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Medico-economic study of pain in an emergency department: a targeted literature review

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ABSTRACT

Background: Pain management in emergency departments is a complex objective. The absence of a care pathway or a high level of activity complicates diagnostic or analgesic therapeutic strategies. Medical innovation can impact both individual practices and the functioning of an emergency department.

Objective: We then wanted to understand how medico-economic studies on pain were carried out in an emergency department.

Study design: We reviewed the literature of the last 20 years (between 1998 and 2018).

Setting: Of 846 titles screened, a total of 268 abstracts qualified for further screening, and 578 titles were excluded. A total of 14 studies qualified for inclusion in the review. Studies on medico-economics in an emergency department are very diverse. None of the methods used are identical; the studies differ in their very nature (prospective, retrospective, cost-effectiveness, etc.) and the determination of emergency room costs differs according to the part of the world studied. In addition, organizational impact is rarely measured, although it is an essential dimension for choosing or not a medical innovation.

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Medico-economic; evaluation; innovation; emergency department; pain management

Introduction

Emergency departments play an important role in the functioning of hospitals, but also as first contact care providers. This is a priority reception place for unscheduled activity. The activity is not only important but is constantly increasing.

The need for care of patients in emergency departments combined with the economic context requires hospitals to make rapid decisions and to optimize the use of material and human resources. The objective is to maintain the fluidity of the patient's journey without compromising the quality of care.

An emergency department is very diverse, with serious cases as well as benign ambulatory medicine. Pain calls for the involvement of all categories of consultants: in an emergency room, 60% of patients experience acute pain. This leads to waiting times for a number of patients, which can be very long before they receive an analgesic treatment, when they are not prioritized. For 85% of them, pain is the main reason for seeking medical care [1]. Chest pain is a frequently non-specific symptom that raises the problem of its varied etiology and potential severity.

Pain management is then a key quality indicator of organizational relevance in emergencies. The absence of a care system and too high a level of activity complicate diagnostic or analgesic therapeutic strategies. The introduction of a medical innovation gives hope for a positive impact both on individual practices and on the organizational level [2].

The objective of our work is to review the literature on medico-economic studies conducted on the theme of therapeutic management or pain diagnosis in an emergency department.

Methods

A targeted literature review was conducted to assess medico-economic studies of pain in an emergency department

The MEDLINE database was searched for English-language studies using search terms related to 'program evaluation', 'cost', 'emergency' and 'pain'.

The medline equation was: ('Program Evaluation'[Mesh] OR 'Costs and Cost Analysis'[Mesh] OR Cost OR 'Healthcare Financing'[Mesh] OR 'Economics'[Mesh]) AND ('Emergency

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Service, Hospital'[Mesh] OR 'Emergency Medical Services'[Mesh] OR emergency) AND ('Pain'[Mesh] OR 'Pain Management'[Mesh])

The search was limited to the following: studies published from 1998 to 2018 to capture the most up-to-date studies; in the English language; related to the economic evaluation of pain in a medical emergency department; and peer-reviewed journals. The bibliography of reviewed articles identified as part of this search was further screened for relevant articles not identified in the original search.

The resulting titles and abstracts were screened methodically and exported to Microsoft excel for an additional review. An article was retrieved for full review when its abstract met each of the including criteria. Articles were excluded from full review when its abstract met any of the following criteria: the study does not report economic study, case series, editorial or commentary.

From full-text reviews, study details including 'country', 'type of study', 'population' size', 'method', 'costs evaluation' and 'results' were extracted.

Results

Medical-economic studies on pain treatment in an emergency department are few and heterogenous. Of 846 titles screened, a total of 268 abstracts qualified for further screening, and 578 titles were excluded. A total of 14 studies qualified for inclusion in the review.

A flow chart summarizing the study selection and inclusion is reported in [Figure 1](#).

The specific characteristics of each of the fourteen studies are summarized in [Table 1](#).

The publications identified are based on two major themes in emergency departments: the assessment of diagnostic costs in the context of chest pain and the drug based analgesic strategy

Assessment of diagnostic costs in the context of chest pain

This first theme is over-represented in the literature since it is a field with a high economic stake in terms of the necessary investments.

Chest pain is one of the most frequent causes of emergency room visits. These are managed and usually classified into three categories: low, medium or high risk.

Eight million patients per year in the United States are treated by emergency departments for these pains compatible with cardiac ischemia. When investigated by non-invasive imaging, only 30% of them suffer from coronary artery disease, resulting in \$10 billion in overly cautious spending.

In a 2015 study, these figures are explained by Culler et al. [3]: the 67.2% of patients with non-heart chest pain each incur \$3,331 in expenses. Much work has therefore focused on improving diagnostic techniques that can be used to send patients home who do not need care as quickly as possible.

Coronary computed tomography angiography (CCTA) allows coronary artery disease to be excluded quickly and non-invasively. The ROMICAT study is being launched, among other things, to ensure that this method does not increase costs compared to conventional techniques [4]. This 2013 study is innovative in that it uses a sophisticated cost calculation calculator that is,

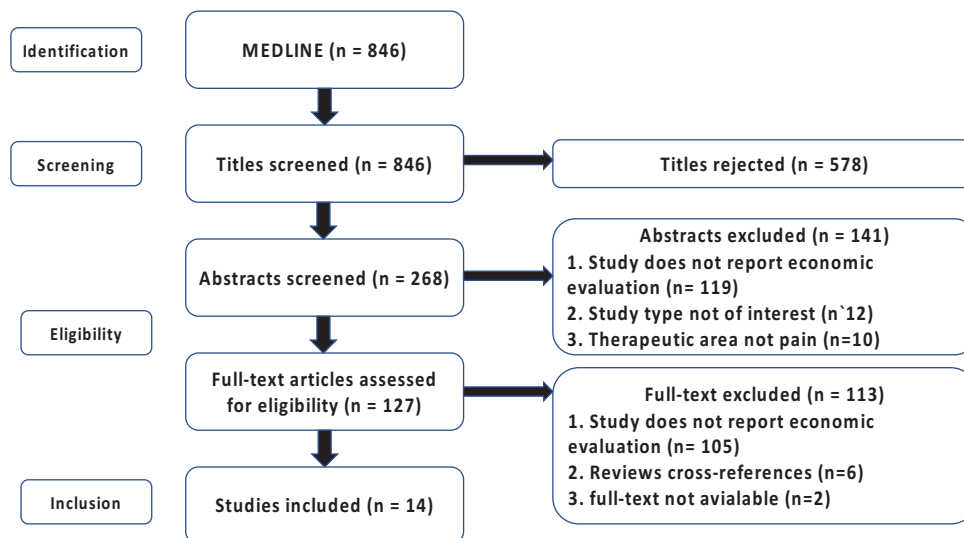


Figure 1. flow chart.

Table 1. Specific characteristics of the fourteen studies.

Authors (Year)	Title	State	Stude design	Population (n =)	Costs data inputs	Results
1 Hubert et al [13].	Prehospital pain treatment: an economic productivity factor in emergency medicine?	France	Cost analysis (Prospective, multicentre cohort study)	568	Literature data	No significant difference between cases and controls was found concerning "Medical Treatment Duration" (P = 0.134). Conversely, a difference was found for Care Workload, with a mean value of 53.7
2 Casamayor et al. [14]	Administration of intravenous morphine for acute pain in the emergency department inflicts an economic burden in Europe	France, Spain, Italy, Germany, UK	Cost analysis (structured literature review)		Drug, material, workforce, adverse events, IV complications	If costs associated with the management of morphine-related adverse events and IV-related complications are also considered, the total costs amount to €121.13–€132.43.
3 Doleman et al. [15]	Patient controlled analgesia: effective and cost-effective management of acute pain within the Emergency Department?	UK	Cost analysis (Randomised controlled trial)	20	Cost of equipment, analgesic drugs, and staff time.	Overall costs were higher with patient-controlled analgesia than standard care in both groups: pain from traumatic injuries incurred an additional £18.58 (€21.79 US\$23.10) per 12 h; and non-traumatic abdominal pain an additional £20.18 (€23.67 US\$25.09) per 12 h.
4 Pritchard et al. [16]	The cost-effectiveness of patient-controlled analgesia vs. standard care in patients presenting to the Emergency Department in pain, who are subsequently admitted to hospital	Australia	Cost analysis (Prospective study)	926	Cost and length of hospital stay (hospital administration record and inpatient costs (Australian refined diagnosis-related group reimbursement codes)).	The mean cost was highest in the ACS group (\$13 509; 95% CI, \$11 794 – \$15 223) followed by other cardiovascular conditions (\$7283; 95% CI, \$6152–\$8415) and non-cardiovascular conditions (\$3331; 95% CI, \$2976–\$3685).
5 Cullen et al. [3]	Cost and outcomes of assessing patients with chest pain in an Australian emergency department	USA	Cost analysis (observational cohort study)	368	Cost accounting system tracks all costs associated with each patient's hospital admission at a line-item level.	In comparison with usual care, cCTA-guided triage, whereby patients with no "coronary artery disease" are discharged, could reduce total hospital costs by 23% (P < 0.001).
6 Hulten et al. [4]	Cost and Resource Utilization Associated With Use of Computed Tomography to Evaluate Chest Pain in the Emergency Department	USA	Cost-effectiveness of three diagnostic strategies for patients with acute chest pain at the emergency department (decision tree model)	Simulation/ 10,000 patients	Published literature	BPCAs could have a significant impact in the diagnosis of acute chest pain, in particular for populations with high incidences of CIN.
7 Espinosa et al. [5]	The Rule Out Myocardial Infarction Using Computer Assisted Tomography (ROMICAT) Study	USA	Cost-minimization analysis	46	Hospital costs were calculated using hospital department specific Medicare cost/charge ratios. Length of stay was calculated as total hospital room days billed (regular and intensive care).	Patients randomly assigned to the perfusion imaging-guided arm had \$1,843 (95% confidence interval [CI] \$431 to \$6,171) lower median in-hospital costs and 2.0-day (95% CI 1.0 to 3.0 days) shorter median lengths of stay but similar rates of in-hospital and 30-day follow up events as patients in the conventional arm.
8 Stowers et al. [6]	An Economic Analysis of an Aggressive Diagnostic Strategy With Single Photon Emission Computed Tomography Myocardial Perfusion Imaging and Early Exercise Stress Testing in Emergency Department Patients Who Present With Chest Pain But Nondiagnostic Electrocardiograms: Results From a Randomized Trial	USA				

(Continued)

Table 1. (Continued).

Authors (Year)	Title	State	Stude design	Population (n =)	Costs data inputs	Results
9 Wong et al. [7]	Diagnostic utility, safety, and cost-effectiveness of emergency department-initiated early scheduled technetium-99m single photon emission computed tomography imaging followed by expedited outpatient cardiac clinic visits in acute chest pain syndromes	Singapore	Cost-effectiveness (prospective, non-randomized study)	108	Estimated costs are based on prevailing averaged hospital discharge bills	Compared with standard strategy, early outpatient SPECT initiated by EMD physicians followed by cardiac clinic evaluation resulted in 2.9 days of hospitalization or \$781.23 saved per patient per EMD visit.
10 Wyrick et al. [8]	Cost-Efficiency of Myocardial Contrast Echocardiography in Patients Presenting to the Emergency Department With Chest Pain of Suspected Cardiac Origin and a Nondiagnostic Electrocardiogram	USA	Cost-effectiveness (decision tree)	957	Costs estimated from national average Medicare charges adjusted by a cost-charge ratio	Preventing unnecessary admissions and tests would have saved an average of \$900 per patient, in addition to reducing their ED stay
11 Priest et al. [9]	Cost-Effectiveness of Coronary Computed Tomography and Cardiac Stress Imaging in the Emergency Department	USA Australia	Cost-effectiveness (decision analytic model)	-	Average national reimbursement in the United States using Current Procedural Ter- minology codes and Clinical Classifications Software	The CTA strategies were cost saving (lower costs, higher quality-adjusted life-years) compared with stress ECG, echocardiography, and SPECT
12 Peitz et al. [10]	Association of Body Mass Index With Increased Cost of Care and Length of Stay for Emergency Department Patients With Chest Pain and Dyspnea	USA	Costs analysis (prospective, 4-center, outcomes study)	851	Costs for imaging, pharmacy, laboratory, and other service are groupings in the universal hospital claims submission form	BMI was associated with increases in cost of care and length of hospital stay for patients with chest pain and dyspnea.
13 Nieuwets et al. [11]	Medical consumption compared for TIMI and HEART score in chest pain patients at the emergency department: a retrospective cost analysis	Netherlands	Cost analysis (retrospective study)	680	Costs of hospital admission and ED visits were based on Dutch guidelines for medical cost analysis	With different cut- offs for low risk, HEART 0–2 (miss rate 0.7%), would have resulted in a total of €25 365 in savings, compared with €71 905 when an alternative low risk cut-off for TIMI of TIMI≤1 would be used (miss rate 3.0%).
14 Cakir et al. [12]	Acute Nontraumatic Chest Pain in Emergency Department and Cost-Effectiveness Evaluation	Turkey.	Cost analysis (retrospective study)	1028	Literature review	Fast and effective evaluation of ischemic CP in the ED and correct management of patients by correct determination of the risk factors provides a high level of cost-effectiveness

ED: emergency department; ACS: symptoms of possible acute coronary syndrome; cCTA: Coronary computed tomographic angiography; BPCA: blood-pool contrast agent; CIN: contrast-induced nephropathy; CAD: coronary artery disease; SPECT: single-photon emission computed tomography

according to Hulten et al., more accurate than a simple approach based on Medicare reimbursement values. It shows that the CCTA could have reduced total hospital costs by 23%.

CCTA is a less traumatic method than Coronary angiography, the conventional method.

This study is formative in two ways, since it shows that a single parameter can produce radically different results, if you take the time to study it. Indeed, when stenosis increases to more than 50%. As a result, the costs increase so much that the use of CCTA is ultimately more expensive than the traditional method.

CCTA is less traumatic than the reference method of invasive coronary angiography, but is nephrotoxic and has X-ray toxicity.

The more expensive BPCA contrast agents have a higher molecular weight, so they are less nephrotoxic [5]. Espinosa et al. attract our attention because it brings a progress in the medico-economic approach. In addition to the cost studied traditionally, it focuses on cost-effectiveness through an indicator: QALY which is an indicator to estimate the value of life (a healthy year of life corresponds to a QALY score of 1).

Not surprisingly, this method, although more expensive to purchase, is more cost-effective than conventional CCTA because it results in less toxicity.

Another alternative method to CCTA in the diagnosis of chest pain without evidence ischemia on ECG is single-photon emission computed tomography (SPECT) with technetium-99m. This method is considered more discriminatory than CCTA, resulting in lower costs and fewer adverse effects.

To evaluate this method from an economic point of view, Stowers et al. and Wong et al. took an interest in it.

American study shows a lower median cost of \$1843 with SPECT compared to the conventional protocol and a median length of stay of 2 days [6].

Wong et al. show a saving of \$566 (at the current Singapore dollar rate) and a reduced stay of 2.9 days [7].

These two studies, carried out 10 years apart and on two different continents, show similar results but are sufficiently different to question the relevance of cost-effectiveness studies because they depend on many factors: the population studied, the diagnostic protocol, the statistical method, the data processing or the different sources of cost documentation (literature, patient invoice, health insurance data).

Another difficulty for conducting medico-economic studies in emergency departments is the diversity of possible questions, almost as important as the number of existing protocols.

In the management of chest pain, we have seen CCTA, CCTA with BPCA and SPECT. To continue in the

exhaustiveness, Wyrick et al. armed with computer software took an interest in contrast echocardiography (CCE) [8]. This method showed a good negative predictive value compared to the usual method, saving as much as \$900 per patient.

In the same vein and with the same calculator, Priest et al., an American-Australian collective, wanted to compare multiple diagnostic strategies: stress ECG, stress echocardiography with stress or pharmacological, SPECT, CCTA alone and confirmed CCTA with SPECT [9].

CCTA strategies are less expensive than other strategies and the one combining SPECT also increases the patients' QALY indicator. Indeed, with a reduction in re-hospitalization due to false positives, patients have a more pleasant life.

We have previously seen that certain biases, such as the existence of thrombosis or stenosis, could modify the results of studies. In this context, Peitz et al. have shown the significant increase in the costs associated with a high body mass index in the management of chest pain and dyspnea in emergency departments [10].

The questioning of scientific work must therefore remain a rule and as many parameters as possible must be included in future medical and economic considerations in order to discriminate as much as possible against biases.

After constant improvement in the 'ultratechnological' diagnostic methods of patients with chest pain, the latest international recommendations are moving towards the use of simple risk scores. Nieuwets et al. have studied two of them: the predictive score of the degree of thrombosis in myocardial infarction (TIMI) and the HEART score (History, ECG, Age, Risk factors and Troponin) [11].

The use of these simple scores would save almost €80,000 out of 680 patients by discriminating against low-risk patients.

With regard to the international recommendations, Cakir et al. urge us to comply with them. Indeed, in this study, savings seems possible of up to \$10 per patient treated in the emergency room for chest pain, simply by respecting some of the profitability rules dictated in the guidelines [12].

Drug analgesic strategy in emergency medicine

Pain in pre-hospital emergencies is an infrequent topic of study due to a lack of education of health care staff, fear of adverse effects due to opiates and the fact that analgesia is costly in terms of resources. Hubert et al. tried to demonstrate that the work overload related to analgesia could lead SMUR teams to abandon it [13]. Recording two useful scores to measure workload: the CCMS (Classification Clinique des Malades du SMUR) and the

SECSISMUR (Système d'Évaluation de la Charge en Solns du SMUR) they showed that under analgesic, the duration of medical treatment is identical with an increase in workload and its intensity. This is a proposed reason for oligoanalgesia rooted in the mentalities of pre-hospital emergency teams: The time lost for analgesia would represent, at the end of the day, missed interventions.

Casamayor et al., using guidelines from five European countries, estimate the costs associated with the management of IV morphine by an emergency room nurse [14]. These costs include the cost of morphine, labor time, equipment, cost of adverse events, administration complications, including treatment costs, labor time and equipment for them.

This study is indicative of the distribution of costs since it shows that 73% are attributable to adverse events and complications and that the remaining three quarters are due to nurses' working time, while the cost of morphine is very low.

Conducting a medico-economic study solely on the price of a drug therefore does not seem relevant.

A good way to save on labour costs related to the administration of drugs and morphine, in particular, could be the use of Patient Controlled Analgesia (PCA). Its clinical advantages are no longer to be demonstrated in the treatment of post-operative pain, which is why the idea of using PCA in emergency departments appeared, with scores comparable to intermittent IV boluses. Doleman et al. and Pritchard et al. compare PCA to standard treatment by studying not only the pain experienced but also the cost necessary to avoid moderate to severe pain [15,16]. Taking into account the different costs, PCA is about twice as expensive as conventional morphine administration.

Discussion

Studies on medico-economics in an emergency department are very diverse. It is important to be cautious about their results. Indeed, none of the methods used are identical, the nature of the studies differs in their very nature (prospective, retrospective, cost-effectiveness, etc.) and the determination of emergency department costs differs according to the part of the world studied. The publications identified in our study focus on two main areas: the assessment of diagnostic costs in the context of chest pain and the drug analgesic strategy.

For cost-effectiveness or cost-usefulness evaluations as presented above, the bulk of the costs studied are direct costs.

However, for the medico-economic evaluation of a therapeutic innovation in the field of acute pain management, quality indicators should be taken into account,

in addition to direct costs. When measuring quality, the six quality dimensions defined by The Institute of Medicine should be appraised. Haugland et al. [17] argue that this multidimensional approach to quality measurement seems particularly reasonable for services with a highly heterogenic patient population and complex operational contexts, like emergency medical services:

- Patient satisfaction:/patient centeredness
- Safety
- Effectiveness
- Efficiency
- Equity
- Timeliness

In addition, emergency services face, more or less frequently, peaks in activity and experience steady growth in their activity, requiring a highly structured organization likely to adapt to situations of high tension. The organizational variability of emergency departments, the variability in the typology of patients, the disparity in activity according to time of day, day, week or season associated with the complexity of the funding model make any non-systemic medico-economic study extremely delicate.

In view of these ways of operating an emergency service, the organizational impact should also be taken into account. To date, this dimension has not yet been assessed. The possible organizational impact of an innovation could be addressed from the perspective of the internal and external consequences of the organization.

Conclusion

In the field of pain management in an emergency department, the evaluation of diagnostic or therapeutic innovations is currently conducted on the basis of clinical and medico-economic studies. However, the implementation of an analgesic patient management strategy in an emergency department is a complex decision-making process that requires taking into account other dimensions such as organizational impact. New multi-criteria systemic methodologies must be proposed for new assessments.

Disclosure statement

No potential conflict of interest was reported by the authors.

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