Aim. Hand hygiene (HH) is an essential component in preventing healthcare associated infections. The purpose of this study was to evaluate HH compliance among health care workers (HCWs) in intensive care units at Beni-Suef university hospital, Egypt before and after an intervention educational program.

Methods. Data were collected by using the standardized WHO method for direct observation “Five moments for HH” approach. Observations were conducted in six ICUs before intervention (March to April 2017) and after the intervention (July to August 2017). The study included 608 opportunities (observations) among 177 HCWs collected before and 673 opportunities among 163 HCWs collected after the intervention.

Results. Overall HH compliance increased significantly from 30.9 (95% CI: 27.2-34.6%) before intervention to 69.5 (95% CI: 65.2-72.6%) post intervention; with the highest HH compliance rate among nurses compared to physicians and workers (P = 0.001). Significantly higher HH compliance rates were observed after body fluid exposure, before aseptic procedures, and after patient contact compared to before patient contact and after patient surrounding contact (P = 0.001). In binary logistic regression analyses a statistically significant difference was shown (P = 0.047) for HH compliance among events before and after patient contact (OR = 1.399, 95% CI: 1.004-1.948).

Conclusions. The interventional educational program improved the HH compliance among ICUs-HCWs at Beni-Suef university hospital. The hospital should conduct monthly observational monitoring for the ICUs units sharing the findings to spread best practices. Provision of sustained training programs to help efficient and effective HH for care delivery is mandatory.

Keywords
Compliance • Hand hygiene •HCWs

Summary
Non compliance with HH protocols in hospitals, especially in ICUs, is a serious contributing yet preventable cause of HAIs. Most ICU endemic infections result from HCWs hands contamination with micro-organisms with frequent outbreaks due to cross transmission due to frequent invasive procedures for ICU patients [11-13]. The purpose of the current study is to measure the compliance with HH practices among HCWs in ICUs at Beni-Suef university hospital before and after an intervention program for HH based on WHO strategies.

Materials and methods
This study was conducted among 177 HCWs working in six different ICUs - Beni-Suef university hospitals, Egypt; between March and August 2017. ICUs included in the study were: six ICUs were included in the study. The Critical Intensive Care Unit (CICU): 19 beds; the Surgery Care Unit (SCU): 12 beds; the Cardiothoracic Care Unit (CCU): 6 beds; Chest Care Unit: 8 beds; Neonatal Intensive Care Unit (NICU): 10 beds; and the Pediatric Care Unit (PICU): 10 beds. All of the ICUs followed local infection control policies and procedures. Alcohol-based hand rub dispensers are available for each ICU, and one dispenser per every two ICU beds within each unit.
DESIGN
This is a prospective, Interventional study divided into three phases:
Phase 1: pre-intervention; from March to April 2017; 8 weeks. Baseline hand hygiene compliance rate was assessed.
Phase 2: interventional phase, from May to June 2017, 8 weeks. Interventions training and education were carried out by the infection control team for the study participants. The educational programs aimed at raising their awareness at all levels. The training was held at least on three different occasions for each ICU HCWs to ensure their active participation concerning HH knowledge and practice. Workplace posters and explanatory leaflets depicting the 5 moments for hand hygiene, instructions on the techniques of hand Sanitizers and hand washing were posted to act as a reminder for them. In addition, active presentations, video show and training handouts were given to each participant.
Phase 3: post-intervention, from July to August 2017; 8 weeks. Hand hygiene compliance rate was assessed post-interventional training.
Hand hygiene compliance assessment in phase 1 and 3: An observation record form was used for an unscheduled direct observation by members of the infection control team for the 5 HH opportunities [14] among ICUs HCWs; (1) before patient contact, (2) before an aseptic task, (3) after exposure to bodily fluids, (4) after patient contact and (5) after contact with patient surroundings. The observations were carried out in a 20-30-min periods, several times a week. No more than two patients were observed at a time. HCWs did not know the schedule of the observation periods. The HH compliance rate was calculated. The HH compliance data were discussed regularly during the infection control committee (ICC) meeting and with the ICU staff. The data were reported in a composite unit by job category.

STUDY SUBJECTS
Post intervention observations were done for 163 HCWs; 106 nurses, 34 physicians, and 23 workers (radiographers, laboratory technicians, ECG technicians, physiotherapists and respiratory therapists). Distribution of study subjects shown in Table I revealed that 95%, 89.5% and 85% of nurses, physicians and workers were observed post-intervention.

Ethical considerations
To ensure privacy, dignity, and integrity, the used questionnaire was anonymous. All required permissions were obtained from the hospital administration and from the head of the infection control unit.

Statistical analysis
Data were analyzed using the software, Statistical Package for Social Science, (SPSS Inc. Released 2009 - PASW Statistics for Windows Version 18.0. Chicago: SPSS Inc.) Frequency distribution, percentage and descriptive statistics including mean and standard deviation were calculated. McNemar test was performed when indicated. A Binary logistic regression model was conducted. Odds ratio (OR) and antecedent 95% confidence intervals were used to identify potential determinants of HH compliance. P-value was considered significant if ≤ 0.05.

Results
This study involved observing 112 nurses (89% females & 11% males) 67 % of them were staff nurse and 33% were head nurse with a mean age of 32.41 years ± SD 11.26. Their mean work experience was 9.97 years ± SD 9.58. Thirty-eight physicians were observed for HH compliance (45.7% males & 54.3% females), 33% were clinical residents, 58% were specialists and 10 % were consultants. Their mean age was 30.74 years ± SD 6.8 with a mean work experience of 5.74 +± SD 6.56. Workers constituted 15% of the study group (32% males & 68% females) with a mean age of 32.41 years ± SD 11.26 and a mean work experience of 9.97 years ± SD 9.58.
Study observations included 608 ICU opportunities, collected before the intervention program (March to April 2017), and 673 observations collected after the intervention program (July to August 2017).
A statistically significant improvement (P = 0.01) in the overall HH compliance rate from 30.9(95% CI: 27.2-34.6%) before the intervention to 69.5(95% CI: 65.2-72.6%) post intervention (P = 0.001) is shown in Table II. Pre-intervention compliance rates were lower for the neonatal and cardiac ICUs. Table II also represents the difference between HCWs HH compliance rate pre and
Improvement of Hand Hygiene Compliance among Health Care Workers in Intensive Care Units

Discussion

Hand hygiene is an effective tool in the reduction of health care associated infection (HAIs) in healthcare facilities, especially in intensive care units (ICUs), and poor compliance for hand hygiene is associated with high rates of HAIs [15]. In the present study, the success of the interventions (educational) program carried out for ICU HCWs showed a significant improvement in the HH compliance rates evidenced by the increase in overall hand hygiene compliance rate in all ICUs from 30.9% before the intervention to 69.5% after the intervention (Tab. I). This finding is in agreement with similar Middle East studies from Saudi Arabia, Kuwait reporting improvement from 43-60.8% before intervention to 61.4-86.4% post-intervention [16, 17], and similar to the reported improvement post intervention from 23.1% to 64.5% in Argentina [18], and from 30.0% to 56.7% in Brazil [19] and from 51.0% to 67.2% in a multi-center Multi-national study including 55 departments in 43 hospitals in Costa Rica, Italy, Mali, Pakistan, and Saudi Arabia [4].

In the current study, HH compliance was highest for moments 2, 3 & 4 and lowest for moments 1&5 (P = 0.001). This observation was constant in the pre and post interventional phases. Improvement of HH practice was observed among HCWs for the 5 moments post the interventional program. Moment 1 improved from 22.1% to 69% in agreement with similar European and Arabian studies reporting improvement from 35% and 52% [17, 20, 21], reflecting lesser concern of personal HCWs risk of contamination before patient’s contact or representing a vector for pathogenic

| Variable*                  | Compliance rate% (95% CI) | Pre-intervention | Post-intervention |
|----------------------------|---------------------------|------------------|-------------------|
| ICUs                       |                           |                  |                   |
| Pediatric ICU              | 37.8 (27.9-47.8)          | 74.2 (66.5-81.9) |
| Chest ICU                  | 32.3 (22.7-41.8)          | 71.1 (65.1-79.1) |
| Surgery ICU                | 35.4 (26.5-44.5)          | 68.8 (59.3-79.2) |
| Neonatal ICU               | 25.0 (10.9-39.0)          | 69 (59.0-79.0)   |
| Critical ICU               | 30.4 (21.9-39.0)          | 71.1 (65.1-79.1) |
| CCU                        | 24.3 (17.4-31.2)          | 61.0 (51.5-70.04)|
| Healthcare workers         |                           |                  |                   |
| Nurses                     | 37.9 (32.8-42.8)          | 71.7 (67.2-76.2) |
| Physicians                 | 21.7 (15.8-27.6)          | 67.5 (61.4-73.6) |
| Others                     | 17.5 (7.4-27.7)           | 62.5 (49.4-75.6) |
| Hand hygiene indication    |                           |                  |                   |
| Before patient contact (Moment 1) | 22.1 (15.8-28.4)  | 69.0 (61.7-69.2) |
| Before aseptic procedure (Moment 2) | 40.5 (31.3-49.5)  | 75.3 (66.0-80.5) |
| After body fluid exposure (Moment 3) | 55.4 (43.0-67.8)  | 75.7 (69.0-82.8) |
| After patient contact (Moment 4) | 55.4 (27.6-42.2)  | 72.8 (66.6-79.0) |
| After patient surrounding contact (Moment 5) | 12.4 (5.7-19.04) | 58.5 (48.5-67.7) |
| Overall HH compliance rates | 30.9 (27.2-34.6)          | 69.5 (65.2-72.6) |

ICU: Intensive care unit; HH: Hand hygiene; Others: Radiographers, laboratory technicians, ECG technicians, physiotherapists and respiratory therapists

| Factors                        | P-value | OR     | 95% C.I. for OR |
|-------------------------------|---------|--------|----------------|
|                               |         |        | Lower          | Upper      |
| HCWs: nurses vs physicians and other HCWs | 0.175   | 0.794  | 0.569          | 1.108      |
| Event: after vs before patient contacts | 0.047   | 1.399  | 1.004          | 1.948      |
| ICUs: medical vs surgical      | 0.626   | 1.097  | 0.756          | 1.591      |
| Constant                      | 0.000   | 1.992  |                |            |

CI: Confidant interval; OR: Odds ratio, HCWs: Health care workers; ICU: Intensive care unit
organisms transmission to others [22-24]. Other factors such as work overload and insufficient time could be the cause of this result.

Moment 2 improved from 40.5% to 73.3% similar to the reported improvement from 51.0% to 67.2% in a multinational study conducted in six pilot sites [20]. As for a Moment 3, an observed higher compliance rate from 55.4% to 75.7%, higher than the reported percentages in an Indonesian study with an improvement from 22.2% to 33.3% [26] and similar to that reported on a Saudi Arabian study from 65.2% to 85.2% [16]. High compliance rate of HCWs is logical when hands are visibly dirty or sticky.

Similarly, results of higher compliance rate for a Moment 4 were observed from 35% to 72.8%, a finding which ranges consistent with similar reported improvement from (20.6-78.6% in pre-intervention to 34.1-89.7% in post-intervention) [16, 26].

Compliance with the WHO recommendation for HH practice after contact with patient surroundings (surfaces and objects) was poorly implemented by HCWs in the current study. This is shown by the lowest compliance rates of Moment 5 in the pre and post intervention phases in spite of the highest improvement rates from 12.4% to 58.5% (P = 0.001) yet did not reach a satisfactory percentage. Findings which are similar to the reported improvement percentages for Moment 5 in Indonesia and another study conducted in six pilot sites [20]. Explanation of which might be due to HCWs belief that patient’s surroundings harbor less risk for acquired infections. Therefore, convincing evidence should drive HCWs to practice effective HH to protect themselves [20, 26-28].

Hand hygiene compliance rate among nurses was significantly higher (P = 0.001) compared to the compliance of physicians and other HCWs in pre- and post-intervention phases. This is in concordance with other studies [16, 20-22, 24, 29]. In general, physicians were found to be poor compliant with infection control standards [30].

Conclusions

The HH compliance rate among HCWs improved with the Interventional, teaching program in the six ICUs in Beni-Suef university hospital. Nurses were found more compliant with the HH practice compared to physicians and other HCWs. HH compliance rates after Moments 2, 3 and 4 were significantly higher compared with Moments 1 and 5. Continuous professional performance improvement programs should be periodically implemented and audited to maintain an adequate, safe environment for the HCWs and the patients.

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Conflict of interest statement

None declared.

Authors’ contributions

The authors have contributed substantially to conception of the study, analysis and interpretation of data, drafting of the article, and critical revision of the article. Both authors have given final approval to the article as submitted.

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Correspondence: Manal Mohamed Anwar, Public Health and Community Medicine Department, Faculty of Medicine, Beni-Suef University, Egypt - Tel +20 82 2324879 - Fax +20 82 2333367 - E-mail: M_anwarabdo@yahoo.com