# RESULTS

The study was carried out on 76 patients admitted to the Pediatric Department (including 26 admitted to the ward, 13 to the ICU and 37 to the NICU) and were having prolonged vascular catheterization > 12 hrs. They were 40 males and 36 female as shown in table (9). Their ages ranged from 3 days to 10 years and grouped into 3 groups as shown in table (10).

**Table {9}** Sex distribution of the studied subjects

| Sex | No. | % |
|---|---|---|
| **Male** | 40 | 52.7 |
| **female** | 36 | 47.3 |
| **Total** | 76 | 100 |

**Table {10}** Age groups of the studied subjects

| Age group | No. | % |
|---|---|---|
| **<1month** | 40 | 52.6 |
| **1-12months** | 20 | 26.3 |
| **>12months-10 years** | 16 | 21.1 |
| **Total** | 76 | 100 |

The samples were 27 CVC tips, 24 umbilical catheter tips and 25 peripheral catheter tips with concomitant blood culture samples. Forty five (59.2%) of those catheters were positively colonized when cultured by the semiquantitative method, where as there were 22 (29%) positive blood culture results; 14 (18.4%) were catheter related infection [the same organism was isolated from both the catheter culture and blood culture with the same antibiogram pattern and absence of any obvious focus of infection] and 8 (10.5%) were catheter unrelated infection.

## Analysis of Risk Factors

### 1) Age:

**Table {11}** the catheter colonization in different age groups of the studied patients.

| Age | colonization | |
|---|---|---|
| | -ve<br>n (%) | +ve<br>n (%) |
| <1month<br>(n=40) | 15 (37.5) | 25 (62.5) |
| 1-12 months<br>(n=20) | 8 (40) | 12 (60) |
| >12 months<br>(n=16) | 8 (50) | 8 (50) |

$$X^2 = 0.746$$
$$P = > 0.05$$

Table (11) shows insignificant statistical effect of age with catheter colonization.

**Figure {11}** distribution of the diagnosed CRBSI among different age groups

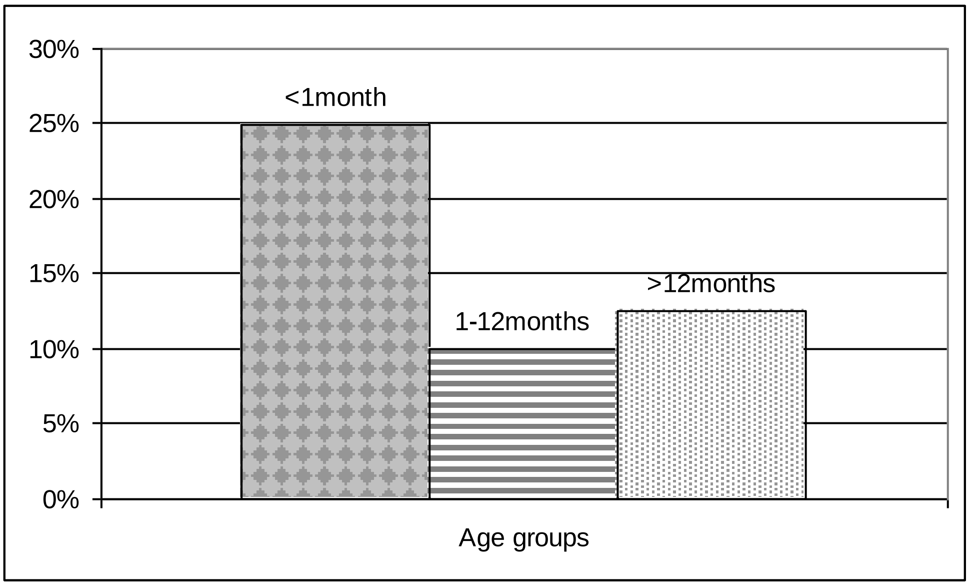



Figure (11) shows that the majority of the CRBSI were found in the patients of < 1 month old.

**Table {12}** distribution of the diagnosed CRBSI among different age groups

| **Age** | **CRBSI** | |
|---|---|---|
| | **-ve n (%)** | **+ve n (%)** |
| **<1month (n=40)** | 30 (75) | 10 (25) |
| **1-12 months (n=20)** | 18 (90) | 2 (10) |
| **>12 months (n=16)** | 14 (87.5) | 2 (12.5) |

***$X^2$ = 2.469***
***P* = > 0.05**

Table (12) shows a statistically non significant effect of the age on CRBSI. ***But***, the most cases of CRBSI were diagnosed in patients less than 1 month old.

## 2) <u>Weight</u>:

**Table {13}** relation of patients' weight with catheters colonization

| Catheter colonization | Weight<br>mean ± S.D. (kg) |
|---|---|
| **Sterile catheters** | 7.48 ± 6.22 |
| **Colonized catheters** | 5.19 ± 5.23 |

***T = 1.76***
***P = > 0.05***

Table (13) shows a statistically non significant relation between weight & catheter colonization.

**Table {14}** relation of patients' weight with CRBSI

| CRBSI | Weight<br>Mean ± S.D. (kg) |
|---|---|
| **positive** | 3.19 ± 3.95 |
| **negative** | 6.79 ± 5.91 |

***T = 2.17***
***P = < 0.05***

Table (14) shows a statistically significant relation between weight & CRBSI.

## 3) Catheter type:

**Table {15}** relation between catheter type and colonization

| **catheter type** | **colonization** | |
|---|---|---|
| | **-ve**<br>n (%) | **+ve**<br>n (%) |
| **Central (n=27)** | 9 (33.3) | 18 (66.7) |
| **Umbilical (n=24)** | 10 (41.7) | 14 (58.3) |
| **Peripheral (n=25)** | 12 (48) | 13 (52) |

$$X^2 = 1.167$$
$$P = > 0.05$$

Table (15) shows that the catheter type has a statistically non significant effect on catheter colonization.

**Figure {12}** relation between catheter type and CRBSI

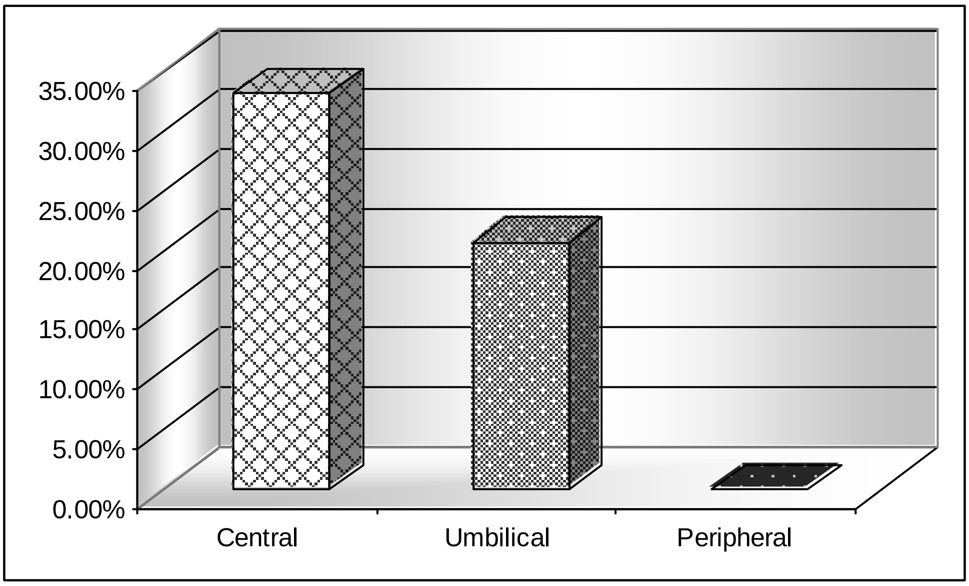



Figure (12) shows the diagnosed cases of CRBSI with different catheter types. Most cases occur with CVCs followed by the umbilical catheters while no cases were diagnosed with the peripheral catheters.

**Table {16}** relation between catheter type and CRBSI

| catheter type | CRBSI | |
|---|---|---|
| | -ve<br>n (%) | +ve<br>n (%) |
| **Central (n=27)** | 18 (66.7) | 9 (33.3) |
| **Umbilical (n=24)** | 19 (79.2) | 5 (20.8) |
| **Peripheral (n=25)** | 25 (100) | 0 (0) |

***$X^2$ = 9.733***
***P = < 0.05***

Table (16) shows that that catheter type has a statistically significant effect on CRBSI; CVCs were associated with the highest rates of CRBSI while no CRBSI occurred with peripheral catheters.

## 4) Number of attempts at catheter insertion:

**Table {17}** Number of insertion attempts and colonization in different catheter types

| Catheter type | No of attempts | Colonization | | $X^2$ | P |
|---|---|---|---|---|---|
| | | **-ve** n (%) | **+ve** n (%) | | |
| **CVCs** | **one (n=17)** | 6 (35.3) | 11 (64.7) | ***0.02*** | ***> 0.05*** |
| | **> one (n=10)** | 3 (30) | 7 (70) | | |
| **umbilical catheters** | **one (n=16)** | 8 (50) | 8 (50) | ***0.54*** | ***> 0.05*** |
| | **> one (n=8)** | 2 (25) | 6 (75) | | |
| **peripheral catheters** | **one (n=10)** | 8 (80) | 2 (20) | ***4.87*** | **<0.01** |
| | **> one (n=15)** | 4 (26.7) | 11(73.3) | | |

Table (17) shows a statistically non significant effect of number of attempts at catheter insertion on central venous catheters and umbilical catheters colonization, whereas it has a statistically significant effect on peripheral catheters colonization.

**Table {18}** Number of insertion attempts and CRBSI in different catheter types

| Catheter type | No of attempts | CRBSI | | $X^2$ | P |
|---|---|---|---|---|---|
| | | -ve n (%) | +ve n (%) | | |
| **CVCs** | **One (n=17)** | 11 (64.7) | 6 (35.3) | ***0.02*** | ***> 0.05*** |
| | **>one (n=10)** | 7 (70) | 3 (30) | | |
| **umbilical catheters** | **One (n=16)** | 13 (81.3) | 3 (18.7) | ***0.032*** | ***> 0.05*** |
| | **>one (n=8)** | 6 (75) | 2 (25) | | |

Table (18) shows a statistically non significant effect of number of attempts at catheter insertion on central venous catheters &umbilical CRBSI.

## 5) Duration of catheterization:

**Table {19}** duration of catheter insertion and colonization of the different types of catheters

| Catheter type | colonization | Duration Mean ± S.D. | *T* | *P* |
|---|---|---|---|---|
| **CVCs** | +ve | 10.1 ± 5.29 | ***2.4*** | ***< 0.05*** |
| | -ve | 6.1 ± 2.66 | | |
| **Umbilical catheters** | +ve | 7.2 ± 4.43 | ***3.87*** | ***< 0.001*** |
| | -ve | 1.7 ± 0.64 | | |
| **Peripheral catheters** | +ve | 3.9 ± 1.21 | ***3.56*** | ***< 0.01*** |
| | -ve | 2.5 ± 0.65 | | |

Table (19) shows a statistically significant effect of duration of insertion on the colonization of the three catheter types.

**Table {20}** duration of catheter insertion and CRBSI with different catheter types

| Catheter type | colonization | Duration Mean ± S.D. | *T* | *P* |
|---|---|---|---|---|
| **CVCs** | +ve | 12.1 ± 5.3 | ***3.56*** | ***< 0.01*** |
| | -ve | 6.4 ± 3.06 | | |
| **Umbilical catheters** | +ve | 9.4 ± 4 | ***3.08*** | ***< 0.01*** |
| | -ve | 3.7 ± 3.46 | | |

Table (20) shows a statistically highly significant effect of duration of insertion on CVCs & Umbilical catheters related bacteremia.

## 6) Site of peripheral catheter insertion:

**Figure {13}** Rate of peripheral catheter colonization in different sites of insertion

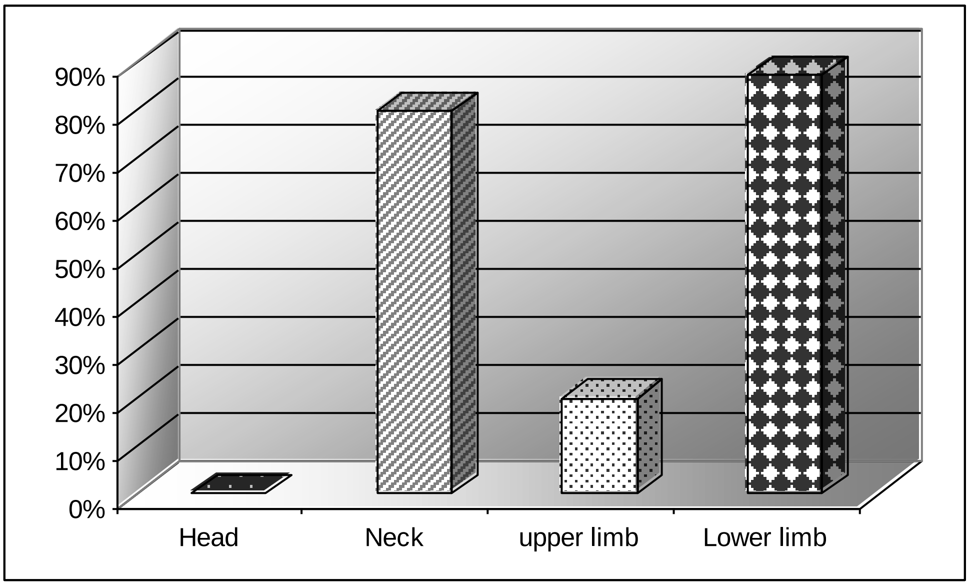



Figure (13) shows that the highest colonization rate was detected with the lower limb catheters.

**Table {21}** Rate of peripheral catheter colonization in different sites of insertion

| site of peripheral catheter | colonization | |
|---|---|---|
| | **-ve**<br>**n (%)** | **+ve**<br>**n (%)** |
| **Head**<br>**(n=4)** | 4 (100) | 0 (0) |
| **Neck**<br>**(n=5)** | 1 (20) | 4 (80) |
| **upper limb**<br>**(n=8)** | 6 (75) | 2 (20) |
| **Lower limb**<br>**(n=8)** | 1 (12.5) | 7 (87.5) |

***$X^2$ = 12.279***
***P* = < 0.05**

Table (21) shows that the site of peripheral catheter insertion has a statistically significant effect on catheter colonization. The highest colonization rate was in those inserted in the lower limbs.

## 7) <u>Site of admission:</u>

**Table {22}** catheters colonization in different hospital admission sites

| site of admission | colonization | |
|---|---|---|
| | -ve<br>n (%) | +ve<br>n (%) |
| **Ward (n=26)** | 13 (50) | 13 (50) |
| **ICU (n=13)** | 6 (46.2) | 7 (35.8) |
| **NICU (n=37)** | 12 (32.4) | 25 (67.6) |

$X^2 = 2.138$
$P = > 0.05$

Table (22) shows a statistically non significant effect of the site of hospital admission on catheters colonization.

**Figure {14}** CRBSI in different hospital admission sites

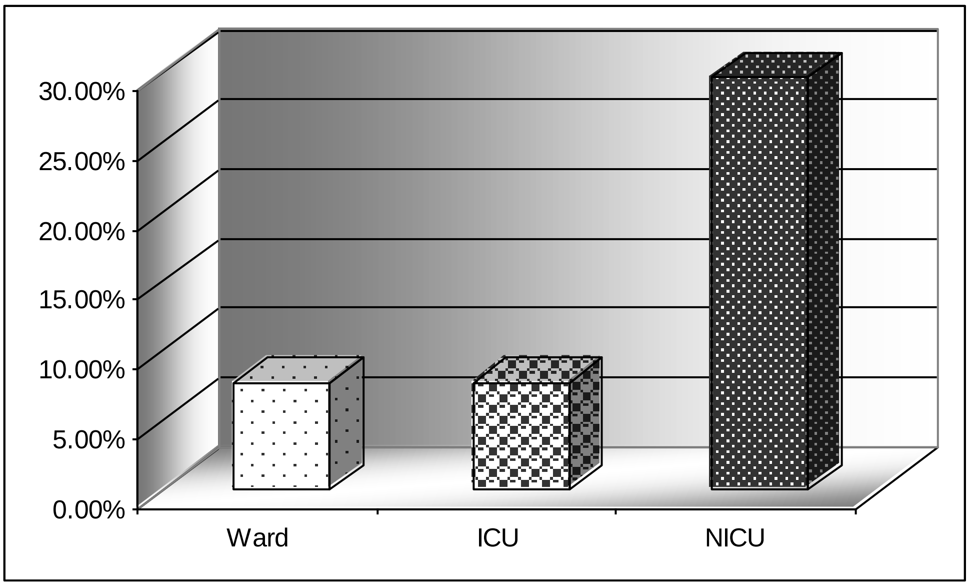



Figure (14) shows that the majority of the CRBSI were found in the NICU**.**

**Table {23}** CRBSI in different hospital admission sites

| **site of admission** | **CRBSI** | |
|---|---|---|
| | **-ve**<br>**n (%)** | **+ve**<br>**n (%)** |
| **Ward (n=26)** | 24 (92.3) | 2 (7.7) |
| **ICU (n=13)** | 12 (92.3) | 1 (7.7) |
| **NICU (n=37)** | 26 (70.3) | 11 (29.7) |

$X^2 = 6.136$
$P = < 0.05$

Table (23) shows a statistically significant effect of the site of admission on CRBSI; the highest rates of CRBSI were occurred in the NICU.

## 8) Medical condition:

**Figure {15}** catheter colonization in different medical conditions

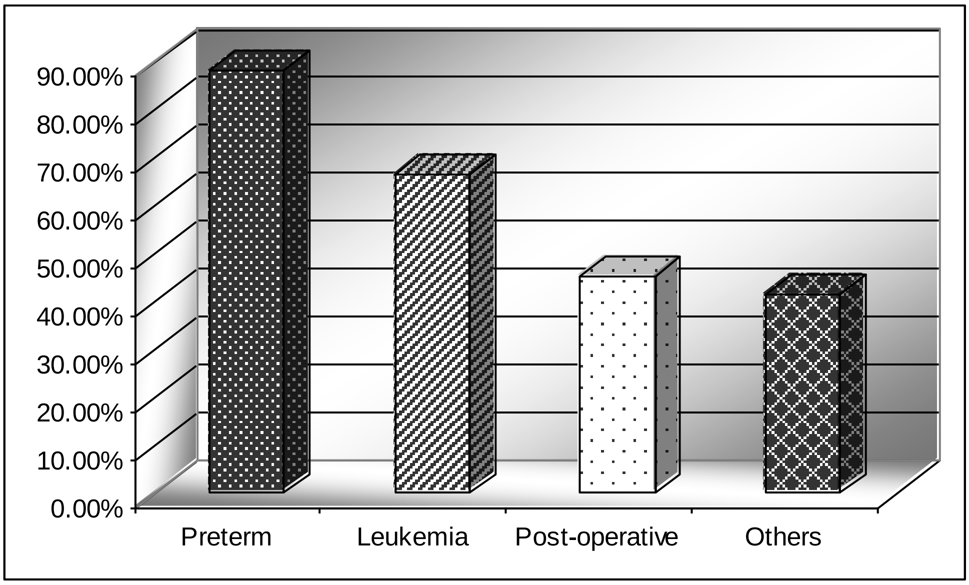



Figure (15) shows that the majority of the colonized catheters were found in preterm cases.

**Table {24}** catheter colonization in different medical conditions

| Disease | Colonization | |
|---|---|---|
| | **-ve** n (**%**) | **+ve** n (**%**) |
| **Preterm (n=26)** | 3 (11.5) | 23 (88.5) |
| **Leukemia (n=3)** | 1 (33.3) | 2 (66.7) |
| **Post-operative (n=11)** | 6 (54.5) | 5 (45.5) |
| **Others (n=36)** | 21 (58.3) | 15 (41.7) |

$X^2 = 14.729$
$P = < 0.05$

Table (24) shows a statistically significant effect of the medical condition on catheter colonization.

**Figure {16}** CRBSI in different medical conditions

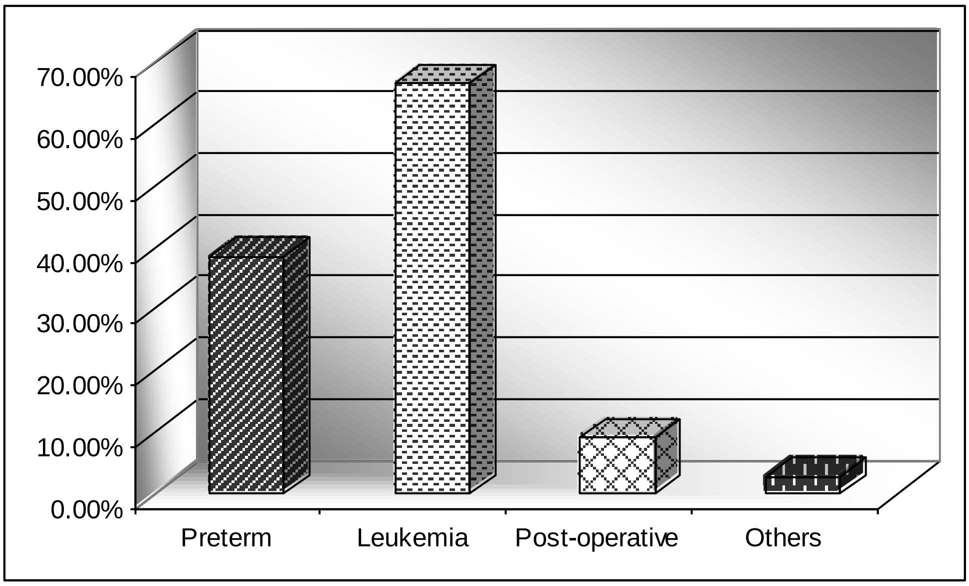



Figure (16) shows that the majority of the CRBSI were diagnosed in preterms.

**Table {25}** CRBSI in different medical conditions

| **Disease** | **CRBSI** | |
|---|---|---|
| | **-ve** n (**%**) | **+ve** n **(%)** |
| **Preterm (n=26)** | 16 (61.5) | 10 (38.5) |
| **Leukemia (n=3)** | 1 (33.3) | 2 (66.7) |
| **Post-operative (n=11)** | 10 (90.9) | 1 (9.1) |
| **Others (n=36)** | 35 (97.2) | 1 (2.8) |

$X^2 = 18.095$
$P = < 0.05$

Table (25) shows a statistically significant effect of the medical condition on CRBSI.

## Isolated Microorganisms

**Table {26}** Microorganisms diagnosed in catheter colonization

| isolated Microorganism | CVCs | Umbilical catheters | Peripheral catheters | Total | |
|---|---|---|---|---|---|
| | | | | No | % |
| ***CNS*** | 3 | 2 | 10 | 15 | 33.33 |
| ***Pseudomonas*** | 4 | 3 | 0 | 7 | 15.6 |
| ***Candida albicans*** | 1 | 3 | 2 | 6 | 13.33 |
| ***Staphylococcus aureus*** | 4 | 0 | 1 | 5 | 11.11 |
| ***E.coli*** | 3 | 2 | 0 | 5 | 11.11 |
| ***Enterobacter*** | 1 | 1 | 0 | 2 | 4.44 |
| ***Micrococcus*** | 1 | 1 | 0 | 2 | 4.44 |
| ***Klebsiella*** | 0 | 1 | 0 | 1 | 2.22 |
| ***Mixed*** | 1 | 1 | 0 | 2 | 4.44 |
| **Total** | **18** | **14** | **13** | **45** | **100** |

Out of 76 cultured catheters 45(59.2%) were colonized. *CNS* was the most frequently isolated organism (33.33%), followed by Pseudomonas (15.6%), *Candida albicans* (13.33%), *Staphylococcus aureus* & *E.coli* (11.11%) as illustrated in table (26) &figure (20).

**Figure {17}** Microorganisms diagnosed in catheter colonization

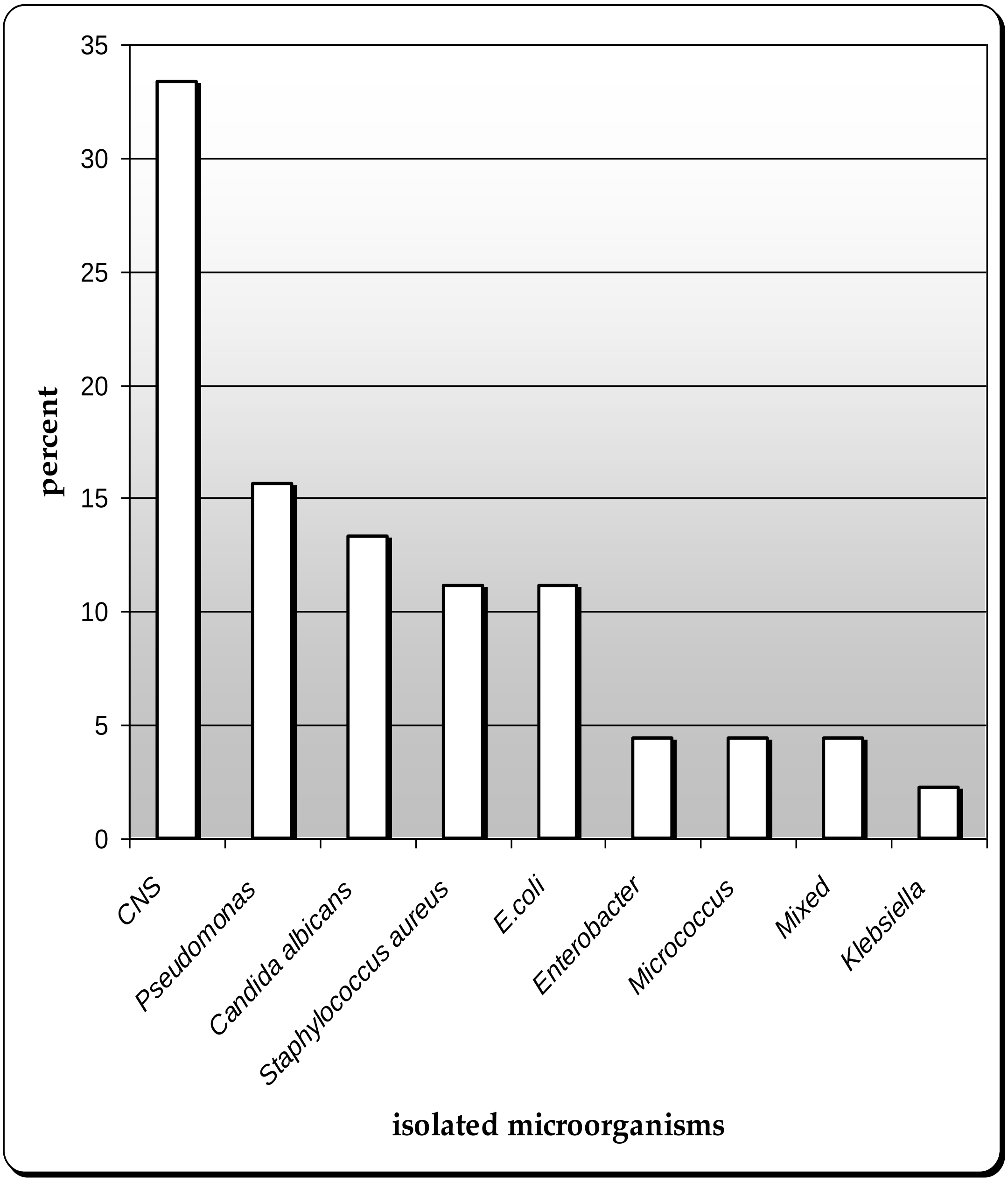
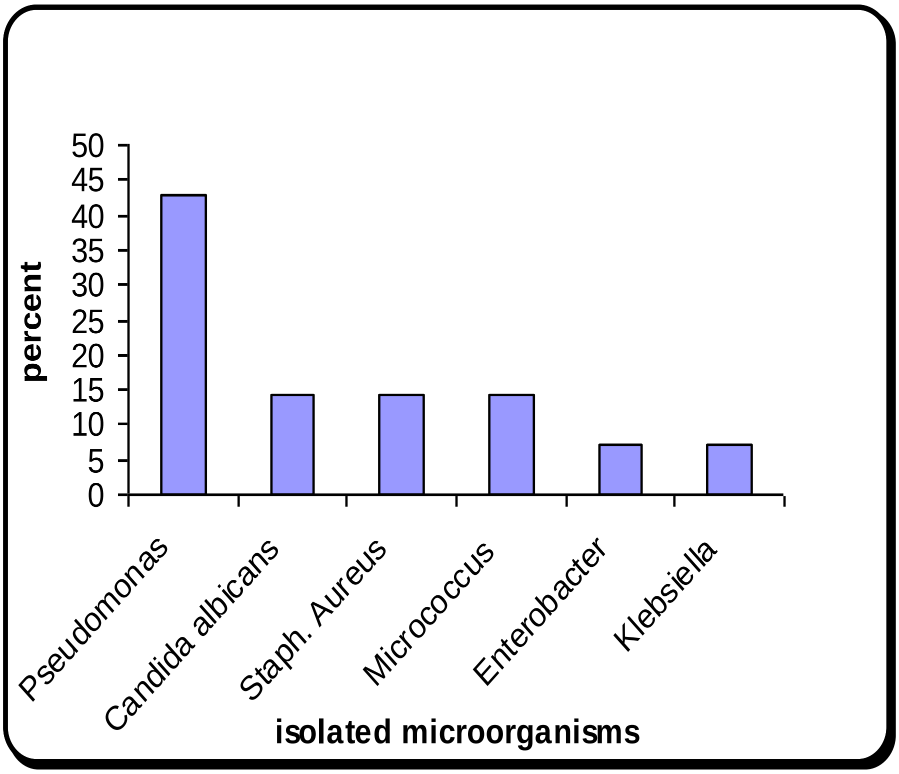


**Table {27}** Microorganisms associated with CRBSI

| isolated Microorganism | No | % |
|---|---|---|
| ***Pseudomonas*** | 6 | 42.9 |
| ***Candida albicans*** | 2 | 14.3 |
| ***Staphylococcus aureus*** | 2 | 14.3 |
| ***Micrococcus*** | 2 | 14.3 |
| ***Enterobacter*** | 1 | 7.1 |
| ***Klebsiella*** | 1 | 7.1 |
| **Total** | **14** | **100** |

Table (27) & figure (18) show that *Pseudomonas* was the commonest organism isolated from the cases of CRBSI.

**Figure {18}** Microorganisms associated with CRBSI



## Antibiotic susceptibility of the isolated organisms

**Table {28}** Antibiotic susceptibility of the isolated strains from CRBSI

| organism | Case no. | CL | CIP | E | GN | MET | TE | VA | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| *Pseudomonas* | ٨ | R | S | R | S | R | S | R | R | R |
| | ١٠ | R | S | R | S | R | S | R | R | R |
| | ١٦ | R | S | R | S | R | S | S | R | R |
| | ٢٧ | R | S | R | S | R | S | S | R | S |
| | ٣٣ | R | S | R | S | R | S | R | R | R |
| | ٤٧ | R | S | R | S | R | S | S | R | S |
| *Klebsiella* | 30 | R | S | R | S | R | R | S | R | S |
| *Enterobacter* | 18 | R | S | R | R | R | R | R | R | S |
| *Staphylococcus aureus* | 12 | R | S | R | R | R | R | S | R | R |
| | 15 | R | S | R | R | R | R | S | R | R |
| *Micrococcus* | 20 | S | S | R | S | R | S | S | R | S |
| | 31 | S | S | R | S | R | S | S | R | S |

*(CL, Cephalexin; CIP, Ciprofloxacin; E, Erythromycin;GN, Gentamycin; MET, Methicillin;TE,Tetracycline;VA,Vancomycin;P, Penicillin; C, Chloramphenicol; R, Resistant; S, Susceptible)*

## Direct catheter staining with Gram stain and acridine orange:

Twenty four umbilical and 25 peripheral catheters were examined by direct staining (Gram and acridine orange stains) whereas the CVCs were excluded due to their opaque material that made it impossible to be examined under the microscope.

**Table {29}** Relationship between direct catheter staining with Gram and acridine orange stains and results obtained with the semiquantitative catheter culture

| | Catheter culture + ve | -ve | total | Sensitivity (%) | Specificity (%) |
|---|---|---|---|---|---|
| **Gram stain** + ve | 11 | 4 | 15 | **41** | **82** |
| -ve | 16 | 18 | 34 | | |
| total | 27 | 22 | 49 | | |
| **Acridine orange stain** + ve | 18 | 6 | 24 | **67** | **73** |
| - ve | 9 | 16 | 25 | | |
| total | 27 | 22 | 49 | | |

This table shows the sensitivity and specificity of both Gram and acridine orange staining of catheter tips in relation to the semiquantitative catheter culture. Gram stain is less sensitive and more specific than the acridine orange stain.

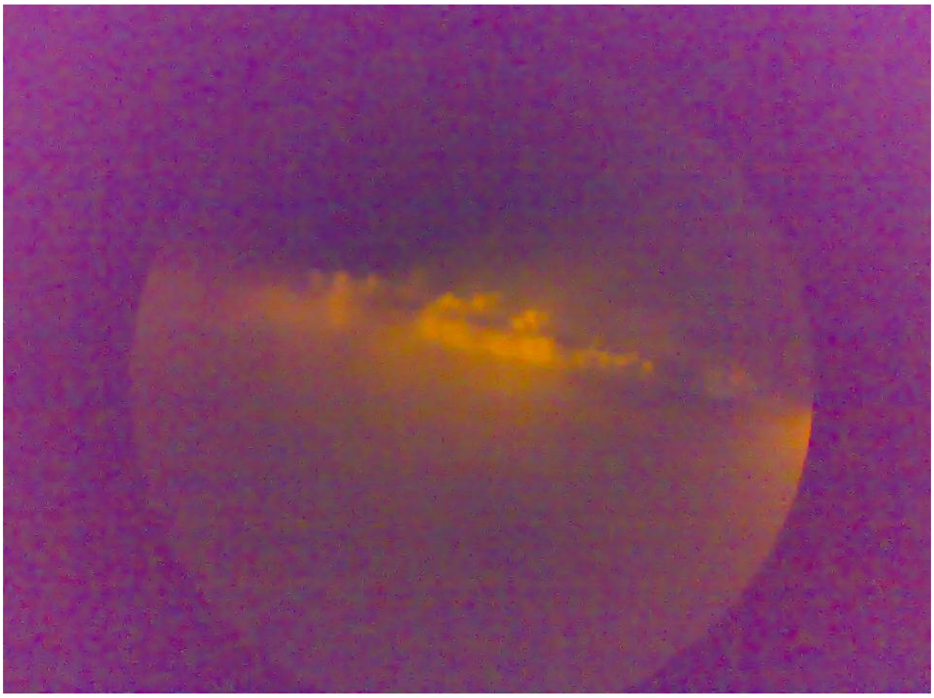


**Figure {19}** acridine orange staining of catheter tip colonized with candida as seen by fluorescence microscope (1000 X)

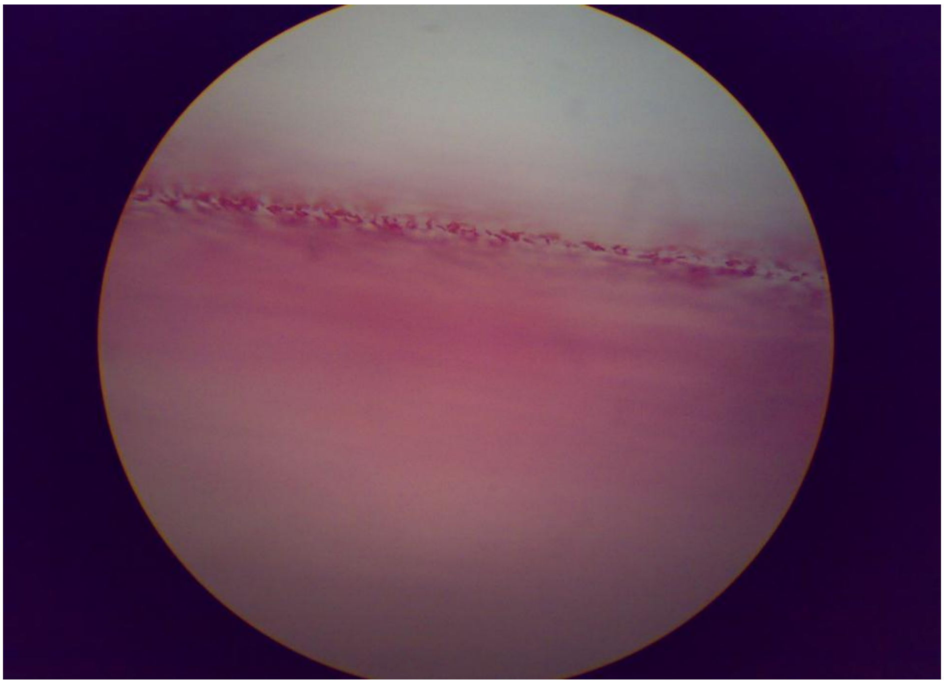


**Figure {20}** catheter tip colonized with Gram negative bacilli as seen by light microscope (1000 X)

## Detection of biofilm production by the isolated staphylococcal strains:

**Table {30}** Results of Congo red agar &Tube method

| | positive | negative | Total |
|---|---|---|---|
| **Congo red agar** | ١٥ | ٥ | ٢٠ |
| **Tube method** | ١٤ | ٦ | ٢٠ |

The variation was only in one strain which gave positive result with congo red and negative by the tube method.

**Table {31}** Degree of agreement between the used methods

| | | Congo red agar | | Total | Kappa | The strength of agreement |
|---|---|---|---|---|---|---|
| | | +ve | -ve | | | |
| Tube method | +ve | 14 | 0 | **14** | 0.875 | 'very good' |
| | -ve | 1 | 5 | **6** | | |
| Total | | **15** | **5** | **20** | | |

This table shows very good agreement between the 2 methods

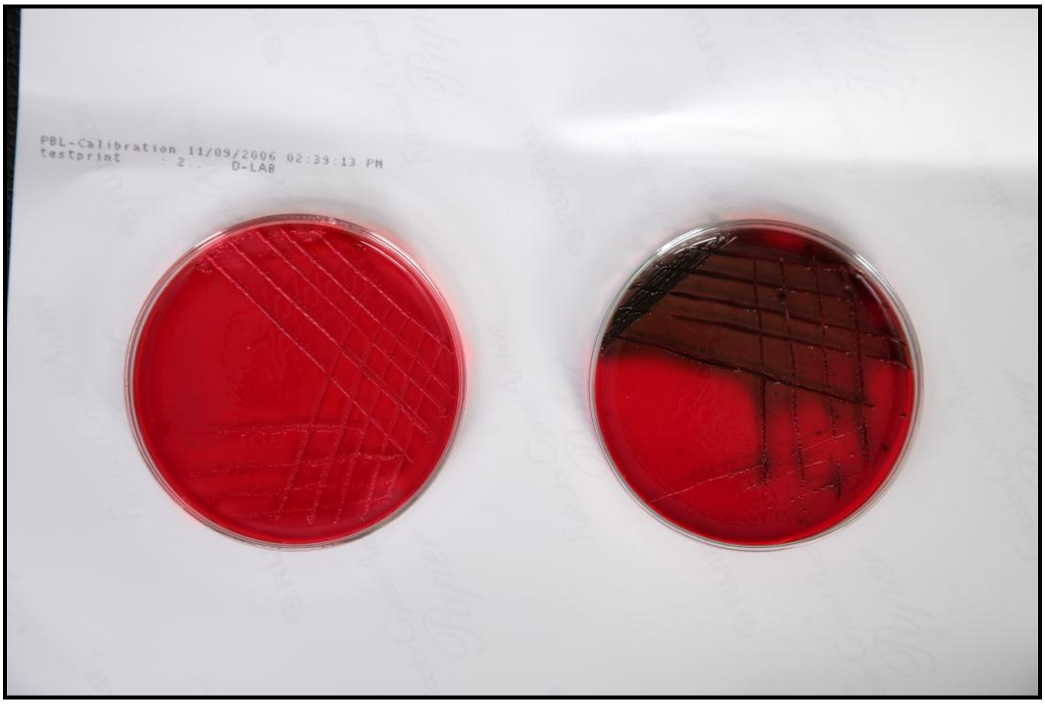



**Figure {21}** Congo red agar showing non biofilm producing staph. (to the left) and biofilm producing staph. with black colonies(to the right)

**Figure {22}** Tube method: a visible film lining the wall of the tube after its staining with trypan blue (right)