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Research Article

The Clustering in Analyzing Effect of Three Risk Factors on the Occurrence of Dehiscence after Laparotomy

Milorad Paunović[*]

University of Belgrade, Clinical Center of Serbia, Belgrade, Serbia

[*]**Corresponding author:** Milorad Paunović, University of Belgrade, Clinical Center of Serbia, Belgrade, Serbia. Tel: +38163449609; Email: miloradpaunovic@yahoo.com

Abstract

The minimum sum of squares clustering method is new method applied in medicine. We first collect data of 1063 patients in hospital in Serbia, taking into account 3 their attributes. Among 1063 patients, 46 of them had the occurrence of dehiscence laparotomy. We analyze the risk of taking surgery based on clustering patient in groups, taking into account the influence of patient sex, infection and smoking on the occurrence of dehiscence laparotomy. Dehiscence of laparotomy occurred in 4.3% of patients. In male patients, in the presence of infection and in patients- smokers, dehiscence of laparotomy is common. In this paper, for the first time, we present the minimum sum of squares clustering method in analyzing risk factors: the influence of patient sex, infection and smoking on the occurrence of dehiscence of laparotomy. We show that the minimum sum-square modeling group is well suited for this research. Some hypotheses can be performed automatically.

Keywords: Dehiscence of laparotomy; Infection; Patient sex; Reintervention; Smoking; Wound

Introduction

Surgical site infections and wound and tissue dehiscence are well-known postoperative complications in gastrointestinal surgery, and general surgery as well. Evisceration is a complication associated with high morbidity, and high mortality as well, and the percentage in colorectal surgery still remains 2-3,5% [1,2]. The infection is certain in 5-10%. The rupture of the abdominal wall occurs in 1% of the cases, however with a high mortality rate (15-45%) [3]. Severity of these complications embraces mild cases needing local wound care and antibiotics to serious cases with multiple reoperations and a high mortality rate. In most cases, such complications prolong hospitalization, with a substantial increase in cost of care [4].

Extension of the age limit of surgical patients leads to the emergence of new problems related to the altered response of the organism (burdened by homeostasis disorders and the function of all age-old systems) on the surgical procedure. Also, patient sex has a major influence on the occurrence of dehiscence of laparotomy. Infection of the surgical wound is one of the most important risk factor for dehiscence of laparotomy. Gastrointestinal surgery, emergency surgery, prolonged surgical time are associated with an increased risk of surgical wound infection. Wound infection defined as purulent secretion from the wound contents, regardless of the bacteriological findings [5]. It occurs in up to 15% of treated patients [6-8].

Smoking, microvascular disease, and severe lung disease are known to cause peripheral tissue hypoxia which increases the risk of wound infection and dehiscence. Collagen disease (Sy. Marphan, Sy. Oehler-Dunloss), although relatively rare, are characterized primarily by disorders in the fibroplasia phase [9]. Also, smoking and the use of corticosteroid therapy as part of these disorders reduces the healing of the epidermis and collagen biosynthesis. Systemic steroid therapy reduces resistance to tearing, slows down angiogenesis and epitelization, especially when given prior to surgery or during the first three days after surgery. Preferably the dosage of steroids is reduced during a critical inflammatory phase of healing of the wound. Simultaneous administration of vitamin A and vitamin C can lead to a reduction in the harmful effects of steroids and smoking. Vitamin A accelerates the achievement of hardness of the wound, re-enteritis and steroid- inhibited wound healing [10].

Methods

Statistical tests

Complications-dehiscence of laparotomy was found in 46 patients. We analyzed the following data as risk factors: the influence of patient sex, infection and smoking on the occurrence of dehiscence after laparotomy of 1063 operated patients at the Department of General Surgery in Nis in the period from 1st January 2018 to 31st July 2019. We organized our research like a prospective study. Statistical sample size is determined by the statistical methodology to meet the basic principle of representativeness. In this paper, results are presented in tables and graphic. In statistical analysis we used parametric tests (Student's t-test) and nonparametric Chi-square test. For statistical analysis we used the software package SPSS 14.0, and the imaging table and a Microsoft Office Word 2003.

Minimum sum-of-squares clustering

One of mostly used criterion for clustering is Minimum Sum-of-Squares (MSS), where all entities are placed in n- dimensional Euclidean space and their dissimilarities calculated as squared distances in Rn. The number of clusters m is given in advance. The objective is to make groups of entities such that the total sum of squared distances within each group or cluster is minimum. It appears that minimizing the intragroup distances is equivalent to maximizing the square distances among entities from different groups [11]. This property makes MSS most popular criterion since it measures in the same time homogeneity and separation. Moreover, MMS may be equivalently presented as the problem of minimizing the square distances from each entity to its own cluster center or centroid [11].

Since MMS problem is NP-hard [11], there are many heuristics already appeared in the literature. The most popular heuristic is so-called k-means method. It alternatively solves allocation of entities to their closest centroid and finding the corresponding centroid of each cluster. Although being very popular due to its simplicity, the results obtained by k-means sometimes are very far from the global optimum [11]. That is the reason why there are many heuristics that are trying to improve precision of k-means algorithm. One among them is J-means and Variable Neighborhood Search (VNS) based heuristic [11].

In this paper we presented data of 1063 patients in 3-dimensional space. As mentioned earlier, those three attributes (or risk factors) are: the influence of patient sex, infection and smoking on the occurrence of dehiscence laparotomy. All three are considered as binary variables. In the next section we will analyze the results obtained by both k-means and VNS heuristics.

The Research Results

Statistical tests

Dehiscence of laparotomy occurred in 4.3% of patients or 46 patients of the total 1063 respondents. Of the total 46 patients with dehiscence of laparotomy, 37 patients were male or 80.4%, while only 9 patients were female or 19.6%. There is a statistically significant relationship between dehiscence of laparotomy and male sex ($\chi^2 = 46.921$; p<0.01). Of the patients who did not have a dehiscence of laparotomy 686 patients were male or 67.5% and 331 patients without dehiscence of laparotomy were female or\ 32.5% (Figure 1).
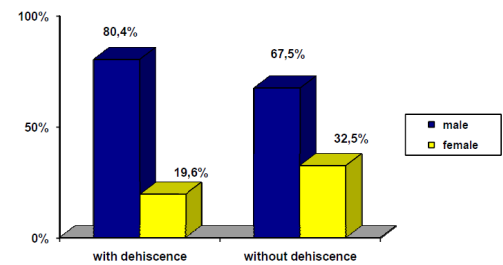

Figure 1: Occurrence of dehiscence of laparotomy in relation to patient sex.

There is a statistically significant relationship between dehiscence of laparotomy and infections ($\chi^2 = 48.623$; p<0,01). Infection was significantly more prevalent in patients with dehiscence of laparotomy. From 46 patients with dehiscence of laparotomy them 19 or 51.3% had an infection, and of the 821 patients without infection, dehiscence laparotomy them 19 or 51.3% had an infection, and of the 821 patients without infection, dehiscence had only 27 of them, or 3.3% (Figure 2).
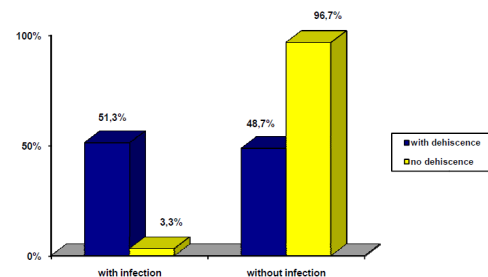

Figure 2: Impact of infection on the occurrence of dehiscence of laparotomy.

Of the 1063 patients examined, 235 were smokers or 22.1%. There is statistically significant correlation between dehiscence of laparotomy and smoking ($\chi^2 = 6.817$; p<0.05). 39 smokers had dehiscence of laparotomy or 16.6% and 196 smokers did not have dehiscence of laparotomy or 83.4%. Of the patients who did not

have a dehiscence of laparotomy 196 patients were smokers or 19.3% and 821 patients without dehiscence of laparotomy were not smokers or\ 80.7% (Figure 3).
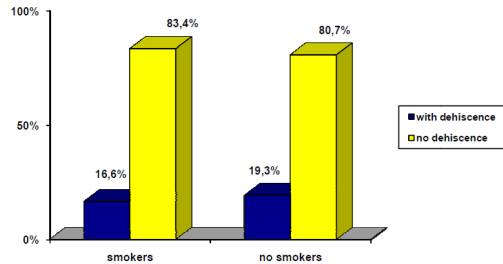

Figure 3: The presence of smoking on the occurrence of dehiscence of laparotomy.

Clustering results

In Table 1 we report results obtained by two heuristics for Minimum sum-of-squares clustering: k-means and VNS. The first the number of desired clusters are given. The second line gives the value of the objective function. In column 3 we report the number of entities in each cluster obtained by k-means. The next 3 columns report the same values given by VNS. It appears that both methods keep 46 patients with dehiscence laparotomy in the same cluster. The difference in results starts after $m=5$, where the total sum of squares is 195.17 and 109.32 obtained by k-means and VNS respectively. Moreover, VNS keeps the 46 patients in the same cluster up to $m=8$. This means that not only the clustering model is important but also the method used.

M	K – means			VNS		
	f	# of entities	Time	f	# of entities	Time
2	423.08	{46,1017}	0.3	423.08	{46,1017}	0.6
3	327.23	{46,480,537}	0.4	327.23	{46,493,524}	0.8
4	268.04	{46,250,287,480}	0.6	268.04	{46,243,250,524}	1.1
5	195.17	{19,27,250,319,448}	0.7	109.32	{46,82,161,276,498}	1.2
6	98.77	{3,17,26,273,296,448}	0.8	64.21	{46,112,139,196,276,294}	1.7
7	72.18	{3,9,10,24,296,352,369}	1	38.48	{15,46,119,167,196,226,294}	2.3
8	52.12	{1,2,8,16,35,288,344,369}	1.3	26.42	{11,12,46,87,186,196,231,294}	2.8

Table 1: Comparison of k-means and VNS heuristics in clustering $n=1063$ patients into m groups.

Some observations regarding results reported at Table 1 are:

(i) Clustering models and methods may be successfully used in medicine in general and more particularly in Surgery in parallel with statistical tests;

(ii) Hypotheses may be automatically derived, e.g., the 46 patients with dehiscence of laparotomy are kept in the same group with up to 8 clusters;

(iii) Results obtained by clustering techniques are more rich in a sense that they provide more information to

practitioners: relations between clusters, introduction of many patient's attributes in analysis, etc.;

(iv) The clustering method used may play a significant role in understanding the final results, i.e., VNS based heuristic outperform significantly k-means heuristic for number of clusters grater or equal to 5.

Discussion

In this section we first discuss our results obtained by statistical tests and then comment on their relations with clustering. Despite major advances in the understanding of the process of wound healing physiology, surgical techniques and the application of modern technologies and materials in surgery, the percentage of impaired healing laparotomy is still high. Dehiscence of laparotomy occurs in approximately 3% of patients. In a retrospective study by Rodriguez- Hermosa Ji and all from Spain, in 57 patients or 0.45% of the total 12622 patients with laparotomy, there was dehiscence of laparotomy. There were 45 male patients and 12 female patients [12]. In India's study from Rajindra Hospital in Patiala male predominance (37/50) was observed, with ratio of male to female being 2.84:1 [13]. In our study compared to sex the patients of the total 46 patients with dehiscence of laparotomy, there were 37 males and 9 females. When it comes to full structure, our study does show a statistically significant difference between sexes. The Cracow study Konig J, Richter P, Zurawska S. and associates with dehiscence of laparotomy occurred in 56 patients or 2.9% of their patients [14]. Our results show that dehiscence of laparotomy was present in 4.3% of patients or 46 patients of the total 1063 respondents. Preoperative preparation is an important stage in the treatment of surgical patients and the adequacy of

preoperative depends on result of the operation, the incidence of complications and mortality of patients. It is necessary that all the general condition of the patients preoperatively stabilized and carry a minimum of anesthesia and surgical preoperative whenever the patient's condition allows [15]. Infection is extremely destructive effect on the wound healing process by increasing the production of cytokines and proteases, which disrupt the synthesis of fibroblasts, and the stability of the wound [16]. Our study confirms this claim, because in patients with the presence of infection, dehiscence of laparotomy is more common, 51.3% of patients with dehiscence of laparotomy had an infection. In Germany, the study was done by Fleischer GM, and all, the dehiscence of laparotomy occurred in 5-10% of patients with infection [3]. In our study, the percentage of the effect of infection on the occurrence of dehiscence is much higher.

Smoking and comorbidities such as diabetes, cardiovascular disease, and lung disease were associated with surgical site infections and dehiscence of tissue and wounds, thus confirming previous reports [17,18]. Several pathogenetic mechanisms may be involved. Smoking, microvascular disease, and severe lung disease are known to cause peripheral tissue hypoxia which increases the risk of wound infection and dehiscence. In addition, some studies suggest that hypoxia, smoking, and diabetes reduce collagen synthesis and oxidative killing mechanisms of neutrophils [19,20]. In our study is statistically significant correlation between dehiscence of laparotomy and smoking. 39 smokers had dehiscence of laparotomy or 16.6%. Comparing the results with the results of international studies in this paper we come to the conclusion that our results are not worse than the results of the world's health task.

Conclusion

When surgeon analyzing three risk factors: the influence of patient sex, infection and smoking, he can identify patients with high risk. Therefore, it is important to identify them early and treat those patients with care. In male patients, in the presence of infection and in patients–smokers, dehiscence after laparotomy is common. Healthy life and good preoperative preparation reduce postoperative wound complications. In this paper, for the first time, we present the minimum sum of squares clustering method in analyzing risk factors: the influence of patient sex, infection and smoking on the occurrence of dehiscence of laparotomy. The minimum sum-square modeling group is well suited for this research. Some hypotheses can be performed automatically. The researchers in future work may use different clustering methods for the analysis of various risk factors in medicine in general.

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