ORIGINAL ARTICLE

Clinical Practice Guideline for the medical care of patients with complex hemorrhagic trauma

Manuel Felipe Valdés Rodríguez[1]*, Berto Delis Condes Fernández[1], Geovanis Alcides Orellana Meneses[1], Juana del Pilar Rodríguez Concepción[1], Aramís Manuel Valdés Rodríguez[2]

[1]"Camilo Cienfuegos" General Provincial Hospital, Sancti Spíritus, Sancti Spíritus, Cuba
[2]University of Medical Sciences of Sancti Spíritus, Sancti Spíritus, Sancti Spíritus, Cuba

***Manuel Felipe Valdés Rodríguez.** manuelfelipe@infomed.sld.cu

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ABSTRACT

Introduction: the process of medical care for patients with complex haemorrhagic trauma in the province of Sancti Spíritus shows insufficiencies in the uniformity of the use of the clinical method in a structured way based on the diagnosis and treatment of these patients.
Objective: to design a Clinical Practice Guide for in-hospital emergency medical care for patients with complex haemorrhagic trauma.
Methods: an investigation was carried out that corresponds to the type of research-development, multistage, with a mixed approach, in the province of Sancti Spíritus from 2012 to 2019.
Results: methodological insufficiencies were detected in the medical care process of patients with haemorrhagic complex trauma. A clinical practice guide was prepared and executed that allowed the structuring of theoretical, clinical and investigative elements to evaluate this type of patients.
Conclusions: the clinical practice guideline proved to be relevant, feasible and effective; it made possible a first approach to Cuban patients with complex haemorrhagic trauma and allowed raising the level of knowledge of doctors about this condition.
Key words: hemorrhagic complex trauma; practice guideline; emergencies; medical care

RESUMEN

Introducción: el proceso de atención médica de pacientes con trauma complejo hemorrágico en la Provincia de Sancti Spíritus muestra insuficiencias en la uniformidad de la utilización del método clínico de forma estructurada en función del diagnóstico y el tratamiento de estos pacientes.
Objetivo: diseñar una Guía de prácticas clínicas para la atención médica de urgencia intrahospitalaria a pacientes con trauma complejo hemorrágico.
Métodos: se realizó una investigación que se corresponde con la tipología de investigación-desarrollo, multietápica, con enfoque mixto, en la Provincia de Sancti Spíritus desde 2012 a 2019.

Resultados: se detectaron insuficiencias metodológicas en el proceso de atención médica de pacientes con trauma complejo hemorrágico. Se elaboró y se ejecutó una Guía de prácticas clínicas que permitió la estructuración de elementos teóricos, clínicos e investigativos para evaluar a este tipo de pacientes.
Conclusiones: la Guía de prácticas clínicas demostró tener pertinencia, factibilidad y efectividad, posibilitó una primera aproximación a los pacientes cubanos con trauma complejo hemorrágico y permitió elevar el nivel de conocimientos de los médicos sobre esa afección.
Palabras clave: trauma complejo hemorrágico; guía de práctica clínica; urgencias médicas; atención médica

INTRODUCTION

Complex trauma is the leading cause of death in people under 45 years of age and generates more than five million deaths annually worldwide.[1,2] In Cuba, the fifth leading cause of death during the last decade is complex trauma due to accidents, some of which are associated with hemorrhage.[3] Blood loss secondary to traumatic injury, a clinical situation identified as complex hemorrhagic trauma (CHT) and defined as any patient who has received or self-inflicted one or multiple injuries secondary to high-energy injury mechanisms, peripheral, visceral or mixed, blunt or penetrating, causing bleeding, associated with progressive severity, with compromise of vital functions and a systemic pathological physiological response, characterized by peripheral hypoperfusion with some degree of consciousness disorders, acute coagulopathy, metabolic acidosis and hypothermia, which has a negative impact on the patient, the family and society, is associated with high morbidity and mortality. Recent research reports that only 13% of these patients reach medical facilities before death and that 30% to 40% die within the first 24 hours of hospital admission (early death), secondary to complications associated with hemorrhage; 25% of these deaths are considered potentially preventable.[4,5]
Since the nineties of the last century, the interest of the scientific community in addressing this disease has increased. Restriction of fluid therapy, administration of hemocomponents, prompt stop of bleeding, abbreviated surgery and prevention of body heat loss, key points to reduce traumatic mortality, were considered as fundamental pillars for its treatment. Resuscitation and damage control surgery arise from these elements.[6]
In the main databases of medical publications and with the use of several search engines, meta search engines, directories and subject guides, few original researches published on in-hospital emergency medical care of patients with complex hemorrhagic trauma were found.
Several of the articles reviewed[6,7,8] refer to the importance of diagnosis and effective treatment of patients with complex hemorrhagic trauma and propose methodological tools and recommendations based on scientific evidence, but there is a lack of reports on the scientific results of applying this evidence. The application of clinical practice guidelines (CPG) during the process of emergency medical care to patients with complex hemorrhagic trauma allows uniformity in care and enables timely treatment and mortality reduction in this type of patients.

In Cuba, and in the Province of Sancti Spíritus, there are no structured programs or guidelines and statistics and information on patients with complex hemorrhagic trauma are scarce. It has been objectified the lack of uniformity in the use of the clinical method according to the diagnosis and treatment of these patients, mainly in the application of its third stage (formulation of the hypothesis), by not using efficiently the method of the previous probability or the prevalence of the picture because, sometimes, a diagnosis can be reached only with the information obtained in the first two stages without the need to perform confirmatory complementary examinations, if it is taken into account that these patients suffer from a time-dependent disease.[9]
It was decided to carry out an investigation with the aim of designing a clinical practice guideline for in-hospital emergency medical care of patients with complex hemorrhagic trauma.

METHODS

A developmental, multistage scientific research was conducted in the General Surgery Service of the "Camilo Cienfuegos" Provincial General Hospital of Sancti Spíritus Province, in the province of the same name, from January 1st, 2012 to December 31th, 2019, including studies with varied scopes and research designs.

I. First stage

Diagnosis of the actual state of the process of in-hospital emergency medical care of patients with complex hemorrhagic trauma. An exploratory study with a mixed quantitative-qualitative approach was carried out. Sub-stages were established.
Sub-stage 1:
A case series study was conducted during the years 2012 to 2017 at the Provincial General Hospital "Camilo Cienfuegos" of Sancti Spíritus.
From a non-probabilistic purposive sampling, case types defined by all patients aged 19 years or older with a diagnosis of hemorrhagic complex trauma were selected. The final sample consisted of 207 patients.
The variables selected were sociodemographic variables, associated chronic diseases, mechanism of injury, type of trauma, topographic location, time between hospital admission, diagnosis and treatment, early bleeding-related complications, medical-surgical treatment and early mortality.
Sub-stage 2:
An exploratory qualitative research was conducted with the objective of deepening the clinical-surgical profile of the in-hospital emergency medical care process in patients with hemorrhagic complex trauma.
The study was developed in the context in which the care of patients with hemorrhagic complex trauma was performed (Trauma Unit, Surgical Unit and Progressive Care Units of the "Camilo Cienfuegos" Provincial General Hospital of Sancti Spíritus) during the years 2012 to 2017.
In this scenario, from the target population, a non-probabilistic sampling of intentional type was carried out that allowed selecting a homogeneous sample; it was considered as a selection criterion that the professionals were Specialists in General Surgery, Anesthesia and Intensive Care.

The sample was made up of 35 physicians: 30 specialists in general surgery, three in anesthesia and two in intensive care; 30 of them worked all the time as assistants and five were administrative, assistants or teachers, with partial involvement in medical assistance.
The analysis of the situation was based on the search for documentary evidence on the process of in-hospital emergency medical care in patients with complex hemorrhagic trauma and the physicians' knowledge of the theoretical aspects of this condition and the process of medical care for this type of patients was determined.
To this end, information gathering techniques and instruments were used, including: analysis of documents (charge sheets, statistical records, individual medical records, operative reports and necropsy protocols), participant observation, in-depth interviews and nominal groups (four groups were formed: two with specialists in general surgery [ten members], one with specialists in anesthesiology [three members] and one with specialists in intensive care [two members]).

II. Second stage

Design of a clinical practice guideline:
An analytical research was conducted aimed at the design of a Clinical Practice Guide for in-hospital emergency medical care in patients with hemorrhagic complex trauma.
The following criteria and periodizations were taken into account in the methodology used.[10]
Phases of the guide
The chronogram and each phase of modeling of the guide for patients with complex hemorrhagic trauma are described; in some cases the periods in which the types of studies are developed overlap.
1st Preparation Phase (from January 1, 2016 to January 31, 2017): this phase ends upon having a defined structure and a sufficient body of knowledge about the health problem. Within this phase were included:

1. The choice of the problem based on the deficiencies detected was based on prioritization criteria taken from traditional priority-setting schemes in health planning, which include relevance, magnitude, importance, vulnerability and feasibility.[11]
2. The type of guide was defined:
   - ✓ Level of care involved: secondary care
   - ✓ Guideline activity: in-hospital emergency medical care
   - ✓ Target professionals: physicians
3. The person responsible for its preparation was appointed: (Manuel Felipe Valdés Rodríguez).
4. A timeline was detailed and August 31th, 2017 was set as the date for delivery of the draft guidance document.

2nd document development phase (from February 1 to August 31, 2017): consisted of drafting a document with all the data and knowledge collected in the previous phase, which ended with the provisional drafting of the guide document. Four key parts were included in this phase:

1. An informed approach to the topic that included several aspects: formulation of the problem, identification and assessment of the

scientific evidence. The strength of the evidence (key areas of scientific uncertainty and theoretical discussion were considered), the relative importance of the benefits, the expected risks and the priority of the intervention.

2. General recommendations for the design were taken into account, including those related to the brevity of the document, which were designed and adapted to hospital care. A theoretical-conceptual document was prepared to justify its development and an operational document that included the algorithm.
3. The AGREE II instrument was used to prepare the guide.[12]
4. An algorithm was constructed to summarize the guide processes and decision analysis techniques were used. The Adán Gil's recommendations[13] were followed in relation to its construction, in which the approved symbols were used.

The algorithm was developed from the review, analysis and integration of scientific evidence on the clinical and diagnostic evaluation of patients with complex hemorrhagic trauma published in peer-reviewed specialized medical journals.[11] In addition, the inadequacies found in the process of in-hospital emergency medical care of these patients were taken into account.

The algorithm was approved by the Scientific Council of the General Provincial Hospital "Camilo Cienfuegos" of Sancti Spíritus and was designed in compliance with the clauses of the Declaration of Helsinki.[14]

3rd Review and critique phase (from September 1 to November 30, 2017): consisted of submitting the structure designed and the wording obtained in the previous phases to the discussion and critique of the professionals included in the nominal groups previously created and involved in its implementation. After collecting the corresponding suggestions and modifications, the final text of the guide was drafted and submitted for expert consultation.

4th Dissemination phase (from December 1 to December 31, 2017): the implementation consisted of disseminating the guide to all personnel involved. At that time, a date was set for implementation (January 1, 2018).

5th evaluation phase (every three months during 2018-2019): compliance was monitored on a quarterly basis during 2018 and 2019; the compliance and effectiveness of the guide was commented and analyzed. The AGREE II instrument was also used during this phase.[12]

Analysis of the information in the first stage:

In the first sub-stage, descriptive statistics were used: by hundreds and frequencies.

In the second sub-stage, a qualitative analysis was carried out in which the information obtained was organized into categories. Once the saturation of the information was reached, a reduction and transformation of the data were carried out, which were codified in the following themes or explanatory planes: cognitive, structural and results. Subsequently, the themes were related and the data were triangulated, which made it possible to generate hypotheses.

The results obtained in the diagnosis of the actual state of the process of in-hospital emergency medical care in patients with complex hemorrhagic trauma made it possible to design a clinical practice guide taking into account the context in which the process takes place.

The authors chose the use of the guide as a scientific result in their research because it is based on a planning process that allows the projection of the process of transformation of emergency medical care to these patients from an actual state to a desired state through intervention actions elaborated in a conscious and intentional way.
Analysis of the information in the second stage:
A qualitative analysis was carried out to design the guide through the results obtained in the diagnosis of the actual state of the process of in-hospital emergency medical care in patients with complex hemorrhagic trauma.

III. Third stage (evaluation of the Clinical Practice Guideline):
Analytical research was conducted for the evaluation of relevance and feasibility in the period from January 1, 2016 to December 31, 2017.
Methodology for the evaluation of relevance and feasibility using expert criteria:
Corresponds to the assessment of its relevance. The research used expert criteria to assess the relevance and feasibility and acceptability of the Clinical Practice Guideline for Intrahospital Emergency Medical Care for Patients with Complex Hemorrhagic Trauma with the aim of refining it and trying to reduce errors before its implementation.[11,15]
It was carried out by means of the expert criterion method in the pairwise comparison modality. The dynamics of the procedures are described in more detail below:
a) Determination of experts.[11,15]
Initially, 35 potential experts were identified, of which 30 were chosen to constitute the final panel of experts. This selection took into account practical experience and expertise in aspects related to in-hospital emergency medical care of patients with complex hemorrhagic trauma, as well as professional prestige and a competence coefficient equal to or greater than 0.8.
The self-assessment test was applied to each selected expert to calculate the competence coefficient, in which first the argumentation coefficient (Ka) and the knowledge coefficient (Kc) were calculated and, subsequently, the competence coefficient (K) was calculated by obtaining the average of the Kc and Ka coefficients. The K coefficient is calculated by the following expression: $K=(Kc+Ka)/2$.
b) Analysis of the experts' criteria.[11,15]
Subsequently, a questionnaire with open-ended and weighting questions, as well as a synthesis of the guide, was prepared for the experts' consideration. Direct delivery was the selected method of consultation.
The questionnaire was sent to each expert with the guidelines for analyzing the guide, as well as the indicators that enabled them to make their judgment. Five evaluative categories were considered with their corresponding rationale. The evaluations given were statistically processed through the steps established by the pairwise comparison procedure.[11,15]
Each aspect included in the guide was evaluated independently by each expert with the following categories (in descending order): very adequate (MA), quite adequate (BA), adequate (A), not very adequate (PA) and inadequate (I).
A quasi-experimental analytical research was conducted for the evaluation of the effectiveness of the designed Clinical Practice Guideline through

ascertainment in surgical practice in the period from January 1st, 2018 to December 31st, 2019.

Methodology for effectiveness evaluation

A non-probabilistic purposive sampling was performed to define a sample of 73 patients with complex hemorrhagic trauma diagnosed in the period from January 1, 2018 to December 31, 2019, who formed the study group. For the purposes of effectiveness evaluation, all the participants in the first stage of the research were assumed as the historical control group.

Criteria and indicators of the effectiveness of the Clinical Practice Guideline:

1. Indicator: adherence to the Clinical Practice Guideline

Type of indicator: process. Dimension: effectiveness

- Definition: recommendations implemented during the medical care of patients with CHT according to the applied guideline.
- Calculation: number of recommendations implemented for patients with CHT/total number of recommendations planned for patients with CHT according to the guideline.
- Rationale: this indicator aims to identify the number of recommendations executed in correspondence with the guideline according to the medical records of patients with CHT during in-hospital emergency medical care.
- Data to be collected and sources: number of recommendations executed in correspondence with the guideline according to clinical records. Purpose: 70%.

2. Indicator: clinical evolution of patients with early complications

Type of indicator: outcome. Dimension: effectiveness

- Definition: clinical evolution of patients with early complications of CHT according to those considered in the theoretical framework of the thesis.
- Calculation: number of patients with unfavorable clinical course with early complications/number of patients diagnosed with CHTx100
- Rationale: this indicator aims to identify the clinical evolution of patients with early complications of CHT presented during the first 24 hours of in-hospital admission.
- Data to be collected and sources: clinical course of patients with early complications of CHT and number of them according to the clinical history in the first 24 hours of in-hospital admission.
- Available standards: 28% (taken from the outcome of the historical control group). Purpose: 20%.

3. Indicator: time between hospital admission diagnosis and treatment

Type of indicator: outcome. Dimension: effectiveness

- Definition: time elapsed in hours from trauma admission to diagnosis and initiation of definitive in-hospital treatment.
- Calculation: number of hours elapsed from admission to diagnosis and initiation of definitive in-hospital treatment/number of patients with CHT.
- Rationale: this indicator aims to identify the time elapsed from admission of the patient with CHT to diagnosis and initiation of definitive treatment during in-hospital emergency medical care

- Data collection and sources: time elapsed in hours according to medical records from admission of the patient with CHT to diagnosis and initiation of definitive in-hospital treatment.
- Available standards: mean 3.60 hours (taken from historical control group result). Purpose: mean 2.50 hours.

4. Indicator: medical-surgical damage control treatment performed
Type of indicator: outcome. Dimension: effectiveness

- Definition: medical-surgical damage control treatment performed.
- Calculation: total number of patients who underwent medical-surgical damage control treatment/number of patients with CHTx100
- Rationale: this indicator aims to identify patients undergoing medical-surgical damage control treatment with a diagnosis of CHT during the first 24 hours of in-hospital emergency medical care.
- Data to be collected and sources: number of patients undergoing medical-surgical damage control treatment according to medical records during the first 24 hours of in-hospital emergency medical care.
- Available standards: 5.3% (taken from historical control group outcome). Target: 50%.

5. Indicator: early mortality
Indicator type: outcome. Dimension: effectiveness

- Calculation: number of patients who died of CHT during the first 24 hours of in-hospital emergency medical care/number of patients diagnosed with CHT.
- Rationale: this indicator aims to identify patients who died with a diagnosis of CHT during the first 24 hours of in-hospital emergency medical care.
- Data to be collected and sources: early deaths coded with a diagnosis of CHT.
- Available standards: 30% (taken from historical control group outcome). Purpose: 20%.

Indicator population: patients admitted with a diagnosis of complex hemorrhagic trauma.

RESULTS

I. First stage. Main diagnostic results.
Sub-stage 1:
During the years 2012 to 2017 discharged 207 patients with the diagnosis of hemorrhagic complex trauma. It was identified that the time between hospital admission, diagnosis and definitive treatment was prolonged (150, 72.4%), that conventional medical/surgical treatment prevailed 201 (97.1%) and 196 (94.6%), respectively, and that 62 (30%) patients died early.
Sub-stage 2:
In the documentary review, deficiencies were detected in the in-hospital emergency behavior in patients with complex hemorrhagic trauma such as prolonged time from admission of the patient with complex hemorrhagic trauma, diagnosis and definitive treatment and in the non-use of damage control medical/surgical management.

In the review of the necropsy protocols, the causes of death were evidenced. The results obtained through the techniques of approximation and identification of the problems were organized according to the categories of the participating groups. By relating all the themes, the triangulation of the data was carried out (Figure 1), which made it possible to generate the following hypotheses:

- The existing infrastructure, both material and human, in the Cuban health system was adequate to provide proper in-hospital emergency medical care to patients with complex hemorrhagic trauma.
- There were learning needs for specialists in general surgery or other specialties related to trauma emergencies on aspects that characterize patients with CHT.
- There was no adequate emergency care of patients due to difficulties in the interpretation of hospital admission times, diagnosis and definitive treatment and variability of medical-surgical treatment of patients with CHT.
- There was no organization or systematization in the intra-hospital emergency medical care of patients with CHT in the Province of Santi Spiritus because there was a lack of structured guidelines, protocols or algorithms of action that would allow an organized flow of care and enable multidisciplinary management for the evaluation of these patients.

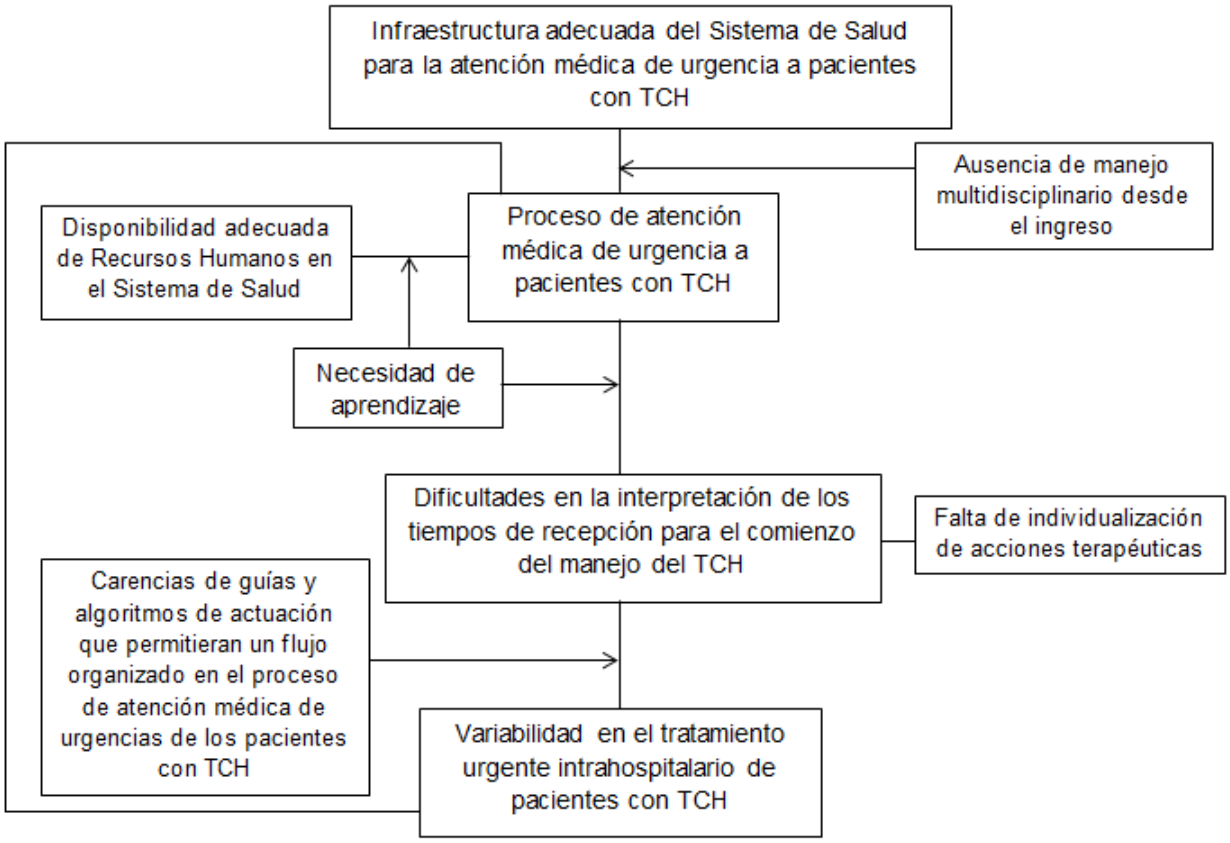

Figure 1. Set diagram. Factors related to the process of in-hospital emergency medical care for patients with CHT
Arrows (⟶) indicate causal relationship and lines (——) indicate association

II. Second stage. Design of the clinical practice guide for the improvement of the in-hospital emergency medical care process for patients with complex hemorrhagic trauma.

From the results obtained in the diagnosis of the actual state of the process of in-hospital emergency medical care of patients with CHT, it was derived that the fundamental ideas that should be developed in a clinical practice guide to modify the problems identified should be: actions to raise the level of knowledge of physicians about complex hemorrhagic trauma, actions that allow multidisciplinary interrelation for the care of patients with this condition and actions to organize the process of clinical, diagnostic and therapeutic evaluation of these patients.

The modeling of the guide was carried out according to the methodology proposed by Alva Diaz,[10] which includes theoretical considerations by way of introduction, scope and objectives, clinical questions, synthesis of essential knowledge on CHT and 18 recommendations on diagnosis and treatment with their respective levels of evidence and degree of recommendation. It also includes an algorithm that, by way of synthesis, made it possible to graph the sequence of steps corresponding to the diagnostic and treatment process (Figure 2).

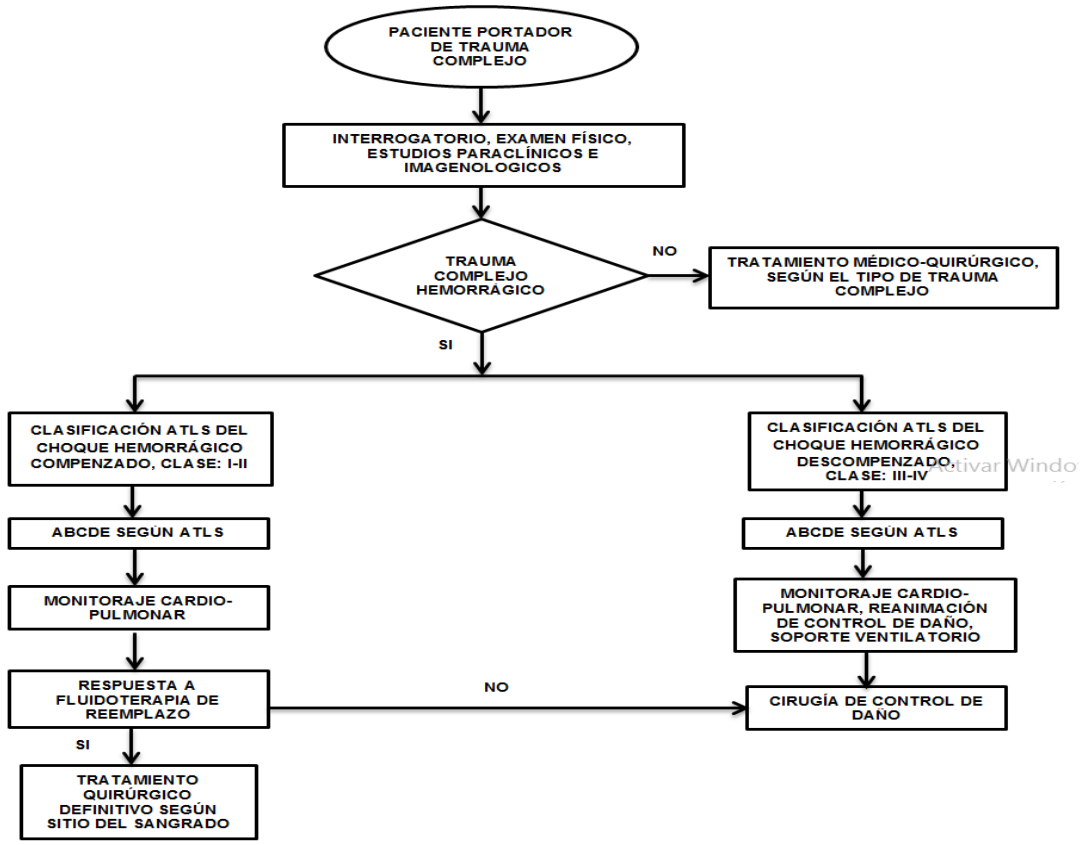

Figure 2. Diagnostic-therapeutic algorithm for patients with complex hemorrhagic trauma

III. Third stage. Evaluation of the Clinical Practice Guideline.

Evaluation of the relevance and feasibility of the proposed Clinical Practice Guideline by means of expert criteria.

In order to obtain an initial evaluation of the relevance of the guide, the expert criteria was used as a method, characterized by its potential to evidence consensus opinions regarding the proposal, based on the judgment issued by people who have a high level of knowledge in the subject under investigation.
The experts conducted the analysis of the guide through the indicators that enabled them to issue their judgment, and when statistically processing the evaluations granted through the steps established by the peer comparison procedure, the indicators to be evaluated reached the category of "very adequate", which allowed affirming that the guide was considered pertinent by the experts consulted.
The proposed guide was positively evaluated by the experts, according to the results obtained, for its contribution to therapeutic decision-making according to the different situations presented, the individualized actions proposed and the multidisciplinary approach to patient behavior.

Evaluation of the effectiveness of the Clinical Practice Guideline for in-hospital emergency medical care of patients with CHT.

In order to evaluate the effectiveness of the guide designed, a quasi-experimental research was carried out from an approach based on the findings in surgical practice during the period of time from January 1, 2018 to December 31, 2019.
For the purposes of the quasi-experiment, we worked with two groups: historical control group, made up of the participants in the diagnosis performed during the first stage (207 patients), and study group, prospectively composed of 73 patients with CHT, i.e., all of those seen in the period from 2018 to 2019.
The results of the effectiveness evaluation according to compliance with the assumed indicators are shown in Table 1. A summary was made showing the purpose figures and comparing the results of each indicator between the historical control group and the group of patients who were treated with the guideline.

Table 1. Results of the evaluation of the effectiveness of the CPG

Indicator	Previous	Purpose	Real	FP
Adherence to CPG	-	70%	83.3%,	Yes
Clinical course of patients with early complications of CHT	28%	20%	12.3%	Yes
Time between hospital admission, diagnosis and definitive treatment	Mean 3.52 horas	Mean 2.50 horas	Mean 2.46 horas	Yes
Medical-surgical treatment for damage control	5.3%	50%	72.6%	Yes
Early mortality	30%	20%	12.3%	Yes

FP: fulfillment of purpose

More than 80% adherence to the recommendations suggested in the guidelines was achieved, while the number of patients with unfavorable clinical evolution due to early complications was reduced to below the established figure. In addition, the time between hospital admission and treatment was reduced and the use of medical-surgical therapeutic options for damage control increased considerably.

Although there is no evidence of statistical significance, this indicator shows the clinical significance of a lower number of deceased patients.
In general, the objectives proposed for each indicator were met.

DISCUSSION

The process of medical care (set of actions to be performed by the physician in order to intervene in an active and determinant way on the health-disease process in an individual, the family and the community to reach a specific result)[16] is one of the dimensions of quality in the medical care of patients with CCH.[17] This process should include a set of actions to convert the structure (institutions, supplies and personnel in charge of patient care) into results (identification, evaluation, diagnosis, treatment and follow-up of patients with complex hemorrhagic trauma).
This process should include a set of actions to convert the structure (institutions, supplies and personnel in charge of patient care) into outcomes (identification, evaluation, diagnosis, treatment and follow-up of patients with complex hemorrhagic trauma) and to add value to the service provided to these patients.[17]
The clinical-surgical profile of the in-hospital emergency medical care process for patients with CHT prior to the design of the CPG was described, which showed inadequacies both in the identification of patients and in the organization of their diagnosis and treatment.
Through the triangulation of the data, a set diagram of the factors related to the process of in-hospital emergency medical care of patients with CHT was developed.
The Clinical Practice Guideline presented in this article was designed and implemented with the intention of improving the process of in-hospital emergency medical care for patients with CHT.
The application of the Clinical Practice Guide allows a resizing and restructuring of the elements involved in the care process for patients with this condition and establishes the necessary conditions for its improvement based on the integration of the system's components.
The effectiveness, feasibility and relevance of the proposed Clinical Practice Guide were validated based on the criteria and assessment of 30 experts and the application of quality indicators.
When developing the process of intrahospital emergency medical care, according to the proposed guide, it was possible to make a first approach to Cuban patients with hemorrhagic complex trauma, which allowed describing some of the clinical and epidemiological aspects that characterized them.
Comparisons with other investigations were not carried out because there is a lack of reports on scientific results when applying the published Clinical Practice Guidelines addressed to patients with CHT.

CONCLUSIONS

Based on the methodological inadequacies detected in the process of in-hospital emergency medical care in patients with CHT, a Clinical Practice Guide was designed with the aim of improving this process. The guide was based on

the integration of theoretical, epidemiological, clinical and investigative elements of the disease under study, as well as its organization and structuring to evaluate and investigate these patients. After the application of the Clinical Practice Guide, its relevance, feasibility and effectiveness were verified.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in this research.

CONTRIBUTION OF THE AUTHORS

MFVR: conceptualization, formal analysis, methodology, data curation, research, resources, validation, visualization, research, writing the original draft, writing (review and editing).
BDCF: methodology, research, visualization, writing (review and edit).
GAOM: data curation, research, resources, validation, writing (review and edit).
JPRC, AMVR: visualization, writing (review and editing).