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**Measuring the observance of contact precautions when treating Buruli ulcer patient in a tertiary hospital in Benin**

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**ABSTRACT**

**Background:** Buruli ulcer, caused by *Mycobacterium ulcerans*, remains a public health issue in Benin. Treatments are based on antibiotics and surgery. Good hygiene is important for its management.

**Objective:** we assess the observance of contact precautions practices by healthcare workers.

**Methods**: Between March and October 2015, the promotion of hands hygiene and basic infection prevention practices were performed at a tertiary hospital in Benin. An effective education system was implemented to improve healthcare workers knowledge and compliance. The study period was divided in two. **Period I** corresponds to the promotion of standard precautions and providing hygiene equipment and materials. **Period II**: hand hygiene audits were conducted using the World Health Organization ‘five moments for hand hygiene’ observational tool. Samples were taken from hands of staff, concurrently, swabbing of environment was achieved. The isolates were identified, tested for antimicrobial susceptibility.

**Results**: there is no significant change for hand hygiene compliance globally, from 24.2%; (95% CI 21·1−36·9) to 33·3% after (31·8−41·3). About 95% of personnel preferred hand washing with soap and water. Multidrug-resistant bacteria, were still present on hands (89%) and environment samples (42%) despite good knowledge of hand hygiene by 80% of medical personnel.

**Conclusion**: Inadequate compliance was noticed despite good knowledge of standard precautions. The lack of qualified personnel and financial resources allocated for this program justified the weak compliance. Antimicrobial resistance is particularly harmful to the Buruli ulcer secondary wound infection treatment.

**Key words**: Benin, hand hygiene, observance, Healthcare workers, Buruli ulcer, Multiresistance.

**Introduction**

Buruli ulcer (BU), a tropical skin disease caused by *Mycobacterium ulcerans* is a major public health concern in Benin; where such disease remains endemic particularly in the district of Allada [1, 2]. The disease had been linked to swampy environments and weak hygiene conditions [3, 4]. The current treatment consists of eight (8) weeks of oral rifampicin (10 mg/kg) combined with intramuscular streptomycin 15 mg/kg administered daily and surgery [5, 1]. This treatment does not necessarily eliminate contamination or secondary infection of lesions and multidrug resistance bacteria, such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* were isolated from infected lesions after completion of treatment [6]. Several antibiotics were routinely used in the treatment of secondary infections, and may have contributed to the emergence of antibiotic-resistant strains. These findings call for an optimization of BU wound management and hygiene procedures to better control secondary infections [7, 8].

In the context of Viral Hemorrhagic Fever (VHF) Ebola and Lassa diseases outbreak in West Africa in 2014, World Health Organization (WHO) and other domestic and international partners, have initiated and supported the implementation of a voluntary program to prevent and control infection (IPC) in all affected countries [9, 10]. The main objectives of IPC program were to appreciate the magnitude of Health care Associated Infections (HAIS), to assure valid comparison and evaluate the benefit of different methods used in the management, prevention and surveillance. As a result of these agreements established by WHO, an invitation to participate to the national promotion of Standards Precautions (SP) was sent to all acute hospitals by the health Ministry of Benin. The Center for Screening and Treatment of Buruli Ulcer of Allada in Benin (CDTUB/Allada) accepted to join the program. Hospital environment safety measures, hand hygiene promotion and an operational committee exclusively dedicated to monitor IPC was implemented. We assessed the efficacy of Standards Precautions practices, including strategy, feasibility and adaptability to the local context.

**I Materials and Methods**

**1 Local situation**

This study was carried out at the medical zone of Allada, in the CDTUB/Allada. It is one of the most endemic regions for BU in Benin, a country where around 1000 new cases of BU are discovered per year [1, 2]. This tertiary hospital of 150 bed, is a major referral center for people living with in a 40 km radius from Allada. Approximately three thousand (3000) patients are admitted per year. Water hygiene and sanitation levels indicators are very low [1].

**2 Study design**

We performed a quasi-experimental study in the CDTBU/Allada, between 1st march 2015 and 30th October 2015. During the first period (Period I), which lasted from 1st March to 30th April 2015, a baseline audits of healthcare workers (HCWs) technique and compliance of hand hygiene were conducted using the WHO five moments for hand hygiene observational tool [11, 12]. Three months April, May and Jun 2015 were used for the implementation of a multi-faceted approaches to hand hygiene focusing on administrative support, availability of alcohol-based hand rubs, mobile sink with refillable running water and others equipment’s. HCWs received training and intensive education during ten (10) weeks for IPC management. A design of new posters for SP, were placed at key locations throughout the hospital, followed by an intensive environmental disinfectionwith particular attention to patient’s surroundings. During **period II** (after intervention), from 1st July to 31st October, 2015,hand hygiene audits were monthly conducted by IPC staff using the WHO five moments for hand hygiene observationaltool. Verbal feedback was provided directly to HCWs during audits. The patient clinical staff ratio was not changed throughout the study. There were no change in the auditing method or in the lead auditor during the study. HCWs were also interviewed, complemented by structural observations of their practices of SP. The medical staff members were informed of the necessity to choose appropriate antimicrobial therapy in secondary wound infections and received guidance on howto achieve this. No other infection prevention were introduced.

**3 Microbiological investigations**,

Samples were weekly collected from the hands of clinical staff and from patient surroundings (floor areas, bed frames, cases notes, chairs, lockers, door handles, light switches, nurse call buttons, telephones, sinks, faucet, toilet seats, stands for infusion apparatus, intravenous pump buttons, mobile instrument tables, and sterilizing drums). The samples were taken using sterile cotton tipped swabs moistened with phosphate buffered saline and transported to the laboratory within one (1) hour for analysis.

**4 Drug susceptibility pattern of isolated bacteria**

Antibiotics susceptibility was performed using agar disk diffusion method on Mueller Hinton agar according to the National Committee for Clinical Laboratory Standards (NCCLS) recommendations [13]. The inoculate was prepared directly from an overnight agar plate adjusted to 0.5 McFarland standard. Commercially prepared antibiotics impregnated discs (Becton Dickinson, Meylan, France) for Interpretation of antimicrobial susceptibility followed the recommendations of the Antibiogram Committee of the French Microbiology Society (CA-SFM). Several antibiotics were tested: Oxacillin (5𝜇g), Vancomycin (30𝜇g), Rifampicin (30𝜇g), Gentamicin (15𝜇g), Trimethroprim Sulfamethoxazole (1.25/23.75𝜇g), Ciprofloxacin (5𝜇g), Erythromycin (15 UI), Pristinamycin (30𝜇g). Evaluation of methicillin resistance was performed by plating samples on buffered Mueller-Hinton agar with 2% (w/v) NaCl. In addition Gram negative rod were tested against ceftriazone, ceftazidine, cefotaxime and Imipenem.

**5 Statistical analysis**

All statistics were performed by SPSS software 11.5. Contingency table analysis was done by χ2 test or two tailed Fisher's exact test for categorical variables. A P value of 0.05 was considered statistically significant.

**II RESULTS**

**I Observance of contact precautions**

I 1 Observance of hand hygiene

The only technique of hands hygiene applied by HCW’S observed was hand washing with water and soap during the period study. HCW’S compliance with the five moments for hand hygiene increased from a baseline (1460/6031) **24.2%** (95% CI 21•1−36•9) in 120 sessions of 45mn to (2263/6785) **33·3 %** (95% CI 31•8−41) in 122 sessions of 45m. Of those opportunities that were missed in period II 60% (2743/4571) occurred after contact with a patient surroundings. The sites commonly touched were the bedframe (400 contacts) and case notes (822 contacts). Table 1 and figure 1 show details of compliance. Hand washing compliance after touching patient surroundings decrease significantly from 16.7% to 9% *P* = 0. 0002.

**Figure 1** Hand hygiene compliance according to WHO five moments by HWCS March –october 2015

**Table I** **hand washing process compliance by health workers during the period study**

|  |  |  |
| --- | --- | --- |
| **Different step of hand washing technique****according to WHO guideline**  | **Period 1**Baselinecompliance of HCW’S | **Period 2**Compliance after training of HCW’S |
| 1-Wet hands with water | **0%** | **100% (30/30)** |
| 2-Apply enough soap to cover all hand surfaces  | **20%(06/30)** | **100% (30/30)** |
| 3-Right palm over left dorsum with interlaced fingers and vice versa. 15 à 20s | **40%(12/30)** | **100% (30/30)** |
| 4- Rub hands Palm to palm with fingers interlaced. | **60%(18/30)** | **100%**  |
| 5-Backs of fingers to opposing palms with fingers interlocked. | **0%** | **50%** |
| 6-Rotational rubbing of left thumb clasped in right palm and vice versa. | **0%** | **52%** |
| 7-Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa. | **0%** | **10%** |
| 8-Rinse hands with running water. | **100%** | **100%**  |
| 9-Dry hands thoroughly use a single towel. | **0** | **20%** |
| 10-Use towel to turn off faucet. | **0** | **10%** |

**I** 2 Others contact precautions

A total of 30 HCW’S were involved, 90 % (27/30) indicated that they use gloves during wound care, although some used the same gloves for several patients. A summary of the different frequency of compliance to contact precautions during the study period is shown in Table II. There is a lack of availability of wound care materials and sterile dressing materials indicated by 87% (26/30) of all participants. There was no working autoclave (sterilizing equipment) available. Other shortages noticed were: running and clean water, electricity.

**2 Results of interviews**

From period I to period II, there were no significant in the average age of patient 18.5 vs 18.3 years p = 0.2, length of stay of patient 14.21 vs 14.10 days p= 0.18, or monthly number of admissions to the CTDB/Allada. Participants. 70% (21/30) of HWCS, involved in the study were female. Majority of HWCS (80%) had received training on SP during the year. More than 50% of HWCS have length service above 10 years. Waste management and low access to improved water sources is a major concern in the center according to 90% of personnel. Level of knowledge regarding hand hygiene immediately before touching a patient for preventing transmission of germs and unclean hands as an important route of cross transmission were expressed respectively by **25%** and **23%.**

**Table II Observance of contact precaution by health workers according to period**

|  |  |  |
| --- | --- | --- |
| **Contact precaution taken** | **Period I** | **Period II**  |
| Wearing Gloves | 77% (23/30) | 93% (28/30) |
| Facial protection (eyes, nose, and mouth) | 30% (9/30) | 57% (17/30) |
| Gown | 67% (20/30) | 87% (26/30) |
| Prevention of needle stick and injuries from other sharp instruments | 80% (24/30) | 93% (28/30) |
| Disposal equipment  | 10% (3/30) | 53% (16/30) |
| Decontamination of equipment used | 90% (27/30) | 97% (29/30) |
| Respiratory hygiene and cough etiquette | 47% (14/30) | 87% (26/30) |
| Waste disposal | 60% (18/30) | 83% (25/30) |
| Linens | 23% (7/30) | 70% (21/30) |
| Environmental cleaning | twice weekly | Every day |
| Patient care equipment | 20% (6/30) | 86% (25/30) |

**3 Isolation of bacteria from clinical staff hand and patients surrounding**

A total of 310 samples from the clinical staff hand and patients surroundings were screened for the pathogen bacteria; in each period, from which 92% (n= 121) were correctly identified and 8% (n=11) were not identified. The most isolated bacteria were *Staphylococcus* *aureus* and *Acinetobacter baumannii*, the distribution of isolates from various samples is presented in Table III.

**Table III- Comparative study of microorganisms according to period of analysis**

|  |  |  |
| --- | --- | --- |
| *Isolated Bacteria* | Health workers Hands | Patient surroundings |
| *Staphylococcus aureus**(45)* | **Period I** | **Period II** | **Period I** | **Period II** |
| (12/45) 26,7% | (5/45) 11,1% | (18/45) 40% | (10/45) 22,2% |
| *Acinetobacter baumannii**(29)* | (7/29) 24,1% | 0% | (16/29) 55,2% | (6/29) 20,7% |
| *Klebsiella pneumoniae**(20)* | (6/20) 30% | (1/20) 5% | (9/20) 45% | (4/20) 20% |
| *Enterobacter cloacae**(16)* | (2/16) 12,5% | 0% | (11/16) 68,8% | (3/16) 18,8% |
| *Escherichia coli**(8)* | (3/8) 37,5% | 0% | (5/8) 62,5% | 0% |
| *Pseudomonas fluorescens**(3)* | 0 (0%) | 0% | (2/3) 66,7% | (1/3) 33,3% |
| Total 121 | **30** | **6** | **61** | **24** |

**4 Antimicrobial susceptibility**

Out of 121 isolates tested, (97/121) 80%) were resistant to one or more antibiotic, while 12% (15/121) were fully susceptible. All isolates from the study were susceptible to imipenem. *Staphylococcus aureus* were resistant to oxacillin (MRSA) 64% (29/45), 67% (30/45) to rifampicin and 7% (3/45) were resistant to vancomycin. The highest proportions of resistance among Gram negative isolates were observed against trimethoprim/sulfamethoxazole (72%). Most *Acinetobacter baumannii* isolates were resistant to all potentially active beta-lactams, with the exception of imipenem (second-line drug not currently available in Benin). The distribution of the antibiotics resistance patterns of the isolates are presented in Table IV.

**IV Discussion**

The study hospital is a tertiary, referral acute care public hospital in Allada district, essentially devoted to Buruli ulcer treatment. Despite efforts from WHO and other organizations, Buruli ulcer disease remains an important cause of major incapacity with a long period of treatment and costly hospitalizations [14; 15], which are factors contributing to the occurrence of HAIS. In this study we aimed to assess the compliance of contact precautions to be taken by HWCS at CTBU/Allada with a well-established IPC program. Hand hygiene is the leading measure for preventing the spread of antimicrobial resistance and reducing HAIs, but HWCS compliance with optimal practices remains low, 33% post intervention, despite a good knowledge of WHO guidelines. Lower compliance with hand hygiene may be explained by their individual perception of SP. The complexity of many recommendations promotes different interpretations of existing standards in practice, probably also justified the inconsistencies observed. At the beginning of IPC program, hand hygiene compliance by HWCS, increased significantly during the two first months; but decrease progressively with the shortage of clean water and hygiene materiel’s supplied by WHO and others partners [16; 17]. HCWs in our study preferred hand washing with soap and water over alcohol based rubs because most of BU wounds in CTBU/Allada were described as dirty and infected and needed to be clean. The hospital had washing facilities inside the dressing rooms, where patients sometimes were washed by staff. Lack of complete understanding of guidelines can be deduced from the fact that only indications 1, 3 and 5 are sometimes respected by HWCS according to figure 1. These results are concordant with previous data from most health care institutions reported by authors [18; 19]. The majority of missed hand hygiene opportunities in our study occurred after contact with patient’s surroundings, 60% and may have been due to the perceived low risk of the activity being performed, this finding is also observed by Fitzgerald G. et al [20]. In many cases, unsterilized materials were used, for example the recycling of bandages, or some of the sterilized materials were used for several patients. Obviously this carries a risk for infection, not only with wound flora, but may increase HAIS acquisition. This result is not surprising because the minimum requirements of good hygiene and good sanitation are not available. Paper towels are not available in the CTBU/Allada care system and may explain several flaws noticed in the observance of hand washing technique by HWCS presented in table 1.

**Period I** can be considered as the basal situation, during which care practices in CTBU/Allada had several inherent flaws. Non-invasive medical devices were used for several patients without decontamination. Hand hygiene compliance was poor. SP were neglected. The factors for non-compliance of hygiene measures in this study are in consonance with a review conducted to assess barriers to appropriate hand hygiene by Duerink et al [21]. Overcrowding and understaffing of hospitals, unfavorable social background of population, lack of legislations mandating accreditation of hospitals and a general attitude of non-compliance amongst HWCS towards even basic procedures of IPC were noticed. All these situations are known to promote colonization of hospital environment by microorganisms. Although HWCS and patients are considered the most important source of nosocomial microorganisms, there is growing evidence that the colonized hospital environment has also a substantial importance [22]. The high population density of bacteria in the environment (42%), especially on patient surroundings, may explain the presence of most pathogen organisms on the hands of HWCS and highlight the necessity to decontaminate the environmental reservoirs more thoroughly. Although reports in the literature have stressed the difficulty involved in decontaminating such an environment. Talon and Fraise [22, 23] reported no significant benefit from decontaminating the hospital environment.

The bacteria strains isolated in this study displayed a wide range of sensitivity to the 12 tested antibiotics. One of the most intriguing aspects of our study is the high proportion of strains showed resistance to rifampicin (67%), trimethoprim/sulfamethoxazole (72%); may be explained by their used in secondary wound care treatments. There is major concern about subsequent acquisition of antibiotic resistant organisms from the hospital settings. The probabilistic prescription of antibiotics without laboratory analysis is an aggravating factor. The choice of treatment of secondary infections with locally available antimicrobial agents requires a better understanding of the infecting flora and of drug susceptibility patterns. This finding confirms previous studies performed in Benin [24, 25]. The practice of patient self-medication in Benin, the availability and low price of these antibiotics is a factor of abusive used. These antibiotics of doubtful quality can be bought without prescription.

Comparison of resistance patterns among bacteria isolated from patient’s surrounding with those from hands of personnel showed similitude in majority of cases. This situation could lead to HIAS acquisition by cross transmission via hands. It is interesting to notice that the bacteria isolates from the environment during Period II displayed another antibiotic profile different from Period I, along with a significant reduction of isolates rate. Indeed, hand washing technique as measured by quick audit and direct observation became an important part of IPC program and showed globally an improvement over the study period. However, the IPC team did not have the resources to increase the frequency of their education sessions. These results showed the efficacy of the IPC program instituted at CTDBU/Allada and its adaptability to local context. The IPC program has been well implemented despite the shortcomings in its application. This study provides insights into the complexities of infection control in under-resourced healthcare facilities.

**Table IV: Distribution of antibiotype according to reservoirs**

|  |  |  |  |
| --- | --- | --- | --- |
| Isolated Bacteria |  Profil | Patient surroundings | HWCS Hands |
| *Staphylococcus aureus*(45) | 1 OxaRCipR ER FaR GR PtR RifR VanS**(16)**2 FaR PtR RifR ES OxaS CipS GS VanR**(3)**3 OxaR Pt RER CipR GS FaS RifS VanS**(13)**4 CipR RifR GS ES FaS OxaS PtS VanS**(13)** | **7** door handle, locker, cupboard,**0****13** case note, bed frame, door handle**8** bathtub, bed frame, light switch, | **9****3****0****5** |
| *Escherichia coli*(8) | 1 CazR CipR CtxR CroR GS SXTR ImpS**(5)**2 GRCroR CtxRCipSCazS ImpS SXTS**(3)** | **3** bathtub, phone **2** door handle, locker, case note | **2****1** |
| *Klebsiella pneumoniae*(20) | 1 SXTR GR CtxR CroR CazS CipS ImpS**(7)**2 CazR GS SXTR CtxRCroR CipR ImpS**(13)** | **4** remedy bottle, case note,phone**9** bed frame, cupboard, case note, | **3****4** |
| *Enterobacter cloacae*(16) | 1GR CtxSCroSCipSCazSImpS SXTI**(7)**2 CazR CipR CtxRCroRGS SXTR ImpS**(9)** | **5** door handle, phone, bed frame, phone**9** door handle, locker, floor | **2****0** |
| *Acinetobacter**baumanii*(29) | 1 CazR CipR CtxR SXTR GRCroRImpS**(5)**2 CazR CipR SXTR CtxRCroRGS ImpS**(11)**3SXTR CtxRCroRCipS GS CazS ImpS**(7)**4 CazR CtxRCroRCipR GR ImpS SXTI**(6)** | 4 phone, bathtub, floor, light switch8 door handle, phone, locker, cupboard5 bed frame, case note, phone5 bathtub, locker, door handle | **1****3****2****1** |
| *Pseudomonas fluorescens*(3) | CtxR SXTR CipR CroR GRImpS CazI**(3)** | **3** door handle | **0** |

**Abbreviations**: **Antibiotics**

**Antibiotics: Ox, Oxacillin; VA, Vancomycin; Rif, Rifampicin; FA, Fusidic acid; G, Gentamicin; SXT, Trimetroprim sulfamethozolin; PT, Pristinamycin; Cip: Ciprofloxacin, Caz: Ceftazidim, E: Erythromycin, G: Gentamycin, Imp : Imipenem, Cro: Ceftriaxon, Ctx: Cefotaxim.**

**Conclusion**

This study has demonstrated the feasibility of implementation of basic IPC program, however, its weakness is linked to the lack of financial resources and qualified IPC team. The present study revealed a high level of pathogenic organisms on hands and confirmed their presence in patient surroundings. The level of competency and of compliance with hygiene measures remains low. More attention should be paid to the indiscriminate use of antimicrobials in non-infected patients.

**Competing interests**

The authors declare that they have no competing interests

**Authors' contributions**

**ATA** was the principal investigator, participated in the planning and execution of the study, performed data entry and data analysis, and was the main responsible author. **PFDF** performed data entry and microbiological work, and contributed to thewritingprocess**. EMCL** and **TWA** participated in the planning of the study and contributed to the writing process.

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