that strict confidentiality would be maintained, as well as that their data would not be used for business or other purposes without their permission. The questionnaires were distributed and collected on the spot through SO JUMP (a professional online questionnaire platform). A small gift (a piece of soap) valued at approximately $0.50 was given to each respondent who completed the questionnaire.

**Patient and public involvement**

The current study did not include patient and public involvement.

**Statistical analysis**

Questionnaire data are presented as the number of participants and percentages. A Kruskal-Wallis H test was applied to analyze the PHH implementation rate in the different departments. Binary logistic regression analysis was used to identify the demographic predictors for the respondents who had performed HH in the moment "after using the toilet, bedpan, or commode". Only those who responded "always" were included in the analysis. Univariate analysis by non-conditional logistic regression was used to compare each demographic variable in the different groups. Variables with a *P* value <.10 were further tested in the multivariate

logistic regression analysis by the enter method. A 2-tailed *P* value of 0.05 was considered statistically significant.

## RESULTS

### Population characteristics

A total of 310 respondents, including 242 patients (78.1%) and 68 family members/ caregivers (21.9%), completed the questionnaire. The total response rate was 82.4% (310 of 376). The respondents' characteristics are summarized in Table 1. A total of 46.8% of the participants were women, and most of them (86.8%) were married. The majority (79.7%) had a high school education or lower. More than half of the participants (64.5%) were urban or town dwellers, and a similar proportion (66.5%) had an annual income <50,000 RMB (~US$7,987). Most respondents (62.3%) had been hospitalized previously, and 27.7% reported having an infection at present.

### Patients' performance of hand hygiene and their knowledge and attitudes

Most of the participants (72.2%) reported that they did not know about HH or knew very little about it. Less than half (47.4%) of the respondents had received HH education before; of them, HCWs (95, 35.6%) and television (76, 28.5%) were the main resources. A majority (94.2%) of the participants believed that handwashing was important for disease recovery, and almost the same percentage (93.2%) of them believed that handwashing could prevent infection spread among patients.

More than half (62.2%) of the patients washed their hands less than 5 times a day, and approximately half (49.0%) of them spent less than 1 minute washing their hands every time. Washing hands under flowing water (64.7%) was the main route of washing, compared to washing in a basin or using ABHRs; however, only 13.4% and 25.6% of the patients used hand sanitizers and soap, respectively. A total of 41.9% of the respondents reported that they had a dedicated hand towel, but only 20.0% and 21.6%, respectively, chose a dedicated hand towel or tissue to wipe their hands (Table 2).

**Patients' practice of the '7 steps to handwashing'**

The results of patients' practice of the '7 steps to handwashing' are displayed in Supplemental figure 1. Most respondents washed their hands with adherence to the first step (rub palms together: 96.45%, 299 of 310). More than half of them practiced the second step (rub the back of both hands: 66.13%, 205 of 310) and third step (interlace fingers and rub hands together: 66.77%, 207 of 310). A slightly lower number of participants (56.77%, 176 of 310) adhered to the seventh step (rub both wrists in a rotating manner). The implementation rates of the fourth step (interlock fingers and rub the back of fingers of both hands: 26.77%, 83 of 310), and sixth step (rub fingers on palm for both hands: 20.65%, 64 of 310) were lower. However, the fifth step (rub thumb in a rotating manner followed by the area between index finger and thumb for both hands) had the worst execution rate (17.74%, 55 of 310).

**Patient hand hygiene moments**

Three-quarters (75.8%; 235 of 310) of the respondents washed their hands after using the toilet/bedpan/commode, and 86.1% washed their hands when they were visibly dirty (Table 3). Approximately half (47.7%) of the patients washed their hands before touching any breaks in the skin, whereas the implementation rates before any care procedures (19.0%, 59 of 310) and dialysis/contact with IV lines or other tubes (19.7%, 61 of 310) were low. The performance of handwashing before drinking fluids (11.0%, 34 of 310), as well as before and after interacting with visitors (11.9%, 37 of 310 vs 13.2%, 41 of 310) was also very low.

**Patient hand hygiene moments in different departments**

Participants in the Department of Internal Medicine had a relatively high execution rate of HH when their hands were visibly dirty (96.4%, 106 of 110), before eating (82.7%, 91 of 110), and before touching any breaks in the skin (71.8%, 79 of 110). Those in the Department of Surgery tended to wash their hands after using the toilet/bedpan/commode (94.4%, 136 of 144) and after coughing, sneezing, or touching the nose or mouth (50.7%, 73 of 144). Those in the Department of Infectious Diseases had good performance rates of handwashing before interacting with visitors (40.0%, 6 of 15) (Table 4). There were significant differences in this regard between the different departments in the Kruskal-Wallis H test (H=19.838, P=0.001).

**Significant predictors of PHH moments**

A majority of the respondents (75.8%, 235 of 310) “Always” performed HH after using the toilet/ bedpan/commode (Table 5), and the univariate analysis identified one significant predictor:

very few ICU patients practiced HH compared to medical patients (odds ratio [OR]= 0.08, 95% confidence interval [CI]: 0.02-0.41, *P* = 0.002). In the multivariate analysis, we found two significant variables: being a farmer rather than a clerk (adjusted OR= 0.18, 95% CI: 0.05-0.61, P =0.004) and being a freelancer (adjusted OR=0.18, 95% CI: (0.05-0.62, P =0.007). Medical patients had a higher HH performance rate than those in the Department of Obstetrics-Gynecology (adjusted OR= 0.18, 95% CI: 0.04-0.80, P =0.02) and ICU (adjusted OR= 0.06, 95% CI: 0.01-0.45, P =0.006).

## DISCUSSION

In the present study, we examined hospitalized patients' knowledge of, attitudes towards, and practice of HH. Our findings demonstrate that patients' knowledge on HH is lacking; although they are aware of the universal importance of HH practice, they clean their hands less frequently in the hospital.

Although patients had a positive attitude towards HH, their knowledge was insufficient. A majority of the participants (94.2%) held the view that handwashing was important for recovery from disease, and most of them (93.2%) believed that handwashing could prevent the development of infection; however, more than half (52.6%) of the respondents did not receive HH education, and only 13.5% patients had complete awareness on HH. Our findings differ from those of Nabavi et al.,[13] who found that while Iranian residents had a moderate knowledge of HH, their attitudes toward the various aspects of HCAI were negative. This could be attributed to the

fact that the present study's hospital attaches great importance to HCW HH and has implemented the WHO's multimodal HH improvement strategies;[14] therefore, the study participants were in an atmosphere in which the importance of HH is highlighted daily, leading them to believe in its importance. However, due to their poor educational background and non-provision of information by HCWs, they were unaware of why HH was important. Therefore, inpatients need to receive better training on HH if the rates of HCAI are to be lowered.

Patients' performance of standard HH (step, frequency, duration) is poor, and the existing facilities and products are routinely underutilized. Only 17.7% (55 of 310) of patients washed their fingertips and 20.6% (55 of 310) washed their thumbs, consistent with the findings of previous studies.[15] Although the WHO's multimodal HH improvement strategies have been implemented by our hospital's Infection Control Committee with the provision of sinks and wash basins for the performance of soap-and-water cleaning in every patient's room, and the provision of ABHR for waterless hand cleaning in the rooms and corridors for all HCWs and patients,[14] the frequency and duration of handwashing were not satisfactory in this study. Among all participants, 62.2% washed their hands less than 5 times every day and 49.0% spent less than 1 minute every time. Moreover, 35.3% of patients washed their hands without running water, and only 13.4%, 25.6% and 14.4% used hand sanitizers, soap and ABHR, respectively. Previous studies demonstrated that washing hands with soap and water or ABHR is more effective than washing with tap water alone in removing pathogens,[16] and that providing staff education on the

importance of PHH in infection prevention can improve PHH performance.[17] Therefore, staff should receive education on the importance of PHH in the prevention of hospital-acquired infection; second, staff need to be instructed to provide verbal PHH education to all newly admitted patients, and to provide reminders, assistance, and encouragement for PHH practice.[18] In addition, it is also important to ensure that HH products—such as alcohol-based hand wipes or ABHR—are accessible to patients who are bedridden and are unable to get to the sink.[19] Staff or family members should be instructed to provide assistance to improve PHH opportunities.[18] The use of a personalized verbal electronic audio reminder (EAR) has previously been suggested to improve PHH while minimizing increases in the workload of HCWs.[20]

Hands were washed most frequently when they were visibly dirty and after using the toilet, but less frequently before drinking fluids and taking medicine, which would be the optimal time for the prevention of fecal-oral transmission. In this study, 75.8% of the participants washed their hands after using the toilet/bedpan/commode, but only 11.0% of them washed their hands before drinking fluids. Similar results have been observed in other study on patients in transplant units.[21] This may be because some patients may believe that their hands do not require washing until they are visibly dirty, and that simple contact does not require handwashing; others may not have awareness of optimal HH habits.[20] Hospital environments are often contaminated with hospital-acquired pathogens,[16-18] therefore, there is a need for education campaigns aimed at

patient-initiated HH and HH that is directly observed before meals and the intake of medications during hospitalization.[22]

Our results also revealed that only 11.9% of the patients washed their hands before interacting with visitors and 13.2% washed their hands after the visitors left. Visitors may be vectors of pathogenic organisms that are potentially dangerous, particularly to immunocompromised patients.[23] If visitors carry certain pathogenic organisms on their hands and do not perform HH upon entry to the hospital, vulnerable patient populations may be at an increased risk for infection if they do not wash their hands after the visitors leave.[24] Similarly, if patients carrying pathogenic bacteria do not wash their hands before contact with visitors, the risk of visitors developing infection increases, leading to the spread of pathogens that may be a threat to public health. Thus, to win the battle against HCAIs, there is a need for coordinated effort to enforce HH that includes patients, as well as their families, and visitors.[25] In addition to providing better signage and education among care providers[26,27], other hospital approaches, such as the installation of more strict visiting infrastructure (i.e., ICU doors that will not open if ABHR is not used) might be considered.[23]

The present study resulted in some significant findings, the most significant being that ICU patients rarely practice HH compared to those in other departments. This is not surprising as patients in the ICU are generally critically ill or unconsciousness, and they cannot wash their hands by themselves. Even the assistance of professional caregivers does not seem to work. This

suggests the importance of the role of caregivers in ensuring adequate HH in such functionally dependent patients. To the best of our knowledge, this study is the first to provide data on ICU PHH, since most previous studies on ICU HH focused on HCWs or patients' families.[23,28] Considering that multidrug-resistant acinetobacter baumannii infection are highly in ICU [29] and ICU patients are the most susceptible populations to nosocomial infections,[30] attention must be given to improving their adherence to HH rules to reduce hospital infections.

Our study has several limitations. First, since this is a single-center cross-sectional survey, our results may not be applicable to all other institutions. Thus, it is recommended that a multi-center study with a large sample size be conducted in the future. Second, our inclusion of certain patients and wards may have resulted in selection bias. Physically weak patients were also recruited in the present study, and their families or caregivers filled out the questionnaire; therefore, there is a possibility that the family members of caregivers may have provided information on their own HH situation rather than that of the patients. Therefore, there is a need for further observational studies including quantitative hand bacterial cultures to verify the results of this study. Nonetheless, we believe that this study included a representative sample of inpatients. Third, the study was conducted using a convenience sampling method in the category of family members. Finally, our questionnaire was not pretested.

## CONCLUSIONS

In conclusion, this study demonstrated that HH is considered important by most patients. However, their levels of knowledge and practice were unsatisfactory. These results suggest that multifaceted and dedicated efforts are needed to correct this knowledge and behavior. In addition, special attention should be given to those HH moments the compliance rates to which were the lowest, such as before drinking fluids, as well as before interacting with visitors and after they leave.

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## Footnotes

**Contributors:** LYX and YSE contributed to the study conception and design, data collection, analysis, interpretation and drafting the manuscript. LYH and CC contributed to the data collection and data management. MD contributed to the study design, data acquisition and interpretation. All authors critically revised the manuscript and approved the final version.

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**Ethics approval:**The study was approved by the Institutional Review Board of Xiangya Hospital, Central South University (No. 201708955).

**Data sharing statement:** Extra data can be extracted by emailing the corresponding author YSE.

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**Table 1** Demographic characteristics of the 310 patients and their family members or caregivers.

| Characteristic | Participants (%) |
|---|---|
| Identity | |
| Patient | 242（78.1） |
| Family members/caregivers | 68（21.9） |
| Sex | |
| Female | 145（46.8） |
| Male | 165（53.2） |
| Age, years | |
| <30 | 57（18.4） |
| 30-39 | 34（11.0） |
| 40-49 | 56（18.1） |
| 50-59 | 72（23.2） |
| ≥60 | 91（29.4） |
| Marital status | |
| Unmarried | 36（11.6） |
| Married | 269（86.8） |
| Divorced | 1（0.3） |
| Widowed | 4（1.3） |
| Education level | |
| Primary or below | 77（24.8） |
| Junior high school | 88（28.4） |
| Senior high school | 62（20.0） |
| Technical secondary school | 20（6.5） |
| College | 34（11.0） |
| Undergraduate | 28（9.0） |
| Postgraduate or above | 1（0.3） |
| Occupation | |
| Farmer | 67（21.6） |
| Worker | 27（8.7） |
| Clerk | 47（15.2） |
| Medical staff | 2（0.6） |
| Teacher | 3（1.0） |
| Student | 13（4.2） |
| Freelancer | 34（11.0） |
| Unemployed | 45（14.5） |
| Retiree | 72（23.2） |
| Place of residence | |

| | |
|---|---|
| Urban | 147（47.4） |
| Town | 53（17.1） |
| Village | 110（35.5） |
| Income (RMB/year)† | |
| <50,000 | 206（66.5） |
| 50,000~100,000 | 80（25.8） |
| 100,000~200,000 | 18（5.8） |
| >200,000 | 6（1.9） |
| Number of hospitalizations | |
| 1 | 117（37.7） |
| 2 | 74（23.9） |
| ≥3 | 119（38.4） |
| Ward | |
| Medical ward | 110（35.5） |
| Surgical ward | 144（46.5） |
| Obstetrics/gynecology ward | 23（7.4） |
| Pediatric ward | 9（2.9） |
| Infectious diseases ward | 15（4.8） |
| Intensive care unit | 9（2.9） |
| Was surgery performed this time? | |
| Yes | 132（42.6） |
| No | 178（57.4） |
| Is there any infection? | |
| Yes | 86（27.7） |
| No | 224（72.3） |

*† 50,000 RMB ≈ US$7,209*

**Table 2** Performance of hand hygiene and knowledge and attitudes among the 310 patients and their family members or caregivers.

| Items | Total n(%) |
|---|---|
| Knowledge and attitude | |
| Have you received any education related to hand hygiene? | |
| Yes | 147（47.4） |
| No | 163（52.6） |
| Hand hygiene knowledge sources | |
| Television | 76 (28.5) |
| Newspaper | 20 (7.5) |
| Magazine | 18 (6.7) |
| Internet | 37 (13.9) |
| Medical staff | 95 (35.6) |
| Other | 21 (7.9) |
| Do you know anything about hand hygiene? | |
| Don't know | 126（40.6） |
| A little | 98（31.6） |
| Most | 44（14.2） |
| All | 42（13.5） |
| Is handwashing important for recovery from disease? | |
| Yes | 292（94.2） |
| No | 18（5.8） |
| Can handwashing prevent infection in patients? | |
| Yes | 289（93.2） |
| No | 21（6.8） |
| **Performance** | |
| How many times do you wash your hands every day? | |
| ≤2 | 48（15.5） |
| 3~5 | 145（46.8） |
| 6~10 | 69（22.3） |
| >10 | 48（15.5） |
| How long does it take to wash your hands every time? | |
| <1 min | 152（49.0） |
| 1~2 min | 135（43.5） |
| ≥2 min | 23（7.4） |
| Handwashing ways | |
| Wash basin | 560(18.9) |
| Flowing water | 1913(64.7) |

| | |
|---|---|
| Alcohol-based hand rub | 484(16.4) |
| Handwashing products | |
| Tap water only | 1797(46.6) |
| Hand sanitizer | 516(13.4) |
| Soap | 987(25.6) |
| Alcohol-based hand rub | 555(14.4) |
| Ways in which you wipe your hands | |
| Hand towel | 976(20.0) |
| Any towel | 819(17.5) |
| Disposable tissues | 1012(21.6) |
| Clothes on my body | 410(8.8) |
| Wave hands in the air | 873(18.7) |
| Face towel | 588(12.6) |
| Do you have a dedicated hand towel? | |
| Yes | 130（41.9） |
| No | 180（58.1） |
| Times of hand towel washes every day | |
| 0 | 10(7.7) |
| 1 | 32(24.6) |
| 2 | 29(22.3) |
| 3 | 25(19.2) |
| 4 | 27(20.8) |
| Wash once every few days | 7(5.4) |

**Table 3** Patient hand hygiene moments.

| Moments | Seldom n(%) | Sometimes n(%) | Often n(%) | Always n(%) | Not applicable† |
|---|---|---|---|---|---|
| 1. After using the toilet, bedpan, or commode | 21(6.8) | 15(4.8) | 39(12.6) | 235(75.8) | 0(0.0) |
| 2. When returning to the room after a test or procedure | 91(29.4) | 43(13.8) | 54(17.4) | 120(38.7) | 0(0.0) |
| 3. Before eating | 41(13.2) | 37(11.9) | 68(21.9) | 164(52.9) | 0(0.0) |
| 4. Before drinking fluids | 160(51.6) | 63(20.3) | 53(17.1) | 34(11.0) | 0(0.0) |
| 5. Before taking medicine | 130(41.9) | 49(15.8) | 62(20.0) | 66(21.3) | 3(0.9) |
| 6. When visibly dirty | 11(3.5) | 9(2.9) | 23(7.4) | 267(86.1) | 0(0.0) |
| 7. Before touching any breaks in the skin (e.g., wounds, dressing, tubes) | 56(18.1) | 36(11.6) | 61(19.7) | 147(47.4) | 10(3.1) |
| 8. Before any care procedures (e.g., dialysis, IV‡ drug administration, injections) | 145(46.8) | 54(17.4) | 52(16.8) | 59(19.0) | 0(0.0) |
| 9. Before dialysis, contact with IV lines or other tubes | 139(44.8) | 60(19.4) | 44(14.2) | 61(19.7) | 6(1.9) |
| 10. After coughing, sneezing, or touching nose or mouth | 102(32.9) | 61(19.7) | 61(19.7) | 86(27.7) | 0(0.0) |
| 11. Before interacting with visitors | 198(63.8) | 37(11.9) | 38(12.3) | 37(11.9) | 0(0.0) |
| 12. After visitors leave | 190(61.3) | 46(14.8) | 33(10.6) | 41(13.2) | 0(0.0) |
| 13. When there is concern about whether hands are clean | 78(25.1) | 57(18.4) | 83(26.8) | 87(28.1) | 5(1.5%) |

† "Not applicable" represents patients who reported that they did not perform the procedure and therefore did not encounter that moment.

‡ "IV" intravenous.

**Table 4** Patients who "always" or "often" practiced hand hygiene in the different departments.

| Moments | Medical Wards n/N(%) | Surgical Wards n/N(%) | Obstetrics/ gynecology wards n/N(%) | Pediatric wards n/N(%) | Infectious diseases wards n/N(%) | ICU† n/N(%) | Total n/N(%) |
|---|---|---|---|---|---|---|---|
| 1.After using the toilet, bedpan, or commode | 99/110(90.0) | 136/144(94.4) | 19/23(82.6) | 7/9(77.8) | 10/15(66.7) | 3/9(33.3) | 274/310(88.4) |
| 2.When returning to the room after a test or procedure | 71/110(64.5) | 75/144(52.1) | 12/23(52.2) | 7/9(77.8) | 7/15(46.7) | 2/9(22.2) | 174/310(56.1) |
| 3.Before eating | 91/110(82.7) | 108/144(75.0) | 15/23(65.2) | 7/9(77.8) | 9/15(60.0) | 2/9(22.2) | 232/310(74.8) |
| 4.Before drinking fluids | 35/110(31.8) | 38/144(26.4) | 4/23(17.4) | 4/9(44.4) | 5/15(33.3) | 1/9(11.1) | 87/310(28.1) |
| 5.Before taking medicine | 45/110(40.9) | 59/144(41.0) | 12/23(52.2) | 6/9(66.7) | 4/15(26.7) | 2/9(22.2) | 128/310(41.3) |
| 6.When visibly dirty | 106/110(96.4) | 138/144(95.8) | 22/23(95.7) | 7/9(77.8) | 12/15(80.0) | 5/9(55.6) | 290/310(93.5) |
| 7.Before touching any breaks in the skin (e.g., wounds, dressing, tubes) | 79/110(71.8) | 98/144(68.1) | 15/23(65.2) | 5/9(55.6) | 9/15(60.0) | 2/9(22.2) | 75/310(24.2) |
| 8.Before any care procedures (e.g., dialysis, IV‡ drug administration, injections) | 41/110(37.3) | 51/144(35.4) | 8/23(34.8) | 4/9(44.4) | 5/15(33.3) | 2/9(22.2) | 111/310(35.8) |
| 9.Before dialysis, contact with IV lines or other tubes | 37/110(33.6) | 49/144(34.0) | 9/23(39.1) | 4/9(44.4) | 4/15(26.7) | 2/9(22.2) | 105/310(33.9) |
| 10.After coughing, sneezing, or touching the nose or mouth | 51/110(46.4) | 73/144(50.7) | 10/23(43.5) | 4/9(44.4) | 7/15(46.7) | 2/9(22.2) | 147/310(47.4) |
| 11.Before interacting with visitors | 23/110(20.9) | 34/144(23.6) | 8/23(34.8) | 3/9(33.3) | 6/15(40.0) | 1/9(11.1) | 75/310(24.2) |
| 12.After visitors leave | 25/110(22.7) | 32/144(22.2) | 5/23(21.7) | 4/9(44.4) | 6/15(40.0) | 2/9(22.2) | 74/310(23.9) |
| 13.When there is concern about whether hands are clean | 66/110(60.0) | 72/144(50.0) | 13/23(56.5) | 6/9(66.7) | 9/15(60.0) | 4/9(44.4) | 170/310(54.8) |
| Kruskal-Wallis H | 574.47 | 556.01 | 548.99 | 669.5 | 535.47 | 196.56 | 19.838 |
| *P*-value | | | | | | | 0.001 |

† ICU, intensive care unit; ‡ IV, intravenous.

**Table 5** Identity of participants who "always" performed hand hygiene after using the toilet, bedpan, or commode using the characteristics of the patients and their family members of caregivers.

| Characteristic | "Always" perform hand hygiene n/N (%) | Unadjusted OR† | | Adjusted OR | |
|---|---|---|---|---|---|
| | | OR (95%CI‡) | *P*-value | OR (95% CI) | *P*-value |
| Identity | | | | | |
| Patient | 186/242(76.9) | 1 | | | |
| Family members/caregivers | 49/68(72.1) | 0.78(0.42-1.43) | 0.42 | | |
| Sex | | | | | |
| Male | 125/165(75.8) | 1 | | | |
| Female | 110/145(75.9) | 1.01(0.60-1.69) | 0.98 | | |
| Age, years | | | | | |
| <30 | 39/57(68.4) | 1 | | | |
| 30-39 | 28/34(82.4) | 2.15(0.76-6.12) | 0.15 | | |
| 40-49 | 43/56(76.8) | 1.39(0.61-3.15) | 0.44 | | |
| 50-59 | 54/72(75.0) | 1.49(0.69-3.26) | 0.31 | | |
| ≥60 | 71/91(78.9) | 1.64(0.78-3.46) | 0.20 | | |
| Marriage | | | | | |
| Unmarried | 26/36(72.2) | 1 | | | |
| Married | 205/269(76.2) | 1.23(0.56-2.69) | 0.60 | | |
| Divorced | 1/1(100) | / | 1.00 | | |
| Death of a spouse | 3/4(75.0) | 1.15(0.11-12.44) | 0.91 | | |
| Education level | | | | | |
| Primary or below | 59/77(76.6) | 1 | | | |
| Junior high school | 59/88(67.0) | 0.62(0.31-1.24) | 0.18 | | |
| Senior high school | 51/62(82.3) | 1.41(0.61-3.27) | 0.42 | | |
| Technical secondary school | 14/20(70.0) | 0.71(0.24-2.12) | 0.54 | | |
| College | 28/34(82.4) | 1.42(0.51-3.98) | 0.50 | | |
| Undergraduate | 23/28(82.1) | 1.40(0.47-4.22) | 0.55 | | |

| | | | | | |
|---|---|---|---|---|---|
| Postgraduate or above | 1/1(100) | / | 1.00 | | |
| Occupation | | | | | |
| Farmer | 56/67(83.6) | 1 | | 1 | |
| Worker | 23/27(85.2) | 1.13(0.33-3.92) | 0.85 | 0.85(0.21-3.39) | 0.82 |
| Clerk | 34/47(72.3) | 0.51(0.21-1.28) | 0.15 | 0.18(0.05-0.61) | 0.006 |
| Medical staff | 2/2(100) | / | 1.00 | / | 1.00 |
| Teacher | 2/3(66.7) | 0.39(0.03-4.72) | 0.46 | 0.15(0.01-2.26) | 0.17 |
| Student | 8/13(61.5) | 0.31(0.09-1.14) | 0.08 | 0.22(0.04-1.24) | 0.09 |
| Freelancers | 23/34(67.6) | 0.41(0.16-1.08) | 0.07 | 0.18(0.05-0.62) | 0.007 |
| Unemployed | 34/45(75.6) | 0.61(0.24-1.55) | 0.30 | 0.58(0.21-1.61) | 0.29 |
| Retiree | 53/72(73.6) | 0.55(0.24-1.26) | 0.16 | 0.36(0.12-1.08) | 0.07 |
| Place of residence | | | | | |
| Urban | 117/147(79.6) | 1 | | | |
| Town | 37/53(69.8) | 0.59(0.29-1.21) | 0.15 | | |
| Village | 81/110(73.6) | 0.72(0.40-1.28) | 0.26 | | |
| Income (RMB/year) | | | | | |
| <50,000 | 153/206(74.3) | 1 | | | |
| 50,000~100,000 | 61/80(76.3) | 1.19(0.65-2.20) | 0.57 | | |
| 100,000~200,000 | 16/18(88.9) | 1.73(0.48-6.22) | 0.40 | | |
| >200,000 | 5/6(83.3) | 1.73(0.20-15.16) | 0.62 | | |
| Number of hospitalizations | | | | | |
| 1 | 87/117(74.4) | 1 | | | |
| 2 | 59/74(79.7) | 1.36(0.67-2.74) | 0.40 | | |
| ≥3 | 89/119(74.8) | 1.02(0.57-1.84) | 0.94 | | |
| Ward | | | | | |
| Medical ward | 86/110(78.2) | 1 | | 1 | |
| Surgical ward | 117/144(81.3) | 1.21(0.65-2.24) | 0.55 | 1.27(0.58-2.80) | 0.55 |
| Obstetrics/gynecology ward | 14/23(60.9) | 0.43(0.17 -1.13) | 0.09 | 0.18(0.04-0.80) | 0.02 |
| Pediatric ward | 6/9(66.7) | 0.56(0.13-3.40) | 0.43 | 0.95(0.12-7.39) | 0.96 |
| Infectious diseases ward | 10/15(66.7) | 0.56(0.17-1.79) | 0.33 | 0.51(0.13-2.04) | 0.34 |

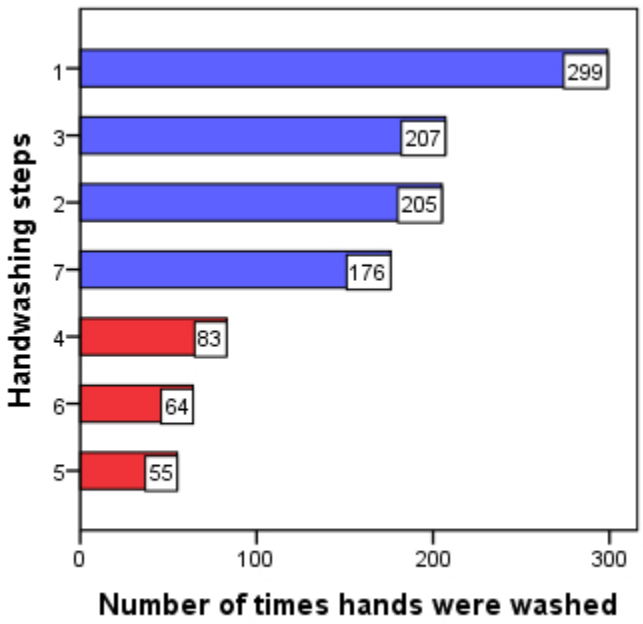
| | | | | | |
|---|---|---|---|---|---|
| ICU§ | 2/9(22,2) | 0.08(0.02-0.41) | 0.002 | 0.06(0.01-0.45) | 0.006 |
| Was surgery performed this time? | | | | | |
| No | 135/178(75.8) | 1 | | | |
| Yes | 100/132(75.8) | 0.99(0.59-1.68) | 0.99 | | |
| Is there any infection? | | | | | |
| No | 171/224(76.3) | 1 | | | |
| Yes | 64/86(74.4) | 0.90(0.51-1.60) | 0.72 | | |

† OR, odds ratio; ‡ CI, confidence interval; § ICU, intensive care unit.

## Figure legends

**Supplemental figure 1. Seven-steps to handwashing**

1. Rub palms together
2. Rub the back of both hands
3. Interlace fingers and rub hands together
4. Interlock fingers and rub the back of fingers of both hands
5. Rub thumb in a rotating manner followed by the area between index finger and thumb for both hands
6. Rub fingers on palm for both hands
7. Rub both wrists in a rotating manner

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**Supplementary File 1**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1-2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 3 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 3-4 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 4 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 4 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 4 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 6 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | *6-7* |
| Bias | 9 | Describe any efforts to address potential sources of bias | 5,6,7 |
| Study size | 10 | Explain how the study size was arrived at | 5 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 5 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 8 |
| | | (*c*) Explain how missing data were addressed | 8 |

| | | | |
|---|---|---|---|
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | 8 |
| | | (*e*) Describe any sensitivity analyses | 8 |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 8 |
| | | (b) Give reasons for non-participation at each stage | 8 |
| | | (c) Consider use of a flow diagram | 8 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 8 |
| | | (b) Indicate number of participants with missing data for each variable of interest | 8 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 8 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 9,10, 11 |
| | | (*b*) Report category boundaries when continuous variables were categorized | 9,10 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | 11 |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 11 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 11 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 15 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 12, 13, 14 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 16 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study | Title |

| | |
|---|---|
| and, if applicable, for the original study on which the present article is based | page |

BMJ Open

# Knowledge and Practice of Hand Hygiene Among Hospitalized Patients in a Tertiary General Hospital in China and Their Attitudes: A Cross-Sectional Survey



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| | |

# Knowledge and Practice of Hand Hygiene Among Hospitalized Patients in a Tertiary General Hospital in China and Their Attitudes: A Cross-Sectional Survey

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## Abstract

**Objectives:** We aimed to gain a better understanding of patients' practice of hand hygiene and their knowledge and attitudes.

**Design:** A Cross-Sectional Survey.

**Setting:** A 3500-bed university-affiliated medical hospital in China.

**Participants:** Inpatients and their family members or caregivers.

**Methods:** An anonymous, self-reported questionnaire were used to collect data.

**Results:** A total of 376 questionnaires were issued, and 310 respondents completed it. Of the 310 respondents, 47.4% had received hand hygiene education, and 13.5% had a completing understanding of hand hygiene. A majority of patients believed that handwashing was important for disease recovery, and that it could prevent infection development. A total of 62.3% of patients washed their hands less than 5 times a day and 49.0% spent less than 1 minute every time. With regards to the seven steps of handwashing, 96.45% of the respondents adhered to the first step (washing the palms), but only 20.6% adhered to the fifth step (thumbs) and 17.7% to the sixth step (fingertips). Most respondents washed their hands only when visibly dirty. Few patients washed their hands before drinking fluids, and before and after interacting with visitors. Hand hygiene compliance was lower among ICU patients than medical patients.

**Conclusions:** In conclusion, this study demonstrated that patients had a positive attitude towards hand hygiene. However, their levels of knowledge and practice were unsatisfactory. A

systematical education about patient hand hygiene is needed in future to correct this knowledge and behavior.

**Keywords:** Patient hand hygiene, Inpatient, Health care-associated infection, China

**Strengths and limitations of this study**

- We measured the hand hygiene knowledge, attitude, and performance from the prospects of patient view.
- We designed the questionnaire combines both WHO and CDC patient hand hygiene related policies.
- A stratified random sampling method was used in order to make the sample representative.
- This is a single-center cross-sectional survey, our results may not be applicable to all other institutions.
- There is a need for further observational studies including quantitative hand bacterial cultures to verify the results of this study.

## INTRODUCTION

Health care-associated infections (HCAIs) are major risk factors for the development of sepsis,[1] which affects more than 30 million patients every year worldwide, leading to 6 million potential deaths.[2] Both the Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) consider hand hygiene (HH) to be the most important factor in the prevention of HCAIs and the spread of pathogens.[3,4] The practice of effective HH plays a key role in the prevention of healthcare-associated sepsis.[5] Great efforts have been made to improve the performance of "My 5 moments for hand hygiene" among healthcare workers (HCWs), and this has had a global improvement. However, the role of patient hand hygiene (PHH) has been underestimated. Emerging evidence suggests that most infections occur as a result of bacteria present within a patient's own flora as well as bacteria present on surfaces within the healthcare environment;[6-8] improving the hand hygiene of patients has important clinical significance in reducing nosocomial infection, improving the quality of life of patients and reducing the rate of hospitalization and mortality.[9] The CDC has therefore proposed nine moments for patients to practice hand hygiene in clinical institutions.[10] However, PHH has been neglected in most medical institutions in China, there were no information provided for patient when they admitted. And also there were few studies have investigated PHH in China, with some of them only focusing on the role of patients as monitors or auditors in the improvement of HCW HH compliance.[11] Thus, the purpose of this cross-sectional study was to investigate inpatient

knowledge, as well as the attitudes towards and practice of PHH during hospital stay with non-provision of PHH information. We also aim to characterize and identify some factors influencing practice compliance, which may contribute to the design of effective patient hand hygiene promotion strategies.

## METHODS

This cross-sectional, single-center study was performed at a 3500-bed university-affiliated medical hospital between November 2017 and December 2017. The study was approved by the hospital's institutional review board (No. 201708955).

In this study, PHH was defined as HH practices performed by a patient on his or her own hands, including handwashing, and the use of alcohol-based hand rubs (ABHRs) and disinfecting wipes.[9] In certain situations, this care may have to be provided to patients by professional caregivers or family members.

### Participants

The study was conducted in 71 clinical wards, including the departments of internal medicine, surgery, obstetrics and gynecology, pediatrics and infectious diseases, and intensive care units (ICUs). Outpatient wards, operating rooms, psychiatric wards, isolation wards, and emergency rooms were excluded.

Patients were enrolled through a random sampling method using a random number table. Firstly, data on the number of beds in each ward were obtained from the hospital management

department, and a total of 3,000 of these beds met our inclusion criteria in terms of ward type. Secondly, according to the largest sample size formula of simple random sampling, with values of $\Pi = 0.5$, $\alpha = 0.05$, and $\delta = 0.05$, a total sample size of 385 was obtained. After correction, the required sample size was 342, but taking into consideration a no-response rate of 10%, a total of 376 patients were required. Finally, patients from each ward were randomly selected using an 8:1 proportion.

Hospitalized patients who provided verbal informed consent and agreed to voluntarily participate in this study were included. Exclusion criteria were: patients with an admission time less than 24 hours, patients who did not return to their bed due to surgery or transfer to the ICU, and those with mental status changes. Family members or caregivers were enrolled to provide patients' demographic information, attitude and the HH care they have provided to patients in the case of patients with impaired consciousness, who were critically ill, or who were under the age of 14 years. Only family members who stayed with the patients in the wards for more than 1 day were enrolled. Visitors, friends, and family members who had only short visits with the patients were excluded. The nurses who were in charge of the eligible patients were selected.

**Questionnaires**

In this study, the survey instrument was a self-designed structured questionnaire that was based on "When should you wash your hands" released by the CDC in 2016,[10] and the "Standard for hand hygiene for health care workers in health care settings" issued by the National Health

Commission of the People's Republic of China in 2009.[12] Experts from the Department of Infectious Diseases were also consulted in this regard. The questionnaire comprised two parts. The first part was designed to allow for the primary nurse to assess the elicited patient disease information, such as diagnosis, whether surgery was performed, or if there was any infection during the hospital stay.

The second part pertaining to PHH was designed for patients and their families or caregivers, and comprises 4 sections. Section 1 pertained to patients' demographic data, including ward type, bed number, place of residence, income, and number of hospitalizations. Section 2 pertained to caregiver information, such as if the respondent is a family member or caregiver, his/her relationship with the patient, length of hospital stay, education, and occupation. Section 3 addressed PHH knowledge and attitudes, while Section 4 evaluated patients' practice of HH, including handwashing moments, steps, number of wash times daily, minutes taken every time, and ways in which hands were dried. The PHH moments were scaled as 'seldom', 'sometimes', 'often', and 'always'. 'Not applicable' was selected for those who reported that they did not perform the procedure and therefore did not encounter that moment.

**Implementation**

The survey was conducted by eight research assistants, all of whom were team members who participated in all study meetings and discussions, who had knowledge on HH and its association with HCAI, and who had received unified training on how to fill out the

questionnaire. The research assistants first obtained approval from the head nurses in the study wards, and then obtained informed consent from the participants who were selected according to our design. Participants were informed that the questionnaire content would not involve invasive measurements or invade privacy, and would not cause injury to the body or mind. All eligible patients and their families/caregivers were informed that participation in the study was voluntarily, and that refusal to participate or withdrawal from the study at any point for any reason would not influence medical decisions. The participants were assured that their information would only be used for research and that strict confidentiality would be maintained, as well as that their data would not be used for business or other purposes without their permission. The questionnaires were distributed to patients who were agreed to voluntary participation in research, and were completed by respondents themselves under the instructions of researchers. The questionnaires were distributed and collected on the spot through SO JUMP (a professional online questionnaire platform). A small gift (a piece of soap) valued at approximately $0.50 was given to each respondent who completed the questionnaire.

**Patient and public involvement**

The current study did not include patient and public involvement.

**Statistical analysis**

Questionnaire data are presented as the number of participants and percentages. A Kruskal-Wallis H test was applied to analyze the PHH implementation rate in the different

departments. Binary logistic regression analysis was used to identify the demographic predictors for the respondents who had performed HH in the moment "after using the toilet, bedpan, or commode". Only those who responded "always" were included in the analysis. Univariate analysis by non-conditional logistic regression was used to compare each demographic variable in the different groups. Variables with a *P* value <.10 were further tested in the multivariate logistic regression analysis by the enter method. A 2-tailed *P* value of 0.05 was considered statistically significant.

## RESULTS

### Population characteristics

A total of 376 questionnaires were issued, and 310 respondents, including 242 patients (78.1%) and 68 family members/ caregivers (21.9%), completed the questionnaire. The total response rate was 82.4% (310 of 376). The Cronbach's alpha of the questionnaire is 0.867, which indicate a good reliability of this self-designed questionnaire. The respondents' characteristics are summarized in Table 1. A total of 46.8% of the participants were women, and most of them (86.8%) were married. The majority (79.7%) had a high school education or lower. More than half of the participants (64.5%) were urban or town dwellers, and a similar proportion (66.5%) had an annual income <50,000 RMB (~US$7,987). Most respondents (62.3%) had been hospitalized previously, and 27.7% reported having an infection at present.

### Patients' performance of hand hygiene and their knowledge and attitudes

Most of the participants (72.2%) reported that they did not know about HH knowledge or knew very little about it. Less than half (47.4%) of the respondents had received HH education before; of them, HCWs (95, 35.6%) and television (76, 28.5%) were the main resources. A majority (94.2%) of the participants believed that handwashing was important for disease recovery, and almost the same percentage (93.2%) of them believed that handwashing could prevent infection spread among patients.

More than half (62.2%) of the patients washed their hands less than 5 times a day, and approximately half (49.0%) of them spent less than 1 minute washing their hands every time. Washing hands under flowing water (64.7%) was the main route of washing, compared to washing in a basin or using ABHRs; however, only 13.4% and 25.6% of the patients used hand sanitizers and soap, respectively. A total of 41.9% of the respondents reported that they had a dedicated hand towel, but only 20.0% and 21.6%, respectively, chose a dedicated hand towel or tissue to wipe their hands (Table 2).

**Patients' practice of the '7 steps to handwashing'**

The results of patients' practice of the '7 steps to handwashing' are displayed in Supplemental figure 1. Most respondents washed their hands with adherence to the first step (rub palms together: 96.45%, 299 of 310). More than half of them practiced the second step (rub the back of both hands: 66.13%, 205 of 310) and third step (interlace fingers and rub hands together: 66.77%, 207 of 310). A slightly lower number of participants (56.77%, 176 of 310) adhered to

the seventh step (rub both wrists in a rotating manner). The implementation rates of the fourth step (interlock fingers and rub the back of fingers of both hands: 26.77%, 83 of 310), and sixth step (rub fingers on palm for both hands: 20.65%, 64 of 310) were lower. However, the fifth step (rub thumb in a rotating manner followed by the area between index finger and thumb for both hands) had the worst execution rate (17.74%, 55 of 310).

**Patient hand hygiene moments**

Three-quarters (75.8%; 235 of 310) of the respondents washed their hands after using the toilet/bedpan/commode, and 86.1% washed their hands when they were visibly dirty (Table 3). Approximately half (47.7%) of the patients washed their hands before touching any breaks in the skin, whereas the implementation rates before any care procedures (19.0%, 59 of 310) and dialysis/contact with IV lines or other tubes (19.7%, 61 of 310) were low. The performance of handwashing before drinking fluids (11.0%, 34 of 310), as well as before and after interacting with visitors (11.9%, 37 of 310 vs 13.2%, 41 of 310) was also very low.

**Patient hand hygiene moments in different departments**

Participants in the Department of Internal Medicine had a relatively high execution rate of HH when their hands were visibly dirty (96.4%, 106 of 110), before eating (82.7%, 91 of 110), and before touching any breaks in the skin (71.8%, 79 of 110). Those in the Department of Surgery tended to wash their hands after using the toilet/bedpan/commode (94.4%, 136 of 144) and after coughing, sneezing, or touching the nose or mouth (50.7%, 73 of 144). Those in the

Department of Infectious Diseases had good performance rates of handwashing before interacting with visitors (40.0%, 6 of 15) (Table 4). There were significant differences in this regard between the different departments in the Kruskal-Wallis H test (H=19.838, P=0.001).

**Significant predictors of PHH moments**

A majority of the respondents (75.8%, 235 of 310) "Always" performed HH after using the toilet/ bedpan/commode (Table 5), and the univariate analysis identified one significant predictor: very few ICU patients practiced HH compared to medical patients (odds ratio [OR]= 0.08, 95% confidence interval [CI]: 0.02-0.41, *P* = 0.002). In the multivariate analysis, we found two significant variables: being a farmer rather than a clerk (adjusted OR= 0.18, 95% CI: 0.05-0.61, P =0.004) and being a freelancer (adjusted OR=0.18, 95% CI: (0.05-0.62, P =0.007). Medical patients had a higher HH performance rate than those in the Department of Obstetrics-Gynecology (adjusted OR= 0.18, 95% CI: 0.04-0.80, P =0.02) and ICU (adjusted OR= 0.06, 95% CI: 0.01-0.45, P =0.006).

**DISCUSSION**

In the present study, we examined hospitalized patients' knowledge of, attitudes towards, and practice of HH. Our findings demonstrate that although patients had a positive attitude towards HH, their knowledge was insufficient, consisting with Cheng VC et al's research[13]. The social desirability factor might be operating, the hospital we involved attaches great importance to HCW HH and has implemented the WHO's multimodal HH improvement

strategies;[14] therefore, the participants were in an atmosphere in which the importance of HH is highlighted daily, leading them to believe in its importance. However, due to non-provision of any PHH information in daily life, nor in hospital after admitted, they were unaware of when and how to wash their hands in clinical practice.

Patients' performance of HH is poor, and the existing facilities and products are routinely underutilized, consistent with the findings of previous studies.[15] Although the WHO's multimodal HH improvement strategies have been implemented by our hospital's Infection Control Committee with the provision of sinks and wash basins for the performance of soap-and-water cleaning in every patient's room, and the provision of ABHR for waterless hand cleaning in the rooms and corridors for all HCWs and patients,[14] the frequency and duration of handwashing were not satisfactory in this study. A systematical education about PHH seems necessary, not only for medical staff, but also for patients themselves. It is of great significance for patients to realize their own behavior for the prevention and control of nosocomial infection and the promotion of their own safety. Staff should receive education on the importance of PHH in the prevention of hospital-acquired infection; and staff need to be instructed to provide verbal PHH education to all newly admitted patients, and to provide reminders, assistance, and encouragement for PHH practice.[16-17] In addition, it is also important to ensure that HH products—such as alcohol-based hand wipes or ABHR—are accessible to patients who are

bedridden and are unable to get to the sink.[18,19] Staff or family members should be instructed to provide assistance to improve PHH opportunities.[18]

Hands were washed most frequently when they were visibly dirty and after using the toilet, but less frequently before drinking fluids and taking medicine, which would be the optimal time for the prevention of fecal-oral transmission. In this study, 75.8% of the participants washed their hands after using the toilet/bedpan/commode, but only 11.0% of them washed their hands before drinking fluids. Similar results have been observed in other study on patients in transplant units.[20] Hospital environments are often contaminated with hospital-acquired pathogens,[16-18] therefore, there is a need for education campaigns aimed at patient-initiated HH and HH that is directly observed before meals and the intake of medications during hospitalization.[21,22]

Our results also revealed that only 11.9% of the patients washed their hands before interacting with visitors and 13.2% washed their hands after the visitors left. Visitors may be vectors of pathogenic organisms that are potentially dangerous, particularly to immunocompromised patients.[23] If visitors carry certain pathogenic organisms on their hands and do not perform HH upon entry to the hospital, vulnerable patient populations may be at an increased risk for infection if they do not wash their hands after the visitors leave.[24] Thus, to win the battle against HCAIs, there is a need for coordinated effort to enforce HH that includes patients, as well as their families, and visitors.[25] In addition to providing better signage and education among care providers[26,27], other hospital approaches, such as the installation of more

strict visiting infrastructure (i.e., ICU doors that will not open if ABHR is not used) might be considered.[23]

This study resulted in some significant findings. patients' performance about PHH are differences in different departments. Patients in 'Medical department' showed significantly higher PHH performance compared with those in 'Department of Obstetrics/ Gynecology'. Patients activity and severity of illness may be working, patients in 'medical department' are mostly treated conservatively, their activity are less restricted than those in 'Department of Obstetrics/ Gynecology', who may need absolute bed rest because of gynecological surgery or give birth to a child just now; In addition, chinese traditional concept may be another factor, which holds that women should not be exposed to cold water after surgery or after childbirth, which may also reduce the practice of hand washing.

The most significant findings being that ICU patients rarely practice HH compared to those in other departments. This is not surprising as patients in the ICU are generally critically ill or unconsciousness, they cannot wash their hands by themselves. Even the assistance of professional caregivers does not seem to work. This suggests the importance of the role of caregivers in ensuring adequate HH in such functionally dependent patients. To the best of our knowledge, this study is the first to provide data on ICU PHH, since most previous studies on ICU HH focused on HCWs or patients' families.[23,28] Considering that multidrug-resistant acinetobacter baumannii infection are highly in ICU [29] and ICU patients are the most susceptible

populations to nosocomial infections,[30] attention must be given to improving their adherence to HH rules to reduce hospital infections.

Our study also identified occupation such as 'farmer' showed good PHH performance compared with 'clerk' or 'freelancer'. We did not found the similar findings in other studies, the reasons for which may be need to be further explored.

Our study has several limitations. First, since this is a single-center cross-sectional survey, our results may not be applicable to all other institutions. Thus, it is recommended that a multi-center study with a large sample size be conducted in the future. Second, our inclusion of certain patients and wards may have resulted in selection bias. Physically weak patients were also recruited in the present study, and their families or caregivers filled out the questionnaire; therefore, there is a possibility that the family members of caregivers may have provided information on their own HH situation rather than that of the patients. Therefore, there is a need for further observational studies including quantitative hand bacterial cultures to verify the results of this study. Nonetheless, we believe that this study included a representative sample of inpatients. Third, the study was conducted using a convenience sampling method in the category of family members. Finally, although the survey findings are interesting, the patients appear to know that HH is important even though they know little about HH knowledge, the social desirability factor might be operating, the results are not an indicator of how patients may actually behave in real life.

## CONCLUSIONS

In conclusion, this study demonstrated that patients had a positive attitude towards HH. However, their levels of knowledge and practice were unsatisfactory. These results suggest that A systematical education about PHH is needed in future to correct this knowledge and behavior. In addition, special attention should be given to those HH moments the compliance rates to which were the lowest, such as before drinking fluids, as well as before interacting with visitors and after they leave.

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## Footnotes

**Contributors:** LYX and YSE contributed to the study conception and design, data collection, analysis, interpretation and drafting the manuscript. LYH and ZL contributed to questionnaire design and data collection. LYH and CC contributed to the data collection and data management. MD contributed to the study design, data acquisition and interpretation. All authors contributed to drafting the manuscript and critically revised the manuscript and approved the final version.

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**Table 1** Demographic characteristics of the 310 patients and their family members or caregivers.

| Characteristic | Participants (%) |
|---|---|
| Identity | |
| Patient | 242 (78.1) |
| Family members/caregivers | 68 (21.9) |
| Sex | |
| Female | 145 (46.8) |
| Male | 165 (53.2) |
| Age, years | |
| <30 | 57 (18.4) |
| 30-39 | 34 (11.0) |
| 40-49 | 56 (18.1) |
| 50-59 | 72 (23.2) |
| ≥60 | 91 (29.4) |
| Education level | |
| Primary or below | 77 (24.8) |
| Junior high school | 88 (28.4) |
| Senior high school | 62 (20.0) |
| Technical secondary school | 20 (6.5) |
| College | 34 (11.0) |
| Undergraduate | 28 (9.0) |
| Postgraduate or above | 1 (0.3) |
| Occupation | |
| Farmer | 67 (21.6) |
| Workman | 27 (8.7) |
| Clerk | 47 (15.2) |
| Medical staff | 2 (0.6) |
| Teacher | 3 (1.0) |
| Student | 13 (4.2) |
| Freelancer | 34 (11.0) |
| Unemployed | 45 (14.5) |
| Retiree | 72 (23.2) |
| Place of residence | |
| Urban | 147 (47.4) |
| Town | 53 (17.1) |
| Village | 110 (35.5) |
| Income (RMB/year)† | |
| <50,000 | 206 (66.5) |

| | |
|---|---|
| 50,000~100,000 | 80（25.8） |
| 100,000~200,000 | 18（5.8） |
| >200,000 | 6（1.9） |
| Number of hospitalizations | |
| 1 | 117（37.7） |
| 2 | 74（23.9） |
| ≥3 | 119（38.4） |
| The length of hospital stay at the time the questionnaire was completed (days) | |
| 1-3 | 67（21.6） |
| 4-6 | 107（34.5） |
| 7-9 | 49（15.8） |
| 10-13 | 51（16.5） |
| ⩾14 | 36（11.6） |
| Ward | |
| Medical ward | 110（35.5） |
| Surgical ward | 144（46.5） |
| Obstetrics/gynecology ward | 23（7.4） |
| Pediatric ward | 9（2.9） |
| Infectious diseases ward | 15（4.8） |
| Intensive care unit | 9（2.9） |
| Was surgery performed this time? | |
| Yes | 132（42.6） |
| No | 178（57.4） |
| Is there any infection? | |
| Yes | 86（27.7） |
| No | 224（72.3） |

*† 50,000 RMB ≈ US$7,209*

**Table 2** Performance of hand hygiene and knowledge and attitudes among the 310 patients and their family members or caregivers.

| Items | Total n(%) |
|---|---|
| Knowledge and attitude | |
| Have you received any education related to hand hygiene? | |
| Yes | 147（47.4） |
| No | 163（52.6） |
| Hand hygiene knowledge sources | |
| Television | 76 (28.5) |
| Newspaper | 20 (7.5) |
| Magazine | 18 (6.7) |
| Internet | 37 (13.9) |
| Medical staff | 95 (35.6) |
| Other | 21 (7.9) |
| Do you know anything about hand hygiene? | |
| Don't know | 126（40.6） |
| A little | 98（31.6） |
| Most | 44（14.2） |
| All | 42（13.5） |
| Is handwashing important for recovery from disease? | |
| Yes | 292（94.2） |
| No | 18（5.8） |
| Can handwashing prevent infection in patients? | |
| Yes | 289（93.2） |
| No | 21（6.8） |
| **Performance** | |
| How many times do you wash your hands every day? | |
| ≤2 | 48（15.5） |
| 3~5 | 145（46.8） |
| 6~10 | 69（22.3） |
| >10 | 48（15.5） |
| How long does it take to wash your hands every time? | |
| <1 min | 152（49.0） |
| 1~2 min | 135（43.5） |
| ≥2 min | 23（7.4） |
| Handwashing ways† | |
| Wash basin | 560(18.9) |
| Flowing water | 1913(64.7) |

| | |
|---|---|
| Alcohol-based hand rub | 484(16.4) |
| Handwashing products† | |
| Tap water only | 1797(46.6) |
| Hand sanitizer | 516(13.4) |
| Soap | 987(25.6) |
| Alcohol-based hand rub | 555(14.4) |
| Ways in which you wipe your hands† | |
| Hand towel | 976(20.0) |
| Any towel | 819(17.5) |
| Disposable tissues | 1012(21.6) |
| Clothes on my body | 410(8.8) |
| Wave hands in the air | 873(18.7) |
| Face towel | 588(12.6) |
| Do you have a dedicated hand towel? | |
| Yes | 130（41.9） |
| No | 180（58.1） |
| Times of hand towel washes every day | |
| 0 | 10(7.7) |
| 1 | 32(24.6) |
| 2 | 29(22.3) |
| 3 | 25(19.2) |
| 4 | 27(20.8) |
| Wash once every few days | 7(5.4) |

† ‘Handwashing ways’, ‘Handwashing products’, and ‘Ways in which you wipe your hands’ these three items are multiple topics, so each number of respondents is over the total number of respondents.

**Table 3** Patient hand hygiene moments.

| Moments | Seldom n(%) | Sometimes n(%) | Often n(%) | Always n(%) | Not applicable† |
|---|---|---|---|---|---|
| 1. After using the toilet, bedpan, or commode | 21(6.8) | 15(4.8) | 39(12.6) | 235(75.8) | 0(0.0) |
| 2. When returning to the room after a test or procedure | 91(29.4) | 43(13.8) | 54(17.4) | 120(38.7) | 0(0.0) |
| 3. Before eating | 41(13.2) | 37(11.9) | 68(21.9) | 164(52.9) | 0(0.0) |
| 4. Before drinking fluids | 160(51.6) | 63(20.3) | 53(17.1) | 34(11.0) | 0(0.0) |
| 5. Before taking medicine | 130(41.9) | 49(15.8) | 62(20.0) | 66(21.3) | 3(0.9) |
| 6. When visibly dirty | 11(3.5) | 9(2.9) | 23(7.4) | 267(86.1) | 0(0.0) |
| 7. Before touching any breaks in the skin (e.g., wounds, dressing, tubes) | 56(18.1) | 36(11.6) | 61(19.7) | 147(47.4) | 10(3.1) |
| 8. Before any care procedures (e.g., dialysis, IV‡ drug administration, injections) | 145(46.8) | 54(17.4) | 52(16.8) | 59(19.0) | 0(0.0) |
| 9. Before dialysis, contact with IV lines or other tubes | 139(44.8) | 60(19.4) | 44(14.2) | 61(19.7) | 6(1.9) |
| 10. After coughing, sneezing, or touching nose or mouth | 102(32.9) | 61(19.7) | 61(19.7) | 86(27.7) | 0(0.0) |
| 11. Before interacting with visitors | 198(63.8) | 37(11.9) | 38(12.3) | 37(11.9) | 0(0.0) |
| 12. After visitors leave | 190(61.3) | 46(14.8) | 33(10.6) | 41(13.2) | 0(0.0) |
| 13. When there is concern about whether hands are clean | 78(25.1) | 57(18.4) | 83(26.8) | 87(28.1) | 5(1.5%) |

† "Not applicable" represents patients who reported that they did not perform the procedure and therefore did not encounter that moment.

‡ "IV" intravenous.

**Table 4** Patients who "always" or "often" practiced hand hygiene in the different departments.

| Moments | Medical Wards n/N(%) | Surgical Wards n/N(%) | Obstetrics/ gynecology wards n/N(%) | Pediatric wards n/N(%) | Infectious diseases wards n/N(%) | ICU† n/N(%) | Total n/N(%) |
|---|---|---|---|---|---|---|---|
| 1.After using the toilet, bedpan, or commode | 99/110(90.0) | 136/144(94.4) | 19/23(82.6) | 7/9(77.8) | 10/15(66.7) | 3/9(33.3) | 274/310(88.4) |
| 2.When returning to the room after a test or procedure | 71/110(64.5) | 75/144(52.1) | 12/23(52.2) | 7/9(77.8) | 7/15(46.7) | 2/9(22.2) | 174/310(56.1) |
| 3.Before eating | 91/110(82.7) | 108/144(75.0) | 15/23(65.2) | 7/9(77.8) | 9/15(60.0) | 2/9(22.2) | 232/310(74.8) |
| 4.Before drinking fluids | 35/110(31.8) | 38/144(26.4) | 4/23(17.4) | 4/9(44.4) | 5/15(33.3) | 1/9(11.1) | 87/310(28.1) |
| 5.Before taking medicine | 45/110(40.9) | 59/144(41.0) | 12/23(52.2) | 6/9(66.7) | 4/15(26.7) | 2/9(22.2) | 128/310(41.3) |
| 6.When visibly dirty | 106/110(96.4) | 138/144(95.8) | 22/23(95.7) | 7/9(77.8) | 12/15(80.0) | 5/9(55.6) | 290/310(93.5) |
| 7.Before touching any breaks in the skin (e.g., wounds, dressing, tubes) | 79/110(71.8) | 98/144(68.1) | 15/23(65.2) | 5/9(55.6) | 9/15(60.0) | 2/9(22.2) | 75/310(24.2) |
| 8.Before any care procedures (e.g., dialysis, IV‡ drug administration, injections) | 41/110(37.3) | 51/144(35.4) | 8/23(34.8) | 4/9(44.4) | 5/15(33.3) | 2/9(22.2) | 111/310(35.8) |
| 9.Before dialysis, contact with IV lines or other tubes | 37/110(33.6) | 49/144(34.0) | 9/23(39.1) | 4/9(44.4) | 4/15(26.7) | 2/9(22.2) | 105/310(33.9) |
| 10.After coughing, sneezing, or touching the nose or mouth | 51/110(46.4) | 73/144(50.7) | 10/23(43.5) | 4/9(44.4) | 7/15(46.7) | 2/9(22.2) | 147/310(47.4) |
| 11.Before interacting with visitors | 23/110(20.9) | 34/144(23.6) | 8/23(34.8) | 3/9(33.3) | 6/15(40.0) | 1/9(11.1) | 75/310(24.2) |
| 12.After visitors leave | 25/110(22.7) | 32/144(22.2) | 5/23(21.7) | 4/9(44.4) | 6/15(40.0) | 2/9(22.2) | 74/310(23.9) |
| 13.When there is concern about whether hands are clean | 66/110(60.0) | 72/144(50.0) | 13/23(56.5) | 6/9(66.7) | 9/15(60.0) | 4/9(44.4) | 170/310(54.8) |
| Kruskal-Wallis H | 574.47 | 556.01 | 548.99 | 669.5 | 535.47 | 196.56 | 19.838 |
| *P*-value | | | | | | | 0.001 |

† ICU, intensive care unit; ‡ IV, intravenous.

**Table 5** Identity of participants who "always" performed hand hygiene after using the toilet, bedpan, or commode using the characteristics of the patients and their family members of caregivers.

| Characteristic | "Always" perform hand hygiene n/N (%) | Unadjusted OR† | | Adjusted OR | |
|---|---|---|---|---|---|
| | | OR (95%CI‡) | *P*-value | OR (95% CI) | *P*-value |
| Identity | | | | | |
| Patient | 186/242(76.9) | 1 | | | |
| Family members/caregivers | 49/68(72.1) | 0.78(0.42-1.43) | 0.42 | | |
| Sex | | | | | |
| Male | 125/165(75.8) | 1 | | | |
| Female | 110/145(75.9) | 0.99(0.59-1.67) | 0.98 | | |
| Age, years | | | | | |
| <30 | 39/57(68.4) | 1 | | | |
| 30-39 | 28/34(82.4) | 2.15(0.76-6.12) | 0.15 | | |
| 40-49 | 43/56(76.8) | 1.53(0.66-3.52) | 0.32 | | |
| 50-59 | 54/72(75.0) | 1.39(0.64-3.00) | 0.41 | | |
| ≥60 | 71/91(78.9) | 1.64(0.78-3.46) | 0.20 | | |
| Education level | | | | | |
| Primary or below | 59/77(76.6) | 1 | | | |
| Junior high school | 59/88(67.0) | 0.62(0.31-1.24) | 0.18 | | |
| Senior high school | 51/62(82.3) | 1.41(0.61-3.27) | 0.42 | | |
| Technical secondary school | 14/20(70.0) | 0.71(0.24-2.12) | 0.54 | | |
| College | 28/34(82.4) | 1.42(0.51-3.98) | 0.50 | | |
| Undergraduate | 23/28(82.1) | 1.40(0.47-4.22) | 0.55 | | |
| Postgraduate or above | 1/1(100) | / | 1.00 | | |
| Occupation | | | | | |
| Farmer | 56/67(83.6) | 1 | | 1 | |
| Workman | 23/27(85.2) | 1.13(0.33-3.92) | 0.85 | 0.85(0.21-3.39) | 0.82 |
| Clerk | 34/47(72.3) | 0.51(0.21-1.28) | 0.15 | 0.18(0.05-0.61) | 0.006 |

| | | | | | |
|---|---|---|---|---|---|
| Medical staff | 2/2(100) | / | 1.00 | / | 1.00 |
| Teacher | 2/3(66.7) | 0.39(0.03-4.72) | 0.46 | 0.15(0.01-2.26) | 0.17 |
| Student | 8/13(61.5) | 0.31(0.09-1.14) | 0.08 | 0.22(0.04-1.24) | 0.09 |
| Freelancers | 23/34(67.6) | 0.41(0.16-1.08) | 0.07 | 0.18(0.05-0.62) | 0.007 |
| Unemployed | 34/45(75.6) | 0.61(0.24-1.55) | 0.30 | 0.58(0.21-1.61) | 0.29 |
| Retiree | 53/72(73.6) | 0.55(0.24-1.26) | 0.16 | 0.36(0.12-1.08) | 0.07 |
| Place of residence | | | | | |
| Urban | 117/147(79.6) | 1 | | | |
| Town | 37/53(69.8) | 0.59(0.29-1.21) | 0.15 | | |
| Village | 81/110(73.6) | 0.72(0.40-1.28) | 0.26 | | |
| Income (RMB/year) | | | | | |
| <50,000 | 153/206(74.3) | 1 | | | |
| 50,000~100,000 | 61/80(76.3) | 1.11(0.61-2.03) | 0.73 | | |
| 100,000~200,000 | 16/18(88.9) | 2.77(0.62-12.46) | 0.18 | | |
| >200,000 | 5/6(83.3) | 1.73(0.20-15.16) | 0.62 | | |
| Number of hospitalizations | | | | | |
| 1 | 87/117(74.4) | 1 | | | |
| 2 | 59/74(79.7) | 1.36(0.67-2.74) | 0.40 | | |
| ≥3 | 89/119(74.8) | 1.02(0.57-1.84) | 0.94 | | |
| The length of hospital stay at the time the questionnaire was completed (days) | | | | | |
| 1-3 | 22/67(32.8) | 1 | | | |
| 4-6 | 32/107(29.9) | 0.87(0.45-1.68) | 0.69 | | |
| 7-9 | 13/49(26.5) | 0.74(0.33-1.67) | 0.47 | | |
| 10-13 | 15/51(29.4) | 0.85(0.39-1.88) | 0.69 | | |
| ⩾14 | 9/36(25.0) | 0.68(0.27-1.70) | 0.41 | | |
| Ward | | | | | |
| Medical ward | 86/110(78.2) | 1 | | 1 | |
| Surgical ward | 117/144(81.3) | 1.21(0.65-2.24) | 0.55 | 1.27(0.58-2.80) | 0.55 |
| Obstetrics/gynecology ward | 14/23(60.9) | 0.43(0.17 -1.13) | 0.09 | 0.18(0.04-0.80) | 0.02 |

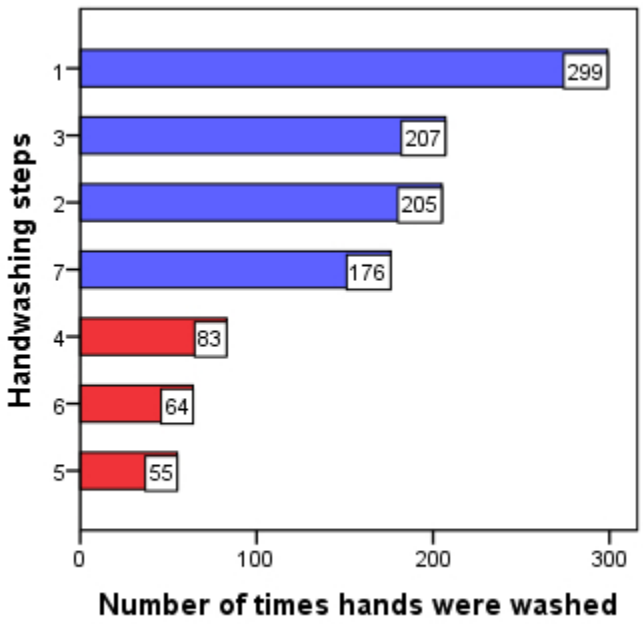
| | | | | | |
|---|---|---|---|---|---|
| Pediatric ward | 6/9(66.7) | 0.56(0.13-3.40) | 0.43 | 0.95(0.12-7.39) | 0.96 |
| Infectious diseases ward | 10/15(66.7) | 0.56(0.17-1.79) | 0.33 | 0.51(0.13-2.04) | 0.34 |
| ICU§ | 2/9(22,2) | 0.08(0.02-0.41) | 0.002 | 0.06(0.01-0.45) | 0.006 |
| Was surgery performed this time? | | | | | |
| No | 135/178(75.8) | 1 | | | |
| Yes | 100/132(75.8) | 1.01(0.59-1.70) | 0.99 | | |
| Is there any infection? | | | | | |
| No | 171/224(76.3) | 1 | | | |
| Yes | 64/86(74.4) | 1.11(0.63-1.97) | 0.72 | | |

† OR, odds ratio; ‡ CI, confidence interval; § ICU, intensive care unit.

## Figure legends

**Supplemental figure 1. Seven-steps to handwashing**

1. Rub palms together
2. Rub the back of both hands
3. Interlace fingers and rub hands together
4. Interlock fingers and rub the back of fingers of both hands
5. Rub thumb in a rotating manner followed by the area between index finger and thumb for both hands
6. Rub fingers on palm for both hands
7. Rub both wrists in a rotating manner

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**Supplementary File 1**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1-2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 4-5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 6-7 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | *6-8* |
| Bias | 9 | Describe any efforts to address potential sources of bias | 6,7,8 |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 8-9 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 9 |
| | | (*c*) Explain how missing data were addressed | 9 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | 9 |
| | | (*e*) Describe any sensitivity analyses | 9 |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 9 |
| | | (b) Give reasons for non-participation at each stage | 9 |
| | | (c) Consider use of a flow diagram | 9 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 9 |
| | | (b) Indicate number of participants with missing data for each variable of interest | 9 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 9 |

| | | | |
|---|---|---|---|
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 10,11,12 |
| | | (*b*) Report category boundaries when continuous variables were categorized | 10,11 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | 12 |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 12 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 12 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 16 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 12-16 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 16 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 18 |

BMJ Open

# Knowledge and Practice of Hand Hygiene Among Hospitalized Patients in a Tertiary General Hospital in China and Their Attitudes: A Cross-Sectional Survey



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| | |

# Knowledge and Practice of Hand Hygiene Among Hospitalized Patients in a Tertiary General Hospital in China and Their Attitudes: A Cross-Sectional Survey

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## Abstract

**Objectives:** We aimed to gain a better understanding of patients' practice of hand hygiene and their knowledge and attitudes.

**Design:** A Cross-Sectional Survey.

**Setting:** A 3500-bed university-affiliated medical hospital in China.

**Participants:** Inpatients and their family members or caregivers.

**Methods:** An anonymous, self-reported questionnaire were used to collect data.

**Results:** A total of 376 questionnaires were issued, and 310 respondents completed it. Of the 310 respondents, 47.4% had received hand hygiene education, and 13.5% had a completing understanding of hand hygiene. A majority of patients believed that handwashing was important for disease recovery, and that it could prevent infection development. A total of 62.3% of patients washed their hands less than 5 times a day and 49.0% spent less than 1 minute every time. With regards to the seven steps of handwashing, 96.45% of the respondents adhered to the first step (washing the palms), but only 20.6% adhered to the fifth step (thumbs) and 17.7% to the sixth step (fingertips). Most respondents washed their hands only when visibly dirty. Few patients washed their hands before drinking fluids, and before and after interacting with visitors. Hand hygiene compliance was lower among ICU patients than medical patients.

**Conclusions:** In conclusion, this study demonstrated that patients had a positive attitude towards hand hygiene. However, their levels of knowledge and practice were unsatisfactory. A

systematical education about patient hand hygiene is needed in future to correct this knowledge and behavior.

**Keywords:** Patient hand hygiene, Inpatient, Health care-associated infection, China

**Strengths and limitations of this study**

- We measured the hand hygiene knowledge, attitude, and performance from the prospects of patient view.
- We designed the questionnaire combines both WHO and CDC patient hand hygiene related policies.
- A stratified random sampling method was used in order to make the sample representative.
- This is a single-center cross-sectional survey, our results may not be applicable to all other institutions.
- There is a need for further observational studies including quantitative hand bacterial cultures to verify the results of this study.

## INTRODUCTION

Health care-associated infections (HCAIs) are major risk factors for the development of sepsis,[1] which affects more than 30 million patients every year worldwide, leading to 6 million potential deaths.[2] Both the Centers for Disease Control and Prevention (CDC) and World Health Organization (WHO) consider hand hygiene (HH) to be the most important factor in the prevention of HCAIs and the spread of pathogens.[3,4] The practice of effective HH plays a key role in the prevention of health-care-associated sepsis.[5] Great efforts have been made to improve the performance of "My 5 moments for hand hygiene" among health-care workers (HCWs), and this has had a global improvement. However, the role of patient hand hygiene (PHH) has been underestimated. Emerging evidence suggests that most infections occur as a result of bacteria present within a patient's own flora as well as bacteria present on surfaces within the health-care environment;[6-8] improving the hand hygiene of patients has important clinical significance in reducing nosocomial infection, improving the quality of life of patients and reducing the rate of hospitalization and mortality.[9] The CDC has therefore proposed nine moments for patients to practice hand hygiene in clinical institutions.[10] However, PHH has been neglected in most medical institutions in China, there were no information provided for patient when they admitted. And also there were few studies have investigated PHH in China, with some of them only focusing on the role of patients as monitors or auditors in the improvement of HCW HH compliance.[11] Thus, the purpose of this cross-sectional study was to investigate inpatient

knowledge, as well as the attitudes towards and practice of PHH during hospital stay with non-provision of PHH information. We also aim to characterize and identify some factors influencing practice compliance, which may contribute to the design of effective patient hand hygiene promotion strategies.

## METHODS

This cross-sectional, single-center study was performed at a 3500-bed university-affiliated medical hospital between November 2017 and December 2017. The study was approved by the hospital's institutional review board (No. 201708955).

In this study, PHH was defined as HH practices performed by a patient on his or her own hands, including handwashing, and the use of alcohol-based hand rubs (ABHRs) and disinfecting wipes.[9] In certain situations, this care may have to be provided to patients by professional caregivers or family members.

### Participants

The study was conducted in 71 clinical wards, including the departments of internal medicine, surgery, obstetrics and gynecology, pediatrics and infectious diseases, and intensive care units (ICUs). Outpatient wards, operating rooms, psychiatric wards, isolation wards, and emergency rooms were excluded.

Patients were enrolled through a random sampling method using a random number table. Firstly, data on the number of beds in each ward were obtained from the hospital management

department, and a total of 3,000 of these beds met our inclusion criteria in terms of ward type. Secondly, according to the largest sample size formula of simple random sampling, with values of $\Pi = 0.5$, $\alpha = 0.05$, and $\delta = 0.05$, a total sample size of 385 was obtained. After correction, the required sample size was 342, but taking into consideration a no-response rate of 10%, a total of 376 patients were required. Finally, patients from each ward were randomly selected using an 8:1 proportion.

Hospitalized patients who provided verbal informed consent and agreed to voluntarily participate in this study were included. Exclusion criteria were: patients with an admission time less than 24 hours, patients who did not return to their bed due to surgery or transfer to the ICU, and those with mental status changes. Family members or caregivers were enrolled to represent patients to provide patients' demographic information, attitude and the HH care they have provided to patients in the case of patients with impaired consciousness, who were critically ill, or who were under the age of 14 years. Only family members who stayed with the patients in the wards for more than 1 day were enrolled. Visitors, friends, and family members who had only short visits with the patients were excluded. The nurses who were in charge of the eligible patients were selected.

**Questionnaires**

In this study, the survey instrument was a self-designed structured questionnaire that was based on "When should you wash your hands" released by the CDC in 2016,[10] and the "Standard

for hand hygiene for health care workers in health care settings" issued by the National Health Commission of the People's Republic of China in 2009.[12] Experts from the Department of Infectious Diseases were also consulted in this regard. The questionnaire comprised two parts. The first part was designed to allow for the primary nurse to assess the elicited patient disease information, such as diagnosis, whether surgery was performed, or if there was any infection during the hospital stay.

The second part pertaining to PHH was designed for patients and their families or caregivers, and comprises 4 sections. Section 1 pertained to patients' demographic data, including ward type, bed number, place of residence, income, and number of hospitalizations. Section 2 pertained to caregiver information, such as if the respondent is a family member or caregiver, his/her relationship with the patient, length of hospital stay, education, and occupation. Section 3 addressed PHH knowledge and attitudes, while Section 4 evaluated patients' practice of HH, including handwashing moments, steps, number of wash times daily, minutes taken every time, and ways in which hands were dried. The PHH moments were scaled as 'seldom', 'sometimes', 'often', and 'always'. 'Not applicable' was selected for those who reported that they did not perform the procedure and therefore did not encounter that moment.

**Implementation**

The survey was conducted by eight research assistants, all of whom were team members who participated in all study meetings and discussions, who had knowledge on HH and its

association with HCAI, and who had received unified training on how to fill out the questionnaire. The research assistants first obtained approval from the head nurses in the study wards, and then obtained informed consent from the participants who were selected according to our design. Participants were informed that the questionnaire content would not involve invasive measurements or invade privacy, and would not cause injury to the body or mind. All eligible patients and their families/caregivers were informed that participation in the study was voluntarily, and that refusal to participate or withdrawal from the study at any point for any reason would not influence medical decisions. The participants were assured that their information would only be used for research and that strict confidentiality would be maintained, as well as that their data would not be used for business or other purposes without their permission. The questionnaires were distributed to patients who were agreed to voluntary participation in research, and were completed by respondents themselves under the instructions of researchers. The questionnaires were distributed and collected on the spot through SO JUMP (a professional online questionnaire platform). A small gift (a piece of soap) valued at approximately $0.50 was given to each respondent who completed the questionnaire.

**Patient and public involvement**

The current study did not include patient and public involvement.

**Statistical analysis**

Questionnaire data are presented as the number of participants and percentages. A Kruskal-Wallis H test was applied to analyze the PHH implementation rate in the different departments. Binary logistic regression analysis was used to identify the demographic predictors for the respondents who had performed HH in the moment "after using the toilet, bedpan, or commode". Only those who responded "always" were included in the analysis. Univariate analysis by non-conditional logistic regression was used to compare each demographic variable in the different groups. Variables with a *P* value <.10 were further tested in the multivariate logistic regression analysis by the enter method. A 2-tailed *P* value of 0.05 was considered statistically significant.

## RESULTS

### Population characteristics

A total of 376 questionnaires were issued, and 310 respondents, including 242 patients (78.1%) and 68 family members/ caregivers (21.9%), completed the questionnaire. The total response rate was 82.4% (310 of 376). The Cronbach's alpha of the questionnaire is 0.867, which indicate a good reliability of this self-designed questionnaire. The respondents' characteristics are summarized in Table 1. A total of 46.8% of the participants were women, and most of them (86.8%) were married. The majority (79.7%) had a high school education or lower. More than half of the participants (64.5%) were urban or town dwellers, and a similar proportion

(66.5%) had an annual income <50,000 RMB (~US$7,987). Most respondents (62.3%) had been hospitalized previously, and 27.7% reported having an infection at present.

**Patients' performance of hand hygiene and their knowledge and attitudes**

Most of the participants (72.2%) reported that they did not know about HH knowledge or knew very little about it. Less than half (47.4%) of the respondents had received HH education before; of them, HCWs (95, 35.6%) and television (76, 28.5%) were the main resources. A majority (94.2%) of the participants believed that handwashing was important for disease recovery, and almost the same percentage (93.2%) of them believed that handwashing could prevent infection spread among patients.

More than half (62.2%) of the patients washed their hands less than 5 times a day, and approximately half (49.0%) of them spent less than 1 minute washing their hands every time. Washing hands under flowing water (64.7%) was the main route of washing, compared to washing in a basin or using ABHRs; however, only 13.4% and 25.6% of the patients used hand sanitizers and soap, respectively. A total of 41.9% of the respondents reported that they had a dedicated hand towel, but only 20.0% and 21.6%, respectively, chose a dedicated hand towel or tissue to wipe their hands (Table 2).

**Patients' practice of the '7 steps to handwashing'**

The results of patients' practice of the '7 steps to handwashing' are displayed in Supplemental figure 1. Most respondents washed their hands with adherence to the first step (rub

palms together: 96.45%, 299 of 310). More than half of them practiced the second step (rub the back of both hands: 66.13%, 205 of 310) and third step (interlace fingers and rub hands together: 66.77%, 207 of 310). A slightly lower number of participants (56.77%, 176 of 310) adhered to the seventh step (rub both wrists in a rotating manner). The implementation rates of the fourth step (interlock fingers and rub the back of fingers of both hands: 26.77%, 83 of 310), and sixth step (rub fingers on palm for both hands: 20.65%, 64 of 310) were lower. However, the fifth step (rub thumb in a rotating manner followed by the area between index finger and thumb for both hands) had the worst execution rate (17.74%, 55 of 310).

**Patient hand hygiene moments**

Three-quarters (75.8%; 235 of 310) of the respondents washed their hands after using the toilet/bedpan/commode, and 86.1% washed their hands when they were visibly dirty (Table 3). Approximately half (47.7%) of the patients washed their hands before touching any breaks in the skin, whereas the implementation rates before any care procedures (19.0%, 59 of 310) and dialysis/contact with IV lines or other tubes (19.7%, 61 of 310) were low. The performance of handwashing before drinking fluids (11.0%, 34 of 310), as well as before and after interacting with visitors (11.9%, 37 of 310 vs 13.2%, 41 of 310) was also very low.

**Patient hand hygiene moments in different departments**

Participants in the Department of Internal Medicine had a relatively high execution rate of HH when their hands were visibly dirty (96.4%, 106 of 110), before eating (82.7%, 91 of 110),

and before touching any breaks in the skin (71.8%, 79 of 110). Those in the Department of Surgery tended to wash their hands after using the toilet/bedpan/commode (94.4%, 136 of 144) and after coughing, sneezing, or touching the nose or mouth (50.7%, 73 of 144). Those in the Department of Infectious Diseases had good performance rates of handwashing before interacting with visitors (40.0%, 6 of 15) (Table 4). There were significant differences in this regard between the different departments in the Kruskal-Wallis H test (H=19.838, P=0.001).

**Significant predictors of PHH moments**

A majority of the respondents (75.8%, 235 of 310) "Always" performed HH after using the toilet/ bedpan/commode (Table 5), and the univariate analysis identified one significant predictor: very few ICU patients practiced HH compared to medical patients (odds ratio [OR]= 0.08, 95% confidence interval [CI]: 0.02-0.41, *P* = 0.002). In the multivariate analysis, we found two significant variables: being a farmer rather than a clerk (adjusted OR= 0.18, 95% CI: 0.05-0.61, P =0.004) and being a freelancer (adjusted OR=0.18, 95% CI: (0.05-0.62, P =0.007). Medical patients had a higher HH performance rate than those in the Department of Obstetrics-Gynecology (adjusted OR= 0.18, 95% CI: 0.04-0.80, P =0.02) and ICU (adjusted OR= 0.06, 95% CI: 0.01-0.45, P =0.006).

**DISCUSSION**

In the present study, we examined hospitalized patients' knowledge of, attitudes towards, and practice of HH. Our findings demonstrate that although patients had a positive attitude

towards HH, their knowledge was insufficient, consisting with Cheng VC et al's research[13]. The social desirability factor might be operating, the hospital we involved attaches great importance to HCW HH and has implemented the WHO's multimodal HH improvement strategies;[14] therefore, the participants were in an atmosphere in which the importance of HH is highlighted daily, leading them to believe in its importance. However, due to non-provision of any PHH information in daily life, nor in hospital after admitted, they were unaware of when and how to wash their hands in clinical practice.

Patients' performance of HH is poor, and the existing facilities and products are routinely underutilized, consistent with the findings of previous studies.[15] Although the WHO's multimodal HH improvement strategies have been implemented by our hospital's Infection Control Committee with the provision of sinks and wash basins for the performance of soap-and-water cleaning in every patient's room, and the provision of ABHR for waterless hand cleaning in the rooms and corridors for all HCWs and patients,[14] the frequency and duration of handwashing were not satisfactory in this study. A systematical education about PHH seems necessary, not only for medical staff, but also for patients themselves. It is of great significance for patients to realize their own behavior for the prevention and control of nosocomial infection and the promotion of their own safety. Staff should receive education on the importance of PHH in the prevention of hospital-acquired infection; and staff need to be instructed to provide verbal PHH education to all newly admitted patients, and to provide reminders, assistance, and

encouragement for PHH practice.[16-17] In addition, it is also important to ensure that HH products—such as alcohol-based hand wipes or ABHR—are accessible to patients who are bedridden and are unable to get to the sink.[18,19] Staff or family members should be instructed to provide assistance to improve PHH opportunities.[18]

Hands were washed most frequently when they were visibly dirty and after using the toilet, but less frequently before drinking fluids and taking medicine, which would be the optimal time for the prevention of fecal-oral transmission. In this study, 75.8% of the participants washed their hands after using the toilet/bedpan/commode, but only 11.0% of them washed their hands before drinking fluids. Similar results have been observed in other study on patients in transplant units.[20] Hospital environments are often contaminated with hospital-acquired pathogens,[16-18] therefore, there is a need for education campaigns aimed at patient-initiated HH and HH that is directly observed before meals and the intake of medications during hospitalization.[21,22]

Our results also revealed that only 11.9% of the patients washed their hands before interacting with visitors and 13.2% washed their hands after the visitors left. Visitors may be vectors of pathogenic organisms that are potentially dangerous, particularly to immunocompromised patients.[23] If visitors carry certain pathogenic organisms on their hands and do not perform HH upon entry to the hospital, vulnerable patient populations may be at an increased risk for infection if they do not wash their hands after the visitors leave.[24] Thus, to win the battle against HCAIs, there is a need for coordinated effort to enforce HH that includes

patients, as well as their families, and visitors.[25] In addition to providing better signage and education among care providers[26,27], other hospital approaches, such as the installation of more strict visiting infrastructure (i.e., ICU doors that will not open if ABHR is not used) might be considered.[23]

This study resulted in some significant findings. patients' performance about PHH are differences in different departments. Patients in 'Medical department' showed significantly higher PHH performance compared with those in 'Department of Obstetrics/ Gynecology'. Patients activity and severity of illness may be working, patients in 'medical department' are mostly treated conservatively, their activity are less restricted than those in 'Department of Obstetrics/ Gynecology', who may need absolute bed rest because of gynecological surgery or give birth to a child just now; In addition, Chinese traditional concept may be another factor, which holds that women should not be exposed to cold water after surgery or after childbirth, which may also reduce the practice of hand washing.

The most significant findings being that ICU patients rarely practice HH compared to those in other departments. This is not surprising as patients in the ICU are generally critically ill or unconsciousness, they cannot wash their hands by themselves. Even the assistance of professional caregivers does not seem to work. This suggests the importance of the role of caregivers in ensuring adequate HH in such functionally dependent patients. To the best of our knowledge, this study is the first to provide data on ICU PHH, since most previous studies on

ICU HH focused on HCWs or patients' families.[23,28] Considering that multidrug-resistant acinetobacter baumannii infection are highly in ICU [29] and ICU patients are the most susceptible populations to nosocomial infections,[30] attention must be given to improving their adherence to HH rules to reduce hospital infections.

Our study also identified occupation such as 'farmer' showed good PHH performance compared with 'clerk' or 'freelancer'. We did not found the similar findings in other studies, the reasons for which may be need to be further explored.

Our study has several limitations. First, since this is a single-center cross-sectional survey, our results may not be applicable to all other institutions. Thus, it is recommended that a multi-center study with a large sample size be conducted in the future. Second, our inclusion of certain patients and wards may have resulted in selection bias. Physically weak patients were also recruited in the present study, and their families or caregivers filled out the questionnaire; therefore, there is a possibility that the family members of caregivers may have provided information on their own HH situation rather than that of the patients. Therefore, there is a need for further observational studies including quantitative hand bacterial cultures to verify the results of this study. Nonetheless, we believe that this study included a representative sample of inpatients. Third, the study was conducted using a convenience sampling method in the category of family members. Finally, although the survey findings are interesting, the patients appear to know that HH is important even though they know little about HH knowledge, the social

desirability factor might be operating, the results are not an indicator of how patients may actually behave in real life.

## CONCLUSIONS

In conclusion, this study demonstrated that patients had a positive attitude towards HH. However, their levels of knowledge and practice were unsatisfactory. These results suggest that A systematical education about PHH is needed in future to correct this knowledge and behavior. In addition, special attention should be given to those HH moments the compliance rates to which were the lowest, such as before drinking fluids, as well as before interacting with visitors and after they leave.

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## Footnotes

**Contributors:** LYX and YSE contributed to the study conception and design, data collection, analysis, interpretation and drafting the manuscript. LYH and ZL contributed to questionnaire design and data collection. LYH and CC contributed to the data collection and data management. MD contributed to the study design, data acquisition and interpretation. All authors contributed to drafting the manuscript and critically revised the manuscript and approved the final version.

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**Table 1** Demographic characteristics of the 310 included patients.

| Characteristic | Participants (%) |
|---|---|
| Identity of the respondents | |
| Patients | 242 (78.1) |
| Family members/caregivers | 68 (21.9) |
| Sex | |
| Female | 145 (46.8) |
| Male | 165 (53.2) |
| Age, years | |
| <30 | 57 (18.4) |
| 30-39 | 34 (11.0) |
| 40-49 | 56 (18.1) |
| 50-59 | 72 (23.2) |
| ≥60 | 91 (29.4) |
| Education level | |
| Primary or below | 77 (24.8) |
| Junior high school | 88 (28.4) |
| Senior high school | 62 (20.0) |
| Technical secondary school | 20 (6.5) |
| College | 34 (11.0) |
| Undergraduate | 28 (9.0) |
| Postgraduate or above | 1 (0.3) |
| Occupation | |
| Farmer | 67 (21.6) |
| Workman | 27 (8.7) |
| Clerk | 47 (15.2) |
| Medical staff | 2 (0.6) |
| Teacher | 3 (1.0) |
| Student | 13 (4.2) |
| Freelancer | 34 (11.0) |
| Unemployed | 45 (14.5) |
| Retiree | 72 (23.2) |
| Place of residence | |
| Urban | 147 (47.4) |
| Town | 53 (17.1) |
| Village | 110 (35.5) |
| Income (RMB/year)† | |
| <50,000 | 206 (66.5) |

| | |
|---|---|
| 50,000~100,000 | 80（25.8） |
| 100,000~200,000 | 18（5.8） |
| >200,000 | 6（1.9） |
| Number of hospitalizations | |
| 1 | 117（37.7） |
| 2 | 74（23.9） |
| ≥3 | 119（38.4） |
| The length of hospital stay at the time the questionnaire was completed (days) | |
| 1-3 | 67（21.6） |
| 4-6 | 107（34.5） |
| 7-9 | 49（15.8） |
| 10-13 | 51（16.5） |
| ⩾14 | 36（11.6） |
| Ward | |
| Medical ward | 110（35.5） |
| Surgical ward | 144（46.5） |
| Obstetrics/gynecology ward | 23（7.4） |
| Pediatric ward | 9（2.9） |
| Infectious diseases ward | 15（4.8） |
| Intensive care unit | 9（2.9） |
| Was surgery performed this time? | |
| Yes | 132（42.6） |
| No | 178（57.4） |
| Is there any infection? | |
| Yes | 86（27.7） |
| No | 224（72.3） |

*† 50,000 RMB ≈ US$7,209*

**Table 2** Performance of hand hygiene and knowledge and attitudes among the 310 included patients.

| Items | Total n(%) |
|---|---|
| Knowledge and attitude | |
| Have you received any education related to hand hygiene? | |
| Yes | 147（47.4） |
| No | 163（52.6） |
| Hand hygiene knowledge sources | |
| Television | 76 (28.5) |
| Newspaper | 20 (7.5) |
| Magazine | 18 (6.7) |
| Internet | 37 (13.9) |
| Medical staff | 95 (35.6) |
| Other | 21 (7.9) |
| Do you know anything about hand hygiene? | |
| Don't know | 126（40.6） |
| A little | 98（31.6） |
| Most | 44（14.2） |
| All | 42（13.5） |
| Is handwashing important for recovery from disease? | |
| Yes | 292（94.2） |
| No | 18（5.8） |
| Can handwashing prevent infection in patients? | |
| Yes | 289（93.2） |
| No | 21（6.8） |
| **Performance** | |
| How many times do you wash your hands every day? | |
| ≤2 | 48（15.5） |
| 3~5 | 145（46.8） |
| 6~10 | 69（22.3） |
| >10 | 48（15.5） |
| How long does it take to wash your hands every time? | |
| <1 min | 152（49.0） |
| 1~2 min | 135（43.5） |
| ≥2 min | 23（7.4） |
| Handwashing ways† | |
| Wash basin | 560(18.9) |
| Flowing water | 1913(64.7) |

| | |
|---|---|
| Alcohol-based hand rub | 484(16.4) |
| Handwashing products† | |
| Tap water only | 1797(46.6) |
| Hand sanitizer | 516(13.4) |
| Soap | 987(25.6) |
| Alcohol-based hand rub | 555(14.4) |
| Ways in which you wipe your hands† | |
| Hand towel | 976(20.0) |
| Any towel | 819(17.5) |
| Disposable tissues | 1012(21.6) |
| Clothes on my body | 410(8.8) |
| Wave hands in the air | 873(18.7) |
| Face towel | 588(12.6) |
| Do you have a dedicated hand towel? | |
| Yes | 130（41.9） |
| No | 180（58.1） |
| Times of hand towel washes every day | |
| 0 | 10(7.7) |
| 1 | 32(24.6) |
| 2 | 29(22.3) |
| 3 | 25(19.2) |
| 4 | 27(20.8) |
| Wash once every few days | 7(5.4) |

† ‘Handwashing ways’, ‘Handwashing products’, and ‘Ways in which you wipe your hands’ these three items are multiple topics, so each number of respondents is over the total number of respondents.

**Table 3** Patient hand hygiene moments.

| Moments | Seldom n(%) | Sometimes n(%) | Often n(%) | Always n(%) | Not applicable† |
|---|---|---|---|---|---|
| 1. After using the toilet, bedpan, or commode | 21(6.8) | 15(4.8) | 39(12.6) | 235(75.8) | 0(0.0) |
| 2. When returning to the room after a test or procedure | 91(29.4) | 43(13.8) | 54(17.4) | 120(38.7) | 0(0.0) |
| 3. Before eating | 41(13.2) | 37(11.9) | 68(21.9) | 164(52.9) | 0(0.0) |
| 4. Before drinking fluids | 160(51.6) | 63(20.3) | 53(17.1) | 34(11.0) | 0(0.0) |
| 5. Before taking medicine | 130(41.9) | 49(15.8) | 62(20.0) | 66(21.3) | 3(0.9) |
| 6. When visibly dirty | 11(3.5) | 9(2.9) | 23(7.4) | 267(86.1) | 0(0.0) |
| 7. Before touching any breaks in the skin (e.g., wounds, dressing, tubes) | 56(18.1) | 36(11.6) | 61(19.7) | 147(47.4) | 10(3.1) |
| 8. Before any care procedures (e.g., dialysis, IV‡ drug administration, injections) | 145(46.8) | 54(17.4) | 52(16.8) | 59(19.0) | 0(0.0) |
| 9. Before dialysis, contact with IV lines or other tubes | 139(44.8) | 60(19.4) | 44(14.2) | 61(19.7) | 6(1.9) |
| 10. After coughing, sneezing, or touching nose or mouth | 102(32.9) | 61(19.7) | 61(19.7) | 86(27.7) | 0(0.0) |
| 11. Before interacting with visitors | 198(63.8) | 37(11.9) | 38(12.3) | 37(11.9) | 0(0.0) |
| 12. After visitors leave | 190(61.3) | 46(14.8) | 33(10.6) | 41(13.2) | 0(0.0) |
| 13. When there is concern about whether hands are clean | 78(25.1) | 57(18.4) | 83(26.8) | 87(28.1) | 5(1.5%) |

† "Not applicable" represents patients who reported that they did not perform the procedure and therefore did not encounter that moment.

‡ "IV" intravenous.

**Table 4** Patients who "always" or "often" practiced hand hygiene in the different departments.

| Moments | Medical Wards n/N(%) | Surgical Wards n/N(%) | Obstetrics/ gynecology wards n/N(%) | Pediatric wards n/N(%) | Infectious diseases wards n/N(%) | ICU† n/N(%) | Total n/N(%) |
|---|---|---|---|---|---|---|---|
| 1.After using the toilet, bedpan, or commode | 99/110(90.0) | 136/144(94.4) | 19/23(82.6) | 7/9(77.8) | 10/15(66.7) | 3/9(33.3) | 274/310(88.4) |
| 2.When returning to the room after a test or procedure | 71/110(64.5) | 75/144(52.1) | 12/23(52.2) | 7/9(77.8) | 7/15(46.7) | 2/9(22.2) | 174/310(56.1) |
| 3.Before eating | 91/110(82.7) | 108/144(75.0) | 15/23(65.2) | 7/9(77.8) | 9/15(60.0) | 2/9(22.2) | 232/310(74.8) |
| 4.Before drinking fluids | 35/110(31.8) | 38/144(26.4) | 4/23(17.4) | 4/9(44.4) | 5/15(33.3) | 1/9(11.1) | 87/310(28.1) |
| 5.Before taking medicine | 45/110(40.9) | 59/144(41.0) | 12/23(52.2) | 6/9(66.7) | 4/15(26.7) | 2/9(22.2) | 128/310(41.3) |
| 6.When visibly dirty | 106/110(96.4) | 138/144(95.8) | 22/23(95.7) | 7/9(77.8) | 12/15(80.0) | 5/9(55.6) | 290/310(93.5) |
| 7.Before touching any breaks in the skin (e.g., wounds, dressing, tubes) | 79/110(71.8) | 98/144(68.1) | 15/23(65.2) | 5/9(55.6) | 9/15(60.0) | 2/9(22.2) | 75/310(24.2) |
| 8.Before any care procedures (e.g., dialysis, IV‡ drug administration, injections) | 41/110(37.3) | 51/144(35.4) | 8/23(34.8) | 4/9(44.4) | 5/15(33.3) | 2/9(22.2) | 111/310(35.8) |
| 9.Before dialysis, contact with IV lines or other tubes | 37/110(33.6) | 49/144(34.0) | 9/23(39.1) | 4/9(44.4) | 4/15(26.7) | 2/9(22.2) | 105/310(33.9) |
| 10.After coughing, sneezing, or touching the nose or mouth | 51/110(46.4) | 73/144(50.7) | 10/23(43.5) | 4/9(44.4) | 7/15(46.7) | 2/9(22.2) | 147/310(47.4) |
| 11.Before interacting with visitors | 23/110(20.9) | 34/144(23.6) | 8/23(34.8) | 3/9(33.3) | 6/15(40.0) | 1/9(11.1) | 75/310(24.2) |
| 12.After visitors leave | 25/110(22.7) | 32/144(22.2) | 5/23(21.7) | 4/9(44.4) | 6/15(40.0) | 2/9(22.2) | 74/310(23.9) |
| 13.When there is concern about whether hands are clean | 66/110(60.0) | 72/144(50.0) | 13/23(56.5) | 6/9(66.7) | 9/15(60.0) | 4/9(44.4) | 170/310(54.8) |
| Kruskal-Wallis H | 574.47 | 556.01 | 548.99 | 669.5 | 535.47 | 196.56 | 19.838 |
| *P*-value | | | | | | | 0.001 |

† ICU, intensive care unit; ‡ IV, intravenous.

**Table 5** Identity of participants who "always" performed hand hygiene after using the toilet, bedpan, or commode using the characteristics of the patients and their family members of caregivers.

| Characteristic | "Always" perform hand hygiene n/N (%) | Unadjusted OR† | | Adjusted OR | |
|---|---|---|---|---|---|
| | | OR (95%CI‡) | *P*-value | OR (95% CI) | *P*-value |
| Identity of the respondents | | | | | |
| Patient | 186/242(76.9) | 1 | | | |
| Family members/caregivers | 49/68(72.1) | 0.78(0.42-1.43) | 0.42 | | |
| Sex | | | | | |
| Male | 125/165(75.8) | 1 | | | |
| Female | 110/145(75.9) | 0.99(0.59-1.67) | 0.98 | | |
| Age, years | | | | | |
| <30 | 39/57(68.4) | 1 | | | |
| 30-39 | 28/34(82.4) | 2.15(0.76-6.12) | 0.15 | | |
| 40-49 | 43/56(76.8) | 1.53(0.66-3.52) | 0.32 | | |
| 50-59 | 54/72(75.0) | 1.39(0.64-3.00) | 0.41 | | |
| ≥60 | 71/91(78.9) | 1.64(0.78-3.46) | 0.20 | | |
| Education level | | | | | |
| Primary or below | 59/77(76.6) | 1 | | | |
| Junior high school | 59/88(67.0) | 0.62(0.31-1.24) | 0.18 | | |
| Senior high school | 51/62(82.3) | 1.41(0.61-3.27) | 0.42 | | |
| Technical secondary school | 14/20(70.0) | 0.71(0.24-2.12) | 0.54 | | |
| College | 28/34(82.4) | 1.42(0.51-3.98) | 0.50 | | |
| Undergraduate | 23/28(82.1) | 1.40(0.47-4.22) | 0.55 | | |
| Postgraduate or above | 1/1(100) | / | 1.00 | | |
| Occupation | | | | | |
| Farmer | 56/67(83.6) | 1 | | 1 | |
| Workman | 23/27(85.2) | 1.13(0.33-3.92) | 0.85 | 0.85(0.21-3.39) | 0.82 |
| Clerk | 34/47(72.3) | 0.51(0.21-1.28) | 0.15 | 0.18(0.05-0.61) | 0.006 |

| | | | | | |
|---|---|---|---|---|---|
| Medical staff | 2/2(100) | / | 1.00 | / | 1.00 |
| Teacher | 2/3(66.7) | 0.39(0.03-4.72) | 0.46 | 0.15(0.01-2.26) | 0.17 |
| Student | 8/13(61.5) | 0.31(0.09-1.14) | 0.08 | 0.22(0.04-1.24) | 0.09 |
| Freelancers | 23/34(67.6) | 0.41(0.16-1.08) | 0.07 | 0.18(0.05-0.62) | 0.007 |
| Unemployed | 34/45(75.6) | 0.61(0.24-1.55) | 0.30 | 0.58(0.21-1.61) | 0.29 |
| Retiree | 53/72(73.6) | 0.55(0.24-1.26) | 0.16 | 0.36(0.12-1.08) | 0.07 |
| Place of residence | | | | | |
| Urban | 117/147(79.6) | 1 | | | |
| Town | 37/53(69.8) | 0.59(0.29-1.21) | 0.15 | | |
| Village | 81/110(73.6) | 0.72(0.40-1.28) | 0.26 | | |
| Income (RMB/year) | | | | | |
| <50,000 | 153/206(74.3) | 1 | | | |
| 50,000~100,000 | 61/80(76.3) | 1.11(0.61-2.03) | 0.73 | | |
| 100,000~200,000 | 16/18(88.9) | 2.77(0.62-12.46) | 0.18 | | |
| >200,000 | 5/6(83.3) | 1.73(0.20-15.16) | 0.62 | | |
| Number of hospitalizations | | | | | |
| 1 | 87/117(74.4) | 1 | | | |
| 2 | 59/74(79.7) | 1.36(0.67-2.74) | 0.40 | | |
| ≥3 | 89/119(74.8) | 1.02(0.57-1.84) | 0.94 | | |
| The length of hospital stay at the time the questionnaire was completed (days) | | | | | |
| 1-3 | 22/67(32.8) | 1 | | | |
| 4-6 | 32/107(29.9) | 0.87(0.45-1.68) | 0.69 | | |
| 7-9 | 13/49(26.5) | 0.74(0.33-1.67) | 0.47 | | |
| 10-13 | 15/51(29.4) | 0.85(0.39-1.88) | 0.69 | | |
| ⩾14 | 9/36(25.0) | 0.68(0.27-1.70) | 0.41 | | |
| Ward | | | | | |
| Medical ward | 86/110(78.2) | 1 | | 1 | |
| Surgical ward | 117/144(81.3) | 1.21(0.65-2.24) | 0.55 | 1.27(0.58-2.80) | 0.55 |
| Obstetrics/gynecology ward | 14/23(60.9) | 0.43(0.17 -1.13) | 0.09 | 0.18(0.04-0.80) | 0.02 |

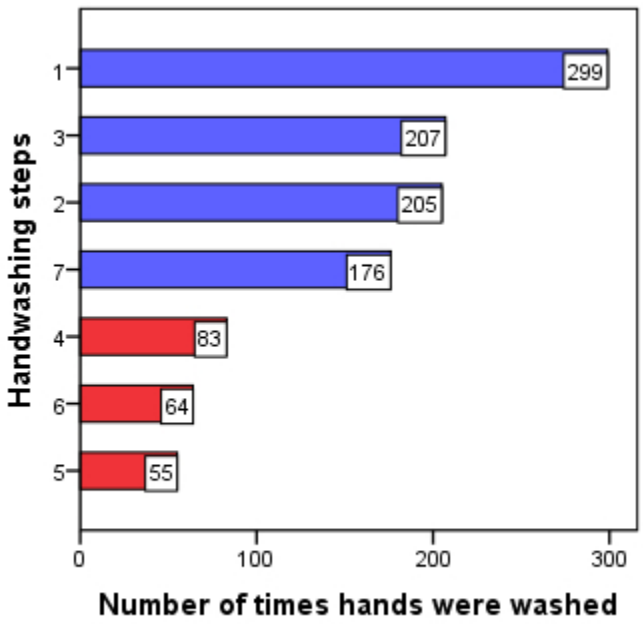
| | | | | | |
|---|---|---|---|---|---|
| Pediatric ward | 6/9(66.7) | 0.56(0.13-3.40) | 0.43 | 0.95(0.12-7.39) | 0.96 |
| Infectious diseases ward | 10/15(66.7) | 0.56(0.17-1.79) | 0.33 | 0.51(0.13-2.04) | 0.34 |
| ICU§ | 2/9(22,2) | 0.08(0.02-0.41) | 0.002 | 0.06(0.01-0.45) | 0.006 |
| Was surgery performed this time? | | | | | |
| No | 135/178(75.8) | 1 | | | |
| Yes | 100/132(75.8) | 1.01(0.59-1.70) | 0.99 | | |
| Is there any infection? | | | | | |
| No | 171/224(76.3) | 1 | | | |
| Yes | 64/86(74.4) | 1.11(0.63-1.97) | 0.72 | | |

† OR, odds ratio; ‡ CI, confidence interval; § ICU, intensive care unit.

## Figure legends

**Supplemental figure 1. Seven-steps to handwashing**

1. Rub palms together
2. Rub the back of both hands
3. Interlace fingers and rub hands together
4. Interlock fingers and rub the back of fingers of both hands
5. Rub thumb in a rotating manner followed by the area between index finger and thumb for both hands
6. Rub fingers on palm for both hands
7. Rub both wrists in a rotating manner

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**Supplementary File 1**

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 1-2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 4-5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 6-7 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | *6-8* |
| Bias | 9 | Describe any efforts to address potential sources of bias | 6,7,8 |
| Study size | 10 | Explain how the study size was arrived at | 6 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 6-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 8-9 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 9 |
| | | (*c*) Explain how missing data were addressed | 9 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | 9 |
| | | (*e*) Describe any sensitivity analyses | 9 |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 9 |
| | | (b) Give reasons for non-participation at each stage | 9 |
| | | (c) Consider use of a flow diagram | 9 |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 9 |
| | | (b) Indicate number of participants with missing data for each variable of interest | 9 |
| Outcome data | 15* | Report numbers of outcome events or summary measures | 9 |

| | | | |
|---|---|---|---|
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 10,11,12 |
| | | (*b*) Report category boundaries when continuous variables were categorized | 10,11 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | 12 |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 12 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 12 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 16 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 12-16 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 16 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 18 |