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The Clustering in Analyzing Effect of Hepatic Disease, Blood Loss and Using of Corticosteroid Therapy on the Occurrence of Dehiscence Laparotomy

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Abstract

The finish line of this study was to determine the influence of hepatic disease, blood loss and using of corticosteroid therapy on the occurrence of dehiscence laparotomy. The minimum sum of squares clustering method is new method applied in medicine. We first collect data of 912 patients in hospital in Serbia, taking into account 3 their attributes. Among 912 patients, 39 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 hepatic disease, blood loss and using of corticosteroid therapy on the occurrence of dehiscence laparotomy. Dehiscence of laparotomy occurred in 4.3% of patients. In patients with perioperative blood loss there exist very significant correlation between dehiscence of laparotomy and this risk factor. In patients with hepatic diseases and in patients who using corticosteroids therapy, 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 hepatic diseases, blood loss and using of corticosteroids therapy 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.

Introduction

Complications related to postoperative wound healing up occur with varying frequency depending on the underlying disease, the patient's and surgeon's technical skills. 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% to 3.5% [1,2]. The infection is certain in 5% to 10%. The rupture of the abdominal wall occurs in 1% of the cases, however with a high mortality rate (15% to 45%) [3]. The 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 a surgical procedure.

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]. Microvascular disease, severe lung disease and blood loss 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, 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

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reduction in the harmful effects of steroids. Vitamin A accelerates the achievement of hardness of the wound, re-enteritis and steroid-inhibited wound healing [10].

Methods

Statistical tests: Research is organized by type of prospective studies that have analyzed the following data as risk factors: the impact of hepatic diseases, perioperative blood loss and the using of corticosteroids therapy on the occurrence of dehiscence laparotomy of 912 operated patients at the Department of General Surgery in Nis in the period from 1st January 2018 to 15th March 2019. Complications-dehiscence of laparotomy was found in 39 patients. Statistical sample size is determined by the statistical methodology to meet the basic principle of representativeness. It was used to determine the optimal normogram sample. In this paper, results are presented in tables and graphical. The statistical analysis using the methods of descriptive statistics (mean, standard deviation), 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, there are many heuristics already appeared in the literature [11]. 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 912 patients in 3-dimensional space. As mentioned earlier, those three attributes (or risk factors) are: the influence of hepatic diseases, blood loss and taking of corticosteroids therapy 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 39 patients of the total 912 respondents.

Of the total 39 patients with dehiscence of laparotomy, 25 patients were male or 64.1% and 14 patients were female or 35.9%. Of the patients who did not have a dehiscence of laparotomy 562 patients were male or 60.9% and 311 patients without dehiscence of laparotomy were female or 39.1%.

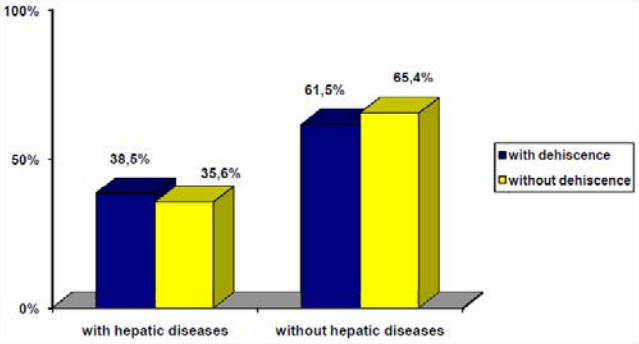

Figure 1: The presence of hepatic diseases on the occurrence of dehiscence of Laparotomy.

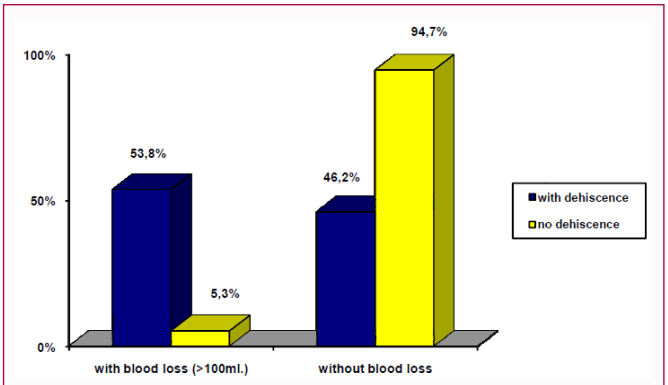

Figure 2: Impact of blood loss on the occurrence of dehiscence of laparotomy.

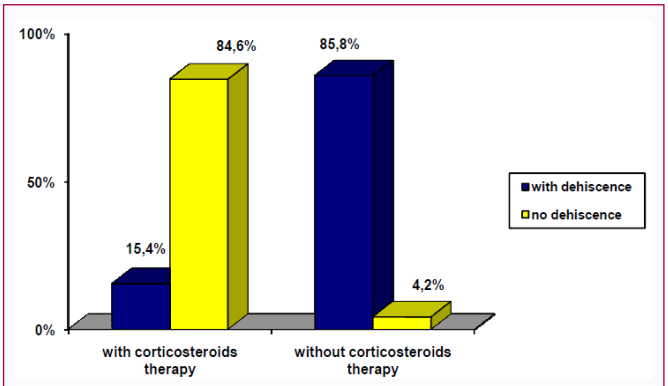

Figure 3: The effect of using of corticosteroids therapy on the occurrence of dehiscence of laparotomy.

Liver diseases (fat infiltration of the liver, cholelithiasis and liver cirrhosis) were statistically significantly higher in the group of patients with dehiscence of laparotomy than in the second group of patients without dehiscence of laparotomy (c^2=1.284; p<0.05). Hepatic disease in patients with dehiscence has 15 patients or 38.5%, and in patients without dehiscence 302 patients had liver diseases or 35.6% patients. Hepatic disease did not have 24 patients with dehiscence of laparotomy or 61.5% and 571 patients without dehiscence of laparotomy or 65.4% (Figure 1).

There is a statistically very significant relationship between dehiscence of laparotomy and blood loss (c^2=26,944; p<0,01). Blood loss (>100 ml) was significantly more prevalent in patients with dehiscence of laparotomy. Of 39 patients with dehiscence of laparotomy them 21 or 53.8% had a blood loss, and of the 873 patients

Table 1: Comparison of k-means and VNS heuristics in clustering n=912 patients into m groups.

m	K – means			VNS		
	f	# of entities	Time	f	# of entities	Time
2	493.02	{ 39,873}	0.1	493.02	{39,873}	0.4
3	327.01	{39,342,531}	0.2	327.01	{39,383,490}	0.5
4	237.06	{39,141,201,531}	0.4	237.06	{39,182,201,490}	0.6
5	171.43	{39,61,80,280,452}	0.4	171.43	{39,90,96,197,490}	0.9
6	92.07	{18,21,56,89,278,450}	0.5	73.51	{39,45,60,86,192, 490}	1.1
7	47.14	{7,9,31,32,185,198,450}	0.6	33.86	{39,42,63,98,179,236,254}	1.2
8	39.46	{2,6,10,26,29,191,198,450}	0.8	24.2	{12,26,39,69,93,168,251,254}	1.4
9	36.31	{2,9,16,19,26,28,188,192432}	0.9	15.63	{11,12,26,39,88,94,179,225,238}	1.4
10	20.09	{2,2,7,18,21,28,32,181,188,432}	0.9	11.05	{9,14,24,39,44,46,89,181,225,238}	1.4

without dehiscence, blood loss had only 46 of them, or 5.3% (Figure 2).

Of the 912 patients examined, 196 took corticosteroids therapy or 21.5%. There is statistically significant cor relation between dehiscence of laparotomy and using of corticosteroids therapy (c^2=6.936; p<0.05). 6 patients who took corticosteroids therapy, had dehiscence of laparotomy or 15.4% and 37 patients with corticosteroids therapy did not have dehiscence of laparotomy or 4.2% (Figure 3).

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 39 patients with dehiscence laparotomy in the same cluster. The difference in results starts after m=6, where the total sum of squares are 92.07 and 73.51 obtained by k-means and VNS respectively. Moreover, VNS keeps the 39 patients in the same cluster up to m=10. This means that not only the clustering model is important but also the method used.

(i) Some observations regarding results reported at Table 1 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 39 patients with dehiscence of laparotomy are kept in the same group with up to 10 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 6.

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 39 patients with dehiscence of laparotomy, there were 25 males and 14 females. When it comes to full structure, our study does not 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 39 patients of the total 912 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].

In a prospective study by Ramnesh G, Sheerin S. and all hepatic dysfunction had 16% of patients or 8 patients [13]. In our study liver disease in patients with dehiscence has 15 or 38.5% of patients. In our study exist a statistically significant relationship between dehiscence of laparotomy and liver disease (c^2=1.284; p<0.05).

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].

Following elective operations, perioperative blood loss was a risk factor of postoperative tissue and wound complications in a dose-dependent manner when adjusting for other risk factors and confounders. This finding confirms previous reports, and suggests that hypovolemia and reduction of tissue oxygenation by loss of red blood cells is detrimental to healing and increases the risk of infection and tissue dehiscence [17,18]. An immunomodulatory effect of allogenic blood transfusions to compensate for perioperative blood loss has been suggested as causative for postoperative wound infections [19]. In our study exist a statistically very significant relationship between dehiscence of laparotomy and blood loss (c^2=26.944; p<0.01). Blood loss (>100 ml) was significantly more prevalent in patients with

dehiscence of laparotomy, 16 operated patients with dehiscence of laparotomy or 48% had a blood loss.

In the study of Akkusa A, Avdinuraza K and a colleague at the Kirikkale University Medical School in Turkey proven that long-term use of corticosteroid therapy leads to a change in enzymes involved in the glycolysis process during wound healing. The study covered three groups. In Group A, eight patients received metilprednisolone seven days before surgery and after surgery to complete healing of the wound. In Group B, twelve patients received methylprednisolone seven days before laparotomy. After surgery, methylprednisolone injections continued, but immunosuppressive treatment with carnitine was also introduced to complete wound healing. In Group C, eight patients received no treatment. In half of the patients examined, wounds were healed within seven days after laparotomy. The remaining wounds were healed up to the fourteenth day after surgery. Tension on the wound line and the content of hydroxyproline are parameters whose values are monitored in all three investigated groups. The study found that there was no statistically significant difference in both parameters in all three groups on the seventh day after laparotomy. On the fourteenth day, both parameters showed a statistically significant difference between the group in which methylprednisolone and control groups were administered ($p<0.05$). Tension values on the wavy line were lower in the group where carnitine was administered compared to the group where methylprednisolone was administered ($p>0.05$). The use of carnitine led to an increase in the level of hydroxyproline in wounds in a group of patients receiving methylprednisolone and carnitine compared to the control group of patients ($p<0.05$). The use of carnitine leads to a decrease in tension on the wound line in relation to the tension of the wound where only methylprednisolone is applied [20]. Our study also showed that dehiscence of laparotomy ($p<0.05$) was more frequent in those treated with corticosteroids. Corticosteroids (given especially preoperatively and during the first three postoperative days) slow down all stages of the wound healing process: inflammation, collagen synthesis, epithelization and angiogenesis. Quick correction is possible using vit A (20 000 IU) and anabolic steroids [10].

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

Dehiscence of laparotomy occurred in 4.3% of operated patients. In patients with perioperative blood loss there exists very significant correlation between dehiscence of laparotomy and blood loss. In patients with hepatic diseases and in patients who used corticosteroid therapy dehiscence of laparotomy is common. By analyzing these three risk factors, the surgeon can identify patients with high risk. Therefore it is important to identify them early and treat those patients with care.

Further, development of clinical pathways would prove valuable if the absolute risk of each patient could be estimated when planning surgery to specifically optimize the patient's preoperative condition to reduce the risk of complications.

Good preoperative preparation reduces postoperative wound complications.

In this paper, for the first time, we present the minimum sum of squares clustering method in analyzing risk factors: the effect of hepatic diseases of patients, blood loss and using of corticosteroids therapy 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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