

**TITLE: EMERGENCY DEPARTMENTS KEY PERFORMANCE INDICATORS: A UNIFIED FRAMEWORK AND ITS PRACTICE**

**SHORT TITLE: ED´s KPIs: A Unified Framework and its Practice**

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# EMERGENCY DEPARTMENTS KEY PERFORMANCE INDICATORS: A UNIFIED FRAMEWORK AND ITS PRACTICE

## ABSTRACT

**Context:** An Emergency Department (ED) in a hospital provides 24-hour care for the injured/severely ill patients. EDs are essential in any healthcare system. However, they face many challenges to provide timely treatment such as: shortage of specialists, inadequate infrastructure, and unavailability of hospital beds, among others. These challenges are worldwide and undermine the effectiveness of operations and quality of services throughout the hospital.

**Methods:** This study aims to improve the performance of EDs using Key Performance Indicators (KPIs). The KPIs will help decision makers to monitor and manage the performance of EDs systematically. Based on an in-depth field study, expert opinions, and literature review we propose five categories of KPIs regarding: Capacity for, Temporality of, Quality of, Outcomes of, and Economics of emergency-care. The KPIs are applicable to the basic stages of emergency care. The achievement of the KPIs in each stage will be a function of (a) How the KPIs are used, (b) Resources for achieving the KPIs, and (c) Management of the resources. The unified systemic framework to manage EDs is presented as an ontology that articulates the very large number of potential ways of ED performance management.

**Results:** 75 KPIs were defined for monitoring purposes. The KPIs and the proposed framework was validated and applied in two EDs at a public children's hospital and a medium size clinic in Chile.

**Conclusions:** Based on the study, we propose to standardize the essential information necessary to assess the performance of EDs in Chile using KPIs for their continuous improvement.

**Keywords:** Key performance indicators in healthcare; Ontology; Emergency department management; Continuous improvement; Chile

## 1. INTRODUCTION

In the past few years, Chilean authorities have taken several steps to improve the country's healthcare services. These include the self-management of public hospitals, the introduction of accreditation systems, the definition of diagnostic-related groups (DRGs), the design of a 2011-2020 national health strategy, and the implementation of the 'AUGE' program (explicit health guaranties). All these actions became essential elements of the clinical-administrative and financial management system of the Chilean health services. However, factors such as long waiting time for medical care or surgery, high demand and collapse of emergency services, failure in the provision of health benefits, and problems accessing services have caused dissatisfaction in patients. Additionally, given the demographic and geographic characteristics of Chile, its emergency services must also deal with natural disasters that often hit the country.

Problems affecting emergency services such as overcrowding have been well documented worldwide. In countries such as Spain, the causes of emergency department (ED) collapse are diverse both internally and externally. Among the internal causes there are factors associated with the allocation of beds and their actual availability, which impact the quality and satisfaction of the services provided to the patients and also the satisfaction of their relatives and health personnel.<sup>1</sup> Dissatisfaction can finally be expressed through violence against health professionals and also causing what it is known as the burnout syndrome of health workers.<sup>2</sup> Other causes of overcrowding that have been reported in countries as diverse as the United States, England, Australia, Spain, Canada, New Zealand and

Taiwan are grouped into three categories: those related with the demand (non-emergency visits, patients who frequently re-visit the unit, volume increase in certain periods (e.g. winter)), those associated with the efficiency or response capacity of the ED (staff size, resolution capacity, among others) and those related with exit factors such as lack of hospitalization beds.<sup>3</sup>

Numerous problems arise from overcrowding, including extended waiting times, increased suffering for those in pain, unpleasant environments, patient dissatisfaction, decreased physician productivity and frustration among medical staff, and sometimes poor clinical outcomes.<sup>4-5</sup> The same issues are affecting Latin American countries where studies additionally show shortage of physicians to allow a constant flow of patients, a deficient primary care, low goals of competition and improvement, lack of economic resources and infrastructure that, at the end, leads to the same deficiencies in the diagnostic and therapeutic processes.<sup>6</sup>

In Chile, as in other countries, emergency services are key within the health care network and the same issues appear. In fact, during the last years, due to epidemiological changes, changes in the needs and perceptions of the population and deficiencies in primary care, overcrowding has grown adding risk to the population already at risk, causing dissatisfaction with the services and damaging the image and prestige of health care institutions.<sup>7</sup> Additionally, according to the Ministry of Health, one out of five emergency patients waited for more than 12 hours for a hospitalization bed (aprox. 78.9% of patients).<sup>8</sup> Thus, and following the same phenomenon worldwide, overcrowding results in longer waiting times, diversions of ambulance routes, longer stays, greater number of medical errors,

higher patient mortality and a greater loss of resources due to financial losses.<sup>9</sup> Signs and symptoms of work-related stress have also been observed.<sup>10</sup>

EDs in Chile permanently face over demand of low or medium severity patients (some between 80 to 90% of the total consultations), which should be seen at the primary care level.<sup>11-12</sup> Unless the problem is solved in the near future, the general public may no longer be able to rely on EDs for quality and timely urgent care, placing the population at risk. This amplifies the importance that EDs work efficiently so they can treat patients who need immediate medical care.

Despite all efforts made by the injection of resources to the Chilean system. The need to review how EDs are being managed is latent, for which it is necessary to have quality information that helps identify where the problems are, and to provide relevant information that assists managers and organizations on their decision-making process to continuously improve.

Many previous studies have focused on general hospital performance management issues related to organizational strategies, and their correct control and implementation.<sup>13-21</sup> In this study we focus exclusively on the performance of EDs.

Chile has an extensive emergency healthcare network connecting different institutions. The network is distributed in sectors of high demand throughout the national territory, totaling 161 public hospitals and other medical facilities. These establishments are of high complexity, i.e. they must have the necessary equipment and qualified human capital to handle any kind of emergency. However,

nowadays public hospitals in Chile face several problems associated with management, the most important being overcrowding of the EDs. Some causes as mentioned before related to overcrowding are insufficient resources related to infrastructure and supplies, high waiting times for hospitalization appointments, and lack of sufficient health professional staff. However, more work needs to be done given the lack of valid and reliable information in many EDs.<sup>22</sup>

Each country has characteristics that may differ regionally which should be considered when assessing healthcare services. Data provided by performance indicators reflects the quality of health systems and acts as a guide to define future actions and research. Previous studies have reported some valuable experiences. A study by Madsen et al.<sup>23</sup> identifies different types of performance indicators used by Danish EDs through a literature review between 1980 and 2010.

Fieldston et al.<sup>24</sup> use a scorecard in a large urban children's hospital to assess the flow of patients and direct resources to areas of most need. Additionally, Welch et al.<sup>25</sup> provide a set of operational indicators, their metrics, and definitions. Their study responded to the increasing demand placed by insurance companies, hospitals, Medicare, and Medicaid (in the United States) for measuring and improving the performance of EDs.

Dynamic reporting tools such as dashboards can be developed to measure the ED's performance. However, it is a challenge to choose an effective and balanced set of performance indicators. Safdari et al.<sup>26</sup> have developed a set of key performance indicators to use in a Balanced Scorecard (BSC) for EDs. Also, Ismail

et al.<sup>27</sup> present a methodology that integrates BSC and simulation models to improve the performance of EDs of a university hospital in the north of Dublin. A simulation model was integrated with the BSC to support the decision-making process. By analyzing scenarios, three key performance measurements were identified: (1) maximum waiting time in the triage; (2) misuse of resources in some treatment; (3) substantial records of patient neglect (i.e. being left without treatment). Similarly, Abo-Hamad & Arisha<sup>28</sup> simulated two performance indicators for an adult ED of an Irish University Hospital: (1) patient flow analysis (mean waiting time for patients and length of stay), and (2) efficiency (productivity, resource utilization and layout efficiency). The authors also integrated simulation with the BSC to improve the communication of objectives and to take necessary actions to monitor achievements and lead to corrections.

In Chile, one study carried out in 2005 aimed to identify the eventual deficits in infrastructure, technology or key staff in EDs using indicators suggested by the Ministry of Health including number of weekly hours hired from health care professionals and staff, built surface and its distribution, quantity, type and quality of equipment and information systems, stock of critical resources, operational budget, investment and maintenance, statistics of urgent consultations and expenditures by health care facilities. One of the main barriers for this study was the amount of data available and its quality; the EDs that participated in the study were characterized by deficiency and non-standardization of the data.<sup>11</sup>

Nonetheless, few health departments have fully developed robust performance management systems, missing the opportunity to transform the practice and

performance of these units.<sup>29</sup> In this context, KPIs provide valuable information for institutions to identify the most relevant organizational aspects, set goals, support action plans, monitor implementation, and to report results. KPIs allow hospital stakeholders to identify critical points and problems that can be solved with low-cost actions, both in time and resources.<sup>30</sup>

The present study aims to propose a set of KPIs for EDs in Chile that better fit the country and its healthcare system. This study includes performance indicators suggested by previous publications, and others captured by our own research experience. The work focused on KPIs related to processes carried out by EDs, as these processes strongly reflect the value proposition being provided to the public and try to handle the different problems that have been identified previously in the literature.

## **2. METHODS**

We present our method for developing EDs' KPIs schematically in Figure 1. It is divided into four stages: (1) gathering information, (2) identifying process flows, (3) proposing performance indicators, and (4) validating indicators.

< Insert Figure 1 >

**Stage 1:** The steps of gathering information include an evaluation of the EDs management through identifying their measurement systems in place. This stage draws on three main sources: field visits to observe operation of EDs in hospitals and clinics, expert opinion from professional staff and technicians of EDs, and

literature review of national and international publications regarding of performance measurements in hospitals.

Field visits were carried out in 5 ED's in Chile and 1 ED in Spain. Expert opinion was given by physicians, nurses, technicians, and administrative staff who belonged to 4 hospitals located in Santiago - Chile (see Table 1). The study also included a search of publications with the following keywords in English and Spanish: performance indicators, emergency departments, key performance indicators, EDs, strategic performance measurement.

< Insert Table 1 >

**Stage 2:** Based on the information gathered, the second stage consisted of plotting the process flows of a standard ED by each triage category (C1, C2, C3, C4 and C5). The flows were subsequently categorized and differentiated per the nature of their work, goals, and processes.

**Stage 3:** In the third stage, based on Stage 2's analysis of process flows, we propose a unified framework for ED performance indicators using an ontology. The framework is shown in Figure 2 and described below. It is presented as a high level ontology as described by Ramaprasad & Syn<sup>31</sup> and Cameron et al.<sup>32</sup>, in the context of public health informatics and mHealth respectively.

< Insert Figure 2 >

Performance management in emergency-care can be deconstructed into four constituent constructs. They are: (a) the object of performance management, (b) the resources managed to obtain the performance, (c) the processes of management, and (d) the criteria of performance. The criteria of performance, in turn, can be deconstructed into two constructs, namely: (a) stage of emergency-care at which performance is measured, and (b) key performance indicators (KPIs). These five constructs define the dimensions of the framework. Each column in Figure 2 represents a dimension. Thus:

Performance Management of ED = f (Object, Resources, Management, Stage, KPI)

The coordinates on each dimension are labeled using a taxonomy of elements derived from Stages 1 and 2. We will describe the construction of each taxonomy right to left in Figure 2.

The KPI taxonomy is a synthesis of 511 indicators derived from the analysis of the flows in Stage 2, and the review in Stage 1. To define the key indicators of the ED, the set of indicators were rigorously analyzed following a series of inclusion criteria. The first inclusion criterion is to avoid duplication of performance indicators. Next, indicators were selected based on measurability in the ED and ease of implementation (non-complex nature). Finally, the contribution of the indicators in the normal operation of the ED was discussed, leaving only those that make a substantial contribution to process improvement. Following these criteria, the original list was reduced to 79 indicators, which constitute our first proposal of

performance indicators for an ED. The proposed set also includes a categorization of the indicator's importance based on two levels, where level 1 represents a very important indicator, and level 2, an important indicator.

The list of indicators was validated in four hospitals with operative EDs. Managers of these EDs (physicians and nurses) analyzed the set of indicators and suggested modifications and new indicators. Based on this feedback, 75 KPIs were defined see Table 2.

< Insert Table 2 >

The 75 indicators were grouped by the authors into ten types: errors, capacity, clinical, waiting time, satisfaction, costs, internal processes, finance, and process time indicators. The ten types were further reorganized into a two-level taxonomy as shown in Figure 2. The first level of the KPI taxonomy has 5 elements: Capacity, Temporality, Quality, Outcome, and Economy. Each of the five were subcategorized as two or three sub-elements. Thus, Capacity may be for Demand or Supply (of care); Temporality may be for Waiting time for or Processing time; Quality may be regarding Compliance, Errors, and Staff Satisfaction; Outcome may be regarding the Effectiveness of care or Patients' Satisfaction with it; and Economy may be about Cost or Financial Indicators. (Note: Words referring to elements of the ontology are capitalized.) Thus:

KPI  $\subset$  [Capacity (Demand, Supply), Temporal (Waiting, Processing), Quality (Compliance, Errors, Staff Administration), Outcome (Effectiveness, Patient Satisfaction), Economic (Cost, Financial)]

The ontology describes performance management in a simple way to understand. In the following, we discuss the validity of the ontology and its application to performance management in two EDs.

**Stage 4:** The last step was to validate the framework for performance management of EDs through application to practice and its feasibility of measurement of the set of performance indicators. Due to the available funds and the willingness of hospitals to reveal information, the set of indicators was implemented and validated in two out of the five Chilean participating EDs: (1) the medium size children hospital and (2) one medium-size clinic that belongs to a state company. The set of KPIs was implemented during the month of April 2016 in the medium size children hospital, which corresponds to the agreed time of work with this hospital for this research project. The implementation in the medium size clinic took place during the whole year 2016, which corresponds to the agreed time of work with this hospital for this research project. The clinic has better information systems that allowed us to work with it for more time, without invading the work of the staff.

### **3. RESULTS**

The full set of indicators was tested during April of 2016 in a medium size children hospital, located in the city of Santiago, Chile, and during the whole year 2016 in a medium size clinic, located in the city of Rancagua, Chile. The hospital and the clinic provide medical consultation, emergency and hospitalization services among others for highly complex pathologies. The ED of the children hospital admits 150

patients on average per day and the ED for the medium size clinic admits 184 patients. The results of the KPIs application for the month of April for the hospital and the clinic are shown in Table 3 (see also supplementary material). An objective was established for each indicator, along with a metric and a frequency, e.g. one waiting time indicator is the average waiting time for admission, the objective associated with it, it is to minimize the waiting time for admission, the metric is the difference between admission time and patient arrival time divided by the number of patients, and the data for this indicator is collected monthly.

< Insert Table 3 >

All time indicators in the hospital and the clinic were measured. However, the hospital does not measure all the parameters required and some of them were tracked independently on patient-by-patient using a card.

Currently the hospital and the clinic does not track short-term mortality after the patient visit the ED and does not have a survey to assess patient satisfaction. All other indicators were measured.

In general, there is practical application of this set of indicators in an ED for monitoring purposes. However, their implementation will be affected by the information available in each hospital. KPIs can potentially provide valuable information for the decision-making process and highlight opportunities for improvement strategies.

#### **4. DISCUSSION**

Why does an ED need to measure such a large number of KPIs? We propose a total of 75 KPIs divided into five categories that are relevant for monitoring purposes. Hospitals should avoid adding burden to their staff to measure these indicators. Hence, the monitoring system can be supported by information systems. In addition, we need to distinguish the difference between monitoring and improvement. The ED should monitor all the set of 75 KPIs but select only some of them in order to design improvement strategies. Some of the KPIs can be adapted or disaggregated to fit the hospital reality.

For instance, in the ED of this children's hospital and medium size clinic most of the indicators 23 (31%) of them are quality indicators. Some interesting results among the quality indicators were found when analyzing the compliance rate of treatment with the triage standards. We found that for the children's hospital there were none C1 patients during the month of analysis, 100% of C2 patients met the standards, 92% of C3 patients were treated according to the triage standards, and 99% of C4 patients met the triage criteria. While in the medium size clinic 100% of the C1 patients met the standards, and just 63% of C2 patients were treated according to the standards, which is a very low percentage given the severity of the patients, the standard compliance rate increases for C3, C4 and C5 patients with 96%, 100% and 100% of compliance, respectively. In addition, patients should be classified by the triage in the first 10 minutes from their admission time; according to the results the children's hospital ED achieved this goal just 81% of the time, while the medium size clinic always met the goal. Also the readmission rate for

patients that were readmitted with a similar or equal medical condition was of 7% in the children's hospital and 1.1% in the medium size clinic. In relation to satisfaction indicators, there was not monthly information available about patient satisfaction or personnel satisfaction for both the hospital and the clinic, and the staff-training rate was lower than 50% during the year. The monitoring system provides information that helps managers to shed lights on opportunities for improvement; for example, improve the compliance rate for C3 patients in the children's hospital and for C2 patients in the clinic and reduce the readmission rate of 7% of patients for the children's hospital. This is a starting point for managers to prioritize the indicators and find improvement opportunities for the unit.

Quality indicators become more critical after understanding the complexity behind EDs. The problem of overcrowding in Chile is a reality, during the year 2017, 17,418,175 patients were treated in an emergency unit, which represents a 16% increase from 2010.<sup>33</sup> An excess in demand leaves little room for others with less urgent conditions. Therefore, indicators looking to minimize errors are relevant to increase the efficiency of the unit, thus keeping low indicators such as error rate in activities supporting diagnosis or in medical or nursing procedures can accelerate the medical attention of the patients. Another key indicator for Chile is patient readmission rates; one way to reduce overcrowding is keeping patient re-visits to EDs to a minimum. It is also important to highlight that Chile will benefit from controlling the mortality rate of patients waiting to be hospitalized. According to a report from the Ministry of Health, during 2010 more than 2,050 patients died in

emergency services waiting for a bed to be hospitalized, and in 2013 that number reached 2,913 people.<sup>34</sup>

The standard compliance indicators are a minimum requirement for any emergency unit to provide quality care, especially when there is an increase in the number of critically ill patients that need immediate care. Especially, when an increase in severity of patient illness means a decrease in turnaround times for beds. Additionally, as ED staff become overwhelmed with caring for this type of patients, they may suffer from stress and burnout, a topic that has acquired enormous importance in recent years. Therefore, indicators that address staff satisfaction must be considered by emergency units. However, and as can be seen in the data collected from the hospitals, none of them have a staff satisfaction survey in place.

There are 20 KPIs in the time category (27%); experts classified 18 of them as very important indicators. Some of the results for the EDs under analysis included that the average cycle time of a patient, i.e. the average time that the patient stayed in the ED of the children's hospital was 1 hour 39 minutes approximately while the average cycle time for the medium size clinic almost duplicated patient stayed with 2 hours 30 minutes. Now, the average treatment time was close to 50 minutes in the children's hospital, having an average waiting time of 49 minutes in total. In the medium size clinic the average treatment time was 1 hour and 36 minutes with a waiting time close to 20 minutes. These are not bad results considering that the wait times in EDs are between 2 and 5 hours, however, there is still room for improvement in both hospitals regarding their average cycle time.

One of the most serious and significant issues is having long waiting times stressing health professionals adding risks, which could cause poor diagnosis and treatment. Sometimes patients in Chile are forced to wait on gurneys in hallways waiting for medical attention, especially during winter periods. Avoiding excessive waiting time in the ED can contribute in reducing overcrowding and the time patients occupy an ED bed. This can be achieved by minimizing time and improving resource allocation.

In the next category, we have the economic indicators with 15 KPIs defined and 2 very important indicators. This is questionable when many organizations are under pressure to deliver effective and compassionate care at lower cost and in an integrated manner. Moreover, one striking result was found among the economic indicators for the children's hospital where the outstanding patient accounts were separated among those patients who belong to the public system (FONASA), and those patients who belong to the private insurance system (ISAPREs) or paid out-of-pocket. The children's hospital ED had 40% of outstanding patient accounts from the FONASA beneficiaries and over 80% of outstanding patient accounts from the ISAPREs beneficiaries or private patients. These results are indicating the cash flow problems that the children's hospital ED is facing, and represent crucial indicators that any hospital or clinic should prioritize and improve.

The number of economic indicators will depend on the costing system and the data available. When an activity based costing system is implemented in the ED most of the cost indicators can be measured, otherwise the level of information to manage the unit will decrease significantly. However, in Chile, few public hospitals have an

information system as the one described. Therefore, in those cases it is recommended that at least the unit is aware of the average costs per patient by triage category. From a financial point of view, a couple of the most important indicators is the payment of accounts and staying within the budget. All of this is necessary to ensure economic sustainability in the department.

The following category includes capacity indicators, totalizing 11 KPIs and all of them classified as very important. The average daily census of the ED from the children's hospital was 158 patients, with a rate of patients by morning, evening and night of 36%, 41% and 23% respectively. The numbers are similar for the medium size clinic with an average daily census of 184 patients and a rate of patients admitted in the morning of 31%, in the evening of 40% and in the night of 29%.

The census of patients has increased and there is an overflow of patients. These indicators help track the insufficiency of infrastructure, equipment and the shortage of healthcare staff in EDs.

Finally, there are 6 main outcome indicators and all very important KPIs. The rate of patient discharges was 91% in the children's hospitals, compared to the 63% observed in the medium size clinic, the other patients, 9% were hospitalized in the hospital, while in the clinic 23% were hospitalized and 14% of them were referred. In addition, 22% of patients left the children's hospital ED without medical attention and 21% left the ED after triage. In the medium size clinic a similar rate, 23%, of

the patients left the ED without medical treatment. This is another example of an indicator that emphasizes the need for improvement strategies.

During 2017, 25.71% of emergency patients waited more than twelve hours to find a hospitalization bed, this percentage increased in relation to 2016 where 24.9% of patients waited more than twelve hours.<sup>35</sup> During this time, these patients occupy physical bed space and require constant monitoring by health care staff. Until the problem of insufficient inpatient beds is addressed, the ED overcrowding problem in Chile will remain. Another overcrowding-induced problem relates to the number of patients who visit EDs, register, and then leave without being seen after waiting several hours either after being admitted or after the triage. All of this data will be collected with the proposed set of KPIs, however it is currently not reported anywhere in the country. Patient satisfaction is also an indicator under this category but EDs generally do not register this information even though violence from patients against emergency staff for dissatisfaction has been documented elsewhere.

In summary, the ultimate goal of this set of KPIs is to provide EDs with a way to assess the effectiveness of their system. We propose that the set of 75 key performance indicators should be set in an ED for monitoring purposes. Targets need to be established and agreed against these baseline indicators. This information will help managers to identify opportunities for organizational improvement and improvement strategies.

Hospitals can select relevant KPIs to propose improvement strategies. For example, one strategy can be to hire additional staff during peak hours to reduce the standard compliance rate with waiting time for triage, another strategy that can emerge is to implement a better control of the exit of patients to reduce the number of patients who left the facility without paying, or to study the flows of patients using value stream map to analyze the average cycle time of patients by triage category. However, the proposal of strategies and tracking its impact is matter of a future research project.

Therefore, feasible metrics to assess the performance of an ED were identified. The set of indicators is valid and have practical application in any ED. However, there are some limitations that should be taken into consideration such as the importance of support of first line directors and leaders to collect and use the information in the decision making process. It is also relevant the use of information systems to avoid adding extra burden to the ED staff. In addition, even though these KPIs were applied during one month in a children's hospital and a whole year in a medium size clinic, the results were of relevance for the administration to assess the actual performance of the ED.

The set of indicators put emphasis in the internal processes carried out in an ED and are a monitoring framework for control purposes. Patient satisfaction with care, rate of adverse events, incidence of occupational accidents, and healthcare cost per capita are some examples of KPIs that help in the identification of improvement strategies of healthcare services. In the future, we expect to apply the indicators to

other EDs to probe the capability of this monitoring system to support the selection of improvement strategies.

#### **IMPLICATIONS FOR POLICY AND PRACTICE:**

- Using a proper performance measurement system is critical to monitor and improve the decision-making process in emergency departments.
- The set of KPIs presented in this research provide a comprehensive view of the services provided without placing an excessive burden on emergency departments to collect data.
- Based on our results, increasing awareness about KPIs would enhanced the performance of EDs because they have a positive impact determining if improvements have being made.
- This set of KPIs allow comparison about essential performance measures of an ED or between EDs promoting learning and supporting continuous improvement, thus achieving a better understanding of ED performance.

## 5. REFERENCES

1. Tudela P, Mòdol J. La saturación en los servicios de urgencias hospitalarios. *Emergencias*. 2015;27:113-20.
2. Miret C, Martínez A. El profesional en urgencias y emergencias: agresividad y burnout. *Anales del Sistema Sanitario de Navarra*. 2010;33(1):193-201.
3. Juan A, Enjamio E, Moya C, García C, Castellanos J, Pérez J, Martínez J, Lores L, Urgellés J, Robles B, Bou E, Romero C, Méndez J, Saavedra J, Céspedes M, Morera M, Vera R, Ferriz C, Tor S, Ramón R. Impacto de la implementación de medidas de gestión hospitalaria para aumentar la eficiencia en la gestión de camas y disminuir la saturación del servicio de urgencias. 2010;22:249-53.
4. Derlet R. Overcrowding in emergency departments: Increased demand and decreased capacity. *Annals of Emergency Medicine*. 2002;39:430-32. DOI: <https://doi.org/10.1067/mem.2002.122707>.
5. Derlet R, Richards J. Overcrowding in the nation's emergency departments: complex causes and disturbing effects. *Annals of Emergency Medicine*. 2000;35(1):63-8.
6. Rodríguez G, González A, Hernández S, Hernández D. Análisis del servicio de Urgencias aplicando teoría de líneas de espera. *Contaduría y Administración*. 2017;63(3):719-32. DOI: <https://doi.org/10.1016/j.cya.2017.04.001>.

7. Tobar E, Retamal A, Garrido N. Elementos de gestión para un Servicio de Urgencia de un hospital universitario. *Revista Hospital Clínico Universidad de Chile*. 2014;25:189-200.
8. El Mercurio. Uno de cada cinco pacientes hospitalizados desde urgencias esperó más de 12 horas por una cama. 2006. <http://www.emol.com/noticias/Nacional/2016/03/10/792229/Uno-de-cada-5-pacientes-hospitalizados-desde-urgencia-espero-mas-de-12-horas-por-una-cama.html>. Accessed 13 Apr 2018.
9. Salway R, Valenzuela R, Shoenberger J, Mallon W, Viccellio A. Congestión en el servicio de urgencia: respuestas basadas en evidencias a preguntas frecuentes. *Revista Médica Clínica Las Condes*. 2017;28(2):220-7. DOI: <https://doi.org/10.1016/j.rmclc.2017.04.009>.
10. Garcia C. Estrés laboral en personal de la unidad de emergencia gineco-obstétrica. Hospital Clínico Regional de Valdivia. 2006. <http://cybertesis.uach.cl/tesis/uach/2006/fmg216e/doc/fmg216e.pdf>. Accessed 13 Apr 2018.
11. Ipinza M. Estudio de la red pública de atención de urgencia de la región metropolitana. *Cuadernos Médicos Sociales (Chile)*. 2005;45:199-216.
12. Burgos E, García C, Mayorga D. Demanda inapropiada a los servicios de urgencia y factores asociados. <http://cybertesis.uach.cl/tesis/uach/2014/fmb957d/doc/fmb957d.pdf>. Accessed 13 Apr 2018.

13. Bisbe J, Barrubés J. El Cuadro de Mando Integral como instrumento para la evaluación y el seguimiento de la estrategia en las organizaciones sanitarias. *Revista Española de Cardiología*. 2012;65(10):919-27. DOI: 10.1016/j.recesp.2012.05.014.
14. Brailsford S, Vissers J. OR in healthcare: A European perspective. *European Journal of Operational Research*. 2011;212(2):223-34. DOI: 10.1016/j.ejor.2010.10.026.
15. Gauld R, Al-wahaibi S, Chisholm J, Crabbe R, Boomi K, Oh T, Palepu R, Rawcliffe N, Sohn S. Scorecards for health system performance assessment: The New Zealand example. *Health Policy*. 2011;103:200-8. DOI: 10.1016/j.healthpol.2011.05.016.
16. Grigoroudis E, Orfanoudaki E, Zopounidis C. Strategic performance measurement in a healthcare organisation: A multiple criteria approach based on balanced scorecard. *Omega*. 2012;40:104-19. DOI: 10.1016/j.omega.2011.04.001.
17. Ioan B, Nestian AS, Tita SM. Relevance of Key Performance Indicators (KPIs) in a Hospital Performance Management Model. *Journal of Eastern Europe Research in Business & Economics*. 2011. <http://www.ibimapublishing.com/journals/JEERBE/jeerbe.html>. Accessed 15 Mar 2016.

18. Khalifa M, Khalid, P. Developing Strategic Health Care Key Performance Indicators: A Case Study on a Tertiary Care Hospital The 5th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare. *Procedia Computer Science*. 2015;63:459-66. DOI: 10.1016/j.procs.2015.08.368.
19. Mutale W, Godfrey-Fausset P, Tembo M, Kaesese N, Chintu N, Balabanova D, Spicer N, Ayles H. Measuring Health System Strengthening: Application of the Balanced Scorecard Approach to Rank the Baseline Performance of Three Rural Districts in Zambia. *Plos One*. 2013;8(3):1-11. DOI: 10.1371/journal.pone.0058650.
20. Shohet, IM. Key Performance Indicators for Strategic Healthcare Facilities Maintenance. *Journal of Construction Engineering and Management*. 2006;132(4):345-52. DOI: 10.1061/(ASCE)0733-9364(2006)132:4(345).
21. Trotta A, Cardamone E, Cavallaro G, Mauro M. Applying the Balanced Scorecard approach in teaching hospitals: a literature review and conceptual framework. *International Journal of Health Planning and Management*. 2012;28:181-201. DOI: 10.1002/hpm.2132.
22. Madsen MM, Kiuru S, Castrèn M, Kurland L. Research into the evidence basis for widely used emergency department performance indicators should be prioritized. *European Journal of Emergency Medicine*. 2016;23(5):396-7. DOI: 10.1097/MEJ.0000000000000357.

23. Madsen MM, Eiset AH, Mackenhauer J, Odby A, Christiansen CF, Kurlan L, Kirkegaard H. Selection of quality indicators for hospital based emergency care in Denmark, informed by a modified-Delphi process. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*. 2016;24(11):1-8. DOI: 10.1186/s13049-016-0203-x.
24. Fieldston E, Zaousti LB, Agosto PM, Guo A, Jones JA, Tsarouhas N. Measuring Patient Flow in a Children's Hospital Using a Scorecard with Composite Measurement. *Journal of Hospital Medicine*. 2014;9(7):463-86. DOI: 10.1002/jhm.2202.
25. Welch SJ, Brent RA, Stone-Griffith S, Davidson SJ, Augustine J, Schuur J. Emergency Department Operational Metrics, Measures and Definitions: Results of the Second Performance Measures and Benchmarking Summit. *Annals of Emergency Medicine*. 2011;58(1):33-40. DOI: 10.1016/j.annemergmed.2010.08.040.
26. Safdari R, Ghazisaeedi M, Mirzaee M, Frazi J, Goodini A. Development of Balanced Key Performance Indicators for Emergency Departments Strategic Dashboard Following Analytic Hierarchical Process. *The Health Care Manager*. 2014;33(4):328-34. DOI: 10.1097/HCM.0000000000000033.
27. Ismail K, Abo-Hamd W, Arisha A. Integrating Balanced Scorecard and Simulation Modeling to Improve Emergency Department Performance in Irish Hospitals. *Proceedings of the 2010 Winter Simulation Conference*. 2010;2340-51.

28. Abo-Hamad W, Arisha A. Simulation-based framework to improve patient experience in an emergency department. *European Journal of Operational Research*. 2013;224:154-66. DOI: 10.1016/j.ejor.2012.07.028.
29. Chapman RW, Beitsch LM. Performance Management Systems: A public Health Model Practice. *Journal of Public Health Management & Practice*. 2017;23(3):311-314. DOI: 10.1097/PHH.0000000000000502.
30. Nikjoo RG, Beyrami HJ, Jannati A, Jaafarabadi MA. Selecting Hospital's Key Performance Indicators, using Analytic Hierarchy Process Technique. *Journal of Community Health Research*. 2013;2(1):30-8.
21. Ramaprasad A, Syn T. Ontological Meta-Analysis and Synthesis. *Communications of the Association for Information Systems*. 2015;37:138-53.
32. Cameron JD, Ramaprasad A, Syn T. An Ontology of mHealth. *International Journal of Medical Informatics*. 2017;16-25.
33. Departamento de Estadísticas e Información en Salud. Estadísticas de Atención de Urgencias. <http://www.deis.cl/estadisticas-atencionesurgencia/> Accessed 16 Apr 2018.
34. La Segunda. Tasa de pacientes fallecidos en espera por hospitalización. <http://impresa.lasegunda.com/2016/10/03/A/0C310V76/QQ3124CI>. Accessed 16 Apr 2018.

35. Ministerio de Salud.

[http://intradeis.minsal.cl/intradeis/atenciones\\_urgencia/reportes\\_publica/Menu.a](http://intradeis.minsal.cl/intradeis/atenciones_urgencia/reportes_publica/Menu.a)

spx. Accessed 16 Apr 2018.

## **6. Figures:**

Figure 1 - Method

Figure 2. Unified Framework of Performance Management of Emergency Departments (EDs)

## **7. Tables**

Table 1. Description of participating hospitals

Table 2. Set of KPIs by category and importance

Table 3. Key Performance Indicators for April 2016 from a medium size children hospital and a medium size clinic

Figure 1 - Method

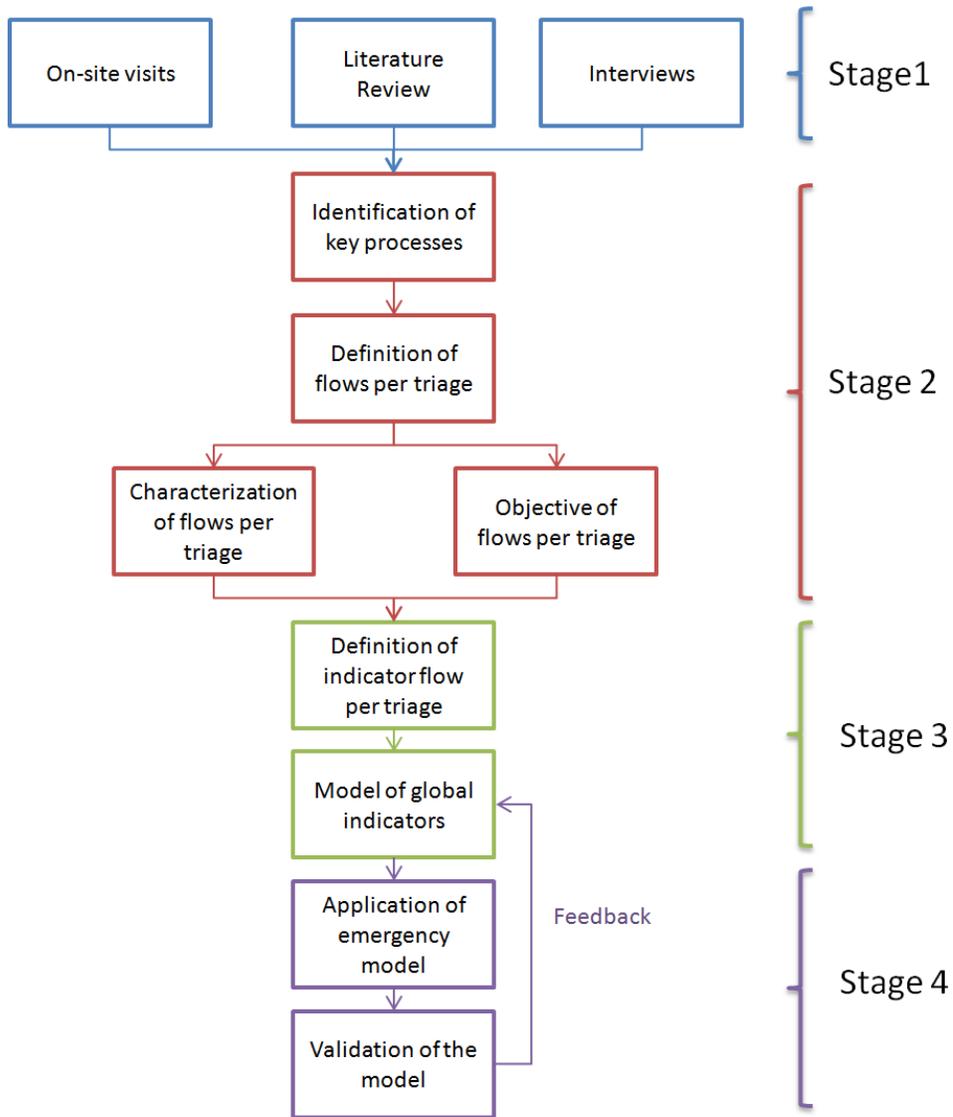


Figure 2. Unified Framework of Performance Management of Emergency Departments (EDs)

Object	Resources	Management	Performance	
			Stage	KPI
Describe	Human	Alignment	Admission	Capacity
Explain	Financial	Allocation	Triage	Demand
Predict	Material	Capacity	Care	Supply
Control	Informational	Utilization	Medical	Temporal
	Spatial	Integration	Nursing	Waiting
	Temporal	Accountability	Testing	Processing
			Support	Quality
			Diagnostic	Compliance
			Discharge	Errors
				Staff satisfaction
				Outcome
				Effectiveness
				Patient satisfaction
				Economic
				Financial
				Revenue

**Illustrative Components:**

Describe human resources alignment for admission capacity-demand for emergency-care.

*Example: Describe how human resources are aligned to meet the capacity demand for admission to emergency care.*

Explain financial resources utilization for care-medical temporal-waiting for emergency-care.

*Example: Explain the use of financial resources to reduce waiting time for emergency medical care.*

Predict spatial resources integration for testing-diagnostic outcome-patient satisfaction of emergency-care.

*Example: Plan physical location of diagnostic testing labs to improve patient satisfaction.*

Control material utilization for care-nursing quality-staff satisfaction for emergency-care.

*Example: Control of material used by the nursing staff to their satisfaction.*

Table 1. Description of participating hospitals

Hospital	Characteristics	Number of beds	Field visit	Expert Opinion
CH1	Medium-size children hospital	200 aprox.	X	X
CH2	Medium-size clinic that belongs to a state company	130 aprox.	X	X
CH3	Large university medical center	600 aprox.	X	
CH4	Large complexity hospital	380 aprox.	X	
CH5	Large complexity hospital	940 aprox.	X	X
SH6	Large university medical center	400 aprox.	X	X

Table 2. Set of KPIs by category and importance

Category	Nº of KPIs	Nº of Very Important KPIs
Quality	23	13
Temporal	20	18
Economic	15	2
Capacity	11	11
Outcome	6	6
<b>Total</b>	<b>75</b>	<b>50</b>