

Conceptual maps for decision-making in postoperative mediastinitis

Mapas conceptuales para la toma de decisiones ante la mediastinitis postoperatoria

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ABSTRACT

Introduction: When it comes to human health, the offer of quality services and work based on patient safety are increasingly demanded. Modernity demands rapid decision-making in any situation, which is facilitated with action guides that include prediction, diagnosis, prevention, treatment and quality control. These are represented in wide-ranging algorithms such as conceptual maps. **Objectives:** To represent in conceptual maps a previously developed guide for the prediction, diagnosis, prevention and control of postoperative mediastinitis. **Method:** A retrospective analytical study of cases and controls was carried out with bivariate and then multivariate analysis for the construction of a prognostic scale, as well as probable diagnostic patterns and a systematic review using PRISMA methodology for the development of the guidelines, which were represented in conceptual maps by the cmaptool program. **Results:** For prediction, PREDICMED prognostic scale was the premise, built from the logistic regression model, with six predictors and their scores ranging from zero to thirteen, with two risk strata: not high and high. For the diagnosis, precede this guide, the four probable diagnostic patterns obtained by two-stage cluster analysis and the prevention and treatment actions for postoperative mediastinitis were developed, as well as checklists, then was all represented in conceptual maps. **Conclusions:** The action guides represented in conceptual maps facilitate the decision-making process in the face of mediastinitis after cardiovascular surgery.

Key words: Postoperative mediastinitis, Cardiovascular surgery, Surgical site infection, median sternotomy.

RESUMEN

Introducción: Cuando se habla de la salud humana, se exige la oferta de servicios de calidad y trabajar en función de la seguridad del paciente. La modernidad demanda rapidez en la toma de decisiones ante cualquier situación, lo cual se facilita con guías de actuación que incluyan predicción, diagnóstico, prevención, tratamiento y control de la calidad. Estas se representan en algoritmos de amplio alcance como los mapas conceptuales. **Objetivos:** Representar en mapas conceptuales una guía para la predicción, diagnóstico, prevención y control de la mediastinitis posoperatoria previamente elaborada. **Método:** Se realizó un estudio analítico retrospectivo de casos y controles con análisis bivariado y luego multivariado para la construcción de una escala pronóstica, así como de los patrones de diagnóstico probables y una revisión sistemática por metodología PRISMA para la elaboración de las guías, que por el programa cmaptool fueron representadas en mapas conceptuales. **Resultados:** Para la predicción se tiene la premisa de la escala pronóstica PREDICMED construida a partir del modelo de regresión logística, con seis predictores y sus puntajes en rango de cero a trece, con dos estratos de riesgo: no alto y alto. Para el diagnóstico

antecedentes los cuatro patrones de diagnóstico probable obtenidos por análisis de conglomerados bietápico y se elaboraron las medidas de prevención y tratamiento de la mediastinitis postoperatoria, así como listas de chequeo, luego representadas en mapas conceptuales. **Conclusiones:** Las guías de actuación representadas en mapas conceptuales facilitan el proceso de toma de decisiones ante la mediastinitis después de cirugía cardiovascular.

Palabras clave: Mediastinitis postoperatoria, Cirugía cardiovascular, Infección del sitio quirúrgico, Esternotomía media longitudinal.

INTRODUCTION

When it comes to human health, providing quality services as well as a work based on patient safety are increasingly demanded. Modernity demands rapid decision-making without hesitation in any situation, which is facilitated by working protocols. These are summarized in algorithms or flowcharts. The best known are decision trees. Nowadays, conceptual maps are broad algorithms that have enabled the evolution of single-criteria to multi-criteria decision-making.¹

In the field of medical sciences, a conceptual map would be more advantageous than a decision tree, as it would graphically represent an action guideline with its theoretical aspects, and would have incalculable educational value.²

Acting with quality, measurable guidelines expressed in conceptual maps demonstrates that we are working for patient safety; especially in high-risk surgical interventions, in which multiple circumstances demand urgency or emergency; as often occurs in cardiovascular surgery in the context of postoperative mediastinitis, which, as a complication of longitudinal median sternotomy, requires rapid decisions.³

Postoperative mediastinitis is part of the deep infection of this incision, with an incidence between 1 and 2% and a mortality rate between 8.6 and 40%; it is therefore considered a feared complication of cardiovascular surgery.^{4,5} According to Ljungquist's⁶ classic definition, an infected surgical wound is one that develops a collection of pus.

The diversity of criteria in decision-making regarding this complication slows down action, which is why a Cuban guideline was developed which should then be presented in a schematic and summarized form; in addition to include prediction, diagnosis, prevention, and control.

From this, the research objectives are: to elaborate and represent in conceptual maps a guideline for prediction, diagnosis, prevention and control of postoperative mediastinitis.

METHODS

A multistage study was conducted at the Hospital Universitario Cardiocentro Ernesto Guevara of

Villa Clara, using a mixed-method, concurrent approach and triangulation, spanning from 2000 to 2019. The final purpose was to develop a decision-making guideline for postoperative mediastinitis and the conceptual maps, representing the good practice guidelines, which included: prediction, diagnosis, preventive measures and treatment or management.

First stage: A retrospective case-control analytical study on the presence of postoperative mediastinitis, which initially required determining its actual incidence based on the population including 4 607 patients undergoing longitudinal median sternotomy at the Hospital Universitario Cardiocentro Ernesto Guevara of Santa Clara from 2000 to 2019; as well as a clinical-epidemiological characterization of the cases with the disease.

The case sample consisted of all patients with this diagnosis (n=45). The Centres for Disease Control and Prevention's (CDC) criteria for deep surgical site infection were used.⁷⁻¹⁰ The control sample, four for each case, n=180, was made according to the established criteria: representativeness, simultaneity and homogeneity with respect to the cases. A bivariate analysis was performed using simple binary logistic regression, the 95% confidence interval for the odds ratio (OR) estimate was determined for each factor, along with the significance of the Wald statistic corresponding to each coefficient (β) in the logistic model equation.

To develop the model, a multivariate binary logistic regression analysis was performed, with the presence of mediastinitis as the dependent variable. The model's performance was assessed based on its calibration and discriminatory capacity.

A prognostic scale was built, the variables being selected from the obtained model predictors, with weights or scores assigned by rounding the corresponding β coefficients to the nearest integer. Its performance was also confirmed. Internal validation (data splitting) was also performed, selecting 70% as the development sample and 30% as the validation sample.

To develop the diagnostic aid using probable patterns, the first step was to subdivide the clinical

elements into major and minor; to do this, quantitative analyses (two-stage cluster analysis) and qualitative analyses (expert judgment) were performed. The results of both analyses were compared, and similarity was considered to propose the classification.

Formation of probable diagnostic patterns.

To define probable diagnostic patterns, a three-ways contingency table was created, corresponding to: risk stratification, number of major and minor clinical elements and presence of mediastinitis (yes or no). The patterns were established based on the frequency distribution of the number of clinical elements in both risk strata.

Second stage: A qualitative study was conducted to develop the action guidelines for postoperative mediastinitis, triangulating the results of prognostic models, the findings from reinterventions and determining the effectiveness of each of the different surgical techniques used as therapeutic alternatives for this condition. The recommended course of action is based on the evidence found, as its development is premised on a thorough literature review. Conceptual maps represent the action guidelines in a comprehensive work algorithm, with concepts, linking words, propositions and connecting lines.

Review methods such as those outlined in PRISMA(11-13) statement were used to review all guidelines, consensus statements and algorithms related to postoperative mediastinitis found; as well as multicenter studies, meta-analyses and any research related to the topic, including cases presentations. Literature available in databases such as PubMed, Cochrane, ClinicalKey, Scopus, and Scielo. With a checklist and review flowchart (**Figure 1**).

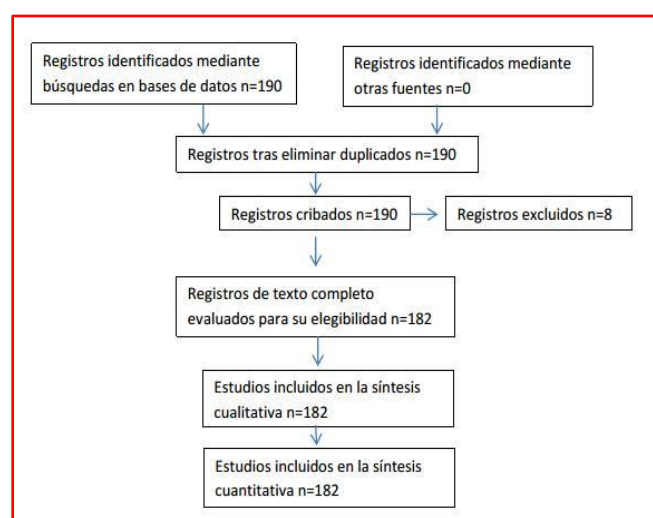


Figure 1- Information flow of the systematic review

After triangulating all the information obtained, the guidelines and map of decision were finalized, classifying the expert consensus *CorSalud* 2025;17:e1151

recommendations into Class I, II (IIa and IIb) and III, as well as by level of evidence, which for this research was Level C.

The conceptual maps were developed using the c-map tool software, version 6-03-01, developed by the Institute for Human and Machine Cognition.⁽¹⁴⁾

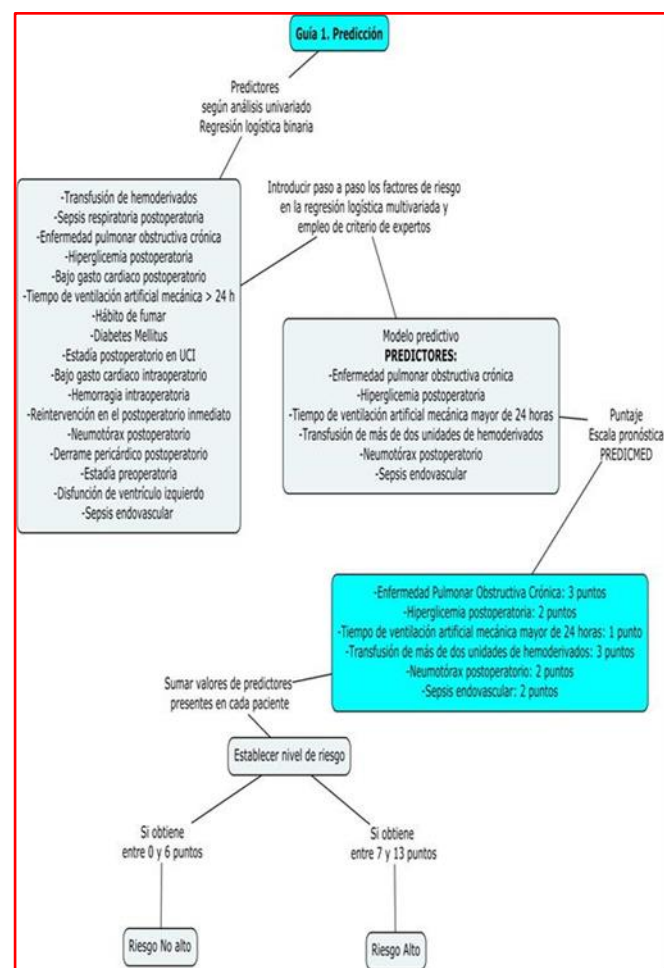


Figure 2- Prediction Conceptual Map

RESULTS

The first map (**Figure 2**) illustrates the prediction, which is essential for targeting prevention based on the calculations.⁽¹⁵⁾ The result of the bivariate analysis with the pre-, intra- and post-operative variables with a statistically significant relationship, is the starting point to obtain the logistic regression model shown in this **figure** and the basis for elaborating the Cuban scale to predict the risk of postoperative mediastinitis PREDICMED¹⁶, with six predictors and weights already explained, with two risk strata in its classification: high and non-high, using the cut-off point drawn at the 90th percentile that coincides with the value 7 of the scale that offers a range between 0 and 13 points. **Figure 3** shows the diagnostic map with a diagnostic aid, the clinical elements initially present in the sample were divided into major and minor using qualitative

methods and mathematically confirmed by two-stage cluster analysis, then, when combined with the risk offered by PREDICMED, four probable diagnostic patterns were obtained, which detection in a patient provides diagnostic inference, including as well the components of a vulnerable sternum, which require different preventive measures.¹⁷

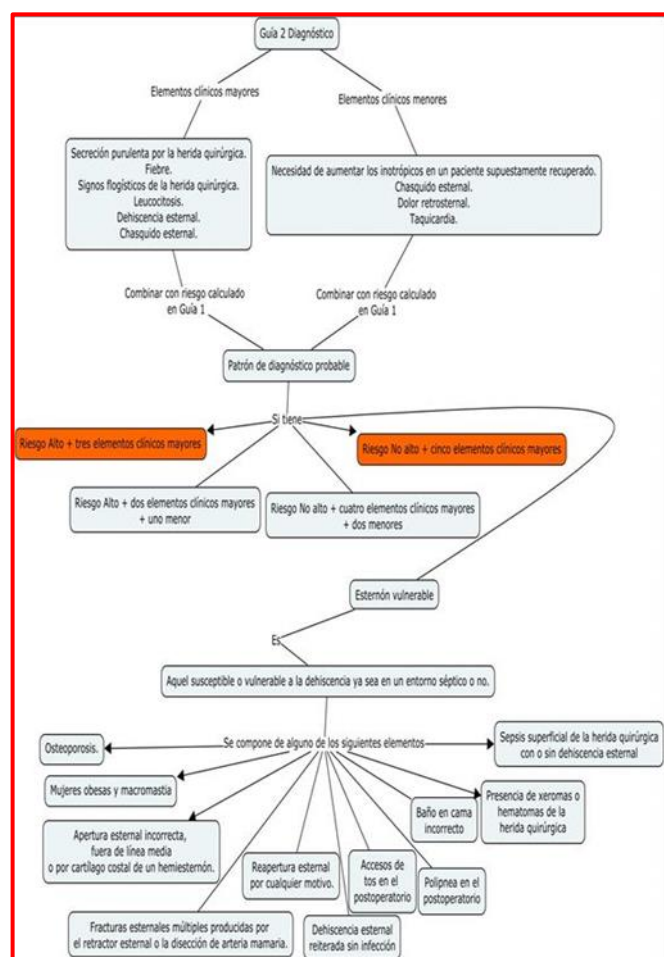


Figure 3- Diagnostic Conceptual Map

The prevention guideline with pre-, intra-, and postoperative measures is presented in **figure 4**, along with other important measures not included in any of these periods.

Figure 5 shows the indications and contraindications of each surgical therapeutic resource for the treatment of postoperative mediastinitis, which includes the novel surgical technique of dermoplasty¹⁸ to obtain an autologous biological neosternum¹⁹, also innovated as part of this research, and **figure 6** is dedicated to quality control with an inspection guideline and a checklist. This summarizes and illustrates the guidelines developed for postoperative mediastinitis.

DISCUSION

The consensus of the European Association for Cardio-Thoracic Surgery published by Abu-Omar Y. *et al*²⁰ maintains the same prevention

elements as the article by Goh S.²¹, but adds that great care must be taken when performing longitudinal median sternotomy, respecting the surgical technique and avoiding bleeding, which is of great importance. Regarding control measures, although they strongly recommend vacuum aspiration, they mention other methods that can be used, such as mediastinal irrigation and live tissue interposition. Predictive elements are similarly not included, as this was not their objective.

The expert consensus of the American Association of Thoracic Surgery reflects multiple prevention measures that are similar to the previous ones. However, this includes smoking cessation 30 days before surgery and the stability of patients with Chronic Obstructive Pulmonary Disease (COPD); in addition to mentioning the control of remote infections and nutritional deficiencies, aspects not included in other guidelines or consensus reports. It reiterates the routine use of mupirocin, antibiotic prophylaxis and other aspects that have been reflected by other authors. It places great importance on early extubation and the removal of urinary catheters and deep venous catheters as soon as possible as very valuable measures in preventing postoperative mediastinitis.²²

In 2016, the guidelines of the America College of Surgeons and the Surgical Infections Society for surgical site infections recommended several aspects similar to the previous ones, such as antibiotic prophylaxis, glycemic control and control of all risk factors, as well as skin preparation, but includes antibiotic-coated sutures.²³

The Asia Pacific Society of Infection Control developed its guidelines for the prevention of surgical site infections, which highlight the control of preoperative risk factors, especially glycemia. In terms of intraoperative recommendations, they suggest the use of alcoholic solutions for skin preparation before the incision, an element with which the author of this study agrees and is therefore included in the developed guideline. They make recommendation II B for the use of adhesives on the skin before the incision, especially in cardiac surgery.²⁴ In 2018, the World Health Organization published a global guideline for the prevention of surgical site infections. It somehow outlines the general guidelines for all the described preventive protocols specific to sternotomy infection and make recommendations regarding climate control systems in operating rooms, an issue frequently not addressed in other guidelines or consensus reports.²⁵

One measure cited by several authors regarding deep sternotomy infection is skeletonized dissection of the internal mammary artery, especially

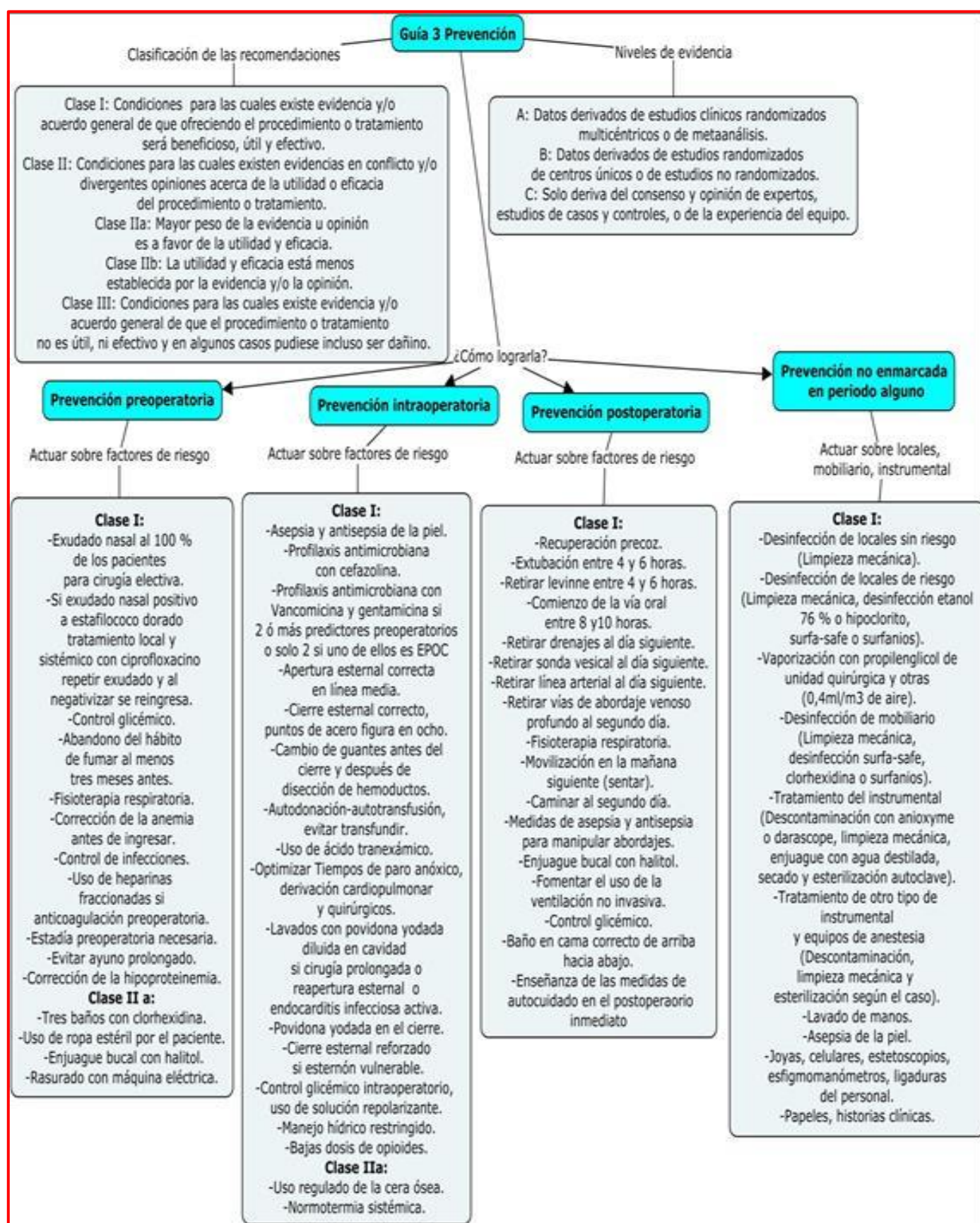


Figure 4- Prevention Conceptual Map

when both are going to be used, although it is recognized that this can be due to multiple causes in this type of patient and not only to the dissection technique used.²⁶ This is what

Crawford TC and his coauthors²⁷ state when they report that regardless of the dissection technique used for the internal mammary artery, diabetics with revascularized coronary artery

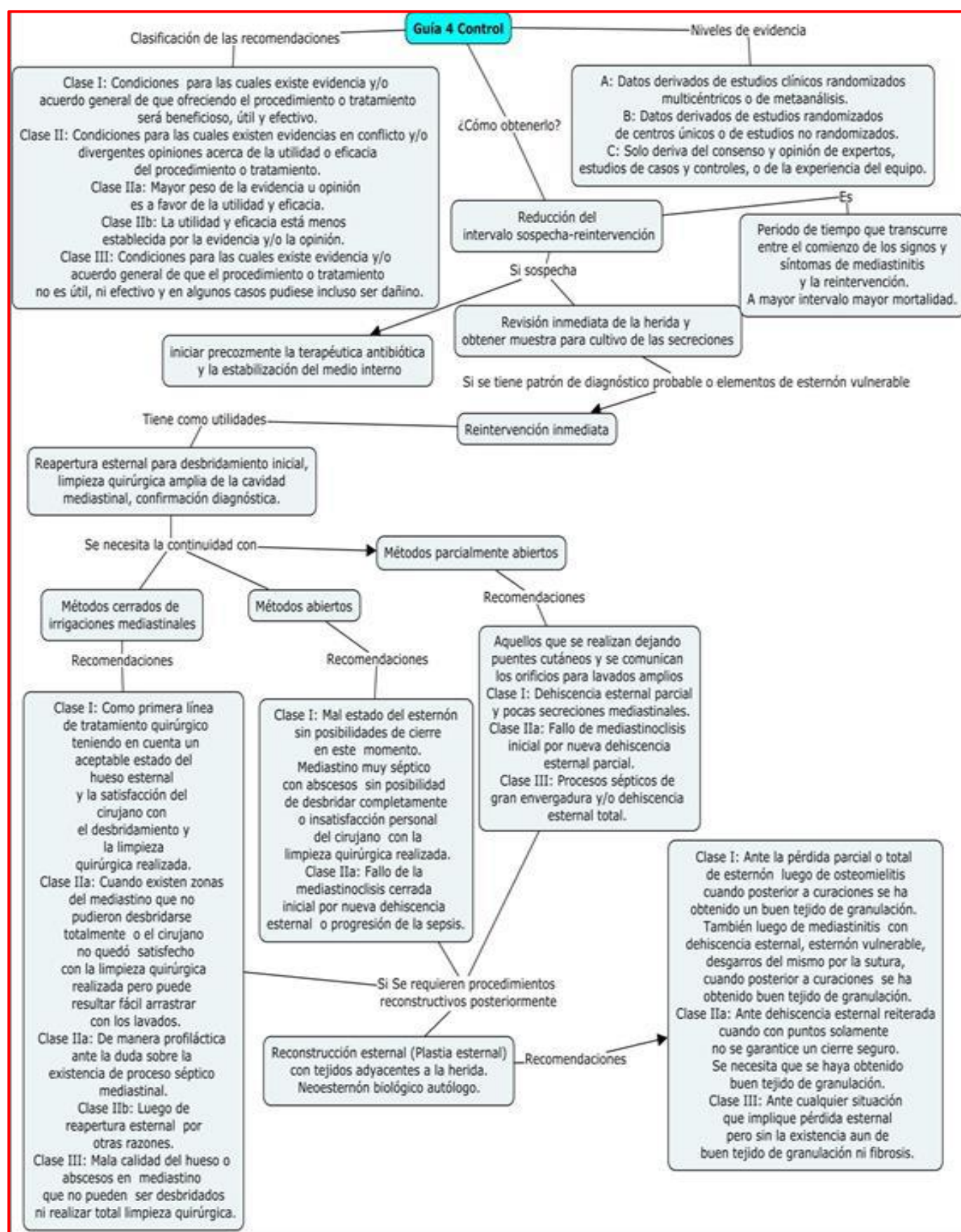


Figure 5- Treatment Conceptual Map

disease presented more deep sternotomy infections than non-diabetics.

In the guidelines resulting from this research, smoking cessation with sufficient advance notice is a key priority. Three months are generally required for elective surgery cases with less urgent

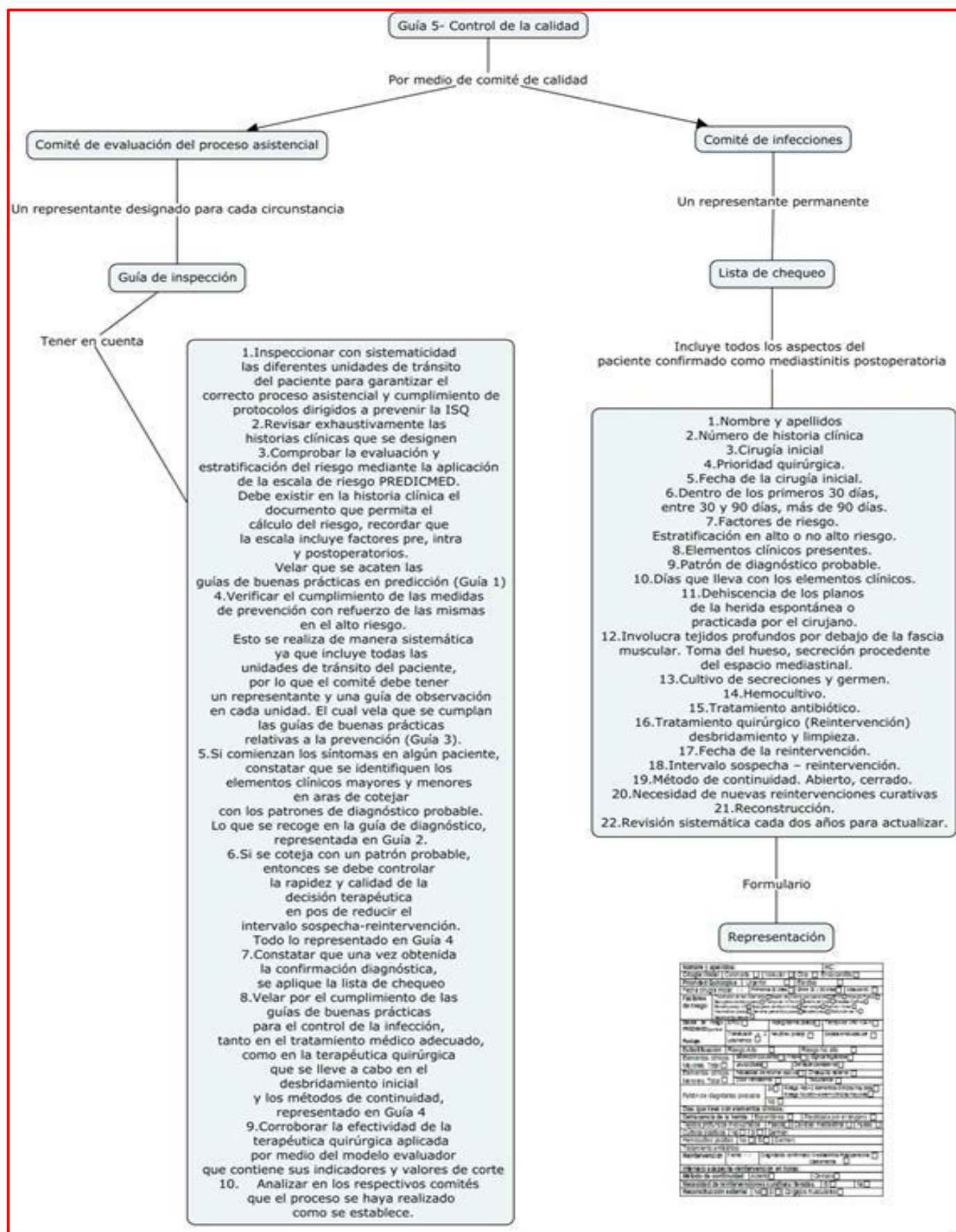


Figure 6- Quality Control Conceptual Map

priorities. Likewise, great importance is placed on all early recovery measures, especially extubation and removal of deep accesses and chest

drains, as well as care of vulnerable sternum components, such as proper bed bathing. Antibio-

disinfection of air conditioning systems are also recommended, and skeletonized mammary artery dissection is also indicated.

Regarding surgical treatment, the consensus by Lazar H. and other authors²², also recommend vacuum aspiration techniques and states that mediastinal irrigation with povidone iodine should not be performed, based on experimental results. However, in the presented guideline, this technique is recommended due to its proven effectiveness in the completed research sample.²⁸

Andersen BM.²⁹ in his work on the prevention of surgical wound infection, offers the most comprehensive preventive guideline that, in the opinion of this author, has been written according to the reviewed literature. It emphasizes aspects related to the quality and safety of surgical care. Checklists dealing with the prevention of surgical site infections are established. It includes the aspects of the patient preparation for the surgery that he or she will be facing. It

comprehends issues related to climate control systems of surgical units, the characteristics of climate control systems, their pressures and temperature, cleaning cycles and filters. It includes the strategies of disinfection and sterilization of both instruments as well such as clothing, furniture and operating rooms and the cycles that are established.

More recent studies maintain similar preventive measures, remarking preoperative glycemic control, the treatment using mupirocin for staphylococcus aureus present in nasal exudates and protocolled antibiotic prophylaxis.^{30,31,32}

CONCLUSIONS

Good practice guidelines for postoperative mediastinitis, elaborated and represented in conceptual maps have provide tools that, since they include prediction, diagnosis, prevention and control, allow to promptly set recommendations to improve the decision-making process.

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CONTRIBUTION OF THE AUTHORS

GJBY is the sole author of this research

