

Effectiveness of therapeutic alternatives for the surgical solution of mediastinitis after a cardiac surgery

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Acronyms

POM: Postoperative mediastinitis

SSI: Surgical site infection

SW: Surgical wound

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ABSTRACT

Introduction: The longitudinal median sternotomy is a widely employed incision in cardiovascular surgery. The infections of the surgical wound are a serious health problem, but in this type of surgery, the deep infection, the postoperative mediastinitis, has high morbidity and mortality and it is a diagnostic and therapeutic challenge. Initially, surgical treatment protocols were open, but their evolution has stimulated the appearance of closed methods.

Objective: To assess the effectiveness of therapeutic alternatives for the surgical solution of mediastinitis after a cardiac surgery.

Method: A cross-sectional assessment study of health technology was conducted under application, with the information between the years 2000 and 2016, with its prior determination of indicators and its cutoffs.

Results: An incidence of 1.54% of postoperative mediastinitis was found. Being 40.9% of patients treated with open methods and 59.1% with closed, by the use of irrigation to the mediastinum with dilute povidone iodine. The application of the open method had an effectiveness of 57.1%, evaluated by seven predetermined indicators, and the closed method presented a complete effect (100%), after the evaluation of nine indicators.

Conclusions: The postoperative mediastinitis has a similar incidence of that in other centers. It has been treated with open and closed methods. The closed technique was more utilized and it achieved excellent therapeutic effectiveness, superior to the open one.

Key words: Postsurgical mediastinitis, Cardiovascular surgery, Therapeutics, Effectiveness

Efectividad de las alternativas terapéuticas para la solución quirúrgica de las mediastinitis después de una cirugía cardíaca

RESUMEN

Introducción: La esternotomía mediana longitudinal es una incisión ampliamente empleada en la cirugía cardiovascular. Las infecciones de la herida quirúrgica constituyen un serio problema de salud; pero en este tipo de cirugía, la infección profunda, la mediastinitis posoperatoria, presenta elevadas morbilidad y mortalidad, y constituye un desafío diagnóstico y terapéutico. Inicialmente los protocolos

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de tratamiento quirúrgico eran abiertos, pero su evolución ha estimulado que aparezcan los métodos cerrados.

Objetivo: Evaluar la efectividad de las alternativas terapéuticas para la solución quirúrgica de las mediastinitis después de una cirugía cardíaca.

Método: Se realizó un estudio de evaluación de tecnología sanitaria en fase de aplicación, de corte transversal, con la información contenida entre los años 2000 y 2016, con la previa determinación de los indicadores para ello y sus puntos de corte.

Resultados: La incidencia de mediastinitis posoperatoria fue de 1,54%. El 59,1% de los pacientes fue tratado con métodos cerrados, mediante el empleo de irrigación al mediastino con yodo povidona diluida. La aplicación del método abierto tuvo una efectividad de 57,1%, evaluada mediante 7 indicadores previamente determinados, y el método cerrado presentó una efectividad total (100%), tras la evaluación de 9 indicadores.

Conclusiones: La mediastinitis posoperatoria tiene una incidencia similar a otros centros, y ha sido tratada con métodos abiertos y cerrados. La técnica cerrada fue la más utilizada y alcanzó una excelente efectividad terapéutica, superior a la abierta.

Palabras clave: Mediastinitis posoperatoria, Cirugía cardiovascular, Terapéutica, Efectividad

INTRODUCTION

The longitudinal median sternotomy is the universally used incision choice for the surgical treatment of the heart and great vessels, which was proposed by Milton since 1897, with extensive use from the decade of the '50's, because it offers an excellent exhibition of these structures¹.

Infectious complications of the surgical wound (SW) are, even today, a serious problem to be solved. One of the most important quality indicators in any surgical service is the SW infection in clean surgeries. Its occurrence complicates the postoperative state, increasing the costs for treatment and hospital stay. This complication has been widely grouped as the surgical site infection (SSI) that is divided in superficial and deep, where is included the involvement of the cavity or organ in question (**Appendix**)^{2,4}. In the context of cardiac surgery, the deep infection, also known as POM (postoperative mediastinitis), is a serious complication with high morbidity and mortality^{1,5}.

It has an incidence of 1-2% with a range of 0.4-5.0%⁵, although there are reports of increased incidences up to 12%, with a range from 0.8 and 2.4% for sternal osteomyelitis⁶, and a mortality ranging from 8.6-40%. For this reason, it is a feared complication in cardiac surgery⁵.

The variable incidence often depends on the definition used for mediastinitis^{2,6,7} (**Appendix**).

The 2014 report of the Center for Disease Control and Prevention (CDC)³ maintains the 1992 criteria, but requires a deeper layer tissue involved in the infection to define the type of SSI; in addition, it establishes a classification of SSI (superficial and deep) in primary and secondary, according to the identified sepsis in either SW, in a patient that has had more than one incision; and the diagnostic criterion is widened by "the surgeon" to other specialists, including the infectiologist, the doctor from the emergency room or another designated doctor. It is also important the extension of the surveillance until 30 days in the superficial SSI and until 90 in some of the deep, what includes cardiac interventions^{2,6,7}.

When suspecting a POM, reoperation is imposed as early as possible, in order to make the necessary debridement and adequate cleaning. In this case the removal of the external suture is necessary, to extreme cares for avoiding accidents, to remove all present sloughs, to do the curettage of the bone, to remove the residual bone wax, to extract catheters or pacemaker electrodes, and to perform extensive washing of the cavity with warm serum and antiseptic solutions such as povidone iodine⁸.

After this initial treatment, the immediate or delayed sternal closure may be carried out, depending on the type of mediastinitis, the evolution time, the spread of infection and pleural involvement; besides the experience of the staff and surgeon's satisfaction when finishing the debridement. Then, based mainly on the state of the sternal bone, a closed or open

method^{8,9} should be chosen. Initially, open surgical treatment protocols were used, but associated with the development of cardiovascular surgery, closed methods have emerged and thanks to progress in care after surgery, morbidity and mortality from infections after the sternal incision have been reduced significantly over these years¹⁰. In the **supplementary material** are described these and other methods of treatment for POM.

In Cuba, there have been published series of patients treated with open and closed methods, and with the interposition of major omentum and pectoral muscle^{11,12}; but there is no information on the sternal systematic reconstruction by any technique.

At the Cardiocentro of Santa Clara, Cuba, patients with POM have been treated through open and closed techniques, but an interposition of living tissues has not been performed; however, other procedures of sternal reconstruction were performed by using the patient's own tissues adjacent to the sternum¹².

The main objective of this study was to evaluate the effectiveness of therapeutic alternatives for the surgical solution of POM after cardiac surgery; for its accomplishment, it was necessary to characterize the sample according to the therapeutic alternative employed and linking it to other variables as mortality and hospital stay.

METHOD

A cross-sectional assessment study of health technology under implementation was conducted, at the *Hospital Universitario Cardiocentro Ernesto Guevara*,

Santa Clara, Cuba, with 44 patients (all) that had POM from 2000 to 2016.

The inclusion criteria correspond to those used by the CDC (**Appendix**)^{2,4}.

Surgical treatment techniques applied

- Closed: Employment of constant wash to the mediastinum (mediastinoclisis) with povidone iodine in clorosodium, after closure of the sternum and superficial planes until the skin surface.
- Open: Daily healing by surgeons in the Intensive Care Unit, with the sternum open for washings and removal of sloughs. Iodinated compresses are left in the mediastinum until the next cure.
- Sternal plasty: In case of any plastic or osteosynthesis procedure for sternal reconstruction.

Clinical and laboratory evolution

The improvement or disappearance of the main signs and symptoms of POM is evaluated. These parameters were determined by the team, thanks to the experience gained in this type of treatment and observation of all responses to the therapy applied. It has been considered as experts' judgment by the researcher, in order to establish different cutoffs, some of which were selected to measure the effectiveness indicators (**Table 1**).

Other indicators

Conversion index: Also, a very important indicator, referred to the fact of having to convert to closed treatment, with mediastinoclisis, to the open one; due to the lack of effectiveness of the former, when

Table 1. Clinical and laboratory evolution indicators.

Indicator	It is a sign of therapeutic effectiveness when there is:
Disappearance of fever	Between the second and third days of starting treatment.
Disappearance of purulent secretion	Between the third and fifth day of starting treatment.
Disappearance of septic shock	Between the second and third days of starting treatment *.
Disappearance of leukocytosis	Between the third and fifth days of starting treatment **.
Microbiology (negative cultures)	Between the second and fourth days of starting treatment.
Permeability of the probes	When the optimal function lasts for more than 7 days.

* It represents an important point of inflection because when a patient is reoperated in a state of septic shock, prognosis is worse, hence, early reoperation has great relevance.

** Sometimes takes longer to disappear totally.

being evaluated by the other indicators. It is considered low when it is below 10%.

Hospital stay: It refers to the total of days the patient was admitted; its breakpoint is close to 32.

Effectiveness: In health care it refers to the extent in which an intervention, service, process, procedure, diagnostic test or treatment produces the desired result. The concept of effectiveness therefore includes the level of adequacy of care provision, insofar as it is provided to those who can benefit from it. It also requires a selection of indicators representing the priority areas for improvement in specific population groups¹³. The percentage is calculated by the formula: Effectiveness = Positive actions * 100 / Total actions¹³.

In this research was used the term «positive indicators» rather than «positive actions», according to the indicators described above. An indicator was considered positive for when it produced the expected effect in over 70% of the sample, except the conversion index that its positivity lies in being low (less than 10%), hospital stay (less than 32 days) and mortality (under 5%), as this is the lowest figure reported in the reviewed literature.

Collection and processing of information

The primary data was extracted from each patient's clinical records, the database of the Intensive Care Department, the microbiological and clinical laboratory reports, and the daily evolution observed by

the researchers.

The Statistical Package for Social Sciences (SPSS), version 20 for Windows, was the one used for these purposes.

RESULTS

From 2000 to 2016, 44 patients were diagnosed with POM, from a total of 2857, which represents 1.54% in that period.

In **table 2** is observed the distribution of patients according to the surgical procedure used; from these, 18 (40.9%) were treated with open procedures and 26 (59.1%) with closed methods.

With the use of closed procedures, there was achieved in all patients (100%) the disappearance of fever and septic shock between 2-3 days (**Table 3**),

Table 2. Distribution of the sample according to the surgical procedure used.

Surgical procedure	Postoperative mediastinitis	
	Nº	%
Open	18	40,9
Closed	26	59,1
Total	44	100

Table 3. Results of the indicators that evaluated the closed procedures (n=26).

Variables	Indicators	Nº	%
Clinics	Disappearance of the fever between 2-3 days	26	100
	Disappearance of the purulent secretion between 3-5 days	23	88,5
	Disappearance of septic shock between 2-3 days	26	100
From laboratory	Disappearance of leukocytosis between 3-5 days	22	84,6
Microbiological	Negative cultures 2-4 days	24	92,3
Permeability probes (days)	> 7	24	92,3
Conversion index	Low (less than 10%)	2	7,7
Mortality		1	3,8
Hospital stay (average days)	27		
Effectiveness (%)	100		

Table 4. Indicators to evaluate open procedures.

Variables	Indicators	Nº	%
Clinics	Disappearance of the fever between 2-3 days	18	100
	Disappearance of the purulent secretion between 3-5 days	14	77,8
	Disappearance of septic shock between 2-3 days	15	83,3
From laboratory	Disappearance of leukocytosis between 3-5 days	12	66,7
Microbiological	Negative cultures between 2-4 days	15	83,3
Mortality		3	16,7
Hospital stay (average days)		41	
Effectiveness (%)		57,1	

and in 88.5% the purulent secretion between 3-5 days; also, the conversion index was low (7.7%), hospital stay was 27 days, and only 1 patient died (3.8%).

By analyzing the nine indicators of these closed procedures, it can be observed that all were positive (9/9), thus, when including them in the **formula** for calculating the effectiveness, the result obtained is 100%. However, only four of the seven indicators evaluated in the open procedures were positive; therefore, the effectiveness was calculated as 57.1% (**Table 4**).

In the latter table, which provides evaluation of the open procedures, is important to note the large difference between the prolonged hospital stay (41 days) and its greater mortality (16.7%) compared to closed procedures.

DISCUSSION

The incidence of POM (1.54%) found in this research is similar to that reported by other authors^{1,5,9,14}, those who located it between 1-5%. Similar figures are provided by Nieto Cabrera³ in Spain (0.5- 4%), Careaga Reyna *et al.*¹⁴ in Mexico (0.55%) and Gutiérrez Urgón *et al.*¹⁵ also in Spain (3.5%), and in the rest of the world (1-2%). Nieto Cabrera³, at the *Hospital Clínico San Carlos* in Madrid, Spain, in a six-year research to develop and validate a model to predict the POM, reported an incidence of 2.4%.

In this study, the effectiveness of therapeutic procedures employed for the POM at the *Cardiocentro Ernesto Che Guevara* has been analyzed and it was

found that the effectiveness of the open method is low, thus, its application in the past recent years has been very rare in this hospital; instead, the closed method has had an excellent effectiveness.

Most patients in this study were treated with closed mediastinal irrigation techniques with dilute povidone iodine, because we do not have the possibility of vacuum aspiration^{6,17}.

With time, treatment techniques for POM have evolved and have been modified. Previously, the open techniques were always the ones utilized, but currently the closed protocols are increasingly in use¹⁰. The early diagnosis and antibiotic therapy, debridement and the use of more appropriate therapeutic techniques by washing/suction systems, plasty with well vascularized tissues as the pectoral muscle or mesentery, and the subsequent introduction of continuous suction systems, have contributed to change the prognosis of this serious postoperative complication of cardiovascular surgery¹⁷⁻¹⁹. However, the POM still has a high lethality^{1,13}, that is why it was decided to conduct this study as part of the first steps to create our own protocols and guidelines.

In the literature reviewed, no work was found that developed an assessment of this type with qualitative and quantitative parameters. In some cases, the results are compared with other techniques or procedures, but in this particular work is not pertinent to do it that way because each of the techniques used has its own indications.

Takahara *et al.*²⁰, in a pediatric hospital in Japan, considered the effectiveness of the treatment with a closed vacuum suction method. They evaluated the effects of treatment on several hemodynamic para-

meters and microbiological cultures, and demonstrated that this technique did not present significant complications or adverse effects in pediatric patients. Nonetheless, these results should be analyzed with caution because they come from a very small sample of only six patients. Meanwhile, Tanaka *et al.*²¹, in an experimental study on therapy with negative pressures for the suction torque, demonstrated the presence of growth factors of the vascular endothelium which facilitate healing.

Salica *et al.*²² also used the method of negative pressures with excellent results, and they made reference to the limitation of using open techniques for the high mortality, which has reduced due to the implementation of methods of continuous closed irrigation to the mediastinum.

Molina and collaborators²³ used the same method of this research, the mediastinal irrigation with povidone iodine, and –likewise– they obtained a low mortality. Similar results describe Kubota *et al.*²⁴, who evaluated the deep surgical wound infections after cardiac surgery and showed that, although mortality of POM is still high, the use of closed methods employing negative pressures achieves a significant reduction in mortality and improves survival, compared with conventional treatment methods.

In our view, each department must use the method that allows it to accomplish better results, although the introduction of new technology is necessary, as systems for vacuum aspiration, for its undeniable benefits^{16,17,25}; but undoubtedly, at the *Cardiocentro Ernesto Che Guevara*, the closed mediastinoclisis with povidone iodine has been very effective.

Vos *et al.*²⁶, in the Netherlands, have created their own working protocol based on suction systems with Redon drains, with the tightly closed cavity and possible combined operation with plastias of the pectoral muscle for sternal reconstruction. Most authors acknowledge the advantages of closed techniques in terms of mortality, hospital stay and costs; in addition, there is no doubt about that it contributed to change the prognosis of this disease¹⁹⁻²⁴.

In this research, the POM had an impact similar to that found by other authors with variable presentation, depending on the developed surgical activity. Patients were treated with open and closed methods, according to the work regulations established; but, like the rest of the world, open techniques are used less and less, and with them, less therapeutic effectiveness, increased mortality and hospital stay were obtained, as well as persistent leukocytosis in

the range of time established for them to disappear, although the healing of some patients was accomplished. However, the closed technique was the most employed, specifically, the mediastinoclisis with povidone iodine, which yielded excellent therapeutic effectiveness.

The introduction of closed vacuum aspiration methods in this hospital would be quiet beneficial, because they are now recognized for their superiority.

CONCLUSIONS

The postoperative mediastinitis has a similar incidence to that of other centers, and it has been treated with open and closed methods. The closed technique was more utilized and it achieved excellent therapeutic effectiveness, superior to the open one.

REFERENCES

1. González R, Raffo M, Vera M, Alarcón E, Saldías R, Gyhra A, *et al.* Mediastinitis postquirúrgica en cirugía cardíaca. *Rev Chil Cir.* 2005;57:203-8.
2. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions of nosocomial surgical site infections, 1992: A modification of CDC definitions of surgical wound infections. *Infect Control Hosp Epidemiol.* 1992;10:606-8.
3. Nieto Cabrera M. Diseño y validación de un modelo predictivo de mediastinitis en cirugía cardíaca [Tesis]. Madrid: Universidad Complutense de Madrid [Internet]; 2014 [citado 28 Feb 2017]. Disponible en: <http://eprints.ucm.es/29771/1/T35996.pdf>
4. Careaga Reyna G, Campos Ortega R. Tratamiento de la mediastinitis y otras complicaciones de la esternotomía en cirugía cardíaca. *Cir Gen.* 2010; 32:217-20.
5. Barthelemy A. Post-sternotomy mediastinitis. En: Mathieu D, ed. *Handbook on Hyperbaric Medicine.* Dordrecht: Springer; 2006. p. 567-76.
6. Tiveron MG, Fiorelli AI, Mota EM, Mejia OA, Brandão CM, Dallan LA, *et al.* Preoperative risk factors for mediastinitis after cardiac surgery: analysis of 2768 patients. *Rev Bras Cir Cardiovasc.* 2012;27: 203-10.

7. Morisaki A, Hosono M, Murakami T, Sakaguchi M, Suehiro Y, Nishimura S, *et al.* Effect of negative pressure wound therapy followed by tissue flaps for deep sternal wound infection after cardiovascular surgery: propensity score matching analysis. *Interact Cardiovasc Thorac Surg.* 2016;23:397-402.
8. Fernández-Palacios Martínez J. Tratamiento quirúrgico plástico de las mediastinitis post esternotomía media tras cirugía cardíaca con circulación extracorpórea en nuestro medio: La utilización unilateral del colgajo de pectoral mayor frente a otros métodos empleados [Tesis]. Gran Canaria: Universidad de Las Palmas de Gran Canaria [Internet]; 2008 [citado 28 Feb 2017]. Disponible en: <https://acceda.ulpgc.es:8443/bitstream/10553/2120/1/3209.pdf>
9. Soto Pernudi S, Quirós Molina P, Chamorro Castro R, Garita Jiménez E, Robelo Pentzke B, Salazar Vargas C. Infección de esternotomía media después de cirugía cardiovascular: Experiencia en el Hospital R.A. Calderón Guardia. *Rev Costarric Cardiol.* 2010;12:11-6.
10. Baillet R, Cloutier D. Progress and milestones in the treatment of deep sternal wound infections. En: Picichè M, ed. Dawn and evolution of cardiac procedures. Milán: Springer; 2013. p. 273-84.
11. Machín Rodríguez JC. Factores predictores de mediastinitis aguda en cirugía cardiovascular, protocolo de prevención y algoritmos diagnóstico y terapéutico [Tesis]. Santiago de Cuba: Universidad de Ciencias Médicas [Internet]; 2011 [citado 28 Feb 2017]. Disponible en: http://tesis.repo.sld.cu/632/1/TESIS_Dr_MACHIN.pdf
12. Bermúdez Yera GJ, Chaljub Bravo E, López de la Cruz Y, Lagomasino Hidalgo AL, Navas Contino M, Quintero Fleites Y, *et al.* Plastia esternal con dermis y músculo pectoral por pérdida total del esternón debido a osteomielitis. *CorSalud [Internet].* 2014 [citado 28 Feb 2017];6:346-51. Disponible en: <http://www.revcorsalud.sld.cu/index.php/cors/article/view/124/294>
13. Servicio Andaluz de Salud. Resultados y calidad del sistema sanitario público de Andalucía [Internet]. Sevilla: Escuela Andaluza de Salud Pública; 2012 [citado 10 Mar 2017]. Disponible en: http://www.calidadsaludandalucia.es/docs/resultados_y_calidad_del_sistema_sanitario_publico_de_andalucia_2012.pdf
14. Careaga Reyna G, Aguirre Baca GG, Medina Concebida LE, Borrayo Sánchez G, Prado Villegas G, Argüero Sánchez R. Factores de riesgo para mediastinitis y dehiscencia esternal después de cirugía cardíaca. *Rev Esp Cardiol.* 2006;59:130-5.
15. Gutiérrez-Urbon JM, Pereira-Rodríguez MJ, Cuenca-Castillo JJ. Estudio de casos y controles de los factores de riesgo de mediastinitis en cirugía de revascularización miocárdica. *Cir Cardiov.* 2013; 20:13-7.
16. Yu AW, Rippel RA, Smock E, Jarral OA. In patients with post-sternotomy mediastinitis is vacuum-assisted closure superior to conventional therapy?. *Interact Cardiovasc Thorac Surg.* 2013; 17:861-5.
17. Dohi S, Inaba H, Tanbara K, Yamamoto T, Kikuchi K, Shimada A, *et al.* Vacuum-assisted closure with a portable system for treatment of poststernotomy mediastinitis. *Gen Thorac Cardiovasc Surg.* 2010;58:415-9.
18. Zor MH, Acipayam M, Bayram H, Oktar L, Erdogan M, Darcin OT. Single-stage repair of the anterior chest wall following sternal destruction complicated by mediastinitis. *Surg Today.* 2014;44: 1476-82.
19. Fulquet-Carreras E. Mediastinitis postoperatoria en cirugía cardíaca. *Cir Cardiov.* 2013;20:10-2.
20. Takahara S, Sai S, Kagatani T, Konishi A. Efficacy and haemodynamic effects of vacuum-assisted closure for post-sternotomy mediastinitis in children. *Interact Cardiovasc Thorac Surg.* 2014;19: 627-31.
21. Tanaka T, Panthee N, Itoda Y, Yamauchi N, Fukayama M, Ono M. Negative pressure wound therapy induces early wound healing by increased and accelerated expression of vascular endothelial growth factor receptors. *Eur J Plast Surg.* 2016; 39:247-56.
22. Salica A, Weltert L, Scaffa L, Guerrieri Wolf L, Nardella S, Bellisario A, *et al.* Negative pressure wound treatment improves Acute Physiology and Chronic Health Evaluation II score in mediastinitis allowing a successful elective pectoralis muscle flap closure: Six-year experience of a single protocol. *J Thorac Cardiovasc Surg.* 2014;148: 2397-403.
23. Molina JE, Nelson EC, Smith RR. Treatment of postoperative sternal dehiscence with mediastinitis: Twenty-four-year use of a single method. *J Thorac Cardiovasc Surg.* 2006;132:782-7.
24. Kubota H, Miyata H, Motomura N, Ono M, Takamoto S, Harii K, *et al.* Deep sternal wound infection after cardiac surgery. *J Cardiothorac Surg.*

- 2013;8:132.
25. Vos RJ, Yilmaz A, Sonker U, Kelder JC, Kloppenburg GT. Vacuum-assisted closure of post-sternotomy mediastinitis as compared to open packing. *Interact Cardiovasc Thorac Surg.* 2012;14:17-21.
26. Vos RJ, van Putte BP, Sonker U, Kloppenburg GT. Primary closure using Redon drains for the treatment of post-sternotomy mediastinitis. *Interact Cardiovasc Thorac Surg.* 2014;18:33-7.
27. Risnes I, Abdelnoor M, Veel T, Svennevig JL, Lundblad R, Rynning SE. Mediastinitis after coronary artery bypass grafting: the effect of vacuum-assisted closure versus traditional closed drainage on survival and re-infection rate. *Int Wound J.* 2014;11:177-82.

APPENDIX

Box. Criteria for surgical site infection ^{5,8,20}.

Superficial infection
Only skin and subcutaneous tissue around the incision: Infection in the first 30 days after surgery and at least one of the following criteria:
- Purulent drainage, with or without laboratory confirmation, of the superficial incision.
- Microbiological isolation in liquid or tissue culture of the surface incision obtained aseptically.
- At least one of the following signs of inflammation:
a) Pain or hypersensitivity
b) Swelling, redness, or heat
c) Aperture of the superficial incision by the surgeon, unless the culture is negative
d) Diagnosis of superficial infection by the surgeon
Deep infection
Affection of deep tissues, fascia, or muscle walls, both superficial and deep incision, or drained through the incision of organ/space infection. Infection: in 30 days after the intervention or 1 year if prosthetic material was implanted and at least one of the following criteria:
- Purulent drainage of deep incision but not adjacent organ/space.
- Spontaneous dehiscence or unintentional opening by the surgeon when the patient has at least one of the following signs/symptoms unless the culture is negative:
a) Fever > 38° C
b) Localized pain
c) Tissue tension
- Abscess or other evidence of deep infection by direct examination or during reoperation, histopathologic or radiologic examination.
- Diagnosis of deep infection by the surgeon.
Infection of organ/space
Anatomical site different from the incision, which was opened or manipulated during the procedure: in 30 days after the intervention or 1 year, if prosthetic material was implanted and at least one of the following criteria:
- Purulent drainage from a drainage tube located through the wound (If the area around the wound is infected, it is not considered a surgical site infection but rather an infection of the skin or tissue).
- Microbiological isolation in liquid or tissue culture of the organ/space obtained aseptically.
- Abscess or other evidence of infection surrounding the organ/space based on direct examination, during reoperation or histopathological or radiological examination.
- Diagnosis of organ/space infection by the surgeon.