COST-EFFECTIVENESS AND OUTCOMES OF DEVICE-INDUCED NEONATAL SEPSIS IN NICU

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ABSTRACT

Introduction*: Infants in neonatal intensive care units carry a high risk for nosocomial infections. The mortality rate of infections in this age group is reported as between 10-50%. In Egypt, there is deficiency of information and gap of knowledge on estimation of economic burden of device-associated infection in NICU. Minimizing device utilization rate and improving infection control measures could yield saving of costs, morbidity and mortality.*

Aims: *1) To determine device associated infection rates with device utilization. 2) Estimate the direct and indirect costs of hospital stays for every case and for the total unit. 3) Determine morbidity and mortality of studied cases.*

Patient and Method: *This is a descriptive and analytical study done during the period from January 2013 to August 2015; included 140 patients admitted to NICU at El-Hussein University hospital with non-sepsis causes. They were selected by simple random method according to the inclusion and exclusion criteria, with full history, examination and investigations to every case. Divided into two groups, the first device utilization group included 100 cases, and the second non-device utilization group included 40 cases.*

Results*: Regarding the duration of hospital stay; there was a highly significant increase in first group, also there was a highly significant increase in the duration of hospital stay with multiple devices use. Regarding nosocomial infection; it was significantly higher in the first group, and much more in multiple device use. Regarding costs; the final cost was significantly higher in the first group (432.5 LE per-day), than the second group (352.9 LE per-day). Also the multiple device costs (533.6 LE per-day) was highly significant higher than single device cost (365.2 LE per-day). Total cost during the period of stay for a case in first group (15201.9 LE) was significantly higher than second group (6910.2 LE). About 70% of the first group improved, but morbidity rate was 8% and mortality rates reached 22%; while in the second group there was 95% cure with no mortality rates.*

Conclusion: *Less aggressive maneuvers and less device insertions mean better outcomes and little expenses in NICU.*

Recommendations: *Regionalization of perinatal health care for preventing preterm labour and RDS to decrease NICU needs and costs. Avoiding aggressive maneuvers and less device insertions mean better outcomes and little expenses in NICU.*

Claim: *There is no conflict of interest either financial or commercial, ethical committee approval in the faculty and university, approval of caregiver was obtained before the study.*

Keywords: *Cost-effectiveness, Device induced, Nosocomial infection.*

INTRODUCTION

Among the 130 million children born each year, approximately four millions die within the first four weeks of life. Of these deaths, 99% occur in poor countries. The primary causes are directly related to prematurity (28%), infection (26%) and intrapartum asphyxia (23%) ***(Brady and Polin, 2013).***

Infants in neonatal intensive care units carry a high risk for nosocomial infections. The mortality rate of infections in this age group is reported as between 10-50% ***(Pollack and Andrew, 2010)***. The most common types of nosocomial infection in NICUs are blood stream infections (BSI) and pneumonias. BSIs are frequently seen with central venous catheter (CVC) and umbilical catheter (UC) use. Ventilator-associated pneumonias (VAPs) are also seen frequently and even represent the most common type of hospital acquired infections in some NICUs ***(Srinivas et al., 2014).***

Cost estimates are used as a source of information to manage strategies, develop new public health policies and establish budgetary priorities ***(Zorilla et al., 2017).***

In USA, the incidence rate of ventilator associated pneumonia (VAP) is 1.27 per 1000 ventilation-days. Durations of mechanical ventilation and NICU stay increase by 211% than patients without VAP and mean hospitalization costs increase by 166%. Hospital acquired infections add an estimated 9.8 billion $ to nation's cost every year. As a result, infection erodes hospital profits ***(Zorilla et al., 2017).***

In Iran; catheter-associated blood-stream infection incidence is 36 %. Otherwise, the length of stay increases by 4.3 fold and total hospital costs increase by 3.6 folds ***(Weiner et al ., 2014).***

In Turkey; the VAP was 47.4 % of device associated infections with incidence rate of 26.5/1000 ventilator days; the bloodstream infection was 30.4 % of device associated infections, with inci-

dence rate of 17.6/1000 catheter days ***(Yalaz et al., 2012).***

In Egypt, there is deficiency of information and gap of knowledge on estimation of economic burden of device-associated infection in NICU. However, minimizing device utilization rate and improving infection control measures could yield very large cost savings, in addition to saving morbidity and mortality.

AIM OF THE STUDY

This is a descriptive and analytical study aim to:

1) Determine device utilization associated infection rates.
2) Estimate the direct and indirect costs of hospital stays for every case and for the total unit.
3) Compare our results with the national results.

PATIENTS AND METHODS

This is a descriptive and analytical study carried out in the NICU of El-Hussein University Hospital, during the period from January 2013 to August 2015; to determine device induced sepsis and its complications, together with their direct and indirect costs during hospital stay, and lastly their outcome regarding morbidity and mortality and comparing these results with other group of newborns in NICU but without device interference as a control group.

The study included 140 patients admitted to the neonatal intensive care unit. They were selected by simple random method according to the inclusion and exclusion criteria. The direct medical costs were assessed by using the patient's medical records and price lists of El-Hussein University Hospital.

They were classified into two groups: the first group is the device use group which included 100 newborns and the second group is the non-device use group which included 40 newborns. The 1st group included 64 male and 36 female newborns. Their gestational age ranged from 28-40 weeks with a mean ± SD of 32.98 ± 2.90 weeks; body weights ranged from 0.8 - 3.7 kg with a mean ± SD of 1.78 ± 0.70 kg. The 2nd group included 23 male and 17 female newborns. Their gestational age ranged from 32-38 weeks with a mean ± SD of 33.73 ± 1.80 weeks; body weights ranged from 1.3 – 3.2 kg with a mean ± SD of 1.84 ± 0.52 kg.

Inclusion criteria:

1. Age from 1 day to 28 days.
2. Newborns with no clinical or laboratory evidence of sepsis before device insertion.

3. Newborns with ETT, UVC, CVL and/or chest tube insertion.

Exclusion criteria:

Any newborn with one of the following:

1. Metabolic disorders simulating neonatal sepsis.
2. Septicemia prior to device insertion.
3. Surgical disorders or undergoing surgical procedure.

All the study patients were subjected to the following:

- Detailed history with special emphasis on: *Prenatal, Natal, Postnatal and Family history.*
- Thorough clinical examination with special stress on: *General,* N*eurological, Chest, Cardiovascular, Abdominal and Skin examination.*
- Investigations included: CBC and blood film, CRP, ABG, Random blood sugar, blood culture, device culture and Chest and heart X-ray
- The cost of their stay in the unit for all the study patients including:

❖ **Constant costs:**

- Health care providers' salaries.
- Incubators, Syringe pumps and monitor costs.
- Water and electricity supplies cost.
- Medical supplies.
- Caregiver visits.

❖ **Variable costs:**

- Oxygen support through nasal cannula, CPAP or mechanical ventilation.
- Investigations either laboratory or imaging
- Drugs Cost

RESULTS

Table (1): Durations of hospital stay among the studied groups.

Duration of stay (days)	Groups		T-test	
	Group I	Group II	T	P-value
Range	4.0 - 82.0	3.0 - 40.0	3.444	<0.001*
Mean ± SD	33.34 ± 17.72	19.64 ± 12.29		

There was a highly significant increase in the duration of hospital stay among group I.

Table (2): Comparison in duration of stay between single and multiple devices among group I

Device / Duration of Stay	Single	Multiple	T-test	
Range (days)	**4 - 52**	**17 – 82**	**T**	**P-value**
Mean ± SD	**27.27 ± 11.77**	**45.3 ± 18.16**	**6.029**	**<0.001***

There was a highly significant increase in the duration of hospital stay with multiple devices.

Table (3): Nosocomial infection rates in studied groups.

Nosocomial		Groups					
		Group I (no. 100)		Group II (n. 40)		Total	
		N	%	N	%	N	%
Negative		20	20	30	75	46	32.8
Positive		80	80	10	25	94	67.2
Total		100	100.0	40	100.0	140	100.0
Chi-square	**X^2**	29.990					
	P-value	<0.001*					

There was a highly significant increase in the rate of nosocomial infection among groups I.

Table (4): Constant costs per-day among both groups.

Cost per-day	Group I & II (LE/day)
Salaries	114.3
Equipment, water and electricity	23.15
Caregiver	25
Medical supplies	10.7
Total constant cost	**139.5**

Table (5): Comparison in average variable costs per-day among both groups.

Cost per-Day	Group I		Group II		T-test	
	Mean	SD	Mean	SD	T	P-value
Investigations	18.529	5.184	17.594	4.686	0.779	0.438
Oxygen	120.458	119.418	81.474	33.358	1.514	0.133
Nutrition	11.522	3.805	11.140	1.514	0.461	0.646
Antibiotics	57.889	22.886	24.405	29.763	5.868	0.001*
Total variable costs	293.058	129.730	213.387	50.080	2.214	0.004*
Total Final cost	432.558	129.730	352.887	50.080	2.827	0.006*

Group I shows highly significant increases in antibiotics, total variable and final costs per-day.

Table (6): Average Costs during Hospital Stay in both groups for one patient.

Cost	Group I		Group II		T-test	
	Mean	SD	Mean	SD	T	P-value
Invest	619.6	313.41	336.36	259.612	3.943	<0.001*
Oxygen	4230.64	4226.81	1395.82	632.31	3.128	0.002*
Nutrition	394.10	237.78	206.00	119.10	3.604	<0.001*
Antibiotics	2221.18	1585.52	755.64	1163.20	4.094	<0.001*
Final	15201.96	8963.96	6910.18	4640.44	4.207	<0.001*

There were highly significant increases in investigations, antibiotics and final costs during hospital stay in both groups for each case.

Table (7): Comparison between Costs per-day in cases with single and multiple interferences among group I

Costs per-day	Single device		Multiple devices		T-test	
	Mean	SD	Mean	SD	T	P-value
Oxygen	62.81	39.89	206.95	144.93	7.315	<0.001*
Nutrition	10.09	2.13	13.68	4.71	5.164	<0.001*
Antibiotics	49.50	25.69	70.48	7.75	5.009	<0.001*
Final	365.18	50.53	533.62	146.29	8.230	<0.001*

There were highly significant increases in costs per-day regarding final, antibiotics and oxygen costs with multiple devices use in group I

Table (8): Comparison between costs during hospital stay in cases with single and multiple devices among group I

	Single		Multi		T-test	
	Mean	SD	Mean	SD	t	P-value
Invest	485	221.524	821.5	324.6856	6.165	0.001*
Oxygen	1748.13	1343.43	7954.40	4349.54	10.359	0.001*
Nutrition	268.60	121.26	582.35	246.38	8.460	0.001*
Antibiotics	1501.53	1107.61	3300.65	1591.71	6.669	0.001*
Final	10119.6	4898.239	22825.5	8266.057	9.647	0.001*

There were highly significant increases in costs during hospital stay regarding final, antibiotics, investigations and oxygen costs with multiple devices use in group I.

Table (9) Morbidity and Mortality Outcomes of the Studied Groups.

Morbidity and	Groups

Mortality	Group I		Group II		Chi-square	
	N	%	N	%	X^2	P-value
Mortality	22	22.0	0	0.0	8.846	0.002*
Morbidity	8	8.00	2	5.00	0.073	0.944
○ **Hydrocephalus**	2	2.00	0	0.00	0.213	0.644
○ **ROP**	1	1.00	0	0.00	0.227	0.634
○ **Skin injury**	4	4.00	2	5.0	0.039	0.843
○ **BPD**	1	1.00	0	0.00	0.227	0.634

There was highly significant increase in mortality and morbidity rates among group I.

Table (10): Comparison between Different NICU Units Regarding Average Duration of Hospital Stay, Cost per-Day and Outcomes when Using Single Device

Country	NICU length of stay	Average cost per-day	Survivors (without complications)	Reference
USA	20 days	3,000 $	95%	***Kornhauser and Schneiderman, 2010***
Turkey	27 days	1042 TRY (303$)	89%	***Comert et al., 2012***
India	30 days	5,450 Rs (125 $)	84%	***Narang et al., 2005***
Egypt	33 days	433 LE (54 $)	70%	***Our study Donia et al., 2017***

There was significant improvement in outcomes and decrease in the duration of stay in the developing countries.

DISCUSSION

The universal goal of the health care system is to ensure adequate care at a reasonable cost. To date, the containment of the increasing costs of medical care has become of highest priority to governments all over the world according to ***Adam et al., (2003).***

Neonatal sepsis remains a significant cause of high mortality and morbidity even in the present

antimicrobial era. Mortality is high during the acute stage while sequelae are often seen among survivors. An early recognition of complications and sequelae is imperative for timely medical and surgical intervention to limit the disabilities and to decrease the costs according to ***Powell K and Marcy S. (2005).***

Our results showed that nosocomial infection was 84% of the cases subjected to device insertion; while the nosocomial infection was only 27.3% of the non-device group. This agrees with a study in Alexandria University about device related nosocomial infection, which showed that there was a high rate of nosocomial infection associated with invasive maneuvers about 68% while the rate of non-device induced nosocomial infection were 11.3% according to ***Sallam et al., (2005).***

In our study; the device group showed very high rate of nosocomial infection in cases with multiple devices insertion. Nosocomial infection was 75% in cases with endotracheal tube only, 85.7% in cases with umbilical venous catheter only, 20% in cases with central venous line only and 100% of multiple devices insertion which agrees with ***Yalaz et al.,(2012).***

Our study showed that nosocomial infection was much higher in cases on mechanical ventilation and endotracheal tube, constituting 75% of cases. Other studies showed that ventilator associated pneumonia was the most common cause of nosocomial infection constituting 41% of cases on mechanical ventilations according to ***Rosenthal et al., (2006)*** and 69% in Alexandria university Hospital according to ***Sallam et al., (2005)*** and 73% in Mazandran University of medical science in Iran according to ***Navaeifar and Rezai, (2013).***

The study showed that 85.7% of nosocomial infection in our cases was due to umbilical venous catheter, while the rate of infection was 20% in central venous line insertion. This agrees with the American academy of pediatrics, where the most frequent nosocomial infections in all birth weight groups is the bloodstream infections; recommending that bloodstream infection surveillance should focus on umbilical or central intravenous catheter use, as it is a major risk factor for infection ***Srinivas et al., (2014).*** In other studies, the blood stream infection was the second cause of nosocomial infection constituting 30% of cases with central line according to ***Rosenthal et al., (2010).***

The duration of hospital stay in NICU in the first group ranged from 4 to 82 days with mean of 33.3±17.8 days. While it is much less in the second group which ranged from 3 to 40 days, with a mean of 19.6±12.3 days with significant difference between both groups. This agrees with ***Allegranzi et al., (2011)*** who showed much increase in duration of stay in cases with nosocomial infections. Their study also agrees with ***Darmstadt et al., (2005).***

During the study period from January 2013 to August 2015, the average cost per-day for the first group (with device utilized) was 433LE including salaries of medical staff, costs of equipment, power, medical supplies, oxygen and air system, investigations and drugs. While the average cost per-day for the second group (with non-device utilized) was 353LE, with significant difference between both groups. This was during the study period, putting nowadays the rate of inflation and elevated prices to the double or triple. While in the developed countries like the USA, the daily cost ranged from 1000 $ up to 10,000 $ and the average cost was 3,000 $ per-day according to ***Kornhauser and Schneiderman (2010)***. This difference is due to the difference of level of facilities, salaries of medical staff and quality and price of material and drugs used, as the overall cost of preterm births in the USA is 26 billion $ in the year of 2010.

Our study shows that the highest costs were found in newborns with multiple device interferences. Average cost per-day in cases with both ETT and UVC insertion was 554 LE; followed by cases with both ETT and CVL insertion where per-day average cost was 460 LE. It also showed highly significant difference between single and multiple device interferences according to oxygen, nutrition, antibiotics and final costs. In a study by ***Kornhauser and Schneiderman (2010)*** in the USA, the average cost for infants hospitalized in neonatal intensive care units is around $3,000 per day. The average cost for a premature baby with single device insertion is $41,610 per day. If the baby is born at 26 weeks with multiple devices inserted, the cost can quickly rise to $250,000 or more. This also agrees with ***Narang et al., (2005)*** in a study in India, where cost per day for preterm with multiple device insertion was 7000 Rs, while in preterm with single device insertion costs 5,450 Rs (125 US $) per day.

Our study shows that the highest cost in NICU was found to be paid

for mechanical ventilation followed by personnel salary and ancillary costs. Each case share per day of salaries is 114.3 LE; each case share of incubator, monitor & syringe P per day is 14.5 LE; Cost consumed by caregiver per day per case is 25 LE; each case share of water and electricity per day is 8.65 LE; and each case share of medical supplies per day is 10.7 LE. Each case share of constant costs per day is 139.5 LE (32.5%). Final cost per day of oxygen and accessories for cases is 44 LE for nasal prong, 105 LE for CPAP and 203 LE for mechanical ventilator (average 27.8%). Average cost per day of instruments (syringes, feeding tube, suction tube, cannulas …etc) per case is 24 LE (average 10.39%). Average costs of parenteral and enteral nutrition per day are 18.5 LE and 6 LE respectively (average 2.66%). Average costs of antibiotics per day are 3.75 LE, 6 LE and 27.5 LE for each line of antibiotics (average 13.38%). Average costs of investigations per day are 18.52 LE (average 4.28%). In another study in Istanbul by ***Comert et al., (2012)***, the daily cost of a preterm was found to be 303$. Interventional costs percent are 31.4%, personnel salary 20.8%, ancillary costs 20.1%, consumable costs 9.7%, drugs 9.3% and investigational costs are 8.7%.

Our study results demonstrated that; newborns with single device insertion had highly significant decrease in the duration of hospital stay than newborns with multiple device insertion. Duration of stay in cases with multiple device utilization was (27.27± 11.77 days), while it was (18.16± 6.03 days) in cases with single device insertion. This agrees with ***Kirkby et al., (2007)*** where the duration of stay significantly increased in multiple device insertion where it was (21.17±5.72 days); while it was (8.27±3.13 days) in cases with single device insertion, with highly significant difference in duration of stay.

Regarding the mortality and cure rates in our study, there was significant difference between both groups. In the first group; cure rate was 70%, deaths were 22% and complications were 8%, where 2% had post-meningitic hydrocephalus, 1% had blindness, 1% had broncho-pulmonary dysplasia and 4% had skin burns. In the second group there was 90% cure rate, 9% skin burn, with no hydrocephalus, blindness, BPD nor deaths. In a similar study in the Sudan, the devices induced sepsis outcomes were 57% improvement, 32% died, 2% had

blindness, 3% had hydrocephalus and 6% had BPD ***(Kheir and Khair, 2014).***

CONCLUSION

Nosocomial infection was significantly associated with the admission to NICU and the rates of infection were increased with multiple device insertions and invasive maneuvers. Nosocomial infection was more in cases with endotracheal insertion, umbilical venous catheter, chest tube, central venous catheter and the rate of infection increase with multiple device insertions. The average costs were also higher in device associated infections however the outcomes were lower and most of patients were improved.

RECOMMENDATION

- Regionalization of perinatal health care and prevention of prematurity and RDS are among the most effective means of NICU needs and decreasing NICU costs.
- Less aggressive maneuvers and less device insertions mean better outcomes and little expenses in NICU.
- Less aggressive ventilation techniques with early weaning strategies from mechanical ventilation may shorten length of hospital stay leading to decreased NICU costs.
- Unnecessary deep venous catheters and other invasive procedures should be limited.

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الملخص العربى

يتعرض الرضع في وحدات العناية المركزة لحديثي الولادة إلى مخاطر عالية للعدوى. وقد ذكر أن معدل وفيات المصابين في هذه الفئة العمرية تتراوح فيما بين 10-50٪.

تعتبر التهابات مجرى الدم (BSI)، والالتهابات الرئوية من اكثر عدوي وحدات العناية المركزه لحديثي الولادة شيوعا. وكثيرا ما ينظر إلى التهابات مجري الدم ان سببها هو القسطرة الوريدية المركزية واستخدام القسطرة السره. وأيضا ترتبط معظم الالتهابات الرئوية بجهاز التنفس الصناعي في كثير من الأحيان، بل ويمثل النوع الأكثر شيوعا من عدوى المستشفيات في بعض وحدات العناية المركزة لحديثي الولادة.

يمثل الإنتان الوليدي أكثر المخاوف ومرتبط بمضاعفات خطيرة، وخاصة بين الخدج ذو الوزن المنخفض جدا عند الولادة. ينقسم الإنتان الوليدي إلى تعفن الدم المبكر والمتأخر، استنادا إلى توقيت العدوى وكيفية انتشار العدوي. ويعرف تعفن الدم المبكر بأنه يحدث خلال بداية الأسبوع الأول من الحياة وتذكر بعض الدراسات أن أغلب الالتهابات التي تحدث في ال 72 ساعة الأولى تكون بسبب انتقال ميكروبات من الأمهات أثناء الولادة. ويعرف الإنتان المتأخر بأن العدوي تظهر عادة بعد 1 أسبوع، وينسب لمسببات الأمراض المكتسبة بعد الولادة. وتشمل عوامل الخطر للإنتان الوليدي عوامل الأمهات، والعوامل الخطر عند حديثي الولادة، وشدة الميكروب.

هذه دراسة توصيفيه تحليليه تمت في وحدة حديثي الولادة في مستشفي الحسين الجامعي في الفترة من يناير 2013 الي اغسطس 2015.

والهدف من هذه الدراسة هو تحديد معدلات الإصابة المرتبطة باستخدام الأجهزة، وتوزيع ونوع العوامل المسببة للأمراض في وحدات العناية المركزة لحديثي الولادة ، لمقارنة نتائجنا مع البيانات الوطنية، لتحديد معدلات الاعتلال والوفيات، لتقدير التكاليف المباشرة للمستشفى لكل حالة وللوحدة الكلية.

وشملت هذه الدراسة 140 مريض تم تسجيلهم في وحدات العناية المركزة لحديثي الولادة في مستشفى جامعة الحسين لأى أسباب غير انتنان الدم. تم اختيارهم بالاختيار العشوائي البسيط حسب مواصفات الاختيار والاستبعاد. قسمت الحالات إلى مجموعتين، المجموعة الأولى. وشملت 100 حالة تعرضت للأجهزة المختلفة، إما أنبوب القصبة الهوائية، القسطرة الوريدية للسره والقسطرة الوريديه المركزيه و / أو أنبوب في الصدر. اما المجموعة المحايدة شملت 40 حالة لم تتعرض لتلك الأجهزة. وكانت معايير الاختيار ان يكون العمر من يوم الي 28 يوم وان لا يعاني من الانتان الدموي او امراض التمثيل الغذائي المشابه للانتان الدموي. وتم اخذ تاريخ مرضي كامل مع فحص اكلينيكي دقيق مع عمل التحاليل والأشعات اللازمة لكل حالة علي حده، كما تم حساب التكاليف لكل حالة علي حده اثناء فترة اقامتها في الحضان شاملة التكاليف الثابتة والمتغيرة بحسب كل حاله.

خلال فترة الدراسة، زادت فترة الإقامة بالمستشفي للحالات التي استخدمت الأجهزة مقارنة بالتي لم تستخدم الاجهزة، كما زادت بطريقة ملحوظة مع الحالات التي استخدمت اكثر من جهاز.

كما كان معدل عدوى المستشفيات أعلى بكثير في المجموعة التي تعرضت لاستخدام الأجهزة بالمقارنة مع المجموعة الأخرى كما زادت بطريقة ملحوظة مع الحالات التي استخدمت اكثر من جهاز .

كما زاد متوسط التكلفة الإجمالية للحالة لكل يوم، وزادت تكلفة الأكسجين المستهلك في اليوم الواحد، وكذلك تكلفة المضادات الحيوية يوميا، وكان ذلك أعلى بكثير في مجموعة المرتبطة بالأجهزة في مقارنة مع مجموعة الغير مرتبطة بأي اجهزة.

وأظهرت ان تكلفت التشخيص وأن التكلفة النهائية لكل يوم اختلاف كبير في كلا المجموعتين. حوالي 70٪ من مجموعة المرتبطة بالأجهزة اظهرت تحسنا ملحوظا ولكن بلغت معدلات الوفيات 22٪ بينما عاني 2% من ارتشاح بالمخ و 1% من انفصال بالشبكيه و 4% من حروق بالجلد و 1% من الاعتلال المزمن بالرئة. بينما في المجموعة الغير متعرضة لأجهزة كان هناك نسبة الشفاء 95٪ ولم تحدث مضاعفات غير حروق في الجلد في 5% من الحالات مع عدم وجود وفيات.

وكانت التكلفة النهائية في المجموعة المستخدمه للأجهزة 432,5 ± 129,7 جنيه للحالة الواحدة في اليوم الواحد. بينما في المجموعة الغير مرتبطة بأجهزة كانت 352,9 ± 50 جنيه مع عدم وجود فرق واضح بين المجموعتين. بينما كان هناك فرق واضح عند استخدام اكتر من جهاز، حيث ان التكلفه عند استخدام جهاز واحد كانت 365,2± 50,5 جنيه، وفي حال استخدام اكثر من جهاز كانت التكلفه 6،533± 146 جنيه في اليوم الواحد للحالة.

وفي الختام، كانت العدوى المكتسبة من المستشفيات مرتبطة بدخول الي وحدات العناية المركزة لحديثي الولادة وازدادت معدلات الإصابة وبشكل كبير مع وجود اتصال بالأجهزة. وكان متوسط التكلفة أيضا قد ارتفع في الحالات المقترنة مع استخدام اجهزه لكن تحسنت اغلب الحالات وكانت المضاعفات قليلة في كلا الحالتين ولكن كانت نسبة الوفيات اعلي في المجموعة المرتبطة باستخدام الاجهزة.

توصي الدراسة بالاهتمام بصحة الحامل والولادة لمنع الولادات المبكرة وبالتالي تقليل الاحتياج للحضان وبالتالي تقليل المضاعفات والتكلفة، كما توصي بتجنب استخدام الاجهزة والتدخلات العنيفة وتقليل استخدام القساطر الوريديه وقساطر السره الوريديه وتقليل استخدام اجهزة التنفس الصناعي لتقليل الوفيات والمضاعفات والتكلفة.