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Hospital outpatient clinics as a potential hazard for healthcare associated infections

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Summary Healthcare acquired infections are no longer confined to the hospital environment. Recently, many reported outbreaks have been linked to outpatient settings and attributed to non-adherence to recommended infection-prevention procedures. This study was divided into two parts: The first is a descriptive cross-sectional part, to assess the healthcare personnel's knowledge and compliance with Standard Precautions (SP). The second is an intervention part to assess the role of health education on reducing the level of environmental and reusable medical equipment bacterial contamination. Assessment of the doctors' and nurses' knowledge and compliance with SP was performed using a self-administered questionnaire. Assessment of environmental cleaning (EC) and reusable medical equipment disinfection has been performed using aseptic swabbing method. The extent of any growth was recorded according to the suggested standards: (A) Presence of indicator organisms, with the proposed standard being <1 cfu/cm^2. These include *Staphylococcus aureus* (including methicillin-resistant *Staphylococcus aureus*, MRSA), *Enterococci*, including vancomycin-resistant *Enterococci* (VRE) and various multidrug-resistant Gram-negative bacilli. (B) Aerobic colony count, the suggested standard is <5 cfu/cm^2. The effect of health education intervention on cleaning and disinfection had been analyzed by comparing the difference in cleaning level before and after interventional education. Good knowledge and compliance scores were found in more than 50% of participants. Primary screening found poor EC and equipment disinfection as 67% and 83.3% of stethoscopes and ultrasound transducers, respectively, were contaminated with indicator organisms. For all indicator organisms, a significant reduction was detected after

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intervention ($p = 0.00$). Prevalence of MRSA was 38.9% and 16.7%, of the total *S. aureus* isolates, before and after intervention, respectively. Although 27.8% of the total *Enterococcus* isolates were VRE before intervention, no *VRE* isolates were detected after intervention. These differences were significant. Development and monitoring of the implementation of infection prevention policies and training of HCP is recommended.

Introduction

Developing countries have reported to have up to 20 times the risk of healthcare acquired infections (HCAIs) compared with developed countries [1]. Healthcare acquired infections are no longer confined to the hospital environment [2]. Outpatient care is defined as care provided in facilities where patients do not stay overnight. Recently, most patient encounters are with outpatients. Thus, infection prevention and control in outpatient settings is critical [2].

Many reported outbreaks have been linked to outpatient settings and attributed to non-adherence to recommended infection-prevention procedures [3]. The main mode of transmission of infection is healthcare personnel (HCP) [4]. Consistent with these data, ongoing education and training of HCP on the basic principles and practices for infection control (IC), hygiene and environmental cleaning (EC) are critical [5]. About one-third of all HCAIs may be prevented by adequate cleaning of medical equipment [6]. Because the equipment used in non-critical settings, such as outpatient clinics, is less likely to have standard cleaning protocols than the equipment used in the critical setting, it is more likely to carry a large number of microorganisms.

Infections with antibiotic-resistant bacteria, including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin intermediate *S. aureus* (VISA), vancomycin-resistant *Enterococcus* (VRE), *C. difficile*, and multiple-resistant Gram-negative bacteria are well known hazards of inpatient care [7]. Recently, the rapid emergence and high prevalence of community-associated infections caused by resistant microorganisms such as *community acquired-MRSA*, *VRE* and *C. difficile* have been recognized in many parts of the world. These organisms have the potential to cause serious infections among patients without known risk factors. This might make outpatient clinics potential reservoirs of those pathogens [4].

This study aimed to assess the potential risk of outpatient clinics at Fayoum University Hospital (FUH) toward the community via a systematic assessment of outpatient HCP's knowledge and compliance with Standard Precautions (SP), assessment of EC and reusable medical equipment disinfection and evaluation of the role of health education (HE) intervention on the improvement of environmental cleaning and equipment disinfection.

Subjects and methods

Study design

This study was divided into two parts: The first was a descriptive cross-sectional part, to assess HCP's knowledge and compliance with SP. The second was an intervention part to assess the role of health educational activity on reducing the level of environmental and reusable medical equipment bacterial contamination.

Study setting

This study was based at the outpatient clinics in FUH. FUH is a 245-bed teaching hospital at Fayoum Governorate (population is approximately 3 million). The average number of patients visiting these outpatient clinics is approximately 13,000/month.

Participants

Full-time medical doctors and nurses on duty at one of the outpatient clinics at the time of the visit were included in the study. Participants who agreed to participate provided their verbal informed consent. Final data analysis did not include incomplete questionnaires. Thirty-four doctors and 31 nurses were included in the study.

Study tools

A self-administered questionnaire for the assessment of knowledge and compliance of HCP with SP was used and structured into three sections: the demographic characteristics, knowledge of SP and compliance with SP practice. The knowledge part, which was modified from that advised by Tavolacci et al. [8], included 29 items covering 7 areas of SP. The degree of knowledge was measured using ''Yes'' ''No'' or ''Don't know'' questions on each item being evaluated. The compliance part included 20 situations in 4 different areas of SP. It was modified from that advised by Luo et al. [9] and included three compliance possibilities (always, sometimes and rarely). Sixty-five out of seventy HCP returned fully filled questionnaire with a 92.9% response rate.

Assessment of environmental cleaning was performed at five outpatient clinics with a high turnover of patients being examined at these clinics: Internal Medicine, General Surgery, Pediatrics, Tropical Diseases and Gynecology Clinics. Sample collection was performed in the middle of the working day. No advance notice was given to HCP to prevent any changes to routine practice.

An aseptic swabbing and streaking technique was performed and the extent of any growth was recorded according to the suggested standards for microbial sampling of the healthcare environment [10].

The first standard: The presence of an indicator organism, with the proposed standard as <1 cfu/cm^2. These organisms include *S. aureus* (including *MRSA*), *Enterococci* including *VRE* and various multidrug-resistant Gram-negative bacilli.

The second standard: The aerobic colony count (ACC) was based on an internationally agreed figure. The suggested standard is 5 cfu/cm^2 for hand contact surfaces. ACC = (cfu/cm^2).

Sterile cotton swabs immersed in 1 ml BHI broth were used to swab examination tables and medication side-tables, as indicators of cleanliness of the clinical area, and doctors' desks as an indicator of the cleanliness of the non-clinical area. Routinely, these surfaces were cleaned daily, when contaminated with blood, body fluids, secretions, or excretions, and when these surfaces were visibly dirty or soiled.

Within 1 h after sample collection, a sterile pipette tip was used to add approximately 100 μL from each sample to blood agar plates (used for ACC), mannitol salt agar (for selection of *S. aureus*), MacConkey's agar (for differentiation of Gram-negative bacilli) and bile esculin azide agar (for selection of *Enterococci*).

Assessment of reusable medical equipment cleaning and disinfection, namely stethoscopes and ultrasound transducers as they are the most frequently used medical equipment at the outpatient settings and they are the most frequently missed during disinfection because their risk as a source of HCAIs is underestimated among HCP. Routinely, stethoscopes and ultrasound transducers were cleaned after each use. Stethoscopes and ultrasound transducers were randomly selected from the clinics. Each stethoscope and ultrasound transducer was cultured by direct imprint on blood agar and incubating the culture aerobically for 24 h for ACC assessment. Next, the surface of each stethoscope and ultrasound transducers was swabbed with a moistened sterile cotton swab immersed in 1-ml BHI broth, incubated for 24 h for enrichment of indicator strains and then subcultured on selective agar plates as previously described with environmental surfaces swabbing.

Screening for antibiotic resistant organisms using the disc diffusion method on Muller Hinton agar (Oxoid, UK) [11].

(a) Screening for MRSA, using 30 μg cefoxitin discs (Oxoid, UK).
(b) Screening for VRE, using Teicoplanin discs (30 μg) and Vancomycin discs (5 μg) (Oxoid, UK).
(c) Screening for ESBLs and AmpC enzymes production in detected Gram-negative bacteria. Resistant Gram-negative isolates were further identified to species level using the Microbact (12A) Gram-negative identification system (Oxoid, UK).

Intervention in the study

Health education sessions (1 h/week) for 8 weeks were given to personnel responsible for EC and medical equipment disinfection at the point of care locations. Sessions addressed the main topics of SP and EC. Thirty nurses and 15 housekeeping staff were trained in the health education sessions. During and after the duration of the education sessions, the staff was asked to adhere to surface cleaning and disinfection guidelines. Four weeks later, an assessment of the effectiveness of the introduced education was performed by measuring the level of bacterial contamination of the environment and reusable medical equipment using the same procedures previously described.

Ethical considerations

This study was reviewed and approved by the Fayoum Faculty of Medicine Research Ethical Committee prior to the start of the work.

Questionnaire scoring system

Knowledge score

A correct answer was given 1 point, and a wrong answer or 'unknown' answer was given 0 points. The maximum possible score was 29. This score was used to compare knowledge between groups. A cut-off point was based on the median value of the total knowledge score. Knowledge scores at or above the median point were designated ''Good Knowledge'' and those below the median point were designated as ''Poor Knowledge.''

Compliance score

A score was calculated by giving a score of 2 points for ''always,'' 1 point for ''sometimes'' and 0 points for ''rarely,'' resulting in a score ranging from 0 to 40. The cut-off point was based on the median value of the compliance score. Scores at or above the median point were designated as ''Good Compliance'' and scores below the median were designated as ''Poor Compliance.'' A logistic regression model was performed to identify predictors of good compliance.

Data analysis

Data were analyzed using the statistical package SPSS version 16. Comparison between groups was performed using the χ^2 test for qualitative variables and *t*-test, and an ANOVA test for quantitative variables. Comparison between data before and after intervention was performed using the Wilcoxon test for quantitative non-parametric variables and the McNemar's test for paired qualitative variables. A p value <0.05 was considered statistically significant.

Results

Demographic characteristics of the participants

Sixty-five HCP completed the questionnaire, 39 (60.0%) females and 26 (40.0%) males, of which 31 (47.7%) nurses and 34 (52.3%) doctors. The participants' age ranged from 21 to 56 years old (mean ± SD) = (29.45 ± 5.86) years. The years of experience ranged from 6 months to 20 years, (mean ± SD) = (7.07 ± 6.42) years. Most of the participants, 54 (83.1%) reported that they needed IC training.

Knowledge and compliance scores and their relationship

Table 1 shows the mean knowledge and compliance scores according to the demographic characteristics of the participants. Sixty-one percent of the participants had good knowledge and 55.4% had good compliance scores. No significant difference in the mean knowledge score was observed between these subgroups ($p > 0.05$). Factors associated with significantly higher compliance scores included being a nurse ($p = 0.004$) and having an experience >6 years ($p = 0.03$). A significant association between good compliance and good knowledge was found ($p = 0.039$).

Only 36.0% of participants knew when to use alcohol-based hand rub in contrast to 80.0% of participants who responded correctly to questions about hand hygiene (HH). Questions about the disposal of sharps and use of gloves and PPE were answered correctly in 77.0% and 73.0% of patients, respectively. Multivariate logistic regression analysis revealed that significant predictors associated with good compliance were males versus females, nurses versus doctors and good versus poor knowledge with odd ratios (OR) (95% CI): 5.02 (1.07—23.48), 7.2 (1.45—36.12) and 3.48 (1—12.24), respectively.

Environmental cleaning/reusable medical equipment screening results before and after intervention

Tables 2 and 3 show that there was a significant reduction in ACC after intervention in different samples at different clinics.

The distribution of the number of positive and negative samples of *S. aureus*, *Enterococci* and Gram-negative bacteria before and after intervention according to sample site is shown in Table 4. For all indicator organisms, a significant reduction was detected after intervention ($p = 0.00$).

The difference in cleaning level before and after intervention was detected in most clinics for selected organisms, but the cleaning level improvement was significant for *Enterococci* at Tropical, Surgical and Medicine Clinics (p value = 0.031, 0.031 and 0.000, respectively). Data are shown in Table 5.

Table 1 Knowledge and compliance scores of participants according to demographic characteristics.

Variable	Total knowledge score		Total compliance score	
	Mean ± SD	*p* value	Mean ± SD	*p* value
Sex				
M	20.97 ± 4.2	0.874	34.3 ± 4.13	
F	21.15 ± 4.7		34.11 ± 4.5	0.84
Age groups (years)				
20–29	21.8 ± 3.1	0.224	33.8 ± 4.96	
30–39	19.8 ± 5.9		35.04 ± 2.9	0.521
≥40	21 ± 1.6		33.7 ± 4.11	
Clinic				
Surgery	21.26 ± 4.5	0.706	34.5 ± 3.8	0.59
Int. Med.	20.26 ± 4.8		34.04 ± 4.9	
Tropical	21.06 ± 4.3		33.13 ± 2.5	
Gynecology	22.3 ± 1.2		35.5 ± 2.9	
Pediatrics	21.6 ± 4.4		32.3 ± 5.0	
Job				
Nurse	20.9 ± 54.0	0.807	35.8 ± 2.9	0.004
Doctor	21.17 ± 3.44		32.88 ± 4.8	
Nursing education				
School	19.1 ± 6.7	0.610	35.6 ± 2.7	0.76
Institute	20.85 ± 5.37		35.09 ± 4.9	
Years of experience				
<6 years	19.2 ± 2.7	0.082	33.06 ± 5.03	0.03
≥6 years	17.76 ± 4.13		35.3 ± 3.09	

Prevalence of antibiotic-resistant bacteria

Fourteen *MRSA* isolates were detected before intervention (38.9% of total *S. aureus* isolates) compared to 4 (16.7% of total *S. aureus* isolates) detected after intervention. No *MRSA* isolate was detected in the Pediatric or Tropical Clinics.

Ten *VRE* isolates were detected before intervention (27.8% of total *Enterococcus* isolates). No *VRE* isolates were detected after intervention.

Discussion

The lack of knowledge is the major reason for non-adherence to SP and isolation precautions. More than half of participants in this study had good knowledge and compliance with SP. A significant relationship between the participants' knowledge and compliance has been found in this study ($p < 0.001$). However, the translation of the respondents' understanding of IC guidelines into adherence to patient care is sometimes inconsistent [12]. Because knowledge-base deficiency among HCP might be attributed to a lack of investment in staff training or a misunderstanding of HCP safe behavior [13], intensive education combined with strict supervision of HCP compliance has been suggested. The findings of this study were in contrast with some previous studies, which reported that long experience, profession, age and sex were significant predictors of IC knowledge [12,14].

A good understanding of HH regulations, except for proper recognition for the use of alcohol-based hand rub, was reported in this study. This defect might be due to the lack of regular post-employment education on issues of SP because only 27.7% of our participants had IC training. Most of the participants answered correctly for items related to the disposal of sharps, and use of gloves and PPE. This finding reflects the high awareness of HCP about blood borne infections.

According to this study, the average times of wearing mask and goggles were found to be relatively low compared with the times of wearing gloves. These results could be accepted as moderate when compared with those obtained from developed or developing countries about compliance with SP. In Italy, during patient contact, wearing gloves was reported as 88.6%, wearing protective eyewear was 35.8% and wearing a mask was 35.5% [15]. A Turkish study reported satisfactory compliance with SP [16]. In India, only 32% of participants wear eye protection when indicated [17]. Other surveys elsewhere in Africa documented that HCP often failed to practice SP consistently and correctly [18,19]. In this study, the poor practices of HCP in some areas could be related to several

Table 2 Median and IQR[a] of aerobic colony count (ACC) according to sample site before and after intervention.

	ACC/sample site									
	Transducers		Stethoscopes		Examination tables		Doctors' desks		Medication tables	
	Before	After	Before	After	Before	After	Before	After	Before	After
Median	17.5	3.5	50.0	2.00	52.00	5.00	180.00	55.0	500.0	100.0
IQR	8.0–50.0	0.0–5.0	8.75–500.0	0.0–2.0	41.25–500	2.5–56.25	72.5–437.5	7.0–115.0	250.0–500	50.0–100
p value	0.002		0.006		0.004		0.001		0.000	

[a]Interquartile range.

Table 3 Median and IQR of ACC according to clinic before and after intervention.

	ACC/clinic									
	Gynecology		Tropical		Surgery		Pediatric		Int. Medicine	
	Before	After	Before	After	Before	After	Before	After	Before	After
Median	60.0	10.0	500.0	9.00	180.00	28.0	15.0	1.0	50.0	5.0
IQR	11.75–173.75	0.0–24.25	66.0–500.0	5.0–10.0	66.5–437.5	5.25–87.5	5.0–50.0	0.0–3.0	17.5–500.0	2.0–105.5
p value	0.005		0.026		0.011		0.002		0.000	

Table 4 Number of positive swabs for indicator organism before and after intervention according to sample site.

	Before *N* (%)	After *N* (%)	*p* value
Stethoscopes (*N* = 18)			
S. aureus	12 (66.7)	8 (44.4)	0.125
Enterococci	10 (55.6)	0.00	0.002
Gram-negative bacteria	12 (66.7)	4 (22.2)	0.008
Transducers (*N* = 12)			
S. aureus	6 (50.0)	2 (16.7)	0.125
Enterococci	10 (83.3)	0.00	0.002
Gram-negative bacteria	4 (33.3)	0.00	0.125
Examination table (*N* = 10)			
S. aureus	6 (60.0)	6 (60.0)	>0.99
Enterococci	6 (60.0)	0.00	0.031
Gram-negative bacteria	6 (60.0)	4 (40.0)	0.5
Doctor's desk (*N* = 8)			
S. aureus	8 (100.0)	8 (100.0)	>0.99
Enterococci	6 (75.0)	2 (25.0)	0.125
Gram-negative bacteria	8 (100.0)	4 (50.0)	0.125
Medication tables (*N* = 6)			
S. aureus	4 (66.7)	0.00	0.125
Enterococci	4 (66.7)	0.00	0.125
Gram-negative bacteria	6 (100.0)	4 (66.7)	0.5
Total = 54			
S. aureus	36 (66.7)	24 (55.6)	0.00
Enterococci	36 (66.7)	2 (3.7)	0.00
Gram-negative bacteria	36 (66.7)	16 (29.7)	0.00

factors. In Egypt, IC activities have recently gained recognition from the leadership. The absence of appropriate training curricula in IC for HCP in hospitals and medical training facilities could also be an issue.

Compliance with standard and isolation precautions combined with active screening for drug-resistant bacteria in healthcare facilities has resulted in a significant reduction in the endemic level of these bacteria [20]. An evaluation of the potential risk of outpatient clinics by screening of environmental and reusable medical equipment contamination with drug-resistant bacteria was an objective of this work.

The baseline ultrasound transducer contamination rate was 100.0% with a high prevalence of indicator organisms. This is in contrast with other studies reporting lower transducer contamination rates [21] with no identification of pathogenic bacteria [22] or *MRSA* isolates [22,23]. The observed and expected causes of non-adherence to cleaning and disinfection of reusable ultrasound transducers included: clinicians who have someone else cleaning up have different ideas about the correct procedure or because clinicians would simply forget. There was a need to review which transducer required a high level disinfection, the area of the transducer that was disinfected and the methods used for disinfection.

Stethoscopes were potential sources of nosocomial infection. In this study, a baseline assessment of stethoscopes found a 100.0% contamination rate. Previous studies reported stethoscope contamination levels ranging from 38.4% to 100.0% [24,25]. Education about the value and methods of stethoscope disinfection caused a significant reduction in the level of contamination. Consistent with this study, the use of 70% isopropyl alcohol swab was the preferred and most effective cleaning agent in many earlier studies [26]. The majority of stethoscopes examined in previous studies were contaminated with Gram-positive organisms, primarily *Staphylococcus* species [24,26—28]. These findings were consistent with previous findings of this study. No *MRSA* isolates were detected on stethoscopes in this study, in contrast to 17.0% and 42.0% of *S. aureus* isolates, which were MRSA in other studies [24,28]. Uneke et al. [27] found that bacterial isolates from stethoscopes were resistant to nearly all the antibiotics tested. Smith and colleagues [28] found that stethoscopes from the Pediatrics Clinic were contaminated less frequently compared to those obtained from other clinics, which concurred with the current findings.

The hospital environment acts as a potential reservoir because bacteria can persist on hospital surfaces for prolonged periods of time. Contaminated hospital surfaces could cross contaminate

Table 5 Number of positive swabs for indicator organism before and after intervention according to clinic site.

	Before *N* (%)	After *N* (%)	*p* value
Gynecology Clinic (*N* = 10)			
S. aureus	8 (80.0)	6 (60.0)	0.5
Enterococci	6 (60.0)	2 (20.0)	0.125
Gram −ve bacteria	6 (60.0)	2 (20.0)	0.125
Surgery Clinic (*N* = 8)			
S. aureus	8 (100.0)	4 (50.0)	0.125
Enterococci	4 (50.0)	0.00	0.125
Gram −ve bacteria	8 (100.0)	4 (50.0)	0.125
Pediatric Clinic (*N* = 12)			
S. aureus	4 (33.3)	2 (16.7)	0.5
Enterococci	6 (50.0)	0.00	0.031
Gram −ve bacteria	8 (66.7)	4 (33.3)	0.125
Medicine Clinic (*N* = 18)			
S. aureus	10 (55.4)	6 (33.3)	0.125
Enterococci	14 (77.8)	0.00	0.00
Gram −ve bacteria	8 (44.4)	4 (22.2)	0.125
Tropical (*N* = 6)			
S. aureus	6 (100.0)	6 (100.0)	>0.99
Enterococci	6 (100.0)	0.00	0.03
Gram −ve bacteria	6 (100.0)	2 (33.3)	0.125

the hands and gloves of HCP who transfer these organisms to patients and high touch surfaces, such as the bed surface, bed rails, intravenous pump, supply cart and over-bed table [29]. Monitoring disinfection of high touch surfaces close to patients has been recommended to reduce the prevalence of HCAIs [30]. Swab culture for environmental screening was used in this study. Swab cultures are easy to use but broad application of this system is limited due to cost, delay in analysis, need for baseline values for comparison and the difficulty of monitoring multiple surfaces in multiple rooms.

In the current study, nearly all medication and examination tables were contaminated with a significant reduction in ACC and the presence of indicator organisms after intervention. This is consistent with findings of previous studies, confirming that less than 50.0% of surfaces close to patients were clean [31,32]. Doctors' desks had the highest mean ACC among swabbed surfaces. This could be explained by the use of doctors' desks as examination tables by some clinicians, particularly in the Pediatrics Clinic.

Among the screened clinics, the Surgery Clinic had the highest mean ACC and 100.0% of swabs yielded both *S. aureus* and Gram-negative bacteria before educational intervention. This finding has reflected the poor IC practice in a clinic that involves high-risk patients. Pathogens, such as *MRSA*, *VRE* and *C. difficile*, are able to remain viable on dry surfaces for days, weeks or even months, which could contribute to the transmission of healthcare-associated pathogens [33].

Few studies have documented the spread of *MRSA* or *VRE* in clinics. In the current study, detected MRSA strains consist of 38.8% of total *S. aureus* isolates with a significant reduction after intervention ($p = 0.000$). In different published reports, hospital surfaces contaminated with *MRSA* varied from 1.0% to 74.0% of surfaces in patient areas [33,34]. Variations are dependent on the presence of *MRSA* colonized and/or infected patients. In another study, *CA-MRSA* contaminated 19.0% of surfaces in an outpatient clinic that cared for patients with human immunodeficiency syndrome [35].

Vancomycin-resistant *Enterococci* could be directly transmitted from contaminated equipment to patients and have been implicated as sources of several *VRE* outbreaks [36]. In the current study, 27.8% of total *Enterococcus* isolates before intervention were *VRE*. This parallels previous studies, reporting that 0.7—29.0% of environmental sites were positive in areas of *VRE* colonized patients [37]. However, our findings were inconsistent with those obtained from more recent studies, reporting that 60.0—70.0% of the rooms of *VRE* colonized patients were contaminated with *VRE* [33].

This study also suggests that accessing an acceptably clean environment and reusable medical equipment is a crucial issue that requires attention. This would prevent the spread of antibiotic-resistant bacteria among HCP and patients at outpatient clinics.

Conclusion and recommendation

Based on this study, we concluded that proper compliance is associated with good knowledge. Bacterial contamination and the prevalence of antibiotic-resistant bacteria are high. This has been significantly improved after intervention, but unfortunately, it is still lower than the accepted international levels. The development of specific policies on the practice of SP and training and re-training of HCP are highly recommended according to the results of this work. Finally, outbreaks may be controlled by the combination of active surveillance, contact precautions and antibiotic restriction.

Competing interests

None declared.

Ethical approval

This study was reviewed and approved by Fayoum Faculty of Medicine Research Ethical Committee before the start of work.

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