ENVIRONMENTAL RISK FACTORS OF NOSOCOMIAL INFECTIONS IN NEUROLOGICAL INTENSIVE CARE UNIT

Shrief M. Salah El Deen[(1)]; Mahmoud S. Elbokhary[(2)] and Hwaida M. Kamal[(3)]

1) Post Grad. Student Institute of Environmental Studies and Research Ain shams University 2) Institute of Environmental Studies and Research Ain shams University 3) Faculty of Medicine, Baha University

ABSTRACT

Background: The Centers of Disease Control and Prevention (CDC) estimate that 2 million patients develop hospital-acquired infection annually and as many as 88,000 die as a result, adding an estimated $5 billion to the annual national health care costs. **Object:** To evaluate risk factors and methods of infection control in surgical site infections in postoperative neurosurgical patients.

Methods: This study was prospective, uncontrolled and observational study conducted on patients with postoperative neurosurgical operation and admitted to Intensive Care Unit postoperatively. The study was done in Al-Azhar university hospitals from March 2017 to March 2018. The study aim was. Analysis of data was done by IBM computer using SPSS (statistical program for social science version 25).

Results: In the study sample, the mean age and standard deviation (SD) were 42.5 years ±19.1. Female patients were about 40%. Most male patient were above median age of the sample (37.8 years). The overall admission period includes pre-ICU admission, ICU admission and post-ICU admission. The mean and standard deviation of overall admission was 43.7 day±5.5. From the whole study sample, nosocomial infection was estimated to be 88.4% of cases (69 patients). Postoperative mortality among cases was 36%. The rest of cases were either referred or discharged to ward. Comorbid conditions may

present as single factor or multiple factors in the same patient. Patients with nosocomial infections were found to have two or more comorbid conditions while infection-free cases were found to have no or at least one factor in a statistically significant association. It has been found that most cases with traumatic brain injury and hemorrhagic stroke had nosocomial infection (74%). Both types mentioned previously had longer ICU stay. It has been found that nosocomial infection is commonly predominant in traumatic brain injury and intracranial hemorrhage cases (ICH).
Nosocomial infections were found to be either single or multiple infections in the same person. Most of infections were; respiratory tract infection, urinary tract infection or septicemia. When the entire study sample was subjected to logistic regression analysis, age, diagnosis and hospital stay, necessity for ventilation, low Glasgow Coma Scale (GCS), high temperature, high humidity and low karnofsky were found to be significantly independently predictive of postoperative nosocomial infection. Among these patients, type and timing of operative intervention and environmental factors did not significantly affect outcome.
Conclusion: There are many risk factors of nosocomial infection in hospitalized neurosurgical treated, which requires strict monitor, including the development of various effective prevention measures and check of their implementation as well as effectiveness, to reduce the incidence of hospital infection.
Keywords: nosocomial infection, environmental factors

INTRODUCTION

The term “nosocomial infection” can be used interchangeably with “Hospital Acquired Infection.” The Centers of Disease Control and Prevention (CDC) defines a Hospital Acquired Infection (HAI) as a localized or systemic condition resulting from an adverse reaction to an infectious agent (s) or toxin(s) (Abulhasan *et al.*, 2018). An infection is considered HAI if it develops in a patient who has been hospitalized for 48 to 72 hours and no

evidence that the infection was incubating at the time of admission. The CDC estimates that two million patients develop HAIs annually and as many as 88,000 die as a result, adding an estimated $5 billion to the annual national health care costs *(Beer et al., 2010).*

The spread of nosocomial infections by traditional means such as lack of hand hygiene compliance goes as far back as the 1800s *(Cardoso et al., 2015).* By reviewing maternal deaths in two divisions of the maternity department in Vienna, it was noted that more than 10% of women died following childbirth when the baby was delivered by a physician or student in the first division, compared to a lower rate of 3% of maternal death when babies were delivered by a midwife *(Felming et al., 2010).* These differences in death rates could be explained by the fact that medical students and physicians performed autopsies without disinfecting their hands before attending to the next patient. In other words, the physicians were the source of infection to the patients *(Ducel and Fabry, 2002).*

The purpose of this research was to evaluate risk factors and methods of infection control in surgical site infections in postoperative neurosurgical patients.

PATIENTS AND METHODS

This is a prospective study over one year. Institutional Review Board approval was taken prior to launch the study. This study was conducted on 69 patients from a total of 78 with postoperative neurosurgical operation and

admitted to ICU postoperatively. The study was done in Al-Azhar University hospitals from March 2017 to March 2018.

Inclusion criteria

1. Above 18 year
2. Both genders
3. Patient did neurosurgical operation and admitted to neuro-ICU postoperatively.

Exclusion criteria

1. Previous source of infection
2. Patient did surgery outside the hospital.
3. Immunocompromised patient.

Preoperative record:

1. Complete history taking, general and neurological examination and full labs.
2. Demographic criteria
3. Previous condition
4. Nutritional state
5. Neurosurgical disease
6. Preoperative medication and antibiotics
7. Duration of pre-operative admission
8. Comment on drapping
9. Surgical site scrapping
10. Operative preparation
11. Method of sterilization

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12. Document use of personal protective
13. Operative time
14. Blood transfusion
15. Postoperative ICU admission period
16. Total hospital admission
17. Postoperative antibiotics

All patients underwent specimen elaboration from the following sites:

1. IV cannulas
2. Central venous pressure lines
3. Pipes of mechanical ventilation
4. Endotracheal tube
5. Chest tube
6. Foley catheter
7. Mask

In addition, microbiological assessment by smears were recruited for the following sites:

1. Mouth
2. Surgical site
3. Bed sores

Smears were taking also from the following sites:

1. Physician and nurses room
2. Water sources
3. Air conditioners

Data Analysis*:* Analysis of data was done by IBM computer using SPSS (statistical program for social science version 25).

RESULTS

This study will be conducted on patients with postoperative neurosurgical operation and admitted to ICU postoperatively. The study was done in Al-Azhar university hospitals from March 2017 to March 2018. In our study, we recruited 78 patients admitted to neurological intensive care unit over one year.

Cases which have been categorized with nosocomial infection were 69 cases (88.4%). Those with no infections were called infection-free patients. The latter group were only nine patients (11.6%).

❖ Demographic characteristics

The mean age and standard deviation (SD) were 42.5 years ±19.1. Forty-seven patients were male (60.25%). Most male patient were above median age of the sample (37.8 years).

❖ Hospital admission

The overall admission period included pre-ICU admission, ICU admission and post-ICU admission. The mean and standard deviation of ICU admission period was 43.7 day±5.5. The distribution of values was not normal. Two patients were regarded as outliers with longstanding period in

ICU up to 3 months. The Table 1 summarizes the hospital admission periods in our study.

Table 1: Hospital admission periods in days

Admission	Mean (SD)	95% CI
Pre-ICU*	5.6 (.25)	3.5-7.7
ICU*	43.7 (5.5)	26-61.4
Post-ICU* ward	16.3(4.4)	11.5-21.1

*ICU: Intensive Care Unit

It has been found that cases with positive infection (nosocomial infections) were statistically significant.

Table 2: Period of stay in ICU*

Infection	Mean (SD), Range	P value	Significance
Yes	51.3 (14.7), 17-75		
No	12 (.48), 5-19	0.0001	HS

*ICU: Intensive Care Unit

❖ Comorbidities and Mortality

Diabetes mellitus was found in 24% of cases, fourteen percent of patient had elevated lipid profile (dyslipidemia). Hypertension was found in 21% of cases. The table below summarizes our findings (see table 3).

From the whole study sample, nosocomial infection was estimated to be 88.4% of cases (69 patients). Postoperative mortality among cases was 36%. The rest of cases were either referred or discharged to ward.

Table 3: Frequency of comorbidities among our study			
Disease*		N	%
No risk factor		29	37.1
Diabetes	**Yes**	19	24.3
	No	59	57.7
Hypertension	**Yes**	17	21.79
	No	61	78.21
Cushing syndrome	**Yes**	14	17.9
	No	64	82.1
Peptic ulcer	**Yes**	10	12.8
	No	68	87.2
Dyslipidemia	**Yes**	9	11.53
	No	69	88.47
Neutropenia	**Yes**	7	8.97
	No	71	91.03
Asthma	**Yes**	5	6.14
	No	73	93.86
Urolithiasis	**Yes**	5	6.14
	No	73	93.86
Tuberculosis	**Yes**	2	2.56
	No	76	97.44
• ***The cumulative percentage is not a reflective to the total number, single patient may have one or two comorbid condition***			

Table 4: Nosocomial infection vs. number of comorbidities.

	Comorbidity		
Nosocomial infection	**0-2**	**3-4**	**Total**
Yes	24 (27.59%)	45 (51.72%)	69 (79.3%)
No	8 (9.19%)	1 (1.14%)	9 (10.3%)
	32 (36.78%)	46 (52.87%)	78 100

Comorbid conditions may present as single factor or multiple factors in the same patient. Patients with nosocomial infections were found to have two or more comorbid conditions while infection-free cases were found to have no or at least one factor in a statistically significant association as in Table 4&5.

❖ Disease spectrum

Primary diagnoses for which admission was made were varied. Forty-seven case was admitted due to traumatic brain injury. Twenty-two cases were admitted for postoperative neuro-oncological operation. The table 6 summarizes the primary diagnoses admitted in our ICU.

Table 5: Frequency of diagnoses in our study.

	N	%	Total
Traumatic Brain injury (TBI)	48	60.25	
-Acute epidural hematoma	11	14.1	
-Acute subdural hematoma	18	23.07	
-Chronic subdural hematoma	5	6.41	
-Decompressive craniectomy for malignant brain edema	14	17.94	
Nuero-oncology	7	8.97	
-Benign brain tumors	3	3.84	
-Malignant brain edema	4	5.12	
Epilepsy surgery	3	3.84	
Surgically treated stroke	16	20.51	
-Intracranial hemorrhage evacuation or EVD* insertion	14	17.94	
-Malignant edema treated by decompressive craniectomy	2	2.56	
Traumatic spinal cord injury due to fracture and treated by surgical intervention	5	6.41s	

EVD: external ventricular drain

It has been found that most cases with TBI and hemorrhagic stroke had nosocomial infection (74%). Both types mentioned previously had longer ICU stay.

It has been found that nosocomial infection is commonly predominant in TBI and ICH cases with statistically significant value (p=0.00005).

❖ Impact of Glasgow coma score (GCS)

The GCS was measured throughout admission till discharge. Putting a single numerical value for each patient would not respect the time as GCS is a dynamic with consciousness state. Hence, patients were categorized into minimal, mild, moderate, severe and critical consciousness. The minimal consciousness ranged from (14-15). Mild GCS was ranging from (13-10), moderate was ranging from (9-8), and severe was ranging from (7-4), while critical level was below 4. The bar graph (figure 1) summarizes the levels of consciousness in our study.

❖ Value of mechanical ventilation

Some study participants were brought to be on mechanical ventilation. Indication of mechanical ventilation varied among our study sample. Patients with severe and critical GCS were hold on ventilation (22 patients). Fourteen patients were hold on mechanical ventilation due to hypoxia, severe bronchial secretions and acute respiratory distress syndrome.

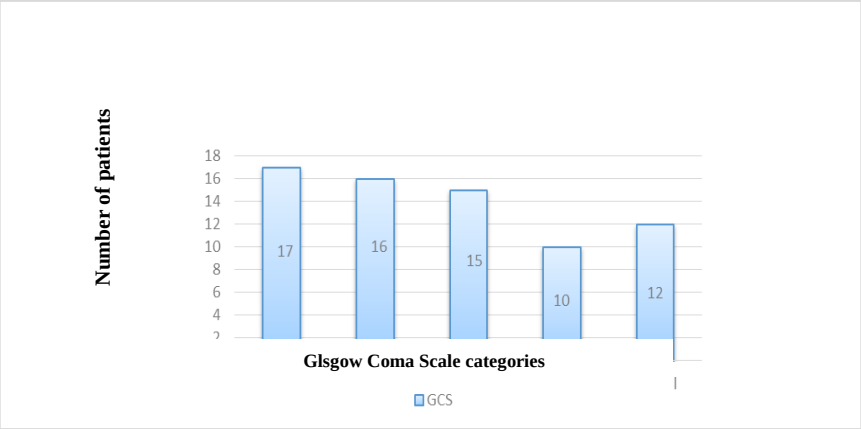

Figure 1: Glsgow Coma Scale categories among our study

❖ Positioning

Thirty-seven patients had low karnofsky score (40% and below). At this level, patient are in need for frequent change in position. The rest of our study were above that level. The figure 2 summarizes the frequency.

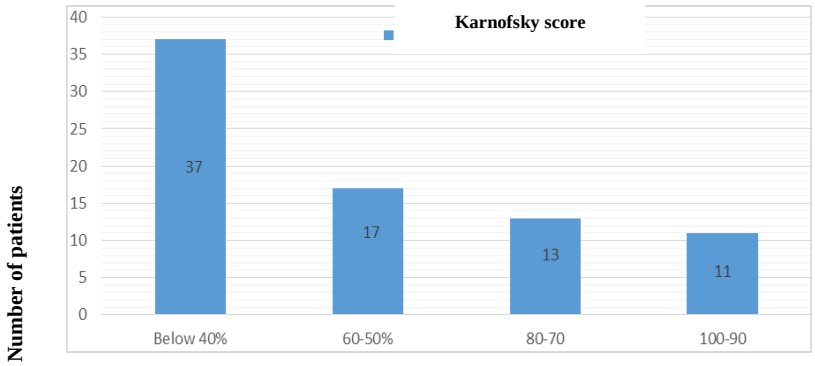

Figure 2: Grade of Karnofsky score

❖ Operative time

The operative time was calculated in minutes. The mean and standard deviation of operative time was 266.3 minutes±52.4. Operative time was mostly correlated with neurooncology cases. Lower operative time was mostly seen in traumatic brain injuries.

❖ Nosocomial infection

Cases which have been diagnosed with nosocomial infection were 69 cases. Nosocomial infections were found to be either single or multiple infections in the same person. Most of infections were; respiratory tract infection, urinary tract infection or septicemia (Table 7).

Table 7: Types of Nosocomial infection

Type	N	%
Respiratory tract infection	44	56.4
Septicemia	25	32.05
UTI	20	25.6
Eye	19	24.3
Surgical site infection	15	19.23
Catheter related infection	15	19.23
Gastrointestinal tract	11	14.1

* UTI: Urinary tract infection

❖ Microorganism isolated

The most microorganisms isolated in all 69 patients were gram negative organisms (67.9%). Gram positive bacteria were followed to be isolated in around 61.53%. Fungal infections were found in 18 patients with urinary tract infection and esophagitis (mostly candida species). The table 8 below summarizes the frequencies.

Table 8: Types of microorganisms isolated

Microorganism	N	%
Gram –ve	53	67.9
Gram +ve	48	61.53
Anaerobic infection	19	24.35
Fungal infection	18	23.07

Microbial isolation sites were drained throughout admission. Sputum (60.2%) followed by urine samples (45.3%) were the most common sites for microbiological isolation followed by specimens taken from CVP or intravenous cannula.

❖ Humidity and temperature

In our study, the ICU room humidiy (%), nurse/bed ratio, area around patients and temperature were studied also. The table 9 contains the frequency distributions of such measures.

Table 9: Frequency distribution of nurse/bed ratio, area around patients, temperature (C) and humidity (%).

Factors	Minimum	Maximum	Mean ± SD
Nurse/bed ratio	1.3	2.1	1.88 ± 0.47
Area around patient bed (m^2)	9.3	15.6	11 ± 2.75
Temperature (C)	21.7	30.12	24.6 ± 6.15
Humidity (%)	29.9	42.1	36.13 ± 9.03

❖ Risk factors for colonization and nosocomial infection: Regression analysis

When the entire study population was subjected to logistic regression analysis, age, diagnosis and hospital stay, necessity for ventilation, high temperature, high humidity and low karnofsky were found to be significantly independently predictive of postoperative nosocomial infection (Table 10). Among these patients, type and timing of operative intervention and environmental factors did not significantly affect outcome

Table 10: Independent predictors for ICU nosocomial infection

Factors	Odd ratio	P value
Age	1.9	0.001
Disease	0.2	0.0005
ICU stay	3.7	0.0001
Mechanical ventilation	4.1	0.00001
High Temperature	4.5	0.00001
High Humidity	3.9	0.0001
Low Karnofsky scale (below 40%)	3.6	0.005

DISCUSSION

The spread of nosocomial infections by traditional means such as lack of hand hygiene compliance goes as far back as the 1800s. The epidemiological findings of Dr. Ignaz Semmelweis helped to shed light on ways of controlling infections in a health care setting. By reviewing maternal deaths in two divisions of the maternity department in Vienna, Semmelweis noted that more than 10% of women died following childbirth when the baby was delivered by a physician or student in the first division, compared to a lower rate of 3% of maternal death when babies were delivered by a midwife. These differences in death rates could be explained by the fact that medical students and physicians performed autopsies without disinfecting their hands before attending to the next patient. In other words, the physicians were the source of infection to the patients. The midwives did not have any contact with cadavers.

The study aim was to evaluate risk factors and methods of infection control in surgical site infections in postoperative neurosurgical patients.

The number of nurses and environmental conditions affects the nosocomial infection rate in the ICU. Some authors reported that keeping not enough number of nurses increased the infection rate in the ICU *(Zhao et al., 2017).* Determine the ideal nurse number for preventing nosocomial infections in the ICU is difficult. The patients' clinical condition, the nurses' certification to work in the ICU, and some other factors are effective *(Sheng et al., 2007).*

The nurses trained about the ICU procedures are in better accordance with the infection control procedures compared with non trained *(Ducel, J. Fabry, 2002).*

A study showed that a nurse/patient ratio of more than 2.2 decreased the infection rate by 30% in the ICU *(Nseir et al., 2012).* The present study reported no statistically significant relationship between the infection rates and the nurse/patient ratio. The regulation about the nurse number working in the ICU is connected to the classification of the ICU in Turkey. If the ICU is a third degree, meant only for patients in a serious condition, it should have one nurse for every two patients in every shift. If the ICU is a second degree, it should have one nurse for every three patients in every shift *(Hartholt et al., 2014).*

The nurse/patient ratio reported in the present study was concordant with this regulation. This is the reason why no statistically significant relationship

of the nurse/patient ratio with the infection rates was found in the study. Future studies should consider not only the number but also the characteristics of nurses working in the ICU and investigate the quality factors affecting the nurse/patient ratio and infection rates, thus helping to establish new standards *(Dancer, 2014).*

The patients in the ICU are mostly in a bad clinical condition with numerous health problems and underlying diseases.

Their thermoregulation system is not working well enough. The changes in the room temperature affect the body temperature directly in the ICU patients. Therefore, the temperature and humidity should be maintained within specified limits in the ICU. The CDC environmental infection control guidelines state that the temperature should be between 20°C and 24°C and the humidity should be between 30% and 60% at the hospitals. The present ICU regulations specify that the temperature should be kept 22°C–28°C and the humidity should be 30%–60 %. The prevalence of some of the gram-negative bacterial infections, such as Acinetobacter spp., increases in the hot weather. Gram-negative bacteria infections are the problematic infections in the ICU because of their increasing resistance to antibiotics. The present study found no relationship of temperature and humidity with the infection rates [36.13 (29.9-42.1)]. The humidity was within limits [24.6 (21.7-30.12)], and the temperature exceeded the limits only for a short time. No major

differences in these measurements were found *(Muñoz, Burillo and Bouza, 2001).*

This was the reason why a relationship of temperature and humidity with the infection rates was not found. A statistically significant relationship was observed between humidity and catheter-related urinary tract infection rate in the present study. Few studies determined the relationship of increasing temperature and humidity with the nosocomial urinary tract infection caused by Pseudomonas aeruginosa. Some other studies linked urinary tract infections with high temperature and low humidity *(Sheng et al., 2007).*

The relationship between humidity and urinary tract infection needs to be further investigated before reaching any definite conclusions. The design of the ICU, having enough isolation rooms, area for each patient, and number of patients sharing the same room are related to the nosocomial infection rate. The area around the patient bed has a number of microorganisms. Therefore, the design of the room and the number of patient beds and surfaces in the room are important factors for infection control *(Şimşek et al., 2017; Zhao et al., 2017).*

An ideal ICU should have at least an area of 20 m2 with a single bed. The regulations about ICU beds specify at least 12 m2 for each bed and at least 1.5-m distance between the two beds. The present study reported a negative correlation between the infection rates in the ICU and the size of the patient bed. This is thought to be an important finding. Because of an increasing demand of ICU beds, accepting more patients in ICU rooms might

cause an increase in infection rates. Even if it is difficult to provide the ideal conditions, the compliance to the standards is important. At least the regulations related to the ideal conditions should not be disregarded *(G. Ducel, J. Fabry, 2002).* Although the present study did not find any statistically significant relationship with the infection rates, it is still believed that the number and qualification of the nurses working in the ICU are important in preventing nosocomial infections. Beside the standard number, qualification standards should also be established. The distance between the patient beds is important for infection control. Hence, designing an ICU has increasing importance. Temperature and humidity can affect the nosocomial infection rates *(Dancer, 2014).*

Types of nosocomial infection [respiratory tract infection (56.4%), septicemia (32.05%), urinary tract infection (25.6%), eye (24.3%), surgical site infection (19.23%), catheter related infection (19.23%), gastrointestinal tract (14.1%)].

Types of microorganisms [Gram-ve organisms (67.9%), Gram+ve organisms (61.53%), anaerobic organisms (24.35%), fungal (23.07%).

Relation between nosocomial and comorbidities

In conclusion, there are many risk factors of nosocomial infection in hospitalized neurosurgical treated, which requires strengthening monitor, including the development of various effective prevention measures and

check of their implementation as well as effectiveness, to reduce the incidence of hospital infection.

Further studies are needed to investigate the exact relationship of internal and external factors with nosocomial infections in the ICU

The purpose of this research was to evaluate risk factors and methods of infection control in surgical site infections in postoperative neurosurgical patients.

This study was prospective, uncontrolled and observational study conducted on fifty sex patients with postoperative neurosurgical operation and admitted to ICU postoperatively. The study was done in Al-Azhar university hospitals from March 2017 to March 2018. The study aim was to evaluate risk factors and methods of infection control in surgical site infections in postoperative neurosurgical patients.

Analysis of data was done by IBM computer using SPSS (statistical program for social science version 25).

The mean age and standard deviation (SD) were 42.5 years ±19.1. Male patients were prevalent in the sample. Forty-seven patients were male (60.25%). Most male patient were above median age of the sample (37.8 years).

The overall admission period contains pre-ICU admission, ICU admission and post-ICU admission. The mean and standard deviation of overall admission was 43.7 day±5.5. The distribution of values was not

normal. Two patients were regarded as outliers with longstanding period in ICU up to 3 months.

It has been found that cases with positive infection (nosocomial infections) were statistically significant associated with long ICU stay (p=0.0025). Patients who never developed nosocomial infections had shorter ICU stay (p=0.0001).

From the whole study sample, nosocomial infection was estimated to be 88.4% of cases (69 patients). Postoperative mortality among cases was 36%. The rest of cases were either referred or discharged to ward.

Comorbid conditions may present as single factor or multiple factors in the same patient. Patients with nosocomial infections were found to have 2 or more comorbid conditions while infection-free cases were found to have no or at least one factor in a statistically significant association.

It has been found that most cases with TBI had longer ICU stay.

It has been found that nosocomial infection is commonly predominant in TBI and ICH cases.

The GCS was measured throughout admission till discharge. Putting a single numerical value for each patient would not respect the time as GCS is a dynamic with consciousness state. Hence, patients were categorized into minimal, mild, moderate, severe and critical consciousness. The minimal consciousness ranged from (14-15). Mild GCS was ranging from (13-10),

moderate was ranging from (9-8), and severe was ranging from (7-4), while critical level was below 4.

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When the entire study population was subjected to logistic regression analysis, age, diagnosis and hospital stay, necessity for ventilation, low GCS, high temperature, high humidity and low karnofsky were found to be significantly independently predictive of postoperative nosocomial infection. Among these patients, type and timing of operative intervention and environmental factors did not significantly affect outcome.

CONCLUSION

There are many risk factors of nosocomial infection in hospitalized neurosurgically treated, which requires strengthening monitor, including the development of various effective prevention measures and check of their implementation as well as effectiveness, to reduce the incidence of hospital infection.

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عوامل الخطورة البيئية للاصابة بالعدوى المكتسبة في وحدات الرعاية المركزة للمخ والاعصاب

شريف محمد صلاح الدين[١]– محمود سري البخاري [٢]– هويدا محمد كمال [٣]
١) طالب دراسات عليا معهد الدراسات والبحوث البيئية ٢) معهد الدراسات والبحوث البيئية، جامعة عين شمس ٣) كلية طب، جامعة بنها

المستخلص

إن العدوى المكتسبة في الرعاية المركزة لمرضى جراحة المخ والاعصاب قد تؤدي الى زيادة فترة الرقود في الرعاية المركزة وبالتالي زيادة ثقل اضافية على رد فعل الجسم لمقاومة مابعد العملية مما يوهن صحة المريض وقد يؤدي الى الوفاة.

تعتبر عدوى الجهاز التنفسي، التناسلي والوعائي وكذلك عدوى الجروح الناشئة ما بعد العملية وقرح الفراش من اشكال العدوى البكتيرية محل الدراسة.

ان هدف الدراسة الاساسيهو تقييم العوامل البيئية المؤدية الى حدوث العدوى المكتسبة في المرضى الذين ادخلوا غرف الرعاية المركزة لجراحات المخ والاعصاب مابعد اجراء جراحة المخ او العمود الفقري وطرق مكافحة هذه العدوى بكافة اشكالها.

شملت هذه الدراسة من هم فوق ال١٨ سنة وكلا الجنسين من الذين خضعوا لعمليات جراحة المخ والاعصاب والعمود الفقري فيما بعد العملية. تم جمع المعلومات المطلوبة واخضاعها للفحص والتحليل باستخدام برنامج الاحصائي اس بي اس اس النسخة ٢٥.

تم اخذ موافقة مجلس الاخلاقيات الطبية قبيل بدء الدراسة.

تعتبر هذه الدراسة دراسة مسبقة، مسحية ولا تتضمن وجود مجموعة سيطرة فيها. اقيمت هذه الدراسة في مستشفيات جامعة عين شمس للفترة من مارس ٢٠١٧–مارس ٢٠١٨. وخلال مدة عام تم جمع ٧٨ حالة.

بلغ متوسط العمر الحسابي هو ٤٢,٥ سنة وانحراف معياري يبلغ ١٩,١. كان عدد الرجال اكثر من النساء حيث كان الرجال ٤٧ فرداً. امضى افراد العينة فترة في الرعاية المركزة بمتوسط ٤٣,٧ يوم بعد استبعاد عينتين قضتيا ٣ اشهر. بلغت نسبة الالتهابات ٨٨,٤% من الحالات اي ما يعادل ٦٩ حالة. نسبة الوفاة نتيجة الالتهاب بلغت ٣٦%.

لقد وجد احصائياً ان الحالات المصابة بالالتهاب (اياً كان نوعه) قد مكثت بشكل اطول في الرعاية المركزة عن تلك الحالات التي لم تصب.

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عندما تم اخضاع المتغيرات ذات العلاقة الترابطية مع حالة الالتهاب لدراسة الانحدار بين المتغيرات والنتيجة وجد ان العمر والتشخيص والمكوث في المستشفى قبيل العملية والحاجة للتنفس الصناعي وانخفاض درجة الوعي وارتفاع الرطوبة ودرجة حرارة الجو داخل غرفة الرعاية المركزة مع انخفاض مؤشر كارنوفسكي كانت اسباب مهمة لحدوث الالتهاب داخل الرعاية المركزة.

ان اسباب حدوث الالتهاب داخل الرعاية هي عديدة بالنسبة لمريض تم علاجه بواسطة تداخل جراحي عصبي، هؤلاء المرضى يحتاجون الى التقييم ماقبل العملية ومراجعة كافة الاطر العلمية التي على اساسها يتم معالجة المريض في الرعاية المركزة والمتعلقة بدرجة الحرارة والرطوبة وعدد الاسرة وعدد الممرضات اللازم لكل سرير وخلافه لتقليل نسبة الاصابة بالعدوى.