Isolation, characterization and prevention of various microbial strains in NIC unit and PIC unit

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The health of the hospital associated persons, particularly those dealing directly with insertion of devices, are serious cause of concern for hospitals. In this study, the most prevalent organism on the surface of medical devices in PICU were CoNS (16.66%) and Staphylococcus aureus (16.66%), while in NICU the most prevalent organism was Klebsiella spp. (11.25%) among Enterobacteriaceae group followed by Acinetobacter baumannii (10%), Escherichia coli (2.5%), CoNS (6.25%), S. aureus (6.25%) and Enterococcus faecalis (6.25%). The most common species identified from blood specimen of clinical samples shows the maximum presence of Candida sp. (60/135) followed by A. baumannii (21/135), Klebsiella Pneumoniae (20/135), Enterococci (12/135), Burkholderia cepacia complex (8/135), S. aureus (6/135), E. coli (5/135), Pseudomonas aeruginosa (3/135). Different antibiotics have been used against these micro-organisms; but Cotrimoxazole, Vancomycin have been found more effective against CoNS bacteria, Clindamycin, Tetracycline for S. aureus, Nitofurantoin for Acinetobacter, and for E. faecalis, A. baumanii, and Klebsiella, erythromycin, Colistin, and Ceftriaxone have been found more effective respectively.

The infections (HCAIs/HAIs) of the health care associates are indicators of the out comings of poor quality of patient care. The Infections of the health-care set-up have direct adverse Consequence, which affect the patients, their families, visitors and society as well. The control of infection of HAIs is therefore the need of an hour. Thus the growing concern about HAIs, together with patient's safety leads the World Health Organization (WHO) to make the World Alliance Safety. An initiative in terms of prevention of HAIs was Alliance's First Global Patient Safety plan, in terms of 'Clean Care is Safer Care'. The Control and preventive activities can only be achieved by sound and systematic base-line data. So the surveillance of HAI has become a common and important set up in many countries. Surveillance systems are therefore plays an important role in designing evidences for the prevention and control of numerous infections.

As the traditional manual methods of surveillance methods are less efficient because of more time Consumption, limited in scope, insensitive, often applied in consistently should be over come. In most of the hospital surveillance activities are passive, involving data analysis of microbiological culture reports of routinely sent diagnostic samples. There is a difference in the infection rate of adults, young and infants, because of difference in their immune systems. These differences occur due to differential use of mechanical devices and surgical procedures in this population. Escherichia coli the most common pathogen in adults (14% of all nosocomial infections), also in pediatrics patients, Staphylococcus aureus has been found the most common isolate.

Study area and study period. The present experimentation was performed in the Microbiology Department, Uttarkanchal College of Biomedical Sciences and Hospital, Dehradun. Samples were collected from NICU & PICU of Shri Mahant Indiresh Hospital, Dehradun from September 2019 to February 2020. All methods were carried out in accordance with relevant guidelines and regulations. The Control and preventive activities can only be achieved by sound and systematic base-line data. So the surveillance of HAI has become a common and important set up in many countries. Surveillance systems are therefore plays an important role in designing evidences for the prevention and control of numerous infections.

Specimen collection. Specimens were collected from the surface of the instruments using moisten (0.9% w/v physiological saline) sterile cotton swab. Similarly, nasal and hand swabs were taken.

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Sample size and sample technique. A total of 260 samples were considered for bacterial examination, 80 from different equipment's, 30 nasal swabs and 30 hand swabs from NICU and 60 from different equipment's 30 nasal swabs and 30 hand swabs from PICU.

Identification. Identification of organism was done as follows:

Gram stain. Gram stain is an extensively used differentiation method that splits bacteria into two major groups; those who retain crystal violet dye after treatment with iodine and alcohol/acetone appear purple are referred as gram positive and the bacteria which loses the crystal violet and shows the counter stain colour is labeled as gram negative.

Procedure. A smear was made on a clean glass slide, air dried and fixed by flame of a burner. Crystal violet—1 min → Washed the slide with water → Grams iodine—1 min → Washed the slide with water → Decolorized with acetone—2–3 s → Washed the slide with water immediately → Safra-nine—30 s → Washed with water, air dried and examined under 100X oil.

Motility by hanging drop preparation. A hollow ground slide i.e. with a shallow, circular concavity in its centre were used. Encircle the concavity with a line streak of soft petroleum jelly applied with a glass rod to the surface of the slide just outside the concavity. A minute drop or suspension of the liquid culture was placed on the surface of the cover slip then the slide was inverted over the cover slip, allow to adhere the jelly, which is then immediately turned so that the cover-slip is uppermost. The liquid drop will then hang from the cover slip in the center of the concavity which was observed under high power 40X.

Catalase test. With a wooden applicator stick or cover slip, growth was transformed from the Centre point of the colony to the surface of glass slide. 1 ml of 3% Hydrogen peroxide was added for bubble formation.

Coagulase test. Bound coagulase. Procedure. Two drops of normal sterile saline was placed on a glass slide. Emulsified colony material from the organism to be identified is put in a liquid in the concerned circles for milky white suspension formation. Then a small amount of plasma is placed in the suspension and mix with a wooden applicator stick. Another drop of saline in the other suspension was placed as a control. Then the slide was rocked back and forth, observing for agglutination of the test suspension.

Free coagulase. Procedure. A little quantity of colony growth of the organisms was emulsified with 0.5 ml of plasma (1:6 diluted) in a small tube and were then incubated at 38 °C for 4 h. and observed for clot formation by gently tilting the tube. In case of no clot formation, the tubes are re-incubated at room temperature and read again after 18 h.

Nutrient agar. Procedure. Near about 28 g of dehydrated powder was mixed with 1000 ml of distilled water, heated to dissolve the medium completely. It was sterilized, autoclaved at about 15lbs pressure at 121 °C for 15 min, and finally the contents were cooled to 45–50 °C and then poured into sterile petri plates.

Blood agar. Procedure. The medium was prepared by adding sterile 5–10% blood to sterile nutrient agar that has been melted and cooled to 50 °C and then poured into Petri plates.

Macconkey’s agar. Procedure. 55.04 g was dissolved in 1000 ml of distilled water, heated to complete uniformity of the mixture and then completely sterilized by autoclaving at 15 lbs pressure 121 °C for 15 min. Cooled to 45–50 °C and poured into sterile Petri plates.

Mannitol salt agar. Procedure. 111.02 g was mixed in 1000 ml of purified distilled water, heated until boiled for complete dissolutions within the medium, and then sterilized by autoclaving at 15lbs pressure 121 °C for 15 min.

Biochemical tests. Indole test. Procedure. Tryptophan broth inoculated with 1 drop from a 24 h brain heart infusion, incubated at 35 °C in an ambient air for 48 h, and then 0.5 ml of Kovac’s reagent was added to the broth culture.

Methyl Red/Voges Proskauer test. Procedure. MR/VP broth was inoculated with 1 drop of broth culture from a 24 h brain heart infusion culture, which was incubated at 35°–38° for a minimum of 48 h in ambient air.

Citrate utilization test. Procedure. Simmons citrate agar was inoculated on slant by the tip of a needle to a colony that is 18–24 h old, then incubated at 35°–38° for up to 8 days. The mixture was observed for growth of blue color, denoting alkalinization.
Bile Esculin test. Few colonies of culture was inoculated for about 18–24 on the surface of the slant of bile esculin agar, then again incubated at 35°–38° in an ambient air for 48 h.

Nitrate reduction test. Procedure. Nitrate broth was inoculated with 1–2 drops from the young broth culture. After completion of incubation, 1 ml of each reagent A and B was added to the test medium.

Oxidase test. Procedure. Filter paper was moistened with the substrate or a commercially available paper disk that has been impregnated with the substrate is used. Using a platinum wire or wooden stick, a small portion of bacterial colony from the agar surface were removed and rubbed on the filter paper or commercial disk. Than observed the inoculated area of paper or disk for a color changes to deep blue or purple color within 10 s.

Urease test. Procedure. The surface of urea agar slant was streaked with a small portion of well isolated colony and the slant was inoculated with 1–2 drops from an overnight brain–heart infusion broth culture. The cap was loosened and the tubes were incubated at 35°–38° in ambient air for 48 h to 8 days.

L-Pyrrolidonyl Arylamidase (PYR) test. Procedure. Before inoculation, the disk was moistened lightly with Analytical grade water. A wooden applicator stick was used to rub a small amount of several colonies for about 18–24 h with pure culture on small area of PYR disk then incubated at room temperature for 2 min. A small portion of detector reagent N, N-dimethylamino-cinnamaldehyde was added and observed for red color development within 1 min.

Fermentation media. Procedure. A tube was inoculated with 1 drop of 18–24 h brain–heart infusion broth culture and was then incubated at 35–38 °C for about 8 days. Acid and gas production is examined.

Decarboxylase test. Procedure. Tubes were inoculated with a drop of brain–heart infusion broth culture, and a thin layer of sterile mineral oil was added to each tube. The cultures were incubated for 4 days at 35°–38° in ambient air and were examined at 24, 48, 82, 96 h.

Triple sugar iron. Procedure. By using a straight inoculation needle, the top of a well isolated colony was touched. TSI was first inoculated by stabbing through the medium to the middle of the tube and then streaking the surface of the agar slant. The cap was loosened and the tubes were incubated at 35°-38°C in excess air for 18–24 h.

Deoxyribonuclease test. Procedure. 42.0 g of dehydrated media was suspended in 1000 ml in AR grade water and then heated with frequent agitation to mix the medium completely. The mixture after sterilization by autoclaving at 118°–121° for 15 min, was then made to cool to 45°, finally poured in sterile Petri plates. Then 100 mg toluidine blue was added before sterilizing the medium or the plates were flooded with 0.1% toluidine blue after incubation as desired.

Phenolphthalein phosphatase test. Procedure. 28.01 g of dehydrated powder was mixed in 1000 ml of distilled water and then heated to boil for complete dissolution of medium. Do not autoclave. Dispense as desired.

Gelatin hydrolysis test. Procedure. 34.00 g of dehydrated powder was dissolved in 1000 ml of distilled water with continuous heating to dissolve the medium completely, then autoclaved at 121 °C for 30 min in a dispensed plate.

Antibiotic susceptibility test. Antibiotic susceptibility test was performed on the basis of organism isolated and antibiotic were selected according to CLSI guidelines. The antimicrobial susceptibility test was carried out Kirby Bauer disk diffusion method.

Muller Hinton agar. Procedure. Nearly 38.0 g were dissolved in 1000 ml of distilled water, with continuous heating for the dissolution of medium completely, and then sterilization was done by autoclaving at 15lbs pressure at 121 °C for 15 min.

Muller Hinton’s agar is used for isolation of gram negative bacilli and gram positive cocci except Streptococcus species.

Kirby Bauer disk diffusion method. Procedure. With a wire loop the 4 to 5 colonies of well isolated similar colonies was touched from the top of agar plate and transferred to the tube that contains 4–5 ml of suitable broth medium, followed by incubation at 35 °C until it matches the 0.5 Mc Farland usually 2–6 h.

A sterile nontoxic cotton swab was put into the inoculum after it adjusts its turbidity of that of standard and the swab was made to rotate many times with continuous pressure on the inside wall of the tube in order to remove excess fluid.

Then on the dried surface of Muller Hinton’s agar plate, the swab was inoculated to bring the swab to room temperature by rotating the entire agar surface to near about 60 degrees each time and finally swab was rimmed
of the agar. Finally the dish lid was replaced and allowed to dry on the surface of the agar before adding the antibiotic disk.

**Observations.** In the study period of about 6 months a total of 260 samples were collected from instruments, hand and nasal from neonatal and pediatrics ICUs. Total no of samples collected from instruments in PICU is 60 and 30 each from nasal and hand (Tables 1, 2 and 3). In NICU the samples collected from instruments were 80 and 30 from hand and nasal each (Tables 4, 5 and 6).

The samples were collected with sterile cotton tipped swabs. The swabs were moistened with sterile normal saline and streaked across a 12 mm² areas and were immediately inoculated on Blood agar, MacConkey agar and the isolates were characteristics by colony identification, gram staining followed by standard biochemical reaction, and the antimicrobial activity was carried out by Kirby Bauer disk diffusion method.

**Results and discussion**

As per the antimicrobial activity is taken into Consideration CoNS are highly sensitive to cotrimoxazole (10/10) followed by linezolid (9/12) while *S.aureus* shows a higher sensitivity to tetracycline (8/10) and vancomycin (8/10) as Shown in Fig. 1a,b. The *Acinetobacter* spp. were most sensitive to (7/7) colistin (7/7) followed by imipenem (7/7) as mentioned in Fig. 2.

Out of 12 CoNS isolated, from the hands of health care worker in PICU the highest sensitivity was observed for vancomycin (10/12), tetracycline (10/12) and co-trimoxazole (9/12), while in *S.aureus* out of 6 isolates tetracycline (6/6) and linezolid (5/6) were the drugs sensitive to the isolates which have been found effective against the inhibition of concerned stains as depicted in Fig. 3a,b. Among the CoNS and *S.aureus* isolates from nasal specimen, linezolid (15/15), vancomycin (15/15) and tetracycline (8/8) followed by linezolid (8/8) and Nitrofurantoïn (6/8) were more effective shown in the Fig. 4a,b.

Out of 30 nasal specimen, predominant isolate was CoNS with a good sensitivity for linezolid (15/15), tetracycline (15/15) and MRSA were produced by 3 isolates in contrast to *S.aureus*, which show good sensitivity

| N = 60 (PICU) | CONS | *S. aureus* | *A. baumanii* | Candida spp. | Micrococcus | Bacillus | No growth |
|---------------|------|-------------|---------------|--------------|-------------|----------|-----------|
| Bed (n = 8)   | 2    | 1           | –             | 1            | –           | 2        | 2         |
| Monitor (n = 6) | 3    | 1           | 2             | –            | 1           | 1        | 2         |
| Infusion pump (n = 6) | –    | –           | –             | –            | –           | –        | 0         |
| Radiant heat warmer (n = 8) | –    | 2           | –             | –            | 1           | –        | 5         |
| Weighing machine (n = 6) | 2    | 1           | 2             | –            | –           | –        | 1         |
| IV stand (n = 6) | –    | 2           | –             | –            | 2           | –        | 2         |
| X ray machine (n = 6) | 1    | 2           | –             | –            | –           | –        | 3         |
| Tubings (n = 8) | 1    | –           | 1             | 1            | 2           | –        | 2         |
| Ventilator (n = 8) | 1    | 1           | 1             | –            | –           | 2        | 2         |
| Total (%)     | 10 (16.6%) | 10 (16.66%) | 6 (10%)       | 2 (3.33%)    | 6 (10%)     | 5 (8.33%)| 21 (35%)  |

**Table 1.** Spectrum of micro-organism isolated from medical devices associated infection in PICU. Different organisms isolated from different instruments of PICU. The organisms which were isolated are CoNS (10), *S.aureus* (10), *Acinetobacter baumanii* (6), *candida* spp. (2), *Micrococcus* (6), *Bacillus* (5).

| Hand swab | CONS | *S. aureus* | Micrococcus | Bacillus | No growth |
|-----------|------|-------------|--------------|----------|-----------|
| (n = 30)  | 12   | 6           | 2            | 4        | 6         |
| (MRCoNS = 3) | 40% | (MRSA = 1) 20% | 6.66%        | 13.3%    | 20%       |

**Table 2.** Hand Carriage of micro-organisms in Health care workers of PICU. Microorganism isolated from hands of health care workers. The organisms which were isolated are CoNS (12/30), *S.aureus* (6/30), *Micrococcus* (2/30), and *Bacillus* (4/30).

| Nasal swab | CONS | *S. aureus* | Micrococcus | No growth |
|------------|------|-------------|--------------|-----------|
| (N = 30)   | 15   | 8           | 5            | 2         |
| (MRCoNS = 3) | 50% | (MRSA = 3) 26.66% | 16.66%      | 6.66%     |

**Table 3.** Nasal Carriage of micro-organism in Health care workers of PICU. Micro-organism isolated from anterior nares of health care workers. The organisms which were isolated are CoNS (15/30), *S.aureus* (8/30), and *Micrococcus* (5/30).
for tetracycline (8/8) followed by linezolid (8/8) and Nitrofurantoin (6/8) and 3 isolates produce MRSA as mentioned in Fig. 5a,b.

Surveillance of health care associates is a well-constituted preventive measure for reduction of infections in HAIs, which are expected to be the carrier of a medium to long-term infector’s systematically. Nosocomial infections (NIs) are common and are increasing treat for hospitalized patients, as they are the major causes of death and disability worldwide. As per the reports of World Health Organization, up to 15% of hospitalized patients get affected by infections associated with nosocomial infections in ICU patients. Regular checkup of device-associated infections in any healthcare center becomes the fundamental issue and an informative not only to health care professionals but also to administration in making various strategies for the prevention and control of such infections. The result of this study is confirming our expectation that the ICU’s are of more risk for the occurrence of nosocomial infection. In the current study as mentioned in Table 7 the most prevalent organism on the surface of medical devices in PICU were CONS (16.66%) and S. aureus (16.66%) (Table 1) while in NICU the most prevalent organism was Klebsiella spp. (11.25%) among Enterobacteriaceae group followed by A. baumanii (10%), E. coli (2.5%), CONS (6.25%), S. aureus (6.25%) and E. faecalis (6.25%) (Table 4). Similar to this result, another study on environment surface of hospital wards showed CONS and Klebsiella spp. as predominant isolates and was the most prevalent isolated bacteria. A study from Northwest Ethiopia also shows the CONS as the most predominant pathogen. However, in the study of Farzaneh Mehraban et al. showed A. baumanii complex and P. aeruginosa the most common bacteria from ICU.
Figure 1. (a) Antibiogram of *S. aureus* isolated from instruments in PICU. (b) Antibiogram of CoNS and *S. aureus* isolated from instruments in PICU. CoNS are highly sensitive to cotrimoxazole (10/10) followed by linezolid (9/12) while *S. aureus* shows a higher sensitivity to tetracycline (8/10) and vancomycin (8/10).

Figure 2. Antibiogram of *Acinetobacter* spp. isolated from instruments in PICU. *Acinetobacter* spp. were most sensitive to (4/6) colistin (4/6) followed by imipenem (4/6).

Figure 3. Antibiogram of CoNS and *S. aureus* isolated from the hands of health workers. (a) Antibiogram of CoNS isolated from hands of health care worker in PICU. (b) Antibiogram of *S. aureus* isolated from hands of health care worker in PICU. Out of 12 CoNS isolated, the highest sensitivity was observed for vancomycin (10/12), tetracycline (10/12), trimoxazole (9/12), while in *S. aureus* out of 6 isolates tetracycline (6/6) and linezolid (5/6) were the drugs sensitive to the isolates.
environment. Agersew Alemu et al. reported CoNS as the most predominant pathogen with overall isolation rates of 24.1%. Although increased rate of isolation was reported from various other studies of USA, India and Nigeria.

Contaminations occur either by direct transfer of contaminated health care worker or by shedding of microorganisms in the nearby vicinity of a patient's bed. In the present study among S. aureus and CoNS, 8/30 (35%) isolates were sensitive for linezolid, vancomycin and MRSA were produced by 3 isolates in contrast to S. aureus, good sensitivity was observed for tetracycline (8/8) followed by linezolid (8/8) and Nitrofurantoin (6/8) and 3 isolates produce MRSA.

Table 7. Growth isolated from NICU and PICU. P value > 0.05, hence the values are non-significant.

| Samples | Instruments | Health care workers |
|---------|-------------|---------------------|
| NICU    | 50          | 51                  |
| PICU    | 39          | 52                  |
| P value | 0.8595      | 1.0000              |

Figure 4. Antibiogram of CoNS and S. aureus isolated from the nares of health workers. (a) Antibiogram of CoNS isolated from anterior nares of health care worker in PICU. (b) Antibiogram of S.aureus isolated from anterior nares of health care worker in PICU. Out of 30 nasal specimen, predominant isolate was CoNS with a good sensitivity for linezolid (13/15), vancomycin (12/15) and MRSA were produced by 3 isolates in contrast to S.aureus, good sensitivity was observed for tetracycline (8/8) followed by linezolid (8/8) and Nitrofurantoin (6/8) and 3 isolates produce MRSA.

Figure 5. (a) Antibiogram of CoNS isolated from medical devices in NICU. (b) Antibiogram of S.aureus isolated from medical devices in NICU. Equal no of a CoNS and S.aureus isolated from NICU and both of them show a good sensitivity pattern for linezolid, co trimoxazole, vancomycin, levofloxacin and in each isolates 2 MRSA isolates were detected.
were MRSA in PICU. Lab contaminated surfaces with resistant microorganisms' increases the spread among patients and in the hospital environment. It is also being observed that some bacterial isolates associated with equipment's, inanimate surfaces, the patient blood culture or other samples of patients does have similarity, and such similarities reinforces the horizontal transference of microbes. As per the reports by Maya frank et al. that, no evidences were found in incline in Nosocomial bloodstream infection (NBI) in patients in Southern Israel during 1992–2001. Maimon et al. mentioned an increase in the number of gram negative enteric bacterial isolates in Southern Israel in year 1989–1992 with maximum Klebsiella spp. (48% of all isolates) and Enterobacter spp. the most predominant which causes Nosocomial bloodstream infections. Krontal et al. reported in year 1988–1998, that 85–90% of all Klebsiella spp. bacteria at PICU were identified as nosocomial. Levy et al. mentioned a nosocomial bloodstream infection rate of 48.5% during year 1988–1994 at a hospital in central Israel.

In this study, the frequency of S. aureus and among Entero-bacteriaceae, Klebsiella pneumoniae and 2 E.coli both of them show sensitivity for colistin and imipenem. Levy et al. mentioned a nosocomial bloodstream infection rate of 48.5% during year 1988–1994 at a hospital in central Israel. In this study, the frequency of S. aureus and among Entero-bacteriaceae, Klebsiella pneumoniae and 2 E.coli both of them show sensitivity for colistin and imipenem. Levy et al. mentioned a nosocomial bloodstream infection rate of 48.5% during year 1988–1994 at a hospital in central Israel.

Antibiogram of isolates from medical devices of ICU In this study, organisms formed from medical equipments of PICU, showed CoNS and S. aureus chief organism, and have been found susceptible to linezolid, tetracycline and vancomycin. Highest sensitivity of S. aureus for vancomycin was found in studies of A. D. khosravi et al. A. baumannii shows susceptibility to colistin and imipenem. Similar picture has been observed by priya dutta et al. The organisms isolated from medical devices of NICU revealed similar picture as in PICU. CoNS and S. aureus although shows resistance to other commonly used drugs, yet linezolid, co-trimoxazole and vancomycin were found to be most effective while for E. faecalis; tigecycline and linezolid were sensitive. From Entero-bacteriaceae family, colistin and imipenem has higher sensitivity pattern and same was observed for A. baumannii. Akash deep et al. in his study isolated 33.3% Klebsiella spp. and observed maximum sensitivity for amikacin. Organism and the antibiogram of isolates from health care workers total of 30 health care workers each from PICU and NICU are included in the study, with a mean age of 20–30 years. Nasal and hand swabs were taken from each individual. Nasal swabs of HCWs from PICU shows a colonization of CoNS (15/30; Table 3), S. aureus (8/30; Table 3) with 6 MRSA strains detected by cefoxitin in disk diffusion test. In this study the antibiotics sensitivity test revealed that CoNS and S. aureus remained sensitive to linezolid, vancomycin, tetracycline and nitro furan to in with low level of susceptibility to erythromycin, Gentamicin and Clindamycin. Ashish pathak et al. in his study isolated S. aureus from nasal carriage in healthy preschool children found highest sensitivity to Clindamycin. At HRP Princess MCS Medical center, Thailand, S. aureus was found resistant to erythromycin, Clindamycin to tetracycline, chloramphenicol and fusidic acid were found resistant with the observation at

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**Figure 6.** (a) Anti biogram of K. pneumoniae isolated from medical devices in NICU. (b) Anti biogram of E.coli isolated from medical devices in NICU. Among Entero-bacteriaceae, 9 Klebsiella pneumoniae and 2 E.coli both of them show sensitivity for colistin and imipenem.
the following rates: 63.2%, 63.2%, 34.2%, 2.6% and 2.6%, respectively. Similar study is done for detection of microbes in hands of health care workers for which swabs from hands were taken and cultured. All participants were found to be colonized with CoNS (12/30; Table 2), S.aureus (6/30 Table 2), MRSA was found in 4 HCW (Table 2) where antibiotic susceptibility pattern revealed their maximum sensitivity for vancomycin, tetracycline, linezolid and co trimoxazole and their resistance for Clindamycin, erythromycin and nitro furan. Similarly a sum of 30 nasal and hand swabs were also collected from health care associates of NICU, which shows the presence of CoNS (13/30 Table 5) and S.aureus (7/30 Table 5) isolates from hand sampling. Antibiogram of CoNS depicted linezolid, vancomycin and nitrofurantoin as the most susceptible antibiotic while erythromycin and Clindamycin as the most resistant one. Antibiogram from hand samples showed sensitivity of CoNS and S.aureus to linezolid, vancomycin and tetracycline and resistance for erythromycin, levofloxacin and co trimoxazole. Colistin sensitivity for Acinetobacter spp. and Klebsiella spp. remains highest. Clinical samples of blood specimen from NICU shows maximum Candida spp. (60/135), followed by Acinetobacter baumannii (21/135), K. Pneumoniae (20/135) (Fig. 11). From PICU, blood specimen from

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**Figure 7.** (a) Antibiogram of Acinetobacter spp. isolated from medical devices in NICU. (b) Antibiogram of Enterococcus faecalis isolated from medical devices in NICU. Acinetobacter spp., were least resistance to colistin (2/8) imipenem (8/8), Enterococcus faecalis shows more sensitivity towards Tigecycline (5/5) followed by linezolid (3/5).

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**Figure 8.** (a) Antibiogram of CoNS isolated from anterior nares of health care workers. (b) Antibiogram of S.aureus isolated from anterior nares of health care workers in NICU. CoNS as the predominant isolates shows a least resistant to tetracycline (1/13) and linezolid (2/13) with 3 MRSA isolated. For S.aureus, linezolid (8/8) susceptibility was observed with (2/8) MRSA detected.
clinical samples shows the presence of A. baumanii (5/21) and candida spp. (5/21) in equal numbers followed by Enterococci (3/21) (Fig. 12).

Prevention is more important than management of device associated infection, simple measures of asepsis and strict adherence to hand hygiene can decrease the incidence of nosocomial infection. The continuous surveillance of hospital environment for microbial infections with continuous inspection over infection control and prevention practices will prevent HAI.

Conclusion
A large number of factors are associated with health care associated infections in the hospitals. The Health care associated infections have significant impact on patients out comings including morbidity, mortality, hospital stay and cost of care. Therefore, a direct focus towards HCAI’s may provide a way for the health quality of health care associates and their impact on the patients. Nursing care measures have direct impact on the prevention of various types of infections, central line infections, urinary system infections, sepsis and antibiotic resistant infections. Control over patient to patient transmission of infection by using hand hygiene's and control over general infection practices are the efficient ways for controlling the spread of resistant organisms. All persons who enter the unit should change into fresh gowns to prevent cross infection of susceptible infants. Environmental hygiene should be improved by removal of dust and dirt using vacuum cleaners with air exhaust and scrubbing of equipment's and inanimate objects will provide a really clean environment. HEPA filter can be used for air

Figure 9. (a) Antibiogram of CoNS isolated from hands of health care workers of NICU. (b) Antibiogram of S. aureus isolated from hands of health care workers of NICU. Out of total CoNS isolated maximum sensitivity was shown for Linezolid (4/4) and Vancomycin (4/4) whereas for S. aureus tetracycline (5/5) and Vancomycin (4/5) showing maximum sensitivity pattern.

Figure 10. (a) Antibiogram A. baumanii isolated from hands of health care workers in NICU. (b) Antibiogram of Klebsiella spp. isolated from hands of health care workers in NICU. A good sensitivity pattern was observed for both A. baumanii as well as Klebsiella spp. for colistin (5/5, 6/6).
filtration. The strict adherence to aseptic protocol must be enforced by institution and periodic surveillance of colonization of HCW as well as equipment's should be done.

Received: 24 August 2020; Accepted: 3 December 2020
Published online: 12 January 2021

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**Author contributions**

The idea development was by Dr. M. Amin Mir, the experimental setup was carried out by Vibha and Bilal Ahmad. The preparation of manuscript was carried out by Dr. M. Amin Mir and Dr. Waqar Ashraf.

**Funding**

There was no any funding agency for the concerned work, and all the expenditures were carried out by the authors itself, although we are thankful to UCBMS, Dehradun and PMU Saudi Arabia for allowing us to work on the project in reference.

**Competing interests**

There is no any conflict of interest among the authors, all have mutually worked together, and performed the work with better understanding and will continue to work progressively.

**Additional information**

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