The study had shown the following results:

The epidemiological features of the studied neonates in stage I and stage III shows similarity in age (36 ± 4 and 37 ± 3 weeks respectively) and birth weight (2411 ± 901 and 2456 ± 868 grams respectively) distribution (Table 20).

Neonatal jaundice and respiratory distress were the leading causes of admission in both stage I (36.7% and 23.3 respectively) and stage II (33.3% and 26.7% respectively) (table 21).

In stage I, 27% of studied neonates were admitted with community acquired infections, 33% had acquired NIs, while 40% were free from infections (Table 22).

In stage III, 23% of studied neonates were admitted with community acquired infections, 10% had acquired NIs, while 67% were free from infections (Table 23).

Nosocomial infections were significantly positively related to (1) Stay period (2) Artificial respiration (3) Blood or plasma transfusion. Nosocomial infections were significantly inversely related to (4) birth weight and (5) gestational age. Neonatal mortality was significantly positively related to nosocomial infections (Table 24).

Community acquired infections were significantly positively related to premature rupture of membranes (Table 25).

Nosocomial infection rate had dropped from 45% to 13% after the application of the infection control program (Table 26).

Klebsiella pneumoniae was the most predominant pathogen in stage I (64%). In stage III, however, CoNS was the most predominant pathogen (Table 27).

In stage I, the mortality rate was highest in nosocomial infections (50%) intermediate in community acquired infections (25%) and lowest in infection free cases (8%) Nosocomial infections were the leader cause of neonatal mortality (62%) in the first stage (Table 28).

The mortality rate had dropped from 27% to 7% after the application of the infection control program (Table 29).

The mean of stay periods had dropped from 9.53 to 6.6 days, but this result was statistically insignificant (Table 30).

The antibiotic sensitivity patterns of isolated strains of CoNS from NI cases were heterogenous (Table 31).

All isolated strains of Klebsiella from nosocomial infection cases were multidrug resistant. Isolated strains shows two patterns of sensitivity: Some Strains shows sensitivity to amikacin, imipenem, but not sensitive to neither chloramphenicol nor gentamycin (Strain A). The remaining Strains were sensitive to Gentamycin, chloramphenicol, and imipenem, but not sensitive to amikacin (Strain B) (Table 32).

By tracing the source of infection, Klebsiellae were isolated from 3 locations in the NICU; The water sink, Feeding bottles, and Liquid Soap (Table 33).

By comparing antibiogram, the sources of Strain A were: The water sink, feeding bottles, and the liquid soap containers. The source of strain B was in the feeding bottles. Feeding bottle samples contained the two strains of Klebsiellae. (Table 34)

Table (20): Epidemiological features of the neonates included in the study

		Stage I*	Stage III**	Stage I & III
Birth weight (grams)	Number	30	30	60
	Range	1150-3850	1150-5050	1150-5050
	Mean ± SD	2411 ± 901	2456 ± 868	2434 ± 877
	> 2500	46.7%	33.3%	40.0%
	< 1500	23.3%	10.0%	16.7%
	1500 - 2500	30.0%	56.7%	43.3%
Gestational age (weeks)	Number	30	30	60
	Mean ± SD	36 ± 4	37 ± 3	36 ± 4
	Range	28-40	30-40	28-40
Sex	Male	15 (50%)	18 (60%)	33 (55%)
	Female	15 (50%)	12 (40%)	27 (45%)
	Total	30	30	60
Mother Education	House wife	19 (63.3%)	18 (60.0%)	37 (61.7%)
	Educated	11 (36.7%)	12 (40.0%)	23 (38.3%)
	Total	30	30	60
Mode of delivery	Vaginal	25 (83.3%)	19 (63.3%)	44 (73.3%)
	Caesarean section	5 (16.7%)	11 (36.7%)	16 (26.7%)
	Total	30	30	60

* Stage I, initial surveillance stage (before applying the infection control program).

** Stage III, terminal surveillance stage (after applying the infection control program).

The epidemiological features show similarities between stage I and stage III in age (36 ± 4 and 37 ± 3 weeks respectively) and birth weight (2411 ± 901 and 2456 ± 868 grams respectively) distribution.

Table (21) Causes of admission of the neonates included in the study

	Stage I*		Stage III**		I & III	
	n	%	n	%	n	%
clinical sepsis	1	3.3	3	10.0	4	6.7
Edema L.L.	0	0	1	3.3	1	1.7
Hypoxic ischemic en	1	3.3	0	0	1	1.7
Meconium aspiration	0	0	2	6.7	2	3.3
Neonatal Convulsion	0	0	1	3.3	1	1.7
Neonatal Jaundice	11	36.7	10	33.3	21	35.0
poor suckling	1	3.3	0	0	1	1.7
Preterm	5	16.7	4	13.3	9	15.0
Preterm + RDS	3	10.0	1	3.3	4	6.7
Respiratory distress	7	23.3	8	26.7	15	25.0
Scaled skin	1	3.3	0	0	1	1.7
Total	30	100.0	30	100.0	60	100.0

* Stage I, initial surveillance stage (before applying the infection control program).

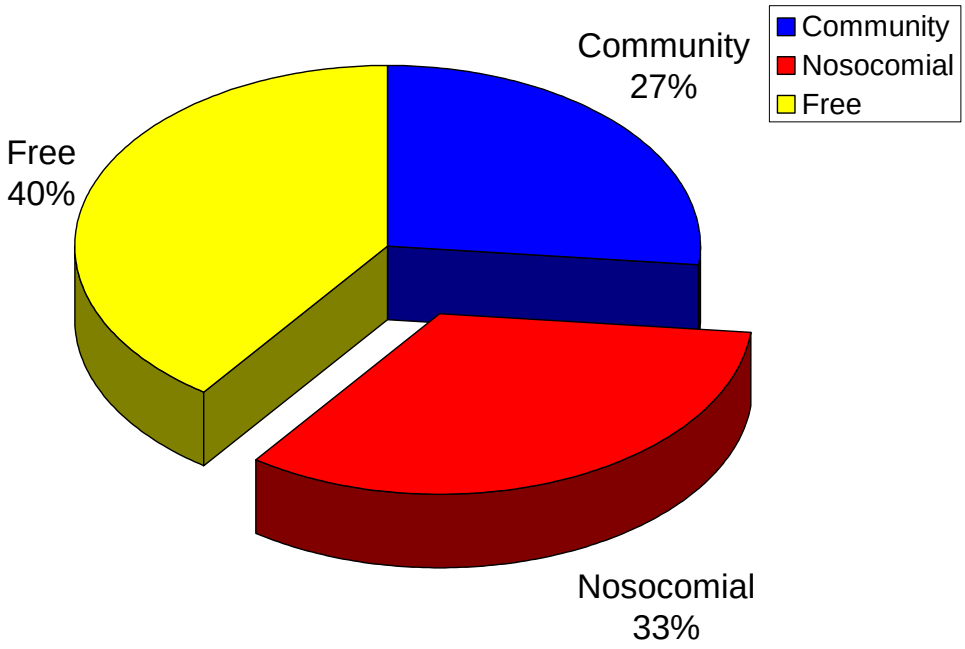
** Stage III, terminal surveillance stage (after applying the infection control program).

*Table (22) Case distribution of the studied neonates in stage I**

	Number	percent
Community	8	27%
Nosocomial	10	33%
Free	12	40%
total	30	100%

* Stage I, initial surveillance stage (before applying the infection control program).

Figure (9) Stage I case distribution*



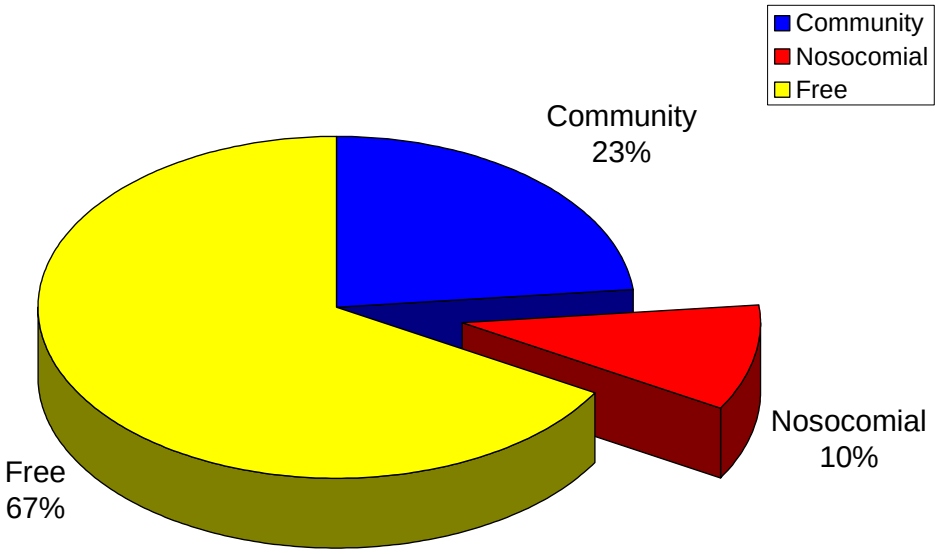
* Stage I, initial surveillance stage (before applying the infection control program).

*Table (23) Case distribution of the studied neonates in stage III**

	Number	percentage
Community Infection cases	7	23%
Nosocomial infection cases	3	10%
Free	20	67%
Total	30	100%

* Stage III, terminal surveillance stage (after applying the infection control program).

Figure (10) Stage III case distribution*



* Stage III, terminal surveillance stage (after applying the infection control program).

*Table (24) Correlations of nosocomial infection with other variables in stage I**

	Nosocomial infection		
	Correlation Coefficient	**P Value**	**Interpretation**
Mortality	0.373	0.021	Significant
Being Male	0.141	0.228	Non Significant
Stay days	0.482	0.003	Highly significant
Artificial Respiration	0.347	0.030	Significant
Peripheral venous catheter	0.309	0.049	Significant
CVC/umbilical	0.094	0.310	Non Significant
O2 box nasal-prongs	0.238	0.103	Non Significant
BLOOD Transfusion.	0.347	0.030	Significant
PROM	-0.277	0.069	Non Significant
BIRTH Weight.	-0.311	0.047	Significant
Gestational AGE	-0.471	0.004	Highly significant
Mother Education	0.049	0.353	Non Significant
Multiple pregnancy	0.094	0.310	Non Significant

* Stage I, initial surveillance stage (before applying the infection control program).

This table shows that nosocomial infections were significantly positively related to (1) Stay period (2) Artificial respiration (3) Blood or plasma transfusion. Nosocomial infections were significantly inversely related to (4) birth weight and (5) gestational age.

Neonatal mortality was significantly positively related to nosocomial infections

*Table (25) Correlations of community infection with other variables in stage I**

	Community infection.		
	Correlation Coefficient	P value	Interpretation
Mortality	-0.023	0.453	Non Significant
SEX	-0.151	0.213	Non Significant
PROM	0.650	0.001	Highly Significant
BIRTH W.	-0.109	0.283	Non Significant
GEST AGE	-0.044	0.408	Non Significant
Mother Education	-0.146	0.221	Non Significant
Multiple gestation	0.141	0.229	Non Significant
Mode of delivery	0.135	0.239	Non Significant
Place of birth	0.210	0.187	Non Significant

* Stage I, initial surveillance stage (before applying the infection control program).

The only statistically significant correlation in this study was with premature rupture of membranes.

Table (26) Nosocomial infection rates before and after application of the infection control program

		Stage I*	Stage III**	total
Nosocomial infection	n	10	3	13
	%	45%	13%	
Infection Free	n	12	20	32
	%	55%	87%	
total	n	22	22	45
	%	100%	100%	

By $\chi 2$ test P value was 0.016490085

* Stage I, initial surveillance stage (before applying the infection control program).

** Stage III, terminal surveillance stage (after applying the infection control program).

Nosocomial infection rate had dropped from 45% in stage I to 13% in stage III.

P value is < 0.05 indicating that the reduction in infection rate is statistically significant and couldn't explained by the chance.

Figure (11) Nosocomial infection rates before and after application of the infection control program

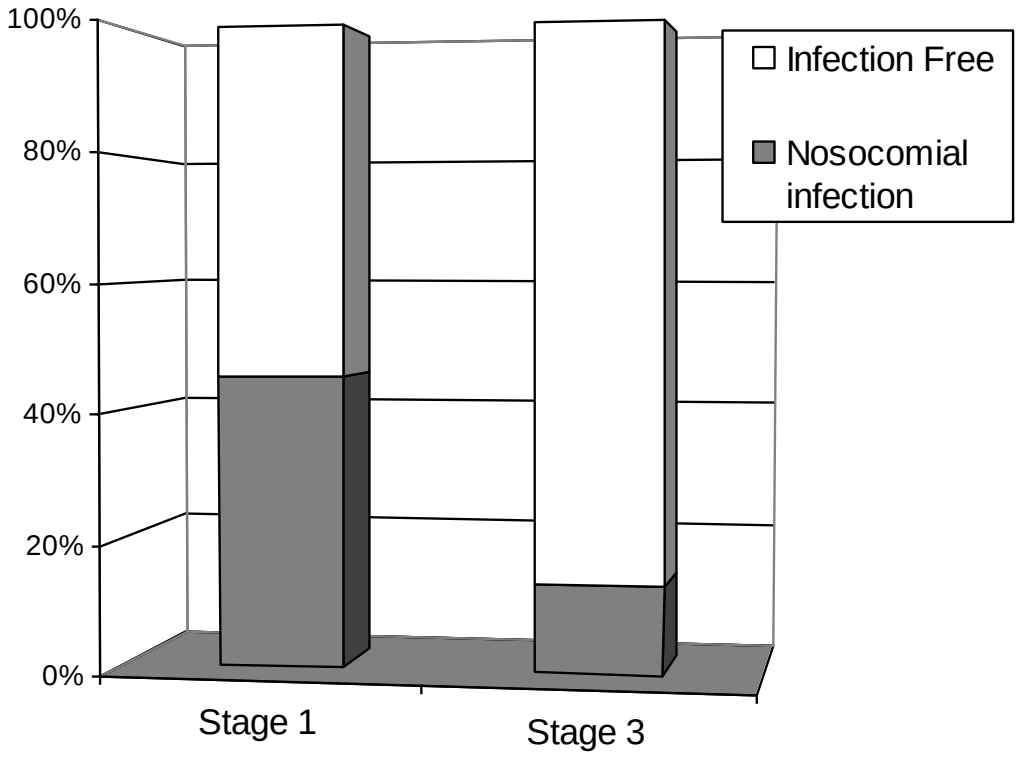


Table (27) Isolated organisms from nosocomial infection cases in stage I and stage III**.*

		Stage I	Stage III	total
Klebsiella	n	7	1	8
	%	64%	33%	
CoNS¶	n	2	2	4
	%	18%	67%	
Candida	n	2	0	2
	%	18%	0%	
total	n	11	3	14
	%	100%	100%	

* Stage I, initial surveillance stage (before applying the infection control program).

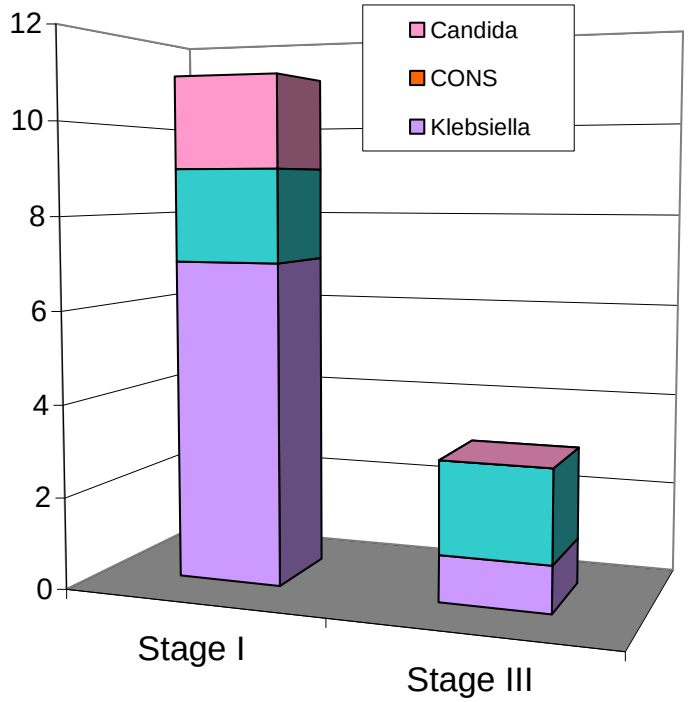
** Stage III, terminal surveillance stage (after applying the infection control program).

¶ CoNS, Coagulase Negative staphylococci

This table shows that *Klebsiella pneumoniae* was the most predominant pathogen in stage I (64%). In stage III, however, CoNS was the most predominant pathogen.

The total strains in stage I (11) is > the total cases (10) due to one case of mixed infection.

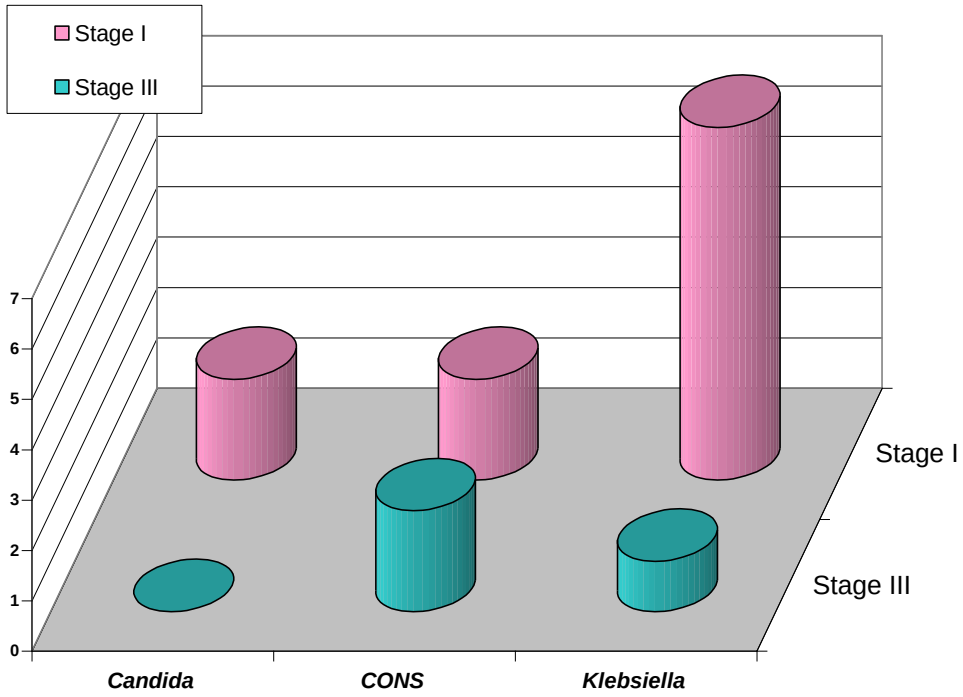
Figure (12) Isolated organisms from nosocomial cases in stage I & stage III***



* Stage I, initial surveillance stage (before applying the infection control program).

** Stage III, terminal surveillance stage (after applying the infection control program).

Figure (13) Change in distribution of pathogens among stage I and stage III**.*



* Stage I, initial surveillance stage (before applying the infection control program).

** Stage III, terminal surveillance stage (after applying the infection control program).

CoNS, Coagulase negative staphylococci

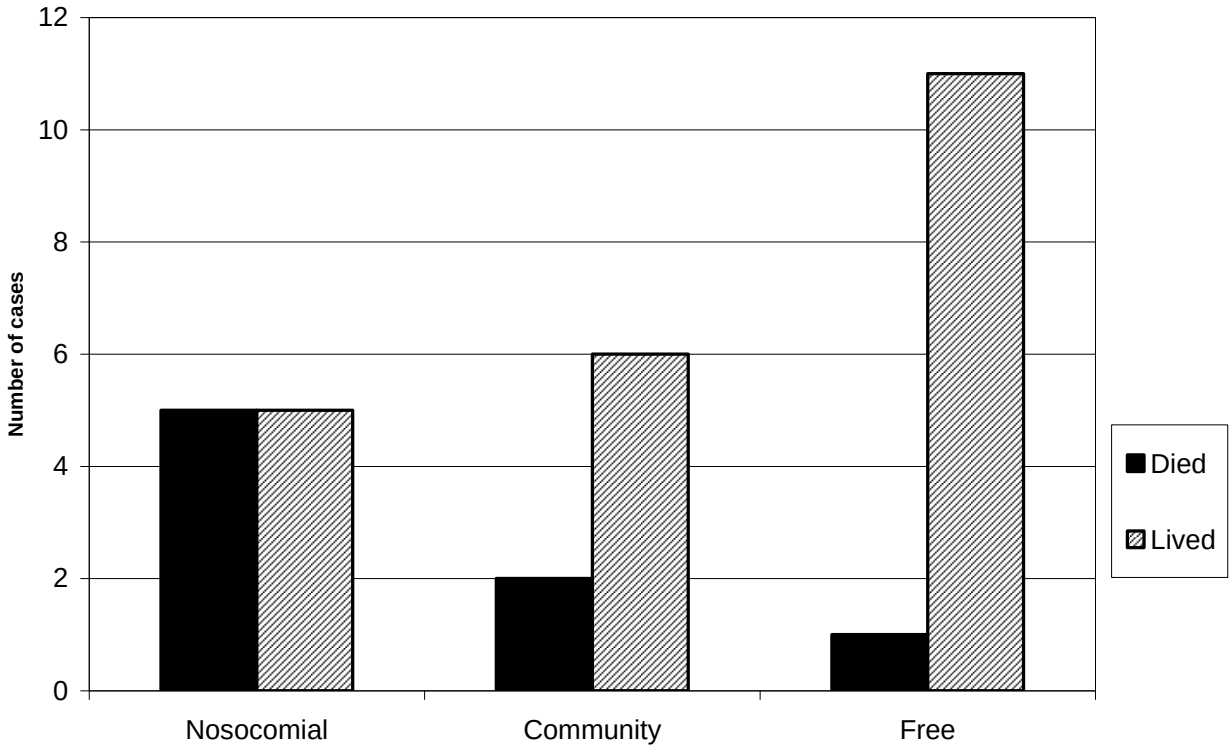
There is a difference in the distribution of pathogens between stage I & stage III. While Klebsiella was the predominant strain (64%) in stage I; CoNS has been the predominant pathogen (67%) in stage III and Candida has disappeared.

*Table (28) Mortality rates in different groups in stage I**

		Nosocomial	Community	Free	Total
Lived	n	5	6	11	22
	%	50%	75%	92%	
Died	n	5	2	1	8
	%	50%	25%	8%	
Total	n	10	8	12	30
	%	100%	100%	100%	

* Stage I, initial surveillance stage (before applying the infection control program).

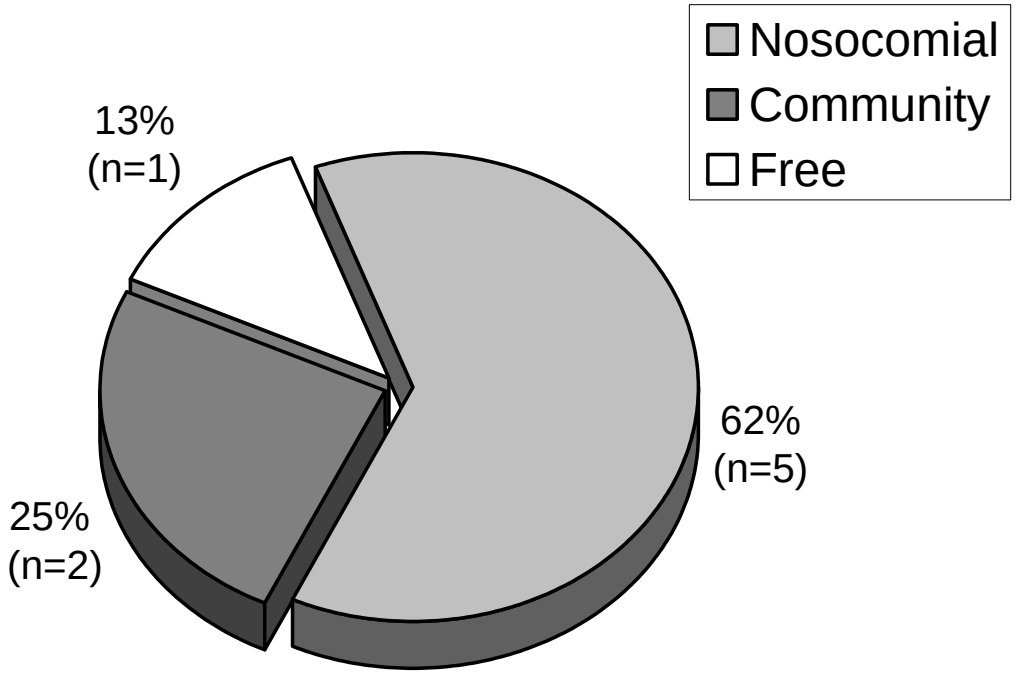
*Figure (14) Mortality rates in different groups in stage I**



* Stage I, initial surveillance stage (before applying the infection control program).

This table and chart shows that the mortality rate was highest in nosocomial infections (50%) intermediate in community acquired infections (25%) and lowest in infection free cases (8%)

*Figure (15) Mortality distribution among different groups in stage I**



* Stage I, initial surveillance stage (before applying the infection control program).

This chart shows that nosocomial infections were the leader cause of neonatal mortality (62%) in the first stage.

Table (29) Mortality rate before and after application of the infection control program

		stage I*	stage III**	Total
Died	n	8	2	10
	%	27%	7%	
Survived	n	22	28	50
	%	73%	93%	
total	n	30	30	60
	%	100%	100%	

By $\chi 2$ test P value was 0.043525

* Stage I, initial surveillance stage (before applying the infection control program).

** Stage III, terminal surveillance stage (after applying the infection control program).

The mortality rate had dropped from 27% in stage I to 7% in stage III.

P value is < 0.05 indicating that the reduction in mortality rate is statistically significant and couldn't be explained by the chance.

Figure (16) Mortality rate before and after application of the infection control program

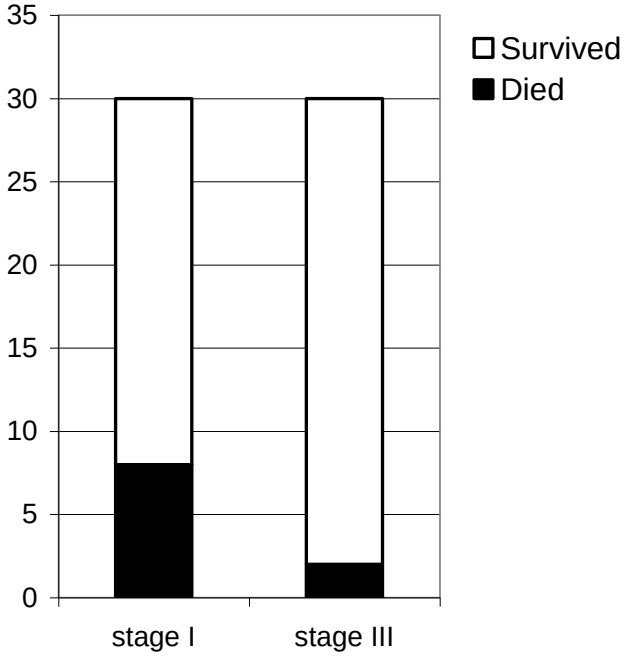


Table (30) Period of hospitalization before and after application of the infection control program

	Stage	N	Mean	Std. Deviation	Std. Error Mean
Stay Period	I*	30	9.53	9.765	1.783
	III**	30	6.60	5.197	0.949

By Student's *t* test t = 1.452 P= 0.152

* Stage I, initial surveillance stage (before applying the infection control program).

** Stage III, terminal surveillance stage (after applying the infection control program).

Although the mean of stay periods had dropped from 9.53 to 6.6 days, this result was statistically insignificant (P > 0.05).

*Table (31) Antibiotic sensitivity of isolated strains of nosocomial CoNS**

Serial N	VA	OX	AMP	CTX	CAZ	CN	C	AK	IMP	SAM	DA	CLR
4	S	R	R	R	R	S	S	S	R	S	S	R
8;	S	R	R	R	R	R	R	S	S	R	S	R

CoNS, coagulase negative staphylococci; S, sensitive; R, resistant.

The antibiotic sensitivity patterns of isolated strains of CoNS were heterogenous.

The two isolated CoNS strains were resistant to oxacillin.

Table (32) Antibiotic sensitivity of isolated strains of nosocomial Klebsiella

Serial N	Strain	Count	%	VA	OX	AMP	CTX	CAZ	CN	C	AK	IMP	SAM	DA	CLR
3	A	3	43	R	R	R	R	R	R	R	S	S	R	R	R
5				R	R	R	R	R	R	R	S	S	R	R	R
24				R	R	R	R	R	R	R	S	S	R	R	R
7;	B	4	57	R	R	R	R	R	S	S	R	S	R	R	R
16				R	R	R	R	R	S	S	R	S	R	R	R
19				R	R	R	R	R	S	S	R	S	R	R	R
31				R	R	R	R	R	S	S	R	S	R	R	R

(S = sensitive; R = resistant)

All isolated strains of Klebsiella from nosocomial infection cases were resistant to: (1) Vancomycin, (2) Oxacillin, (3) Ampicillin, (4) Cefotaxime, (5) Ceftazidime, (6) Ampicillin\sulbactam, (7) Clindamycin, and (8) Clarithromycin.

To the remaining antimicrobials, isolated strains shows two patterns of sensitivity:

(A) Some Strains (will be called Strain A) shows sensitivity to amikacin, imipenem, but not sensitive to neither chloramphenicol nor gentamycin.

(B) The remaining Strains (will be called Strain B) were sensitive to Gentamycin, chloramphenicol, and imipenem, but not sensitive to amikacin

Because Klebsiella strains were responsible for the great majority of nosocomial infection cases, the source of these strains had been traced. The results of tracing the source of these strains are discusses in the following section.

Table (33) Tracing the source of nosocomial Klebsiella

Ser	Source	Organisms isolated
1	Incubator	Coagulase negative Staph
2	Incubator	Coagulase negative Staph
3	Incubator	Coagulase negative Staph
4	Incubator	Coagulase negative Staph
5	Water sink	Coagulase negative Staph
6	Water sink	**Pseudomonas + Klebsiella**
7	Wall oxygen	Anthracoids
8	Wall oxygen	Anthracoids
9	Oxygen box	Coagulase negative Staph
10	Oxygen box	-
11	Feeding bottle	**Klebsiella* + Pseudomonas**
12	Feeding bottle	**Klebsiella* + Pseudomonas**
13	Personnel hands ;	Coagulase negative Staph
14	Personnel hands ;	Diphtheroids + Coagulase negative Staph
15	Personnel hands	Coagulase negative Staph
16	Personnel hands	Coagulase negative Staph
17	Personnel hands	**Pseudomonas**
18	Artificial respiration tubing	**Pseudomonas**
19	Artificial respiration tubing	Anthracoids
20	Antiseptic agent	-
21	Liquid Soap	**Klebsiella**
22	Towels used for hand drying	Coagulase negative Staph
23	Towels used for hand drying	Coagulase negative Staph
24	Faucets	**Staph aureus**
25	Light buttons	Coagulase negative Staph
26	Brushes of feeding bottles	Coagulase negative Staph

* Two strains or variants of Klebsiella were isolated from the same specimen with different antibiotic sensitivity pattern

Klebsiellae were isolated from 3 locations in the NICU

(1) The water sink.

(2) Feeding bottles: two strains of Klebsiella were isolated, showing difference in colony morphology, but the biochemical reactions had revealed that the two stains are *Klebsiella pneumoniae.*

(3) Liquid Soap.

Other medically important organisms isolated were:

(1) Pseudomonas aeruginosa from water sinks, feeding bottles, personnel hands, and artificial respiration tubing.

(2) Staphylococcus aureus were isolated from faucets of hand washing basins.

Table (34) Antimicrobial susceptibility of isolated Klebsiella from tracing samples

Ser	Strain	VA	OX	AMP	CTX	CAZ	CN	C	AK	IMP	SAM	DA	CLR
6	A	R	R	R	R	R	R	R	**S**	**S**	R	R	R
11a	A	R	R	R	R	R	R	R	**S**	**S**	R	R	R
12a	A	R	R	R	R	R	R	R	**S**	**S**	R	R	R
21	A	R	R	R	R	R	R	R	**S**	**S**	R	R	R
11b	B	R	R	R	R	R	**S**	**S**	R	**S**	R	R	R
12b	B	R	R	R	R	R	**S**	**S**	R	**S**	R	R	R

(S = sensitive; R = resistant)

The susceptibility tests had revealed that the sources of Strain A were: (1) The water sink, (2) feeding bottles, and (3) the liquid soap containers.

The source of strain B was in the feeding bottles. Feeding bottle samples contained the two strains of Klebsiellae.