PROSPECTIVE STUDY ON THE INCIDENCE OF HEALTHCARE-ASSOCIATED INFECTIONS IN OPERATED ELDERLY PATIENTS WITH FEMORAL NECK FRACTURE DEPENDING ON THE AVERAGE LENGTH OF STAY AND TIMING OF OPERATION

FILIP PANAIT[1], LORANT KISS[2]

[1]PhD Candidate, "Lucian Blaga" University of Sibiu, [2]"Lucian Blaga" University of Sibiu

Keywords: *microbes, infections, antibiotic prophylaxis*

Abstract: *The study carried out by the authors deals with the Healthcare-Associated Infections (HAIs) occurred in elderly patients with femoral neck fracture, operated. The group of subjects was composed of a total number of 544 patients aged over 60 years, suffering femoral neck fractures and that were hospitalized, from 29.02.2008 until 26.05.2015, in the Department of Orthopedics of Sibiu County Emergency Hospital, aiming at examining the incidence of Healthcare-Associated Infections (HAIs) through a prospective cohort study. Within deep reforms that are necessary in the romanian health care system, studies are needed to show the extent and the factors associated with Healthcare-Associated Infections (HAIs), simultaneously with the implementation of strategies in order to prevent and combat them.*

INTRODUCTION

In Romania there are few attempts to study, systematically, the incidence of Healthcare-Associated Infections (HAIs), especially at the level of the special group of patients aged over 60 years, who underwent surgery for femoral neck fractures. Therefore, in the context of limited resources within the health care system and the importance of identifying ways to prevent these phenomena associated with surgical procedures, through a follow-up study, we intend to draw attention to the interrelationship between the number of hospitalization days, timing of the operation and Healthcare-Associated Infections (HAIs).

The group of Healthcare-Associated Infections (HAIs) includes surgical site infections (SSIs), the group of bloodstream infections (BSIs), urinary tract infections (UTIs), pneumonia (PNEUs) and gastrointestinal system infections (GIs).(1)

Healthcare-Associated Infections (HAIs) represent a public health problem, due to the very high economic costs related to the diagnosis and treatment and through the considerable social impact. Every year there are registered more than 70,000 hip fractures in United Kingdom, reported by the National Institute for Health and Care Excellence and about 300,000 in the USA, reported by the US Center for Disease Control and Prevention (CDC).(2,3)

Healthcare-Associated Infections (HAIs), associated with the advanced age of the patients, require a holistic approach, by setting up some multidisciplinary teams that include physicians specialized in such diseases, geriatric physicians, psychologists and family physicians. The entire team must cooperate for surgical procedures to take place in optimal parameters and with good results. The surgical techniques performed correctly are the main method of preventing the Healthcare-Associated Infections.(4) The antibiotic prophylaxis and antibiotherapy are part of the therapeutic and prophylactic arsenal, since the 4th decade of the twentieth century, improved over the years, through the discovery of new antibiotics, more advanced and efficient. The antibiotic prophylaxis is recommended in surgical procedures located in Altemeir class I and II, while antibiotherapy is established for class III and IV. In both cases, the guides recommend the intravenous administration of antibiotics, to achieve, within appropriate time, the minimal inhibitory concentration of microorganisms or the MIC (Minimum Inhibitory Concentration). The antibiotics are administered by the anesthesia team, in intravenous perfusion. The first administration is performed no more than 60 minutes before the surgery. Biomaterials that are lightly impregnated (0.5 – 1 gram of antibiotic per 40 grams of cement) or biomaterials that are heavily impregnated (3.6 grams of antibiotic per 40 grams of cement) (5) prevent the occurrence of Healthcare-Associated Infections (HAIs). This method is a response to researches that revealed the pellicle biofilm formation by pathogenic bacteria, in particular on the surface of the biomaterials, free of the cellular defense provided by PMN (polymorphonuclear neutrophils) in living tissues.(6)

Allogeneic blood transfusions (ABT) are incriminated if there is an increase of incidence of Healthcare-Associated Infections (HAIs).(3) Meta-analyses (over 13,000 individuals), performed on patients (7) who received allogenic blood transfusions, showed an increase between 9% and 25% of Healthcare-Associated Infections (HAIs), in particular, due to the immunosuppressive effect of the diminution of lymphocyte activity and reduction of population of T-killer cells. Using autologous blood transfusions prevents the risks specified for allogenic blood transfusions (ABT). The use of dextrans or human albumins is not sufficiently studied but there were noticed the minimal effects thereof on the immune system, having a minimal antigenicity, especially on dextrans.(7) Most guides recommend that antibiotherapy should not exceed 24 hours postoperative, except for the interventions of Altemeir class III and IV, that require an extension of up to 48 hours postoperative, especially in case of articular prostheses.

PURPOSE

We carried out this study to follow up the incidence of Healthcare-Associated Infections (HAIs), in case of patients aged over 60 years, who underwent surgery for femoral neck

[1]Corresponding author: Filip Panait, Str. Gutuiului, Nr. 52, Comuna Bâra, Județul Neamț, România, E-mail: panait.filip@yahoo.com, Tel: +40233 765516
Article received on 12.07.2015 and accepted for publication on 11.11.2015
ACTA MEDICA TRANSILVANICA December 2015;20(4):114-118

fractures, depending on the number of hospitalization days and the timing of the operation in order to allow the development of new strategies for the reduction of Healthcare-Associated Infections (HAIs), by transferring patients to primary healthcare services.

MATERIALS AND METHODS

The study was conducted on a sample of 544 patients, aged over 60 years, diagnosed with femoral neck fractures and that were hospitalized in the Department of Orthopedics of Sibiu County Emergency Hospital, from 29.02.2008 until 26.05.2015, who underwent surgery for femoral neck fractures. The study aimed at examining the incidence of Healthcare-Associated Infections (HAIs), though an analytical follow-up study.

The necessary data were collected and processed from the registration forms of patients hospitalized in the Department of Orthopedics of Sibiu County Emergency Hospital. Data processing in the inserted diagrams was performed in the program SPSS 21.

Eligibility criteria: Patients aged over 60 years, who underwent surgery for femoral neck fracture.

Exclusion criteria: Patients with femoral neck fracture who died preoperative within the period studied, patients treated functionally or patients who refused surgery.

We formed two groups of patients, depending on exposure to risk factors in-hospital. We divided the patients according to the average for the entire period of hospitalization studied (Average length of stay ALOS), classifying them into two groups: Group A, consisting of patients for which the exposure to risk factors during the hospitalization does not exceed 16 days, the equivalent of average length of stay (ALOS), for the entire period covered by the study and: Group B, consisting of patients for which the period of exposure to risk factors during hospitalization exceeded 16 days, being hospitalized for a longer period. We follow up the incidence of Healthcare-Associated Infections (HAIs) during hospitalization, for both groups, and the results were compared.

RESULTS

Distribution of cases in the period examined

We will further create an analytical table of femoral neck fractures operated during the period February 2008 – May 2015, discussing the association between the number of hospitalization days, the timing of the operation and the frequency of cases of Healthcare-Associated Infections (HAIs), continuing with the analysis of antibiotic prophylaxis administration and other more refined analysis, depending on the age and sex of patients included in the study. The table below summarizes the distribution by years of cases registered, followed by a graphical analysis of the evolution of annual distribution.

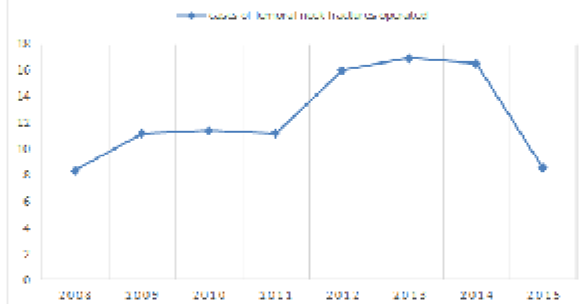
Table no. 1. Annual distribution of cases with femoral neck fractures operated

	Cases with femoral neck fractures operated	
29.02.2008 – 26.05.2015	n	%
2008	45	8.3
2009	61	11.2
2010	62	11.4
2011	61	11.2
2012	84	15.4
2013	95	17.5
2014	88	16.2
2015	48	8.8
Total	544	100

The analysis of annual distribution of number of cases involving femoral neck fractures operated shows an annual increase during the period 2008 – 2013.

From the analysis of table I.1, we estimate that the frequency of cases has progressively increased, until 2013, and starting with 2014 this has significantly decreased.

Figure no. 1. Annual distribution of cases with femoral neck fractures operated



Distribution of cases according to the number of hospitalization days

Table no. 2. Statistical indicators of the number of hospitalization days

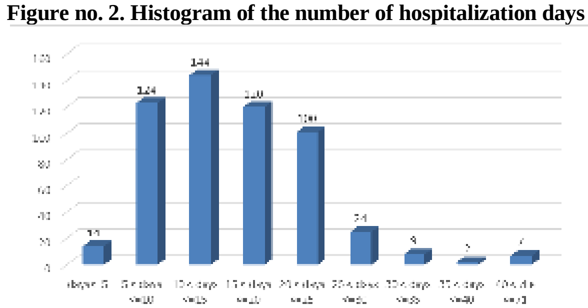
Mean Hospitalization days	Mean -95%	Mean +95%	Dev.std	Er.std	Min	Max	Q25	Median	Q75
16.05	15.45	16.69	7.43	0.32	4.00	71.00	10	15	21

The total number of hospitalization days is 8740 days, with an average of number of hospitalization days of 16.05 days±7.43DS, with minimum values of 4 days and maximum values of 71 days. The median value showed that 50% of patients in the study group received less that 15 days of hospitalization (Me=15), while 25% of them received more than 21 days of hospitalization (Q75=21).

Table no. 3. Distribution of cases according to the number of hospitalization days

Hospitalization days	Femoral neck fractures operated	
	n	n
days<=5	14	2.6%
5 <days <=10	124	22.8%
10 <days <=15	144	26.5%
15 < days <=20	120	22.1%
20 < days <=25	100	18.4%
25 < days <=30	24	4.4%
30 < days <=35	9	1.47%
35 < days <=40	2	1.7%
40 < days <=71	7	1.3%
Total	**544**	**100%**

Figure no. 2. Histogram of the number of hospitalization days



Histogram analysis of distribution of cases according to the number of hospitalization days points out a normal distribution, the 10-15 days period being identified as a period with maximum frequency (26.5% - 144 cases).

In the table below there are reproduced, synthetically, the gross and percentage values of the two groups, established according to the central variable of the research.

Table no. 4. Distribution of cases in the study groups

Study group	N	%
Group A → hospitalization days ≤ 16 days	309	56.8%
Group B → hospitalization days > 16 days	235	43.2%
Total	544	100

Annual average length of stay

Table no. 5. Assessment of average values of number of hospitalization days vs. year of study

Year of study	Mean Hospitalization days	Mean -95%	Mean +95%	Dev. std	Er. std	Min	Max	Q25	Median	Q75
2008	**20.62**	18.3	22.9	7.6	1.12	4	51	18	20	24
2009	**21.62**	19.97	23.2	6.45	0.78	7	44	18	20	24
2010	**21.11**	19.71	22.5	5.53	0.7	4	37	19	21	23.8
2011	**21.52**	20.3	22.7	4.73	0.61	13	41	19	21	23
2012	**12.45**	11.4	13.5	5.09	0.56	**5**	**42**	10	11	14.3
2013	**12.24**	11.27	13.2	4.79	0.47	**5**	**30**	9	11	14
2014	**11.42**	10.4	12.4	4.75	0.5	**4**	**34**	8	11	14
2015	**13.48**	10.55	16.41	10.08	1.36	**6**	**71**	9	12	13
Total	**16.05**	15.42	16.68	7.43	0.32	4	71	10	15	21

Table no. 6. Test for comparing the average values of the number of hospitalization days vs. year of study

	F (95% confidence interval)	p
Testing the homogeneity (Levene Test of Homogeneity of Variances	1.31	0.241
ANOVA Test (Analysis of Variance)	43.269	<0.001

To compare the annual average values of hospitalization it was required the pretest analysis of homogeneity of annual series. The results indicated that the annual variances of the number of hospitalization days do not have significant differences (F(7.536)=1.31, p=0.241, 95%CI) and, accordingly, the annual series are homogeneous. Taking into consideration these results for comparison of average values, the ANOVA test could be applied, which indicated significant fluctuations (F=43.269, p<0.01, 95%CI) of annual average values relating to the number of hospitalization days.

Therefore, it is noted that, compared to 2008-2011, starting with 2012, the average values of the number of hospitalization days decreased significantly, from an average of 21.5 days ±4.7DS, to an average of 12.24 days ± 4.7DS, average value that is maintained at the same low level both in 2013 (12.24 days ± 4.7DS) and in 2014 (11.42 days ± 4.7DS). The significant decrease in the number of hospitalization days is due to the introduction of legally binding rules, regarding the number of hospitalization days, in the annual framework agreement, approved by Government Decision.

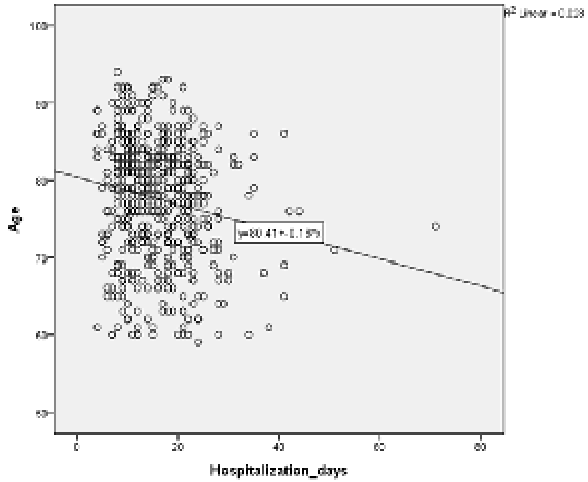
Correlation between the number of hospitalization days, versus patients age

Table no. 7. Estimated parameters in the correlation of values between age, hospitalization days and HAIs

Age vs. hospitalization days	Correlation coefficient	Significance level (p)
	-0.168**	<0.001
HAIs vs. hospitalization days	Correlation coefficient	Significance level (p)
	0.242**	=0.001
Localized infections vs. Healthcare-Associated Infections	Correlation coefficient	Significance level (p)
	0.624**	<0.001

Note: **p<0.01

Figure no. 3. Regression line for age values versus hospitalization days



To investigate the relation between patients' age and the number of hospitalization days, we used the Spearman correlation. As noticed in the above diagram, there is a negative relation, of mild intensity, but statistically significant, between patients' age and the number of hospitalization days. Therefore, the number of hospitalization days tends to increase as patients' age decreases.

Table no. 8. Descriptive statistics on average length of stay (ALOS) depending on the age of patients

Age range	60-64	65-69	70-74	75-79	80-84	>85
mean	17.75	16.95	17.575	16.6	15.4	13.9
standard error of the mean	1.38	1.163	0.92	0.66	0.54	0.59
median	17.5	16.0	18.0	16.0	14.0	12.0
standard deviation	7.96	8.7	9.0	7.13	6.17	6.41
minimum	4.00	6.00	5.00	5.00	4.00	4.00
maximum	38.00	41.00	71.00	44.00	35.00	41.00

Incidence of Healthcare-Associated Infections (HAIs)

Table no. 9. Distribution of cases according to the incidence of HAIs

	Group A		Standardized residual	Group B		Standardized residual
	Observed incidence	Percentage		Observed incidence	Percentage	
No	305	98.7	0.6	214	91.1	0.7
Yes	4	1.3	2.7	21	8.9	3.1
Total	309	100.0		235	100.0	

The statistical processing revealed an association between belonging to the research group (low number versus high number), the hospitalization days' group and HAIs. Similarly, there is a higher frequency of cases of Healthcare-Associated Infections for patients of group B (over 16 days of hospitalization): Chi-square (1) = 17.7, p<0.001.

Table no. 10. Estimated parameters relating to HAIs versus hospitalization days

df=2		p 95% confidence interval
Correlation coefficient (Spearman Rank R)	0.242	p=0.001

We will further analyze various medical parameters and the differences between the two research groups, depending on them.

Table no. 11. Distribution of cases depending on the antibiotic prophylaxis of cases with femoral neck fractures operated

	Group A		Group B		Total	
	n	%	n	%	n	%
without antibiotic prophylaxis	10	3.2%	8	3.4%	18	3.3%
antibiotic prophylaxis	299	96.8%	227	96.6%	526	96.7%
Total	309		235		544	

Figure no. 4. Distribution of cases depending on the antibiotic prophylaxis

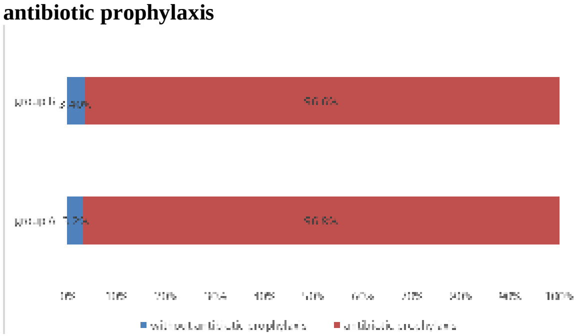


Table no. 12. Estimated parameters relating to the presence of antibiotic prophylaxis versus hospitalization days

df=2	Chi-square c^2	p *95% confidence interval*
Pearson's Chi-square - c^2	0.897	p=0.344
Correlation coefficient (Spearman Rank R)	0.04	p=0.345

The results demonstrated that there is no significant association between antibiotic prophylaxis and the study group (number of hospitalization days). This result is also confirmed by the comparable frequency of patients of the two analyzed groups who received antibiotic prophylaxis (group A → 96.8% versus group B → 96.6%). It is not possible to speak of an association between the administration of antibiotic prophylaxis and the number of hospitalization days.

In group A, a number of 299 patients have received antibiotic prophylaxis from a total number of 309. In group B, a number of 227 patients have received antibiotic prophylaxis from a total number of 235 patients.

Average length of stay versus antibiotic prophylaxis

Table no. 13. Assessment of average values of hospitalization days versus antibiotic prophylaxis

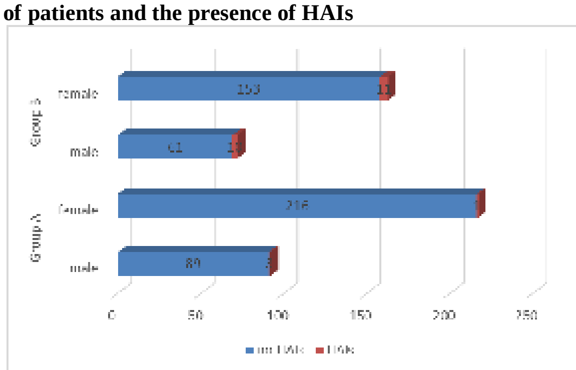
	Mean Hospitalization days	Mean -95%	Mean +95%	Dev. std	Er. std	Min	Max	Q25	Median	Q75
without antibiotic prophylaxis	15.83	12.39	19.06	7.27	1.71	4.0	28.0	9.0	16.0	21.5
antibiotic prophylaxis	16.06	15.4	16.68	7.47	0.32	4.0	71.0	10.0	15.0	21.0

Infections versus gender of patients

Table no. 14. Distribution of cases depending on the gender of patients with femoral neck fractures operated versus HAIs

		Without HAIs		HAIs		Total
		n	%	n	%	n
Group A	**male**	89	96.7%	3	**3.3%**	**92**
	female	216	99.5%	1	**0.5%**	**217**
Group B	**male**	61	85.9%	10	**14.1%**	**72**
	female	153	93.3%	11	**6.7%**	**163**
	Total	519		25		**544**

Figure no. 5. Distribution of cases depending on the gender of patients and the presence of HAIs



Antibiotic prophylaxis versus gender of patients / study group

Table no. 15. Distribution of cases depending on the gender of patients / antibiotic prophylaxis and the study group

	Antibiotic prophylaxis	male		female		Total
		n	%	n	%	n
Group A	no	7	7.6%	3	1.4%	10
	yes	85	92.4%	214	98.6%	299
		92		217		309
Group B	no	3	4.2%	5	3%	8
	yes	68	95.8%	159	97%	227
		71		164		235
	Total	163		381		544

Figure no. 6. Distribution of cases depending on the gender of patients / antibiotic prophylaxis and the study group

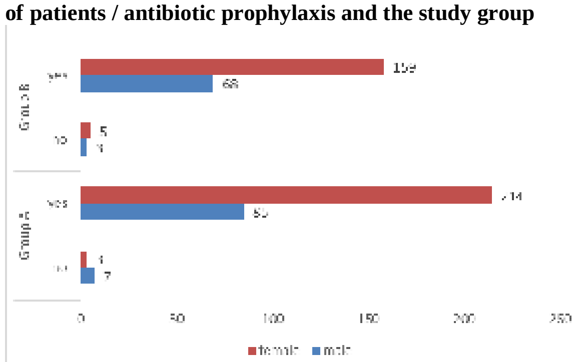


Table no. 16. Estimated parameters in association with the gender of patients and antibiotic prophylaxis

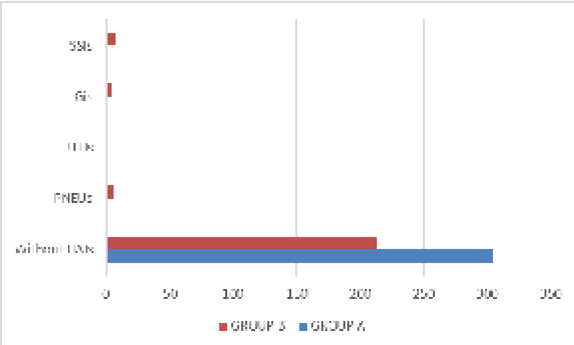
df=1	Chi-square c^2		p *95% confidence interval*	
	Group A	Group B	Group A	Group B
Pearson's Chi-square - c^2	7.99	0.183	0.005	0.668
Correlation coefficient (Spearman Rank R)	0.161	0.028	0.005	0.670

Only in group A (χ^2=7.99, p=0.005, 95%CI) there is an association between the gender of patients and antibiotic prophylaxis. Thus, female patients received more antibiotic prophylaxis. In group B, as shown in the table data, there were no significant differences in terms of antibiotic prophylaxis depending on the gender of patients.

Table no. 17. Distribution of HAIs cases depending on the research group

	Without HAIs	PNEUs	UTIs	GIs	SSIs	TOTAL
GROUP A	305	1	1	0	2	309
	98.7%	0.3%	0.3%	0	0.6%	100%
GROUP B	214	6	2	5	8	235
	91.1%	2.6%	0.9%	2.1%	1.8%	100%

Figure no. 7. Distribution of HAIs cases depending on the research group



There are differences between the two groups, depending on the proportion of Healthcare-Associated Infections (HAIs).

There is a positive and statistically significant correlation between the presence of HAIs and the number of hospitalization days (Phi=0.181, p<0.001). Therefore, the increase of average length of stay (ALOS) leads to the increase of incidence of HAIs. As shown in the table below, the length is associated, especially, with cases of gastrointestinal infections and SSIs (where the standardized residual approaches the value of 2, suggesting that they are the responsible components for the observed statistical difference).

Table no. 18. Contingency table of data on the presence of HAIs within the two groups of research

			Group		Total
			<16 ALOS	>ALOS	
Type of HAIs	0	Analyzed cases	305	214	519
		Standardized residual	0.6	-0.7	
	PNEUs	Analyzed cases	1	6	7
		Standardized residual	-1.5	1.7	
	UTIs	Analyzed cases	1	2	3
		Standardized residual	-0.5	0.6	
	GIs	Analyzed cases	0	5	5
		Standardized residual	-1.7	1.9	
	SSIs	Analyzed cases	2	8	10
		Standardized residual	-1.5	1.8	
Total			309	235	544

However, contrary to expectations, the statistical comparisons performed depending on the length of hospitalization, before surgery, shows that there is no association between the number of preoperative days and the incidence of HAIs: r=0.074, p=0.085.

DISCUSSIONS

Healthcare-Associated Infections (HAIs), relating to the patients of the study, had a significantly higher frequency in case of patients hospitalized for more than 16 days. The gender distribution of HAIs does not highlight significant differences in the two groups studied, both men and women, being exposed, equally, to the risk of contamination.

For the future, further studies are required regarding ALOS and the timing of the operation, to bring information on venous thromboembolism, caused by prolonged stay in hospital. The decrease of ALOS must also be studied from the point of view of the risk of death, caused by an insufficient period of hospitalization to heal the sick people, even under proper primary healthcare services. Comparing the data from the study with the data obtained by other authors, it may be noticed a pretty big difference between average length of stay (ALOS) in Romania and average length of stay (ALOS) in EU or USA countries.(8,1)

CONCLUSIONS

Healthcare-Associated Infections (HAIs) in elderly patients who underwent surgery for femoral neck fractures require multidisciplinary approaches for prevention and treatment. In order to decrease the number of Healthcare-Associated Infections (HAIs), it is necessary to reduce the average length of stay (ALOS), by transfer to primary healthcare services, where the risks are much smaller and the costs are lower. The increase of the average length of stay (ALOS) causes the occurrence of Healthcare-Associated Infections (HAIs), even if the antibiotic prophylaxis was performed adequately.

REFERENCES

1. Guido B, Sonja B, Banz V, Mühlemann K, Candinas D. Impact of intraoperative behavior on surgical site infections. The American Journal of Surgery. 2009;2(198):157-162.
2. Leone S, Borre S, Monforte AA, Mordente G, Petrosillo N, Signore A, et al. Consensus document on controversial issues in the diagnosis and treatment of prosthetic joint infection. Elsevier USA, International Journal of Infectious Diseases. 2010;14S4,S67-S77.
3. Garcia-Alvare F, Al-Ghanem R, Garcia-Alvarez I, Lopez-Baisson A, Bernal M. Risk factors for postoperative infections in patients with hip fracture treated by means of Thompson arthroplasty. Archives of Gerontology and Geriatrics. 2010;50:51-55.
4. Săndesc D, Deutsch P, Grigoraş I, Brinzeu C, Duma RA, Droc G, et al. Profilaxia antibiotică perioperatorie. Recomandări Societatea Română de ATI (SRATI); 2009.
5. Campoccia D, Montanaro L, Speziale P, Arciola CR. Antibiotic-loaded biomaterials and the risks for the spread of antibiotic resistance following their prophylactic and therapeutic clinical use. Biomaterials. 2010;31:6363-77.
6. Günther F, Wabnitz GH, Stroh P, Prior B, Obst U, Samstag Y, et al. Host defence against Staphylococcus aureus biofilms infection: Phagocytosis of biofilms by polymorphonuclear neutrophils (PMN). Molecular Immunology. 2009;46:1805-13.
7. Hill GE, Frawley WH, Griffith KE, Forestner JE, Minei JP. Allogeneic Blood Transfusion Increases the Risk of Postoperative Bacterial Infection: A Meta-analysis, The Journal of trauma, Injury, Infection, and Critical Care. Lippincott Williams & Wilkins .USA; 2003.
8. Verma R, Rigby A, Shaw C, Mohsen A, Femoral Neck Fractures: Does Age Influence Acute Hospital Stay, Delay to Surgery, and Acute Care Costs? Orthopedics. 2010;33:3.