G Chir Vol. 40 - n. 1 - pp. 32-38
January-February 2019

original article

Use of the KSVM-based system for the definition, validation and identification of the incisional hernia recurrence risk factors

L. LICARI[1*], G. SALAMONE[1*], S. CAMPANELLA[1], F. CARFÌ[1], T. FONTANA[1], N. FALCO[1], R. TUTINO[1], P. DE MARCO[1], A. COMELLI[2,3,4], D. CERNIGLIA[3], G. PETRUCCI[3], S. VITABILE[5], G. GULOTTA[1]

* The first and the second authors (Licari L and Salamone G) contributed to the writing of the manuscript in equal measure and must therefore be considered both of them the first authors.

SUMMARY: **Use of the KSVM-based system for the definition, validation and identification of the incisional hernia recurrence risk factors.**

L. LICARI, G. SALAMONE, S. CAMPANELLA, F. CARFÌ, T. FONTANA, N. FALCO, R. TUTINO, P. DE MARCO, A. COMELLI, D. CERNIGLIA, G. PETRUCCI, S. VITABILE, G. GULOTTA

Background. *Incisional hernia is one of the most common complications after abdominal surgery with an incidence rate of 11 to 20% post laparotomy. Many different factors can be considered as risk factors of incisional hernia recurrence. The aim of this study is to confirm and to validate the incisional hernia recurrence risk factors and to identify and to validate new ones.*

Methods. *In the period from July 2007 to July 2017, 154 patients were selected and subjected to incisional hernia repair. The surgical operations were conducted under general anaesthesia. Patients received antibiotic prophylaxis when indicated, according to the hospital prophylaxis scheme. Inclusion criteria of the study were single operator case studies and open laparotomy for incisional hernia repair. The statistical analysis proposed to identify and to verify the risk factors for recurrence of incisional hernia is the Support Vector Machine (SVM). The analysis was conducted verifying 34 risk factors.*

Results. *The data analysis confirmed the known correlations showed in the international literature with a greater incidence of comorbidities such as diabetes 37%, dyslipidaemia and hypercholesterolemia with a cumulative incidence of 16%; tobacco smoke - by combining categories smokers and ex-smokers - reach 46%, COPD 16% and hypertension 51%.*

Conclusions. *The analysis of the data therefore confirmed the correlations showed in the international literature. A KSVM-based system to classify incisional hernia recurrence has been presented. The type of prosthesis and the site of its implant also play a significant role in the development of the recurrence. Sensitivity (86,25%), Specificity (87,14%), Negative Predictive Value (84,72%), Precision (88,46%), Accuracy (86,67%), and Error (13,33%) scores obtained using the proposed technique highlight the validity for the relapse's classification methodology.*

KEY WORDS: Incisional hernia - Risk factors - Recurrence - KSVM.

Introduction

Incisional hernia is one of the most common complications after abdominal surgery with an incidence rate of 11 to 20% post laparotomy. The impact in terms of Quality of Life (QoL) worsening and public health costs is relevant. Moreover, the recurrence of incisional hernia after surgical operation of incisional hernia repair has an incidence rate of 18 to 50% during the first post-operative year depending on some variables (1, 2).

Particularly, many different factors can be considered as risk factors of incisional hernia recurrence such as the surgical technique performed, the use of a mesh, the anatomical site of the mesh positioning, the emergency regimen of the surgical operation, the presence of a dirty/contaminated surgical field, the oldness, the sex, the obesity, the diabetes mellitus type 2, the tobacco use, the malnutrition, the use of immunosuppressor, the chronic pulmonary disease, the ascites and the chronic anaemia (3).

[1] University of Palermo, Department of Surgical, Oncological and Oral Sciences, "Policlinico P. Giaccone", Palermo, Italy
[2] Institute of Molecular Bioimaging and Physiology, National Research Council (IBFM-CNR), Cefalù (PA), Italy
[3] Department of Industrial and Digital Innovation (DIID), University of Palermo (PA), Italy
[4] Department of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta GA 30332, US
[5] Department of Pathobiology and Medical Biotechnologies, University of Palermo (PA), Italy

Corresponding author: Leo Licari, e-mail: lele.licari@gmail.com

These factors were well defined in the past as risk factors for incisional hernia recurrence. The aim of this study is to confirm and to validate the risk factors mentioned above, and to identify and to validate new risk factors responsible of the recurrence.

Patients and methods

In the period from July 2007 to July 2017, 154 patients were selected and subjected to incisional hernia repair. The patients were subjected to surgical procedure at the Department of Surgical, Oncological and Oral Sciences - General and Emergency Surgery of the Policlinico P. Giaccone of Palermo, University of Palermo. The surgical operations were conducted under general anaesthesia. Patients received antibiotic prophylaxis when indicated, according to the hospital prophylaxis scheme. Inclusion criteria of the study were single operator case studies and open laparotomy for incisional hernia repair. Kernel Support Vector Machine (KSVM) is the intelligent data analysis and data mining proposed to identify and to verify the risk more significant factors for recurrence of incisional hernia. The analysis was conducted verifying 34 risk factors that are shown in Table 1.

Intelligent data analysis and data mining

The proposed intelligent data analysis and classification technique are based on machine learning algorithms used to classify the proprietary University of Palermo Policlinico Hospital (UPPH) Dataset. The dataset is composed of 154 patients, each of one codified by 34 qualitative features and classifier into Positive for recurrence risk or Negative for recurrence risk by expert surgeons. The purpose of the study is reached developing an objective tool for incisional hernia affected patients classification, using a Kernel Support Vector Machine (KSVM) based technique. The proposed technique uses 103 vectors composed of 34 qualitative features used for KSVM training to identify incisional hernia recurrence; 51 vectors composed of 34 qualitative features used to validate the proposed technique. In order to make reliable the classifier, generalized to other sets of independent data and to limit problems as over-fitting, without increasing the precision of final standings, the cross-validation is integrated into the proposed technique. In Stratified K-fold cross-validation, the data set is

TABLE 1 - RISK FACTORS VERIFIED FOR RECURRENCE.

Risk factors	
Age	Chevrel R
Sex	Chevrel S
Type of hernia	Cardiovascular morbidities
Urgency regimen of surgical operation	Gastrointestinal morbidities
Surgical technique adopted	Haepatic morbidities
Anaesthesia	Urinary morbidities
ASA score	Other surgical operations
Height	Previous use of mesh
BMI	Type of mesh
Ethnicity	Dimension of the mesh
Job	Dimension of the defect
Endocrine morbidities	Type of suture used
Pulmonary morbidities	Drainage usage
Chevrel M	Post-surgical SSI
Chevrel N	Seroma formation
Chevrel L	Open surgery
Chevrel W	Technique used

divided into k equal subsets, and the holdout method is repeated k times. Each time, one of the k subsets is used as the validation set, and the other K-1 subsets are put together to form a training set. Then the average error across all K experiments is computed. In this work K has been empirically determined as 5 through the trial-and-error method.

Results

The dataset is composed of 154 patients, 83 females and 71 males, mean age 60 y.o. and a mean BMI of 31 kg/m^2.

The preparation for surgical operation evaluated the respiratory function - through chest X-ray, spirometry and pneumological examination - the cardiac function - through electrocardiography and cardiological examination - the metabolic indexes, the American Society of Anesthesiologists (ASA) score and the study of parietal defect by clinical examination supplemented by CT scan and CT dynamic scan.

The 3D reconstruction of the abdominal defect also allowed a better pre-operative evaluation of the most complex cases and made it possible to select the most suitable surgical procedure and prosthetic materials.

The post-operative complications investigated were seroma formation and Surgical Site Infection (SSI).

In 28 cases there was evidence of diabetes mellitus type 2 and obesity in 80 patients.

Regarding cardiovascular disease, 70 cases had arterial hypertension associated in 18 cases also with ischemic heart disease.

Eighteen patients were smokers and 12 were exsmokers; 10 patients were affected by COPD; 21 were affected by thyroid disorders.

Among the various gastrointestinal disorders the most frequently diagnosed were: 11 jatal hernia, 7 GERD, 6 sigmoid diverticulosis and 7 intestinal obstruction.

Among the previous interventions to which patients have been subjected, the most commonly reported were: cholecystectomy in 16 cases, hysterectomy in 11 cases, colectomy in 11 cases, sigmoidectomy in 10 cases, appendectomy in 9 cases.

The localization of the fascial defects was xifopubic in 88 patients, umbilical in 21 patients, mesogastric in 2 cases, hypogastric in 5 cases, umbilical-pubic in 16 cases, pararectal in 2 cases, 4 in trocar, 2 Spigelian hernia and subcostal in 8 cases. Of these cases, 44 were urgent and 110 were with no signs of complications. In 14 cases the diagnosis was of "swiss cheese incisional hernia". The average size of wall defects was 12 cm.

In 12 patients it was possible to perform a direct suture of the defect; in the remaining cases a mesh was positioned to correct the wall defect. Of these, 87 were positioned with IPOM technique, 4 retromuscular (Rives-Stoppa) and 2 preperitoneal.

The general anaesthesia was performed in 141 cases and 109 patients had an ASA score ≥ 3. The remaining 13 cases were performed in local anaesthesia.

Aspiration drains were placed upon the prosthesis and, if a broad dissection of subcutaneous tissue occurred, also in the subcutis. The drainage removal was performed in 2nd post-operative day or when the drained volume was less than 50 ml/24h.

KSVM was performed to verify the effectiveness of the method. The "Ground-Truth" for incisional hernia is the recurrence. The results showed that the proposed method achieves good performance in terms of correct/incorrect classification of patients.

Discussion

Currently, in state of the art, there are not SVM applications on medical data related to incisional hernia. The principal works on data and images classification based on SVM are discussed. Comelli et al. (4) proposed a new technique for classification of patients affected by Crohn's disease (CD). The proposed technique is based on a Kernel Support Vector Machine (KSVM) and it adopts a Stratified K-Fold Cross-Validation strategy to enhance the KSVM classifier reliability. Son et al. (5) applied an SVM method for data classification. The SVM modelling is a promising classification approach for predicting medication adherences in Heart Failure (HF) patients. This predictive model helps to stratify the patients so that evidence-based decisions can be made and patients can be managed appropriately. Comelli et al. (6) presented a system to normal and abnormal tissue classification, using KSVM and k-nearest neighbor (KNN) method, in Positron Emission Tomography Oncological Studies. Zhang et al. (7) proposed a novel hybrid system to classify a given MR brain image as either normal or abnormal.

The goal of the proposed system is to apply these methods to the incisional hernia features extracted

for classifying the patient into Positive for recurrence risk or Negative for recurrence risk. The description of algorithms and mathematical formalisms that are used in the proposed classification technique were described. The SVM presents an efficient algorithm and can represent complex non-linear functions. The most popular and most reliable SVMs are the kernel SVMs. Kernel SVMs have the following advantages (8): work very well in practice and have been remarkably successful in such diverse fields as natural language categorization, bioinformatics and computer vision; have few tunable parameters; training often involves convex quadratic optimization (9).

This study attempts to demonstrate, based on the evidence of scientific literature, the existence of new possible correlations between risk factors and the development of incisional hernia recurrence.

The association between certain characteristics of the patient such as diabetes, chronic lung diseases, smoking, age and increased probability of recurrence was already studied in the guidelines for the prevention of the surgical site infection (SSI) in 1999. The study showed how the contribution of diabetes to the risk of SSI and recurrence is complex. There was a significant relationship between increasing levels of HgA1c and SSI.

In addition, an increase in glucose levels (> 200 mg/dl) in the postoperative period (48h) was associated with an increased risk of SSI. The infection is a risk factor for recurrence too. The infections in diabetics have a double risk.

In DM there is also an alteration of lipid metabolism and a decrease in abdominal wall tissue resistance for ischemic and hypoxic phenomena responsible for wall fragility. The use of nicotine delayed the healing of the wound and may therefore increase the risk of SSI and the development of recurrence (10).

Murariu et al. (11), in 2007, associated age, sex, obesity, pulmonary diseases and diabetes to the development of recurrence.

This data is related to the reduction of reticulin fibers and hyaline degeneration of collagen fibers. There was a recurrence 4 times higher in women (37.3%) especially if obese and with multiple pregnancies. Various mechanical factors have been associated with the development of recurrence including: prolonged abdominal distension in postoperative course (21%), probably because it is responsible for increased abdominal pressure and cough (9%) that creates abdominal hypertension by exercising a strong contraction of the diaphragm and abdominal muscles.

Muresan et al. (10) conducted a study in 2016 comparing the various abdominal plastic procedures and found an increasing of recurrence in onlay mesh positioning, especially if associated with changes in abdominal pressure and high post-surgical pain.

In 2017 Hauters et al. (12) demonstrated a significant recurrence increasing in subjects with BMI> 35 (21%), defect greater than 4 cm (27%), overlap <5 cm (32%), and mesh area/defect area <12 (48%). To understand better the pathophysiology of incisional hernia recurrence and in accordance with the evidences emerged from the previous studies, it was decided to investigate new possible criteria involved in the occurrence of the recurrence.

A sample of 154 patients was enrolled in the study. The correlation with the type of surgical technique, the type of prosthesis, its positioning and the postoperative complications were also evaluated.

The data analysis confirmed the known correlations showed in the international literature with a greater incidence of comorbidities such as diabetes (37%), dyslipidaemia and hypercholesterolemia with a cumulative incidence of 16%; tobacco smoke - by combining categories smokers and ex-smokers - reach 46%, COPD 16% and hypertension 51%.

Patients with DM have a higher risk of SSI especially in open interventions. The infection is a risk factor independently for the development of this pathology, so the simultaneous presence of DM should increase the risk of recurrence.

However, in our experience, in patients with diabetes mellitus type 2 who developed a recurrence only in 11 cases there was evidence of infection.

The number of smokers with incisional hernia is high as reported by other studies on patients with abdominal hernia. Several pathogenic mechanisms seem to be involved. Smoking and the hypoxia of peripheral tissues caused by it increase the risk of surgical wound infection and its dehiscence, presumably also by reducing the oxidative killing of neutrophils, which constitute a critical defence against pathogens.

In the surgical wounds of smokers there is a decrease in the deposition of collagen, with the reduction in the ratio between collagen I and III, often found in incisional hernia. COPD is likely that increase the risk of disease by the presence of persistent cough that results in violent abdominal contractions with tension development on wounds. The high incidence of benign prostatic hyperplasia may be correlated with the advanced age of subjects but it is also configurable with DM and dyslipidaemia to the complex metabolic

syndrome. The sex is also identified as a risk factor for recurrence with major incidence in females. BMI is not very different between the sexes, whereas there is a slight prevalence of infection in males possibly associated with greater cigarette smoking. The study also revealed a probable role in thyroid pathologies, hepatic disease, cirrhosis and steatosis, benign prostatic hyperplasia, and the presence of uterine fibroids in the development of pathology in the study. In our sample there was a high incidence of hyperthyroidism and nodules, the data could be related to the greater presence of women in the study specimen but also to a probable role of the immune system. Cirrhosis and liver disease were often associated, especially in advanced stages, with ascites leading to an increase intra-abdominal pressure and increased wall tension.

Benign prostatic hyperplasia seems to play a role because the increased prostate volume could increases the pressure in the abdominal cavity; similar mechanism could be attributed to uterine fibroids, whose high incidence in the study can be attributed to the prevalence of female gender and advanced age.

The greater incidence of xifopubic incisional hernia (57%) seems to confirm previous cases in which a higher frequency of recurrence in longitudinal incisions was observed. The greater incidence (34%) of recurrence is shown in defects ranging from 5 to 10 cm. The infection is a fearful complication, it is usually secondary to a suppurative infection of the surgical wound or to the devascularisation necrosis of the wall layers above the prosthesis.

Sometimes contamination may also occur at the time of mesh positioning by contact with skin bacterial flora. In literature, the incidence is 2-10% after laparotomy and 0-2% after laparoscopy. To prevent this complication it is important to be careful in the skin disinfection and minimize the manipulation of the mesh. In the present study we have reported this complication in 30 cases, with a greater prevalence in male subjects (13-44).

Conclusion

A KSVM-based system to classify incisional hernia recurrence has been presented. The classification results on a UPPH Dataset of 154 vectors composed of 34 qualitative characteristics extracted from expert surgeons were compared with the results of the data extrapolated from the clinical records. Sensitivity (86,25%), Specificity (87,14%), Negative Predictive Value (84,72%), Precision (88,46%), Accuracy (86,67%), and Error (13,33%) scores obtained using the proposed technique highlight the validity for the relapse's classification methodology (Table 2).

Moreover, classifier usability does not require any parameter setting and deep knowledge about the used learning machine technique. So, its degree of acceptance in medical practices is very high.

The intelligent data analysis therefore confirmed the already obvious correlations showed in the international literature, it also revealed possible associations with other comorbidities such as thyroid, liver, genitourinary and other interventions with the development of incisional hernia recurrence. The type of prosthesis and the site of its implant also play a significant role in the development of the recurrence.

For the little number of patients considered, the low data collection and the high number of factors considered in the study despite the discreet sensitivity and specificity achieved, new studies are required to further investigate new correlations proposals.

TABLE 2 - VALIDITY FOR THE RELAPSE'S CLASSIFICATION METHODOLOGY.

True Positive	46,00%	Sensitivity	86,25%
True Negative	40,67%	Specificity	87,14%
False Positive	6,00%	Positive Predictive Value	88,46%
False Negative	7,33%	Negative Predictive Value	84,72%
		Accuracy	86,67%
		Precision	88,46%
		Error	13,33%

References

1. McKay A, Dixon E, Bathe O, Sutherland F. Umbilical hernia repair in the presence of cirrhosis and ascites: results of a survey and review of the literature. Hernia. 2009 Oct;13(5):461-8.
2. Calaluce R, Davis JW, Bachman SL, Gubin MM, Brown JA, Magee JD, Loy TS, Ramshaw BJ, Atasoy U. Incisional hernia recurrence through genomic profiling: a pilot study. Hernia. 2013 Apr;17(2):193-202.
3. Yahchouchy-Chouillard E, Aura T, Picone O, Etienne JC, Fingerhut A. Incisional hernias. I. Related risk factors. Dig Surg. 2003;20(1):3-9.
4. Comelli A, et al. A Kernel Support Vector Machine Based Technique for Crohn's Disease Classification in Human Patients. Conference on Complex, Intelligent, and Software Intensive Systems. Springer, Cham, 2017.
5. Son YJ, Kim HG, Kim EH, Choi S, Lee SK. Application of support vector machine for prediction of medication adherence in heart failure patients. Healthcare Informatics Research. 2010;16(4):253-259.
6. Comelli A, et al. Normal and Abnormal Tissue Classification in positron Emission Tomography Oncological Studies. Pattern Recognition and Image Analysis. 2018;28(1):106-113.
7. Zhang Y, Wang S, Ji G, Dong Z. An MR brain images classifier system via particle swarm optimization and kernel support vector machine. The Scientific World Journal. 2013.
8. Bermejo S, Monegal B, Cabestany J. Fish age categorization from otolith images using multi-class support vector machines. Fisheries Research. 2007;84(2):247-253.
9. Muniz A, Liu H, Lyons K, Pahwa R, Liu W, Nobre F, Nadal J. Comparison among probabilistic neural network, support vector machine and logistic regression for evaluating the effect of subthalamic stimulation in parkinson disease on ground reaction force during gait. Journal of biomechanics. 2010;43 (4):720-726.
10. Mureşan M, Mureşan S, Bara T, Neagoe R, Sala D, Suciu B. Hernia recurrence long term follow-up after open procedures of abdominal wall plasty-prospective study including 142 patients. Cir Cir. 2016 Sep-Oct;84(5):376-83. doi: 10.1016/j.circir.2015.10.012. Epub 2016 Jan 15.
11. Murariu M, Bota N, Avram J. Causes of recurrent incisional herniation. Cercetări Experimentale & Medico-Chirurgale. 2007:142-146.
12. Hauters P, Desmet J, Gherardi D, Dewaele S, Poilvache H, Malvaux P. Assessment of predictive factors for recurrence in laparoscopic ventral hernia repair using a bridging technique. Surg Endosc. 2017 Sep;31(9):3656-3663. doi: 10.1007/s00464-016-5401-0. Epub 2017 Jan 11.
13. Licari L, Salamone G, Ciolino G, Campanella S, Parinisi Z, Sabatino C, Carfì F, Bonventre S, Gulotta G. The abdominal wall incisional hernia repair in cirrhotic patients. G Chir. 2018 Jan -Feb;39(1):20-23.
14. Salamone G, Licari L, Guercio G, Comelli A, Mangiapane M, Falco N, Tutino R, Bagarella N, Campanella S, Porrello C, Gullo R, Cocorullo G, Gulotta G. Vacuum-Assisted Wound Closure with Mesh-Mediated Fascial Traction Achieves Better Outcomes than Vacuum-Assisted Wound Closure Alone: A Comparative Study. World J Surg. 2017 Nov 16. doi: 10.1007/s00268-017-4354-3. [Epub ahead of print].
15. Salamone G, Raspanti C, Licari L, Falco N, Rotolo G, Augello G, Melfa G, Gulotta G. Non-Occlusive Mesenteric Ischemia (NOMI) in Parkinson's disease: case report. G Chir. 2017 Mar-Apr;38(2):71-76.
16. Salamone G, Licari L, Augello G, Campanella S, Falco N, Tutino R, Cocorullo G, Gullo R, Raspanti C, De Marco P, Porrello C, Profita G, Gulotta G. Deep SSI after mesh-mediated groin hernia repair: management and outcome in an Emergency Surgery Department. G Chir. 2017 Jan-Feb;38(1):41-45.
17. Cocorullo G, Tutino R, Falco N, Licari L, Orlando G, Fontana T, Raspanti C, Salamone G, Scerrino G, Gallo G, Trompetto M, Gulotta G. The non-surgical management for hemorrhoidal disease. A systematic review. G Chir. 2017 Jan-Feb;38(1):5-14. Review.
18. Militello G, De Marco P, Falco N, Kabhuli K, Mascolino A, Licari L, Tutino R, Cocorullo G, Gulotta G. Is it really useful the Harmonic scalpel in axillary dissection for locally advanced breast cancer? A case series. G Chir. 2016 Nov-Dec;37(6):262-265.
19. Salamone G, Licari L, Falco N, Augello G, Tutino R, Campanella S, Guercio G, Gulotta G. Mannheim Peritonitis Index (MPI) and elderly population: prognostic evaluation in acute secondary peritonitis. G Chir. 2016 Nov-Dec;37(6):243-249.
20. Cocorullo G, Mirabella A, Falco N, Fontana T, Tutino R, Licari L, Salamone G, Scerrino G, Gulotta G. An investigation of bedside laparoscopy in the ICU for cases of non-occlusive mesenteric ischemia. World J Emerg Surg. 2017 Jan 18;12:4. doi: 10.1186/s13017-017-0118-5. eCollection 2017.
21. Cocorullo G, Tutino R, Falco N, Salamone G, Fontana T, Licari L, Gulotta G. Laparoscopic ileocecal resection in acute and chronic presentations of Crohn's disease. A single center experience. G Chir. 2017 Sep-Oct;37(5):220-223.
22. Cocorullo G, Falco N, Tutino R, Fontana T, Scerrino G, Salamone G, Licari L, Gulotta G. Open versus laparoscopic approach in the treatment of abdominal emergencies in elderly population. G Chir. 2016 May-Jun;37(3):108-112.
23. Salamone G, Licari L, Agrusa A, Romano G, Cocorullo G, Gulotta G. Deep seroma after incisional hernia repair. Case reports and review of the literature. Ann Ital Chir. 2015;May:1-5.
24. Salamone G, Licari L, Atzeni J, Tutino R, Gulotta G. Histologic considerations about a rare case of recurrent incisional hernia on McBurney incision. Ann Ital Chir. 2014 Dec 3;85(ePub). pii: S2239253X14022828.
25. Guercio G, Tutino R, Falco N, Cocorullo G, Salamone G, Licari L, Cabibi D, Bagarella N, Gulotta G. Solitary metastasis from melanoma causing bowel perforation. Ann Ital Chir. 2015 Nov 26;86(ePub). pii: S2239253X15024287.
26. Licari L, Salamone G, Parinisi Z, Campanella S, Sabatino C, Ciolino G, De Marco P, Falco N, Bonventre S, Gulotta G. Multiparametric evaluation of risk factors associated to seroma formation in abdominal wall surgery. G Chir. 2017 Nov-Dec;38(6):280-284.
27. Salamone G, Licari L, Randisi B, Di Carlo P, Tutino R, Falco N, Augello G, Raspanti C, Cocorullo G, Gulotta G. A primary subcutaneous hydatid cyst in the thigh A case report. Ann Ital Chir. 2016 Apr 8;87(ePub). pii: S2239253X16024324.
28. Salamone G, Tutino R, Atzeni J, Licari L, Falco N, Orlando G, Gulotta G. Liver hydatidosis: reasoned indications of surgical treatment. Comparison between conservative and radical techniques Retrospective study. Ann Ital Chir. 2014 Sep-Oct;85(5):422-30.
29. Salamone G, Falco N, Atzeni J, Tutino R, Licari L, Gulotta G. Colonic stenting in acutely obstructed left-sided colon cancer Clinical evaluation and cost analysis. Ann Ital Chir. 2014 Nov-Dec;85(6):1-7.
30. Salamone G, Licari L, Agrusa A, Romano G, Cocorullo G, Falco N, Tutino R, Gulotta G. Usefulness of ileostomy defunctioning stoma after anterior resection of rectum on prevention of anastomotic leakage A retrospective analysis. Ann

Ital Chir. 2016;87:155-60.
31. Falco N, Fontana T, Tutino R, Licari L, Raspanti C, Mascolino A, Melfa I, Scerrino G, Salamone G, Gulotta G. Complication of endoscopic tattooing: a case report of covered perforation. G Chir. 2016 Mar-Apr;37(2):74-8.
32. Salamone G, Licari L, Randisi B, Falco N, Tutino R, Vaglica A, Gullo R, Porello C, Cocorullo G, Gulotta G. Uncommon localizations of hydatid cyst. Review of the literature. G Chir. 2016 Jul-Aug;37(4):180-185. Review.
33. Guercio G, Augello G, Licari L, Dafnomili A, Raspanti C, Bagarella N, Falco N, Rotolo G, Fontana T, Porello C, Gulotta G. Acute appendicitis: should the laparoscopic approach be proposed as the gold standard? Six-year experience in an Emergency Surgery Unit. G Chir. 2016 Jul-Aug;37(4):174-179.
34. Cocorullo G, Tutino R, Falco N, Fontana T, Salamone G, Licari L, Gulotta G. Rectal bleeding and prolapse… not always benign diseases rather anal cancer. The importance of a correct decision making since primary care. G Chir. 2016 May-Jun;37(3):133-135.
35. D'Arpa F, Tutino R, Battaglia EO, Orlando G, Salamone G, Licari L, Gulotta G. Post-ERCP pancreatitis. A single center experience and an update on prevention strategies. Ann Ital Chir. 2015 May-Jun;86(3):234-8.
36. Licari L, Salamone G, Campanella S, Sabatino C, Ciolino G, Parinisi Z, Carfì F, De Marco P, Gulotta G. Preliminary results about a novel technique of mesh positioning in the abdominal wall hernia repair. G Chir. 2018 Jul-Aug;39(4):223-226.
37. GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. Lancet Infect Dis. 2018 Feb 13. pii: S1473-3099(18)30101-4. doi: 10.1016/S1473-3099(18)30101-4. [Epub ahead of print].
38. Porrello C, Gullo R, Vaglica A, Scerrino G, Salamone G, Licari L, Raspanti C, Gulotta E, Gulotta G, Cocorullo G. Pulmonary Laser Metastasectomy by 1318-nm Neodymium-Doped Yttrium-Aluminum Garnet Laser: A Retrospective Study About Laser Metastasectomy of the Lung. Surg Innov. 2018 Jan 1:1553350617752263. doi: 10.1177/1553350617752263. [Epub ahead of print].
39. Iadicola D, De Marco P, Bonventre S, Grutta EM, Barletta G, Licari L, Gulotta G. Bowel wall thickening: inquire or not inquire? Our guidelines. G Chir. 2018 Jan-Feb;39(1):41-44.
40. Porrello C, Gullo R, Vaglica A, Scerrino G, Giuseppe S, Licari L, Raspanti C, Gulotta E, Gulotta G, Cocorullo G. Retrospective Analysis of 29 Patients with Multiple Pulmonary Metastases from Colorectal Carcinoma Resected by a 1318-nm Laser. Am Surg. 2018 Mar 1;84(3):460-462.
41. Amato G, Agrusa A, Romano G, Salamone G, Gulotta G, Silvestri F, Bussani R. Muscle degeneration in inguinal hernia specimens. Hernia. 2012 Jun;16(3):327-31.
42. Amato G, Romano G, Agrusa A, Cassata G, Salamone G, Gulotta G. Prosthetic strap system for simplified ventral hernia repair: results of a porcine experimental model. Hernia. 2010 Aug;14(4):389-95. doi: 10.1007/s10029-010-0650-7. Epub 2010 Mar 24.
43. Amato G, Romano G, Salamone G, Agrusa A, Saladino VA, Silvestri F, Bussani R. Damage to the vascular structures in inguinal hernia specimens. Hernia. 2012;16(1):63-67.
44. Salamone G, Atzeni J, Agrusa A, Gulotta G. A rare case of abdominal cocoon. Ann Ital Chir. 2013 Oct 5;84(ePub). pii: S2239253X13021531.