Performance Indicators for Hospital Emergency Departments Management

Abstract

An Emergency Department (ED) is an organization that provides 24-hour emergency care for the injured/severally ill patient. These units are essential in any health care system. EDs face challenges worldwide such as the inability to treat patients in a timely manner, shortage of specialists, among others. EDs in Chile are not an exception; the medical network system does not work properly.

This study aims to create a management tool for EDs based on Key-Performance-Indicators (KPIs). KPIs will help to the decision-making staff to monitor the whole performance of EDs providing timely information for the improvement of their management and operation.

Keywords: KPIs in healthcare, emergency department management, continuous improvement

Introduction

Key performance indicators (KPIs) provide valuable information for institutions to identify the most relevant organizational aspects, set goals, support action plans, monitor implementation results, 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 (Nikjoo et al 2013).

Previous studies have focused on a more general perspective of hospital performance management issues, related to organizational strategies, and their correct control and implementation (Khalifa and Khalid, 2015; Mutale et al 2013; Trotta et al 2012; Bisbe and Barrubés, 2012; Grigoroudis et al 2011 and Gauld et al, 2011; loan et al, 2012; Brailsford and Vissers, 2011 and Shohet 2006, among others).

In the past few years, several actions have been taken by the Chilean authorities to improve the overall 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, there are 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, which have caused dissatisfaction in patients.

Additionally, given the demographic and geographic characteristics of Chile, emergency services have to deal also with natural disasters that often hit the country. This, added to the factors mentioned above, justify the existence of EDs in hospitals and public institutions trained to treat patients who need immediate medical care.

Emergency services can be divided into six stages[1]:

a) Patient Admission: The patient is admitted to the unit and welcomed by the receptionist, who enters the patient's data in the corresponding information system.

b) Triage: The patients are classified according to their status, the severity of their condition, and waiting time.

c) Medical care: The patient is treated by a specialist who makes a preliminary diagnosis.

d) Nursing care: The patient is treated by a nurse and given necessary recommendations, if required.

e) Support and diagnostic tests: This is an optional stage where tests are performed to get more information on the patient's condition.

f) Discharge: The patient is sent home, to another health facility or is given indication to be admitted to the hospital.

Chile has an extensive emergency care network connecting different institutions. The network is distributed in sectors of high demand throughout the national territory, totaling 161 public hospitals. These establishments are of high complexity, i.e. they must have the necessary equipment and qualified human capital to handle any kind of emergency. Nowadays, public hospitals in Chile face a number of problems associated with management, the most important been overcrowding of the EDs. The main causes of overcrowding are insufficient resources related to infrastructure and supplies, high waiting times for hospitalization times and lack of sufficient health professional staff.

---

[1] https://www.redclinica.cl/Portals/0/Users/014/14/14/elementos_gestion_servicio_urgencia.pdf

Each country has different characteristics that may differ regionally, which are relevant to consider when assessing health care. Data provided by performance indicators reflects the quality of health systems and acts as a guide to define future actions and research. Previous studies report some valuable experiences; a study by Madsen et al. (2016) identifies different types of performance indicators used by Danish EDs through a literature review between 1980 and 2010. The study consisted on using the Delphi process to select quality indicators for a new national database of quality indicators for emergency hospitals at Denmark. The first step was to review the scientific literature of quality indicators for emergency hospitals and critical conditions. The list of indicators was analyzed and reduced to 43 potential indicators. Then, 55 experts analyzed the list of 43 indicators and rank them according to their "usefulness as quality of the indicators"; two rounds were conducted to analyze the information. Finally, the set of indicators were selected according to the results obtained by the Delphi surveys.

Fieldston et al. (2014) uses 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. (2011) provides 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 emergency department's performance. However, it is a challenge to choose an effective and balanced set of performance indicators. Safdari et al. (2014) aimed to develop a set of key performance indicators to use in a Balanced Scorecard (BSC) for EDs. The study was developed in two phases: the construction of performance indicators based on BSC perspectives, and their inclusion in the hierarchy process framework to select the final KPIs. Also, Ismail et al. (2010) presents 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). In a similar line, Abo-Hamad & Arisha (2013) 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.

The present study aims to propose a set of performance indicators for EDs in Chile. Indicators that fit the reality of the country and its health care 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.

Method

This study sets a methodology for developing emergency department's performance indicators, which is divided into four stages: (1) gathering information, (2) identifying process flows, (3) proposing performance indicators, and (4) validating indicators.

The steps of gathering information include an evaluation of the ED management through identifying assessment and measurement systems in place. This stage draws on three main sources: field visits to observe operation of EDs in hospital and clinics, expert opinion from professional staff and technicians of EDs, and literature review of national and international performance measurements in hospitals.

Based on the information gathered, the second stage consisted on 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 according to the nature of their work, goals and processes.

In the third stage we proposed emergency indicators. We group the set of indicators on 5 categories: quality, time, economic, capacity and outcomes, and 9 subcategories. The last step was to validate the feasibility of measurement of the set of performance indicators in hospitals with EDs. The list of indicators was validated in four hospitals with operative EDs: Dr. Luis Calvo Mackenna Hospital, the Clinical Hospital of Universidad de Chile, Hospital Clínico FUSAT and La Florida Hospital. Managers of these EDs (physicians and nurses) analyzed the set of indicators and suggested modifications and new indicators.

Finally, the set of indicators was implemented and validated in Dr. Luis Calvo Mackenna Hospital during the month of April 2016. Thus, the key performance indicator model was defined to be applied in any national institution.

Results

Table 1 shows the number of validated performance indicators by category and their level of importance. KPIs were divided in five categories according to the type of indicators: quality, time, economic, capacity and outcome indicators. Quality indicators were further divided into three subcategories: error, standard compliance and satisfaction indicators. Time indicators included waiting time and process time indicators. Economic indicators included cost and financial indicators. Capacity indicators were divided in supply and demand indicators. Outcome indicators were classified in one category including indicators of hospitalization, discharge, withdrawal, referrals and mortality.

Table 1. Set of KPIs by category and importance

Category	Nº of KPIs	Nº of Very Important
Quality	23	13
Time	20	18
Economic	15	2
Capacity	11	11
Outcome	6	6
Total	**75**	**50**

A detailed list of time indicators by category is shown in table 2.

This set of mixed indicators covers different aspects of an ED. An objective was established for each indicator, along with a metric, a frequency and the process associated with it, e.g. one waiting time indicator is the average waiting time for admission, the objective associated with 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, the indicator therefore can be measured monthly and belongs to the admission process. Additionally, a goal for every indicator should be set by each ED to compare with the information collected to measure them.

This is a generalized set of indicators and each institution should use them for monitoring purposes. In addition, a selection of those KPIs that best fit the ED problems in any moment should be used for improving the unit. All of them can potentially be implemented and measured in any ED. The validity and practical application of these indicators is tested in the following section.

Table 2. KPIs for EDs

Category 1: Indicators of quality Subcategory: errors	Category 2: Time indicators Subcategory: waiting time
Calling rate to internal consulting physicians with no response	Average admission waiting time.
Reported error rate in medical and nursing procedures	Average triage waiting time.
Error rate in activities supporting diagnosis (tests requests, results, handling of samples, others)	Average examination room waiting time.
Patient readmission rate	Average waiting time to arrive to the internal consulting physician
Intrahospital infection rate	Average waiting time for medical and nursing procedure
Rate of deceased patients waiting to be hospitalized	Average waiting time for activities that support the diagnosis
Rate of sentinel events	Average waiting time for results of supporting activities
Rate of medical complications*	Average waiting time for medical discharge
Patient accident rate (falls or others)	Average waiting time for internal and external transportation
Personal accident rate (medical sharps , splatters)	Average waiting time for bed hospitalization
Medication error rate	Average waiting time
Non-applicable hospitalization rate	
Applicable referral rate due to school accidents	
Subcategory: standard compliance	**Subcategory: process time**
Standard compliance rate of treatment times according to triage classification	Average resuscitation time
Standard compliance time of triage classification times	Average admission time (collection)
Existence of unit protocols	Average triage time
Getting quality certificates or renewing quality certificates	Average examination room time
Subcategory: satisfaction	Average treatment time by internal consulting physician
Average patient satisfaction rate	Average waiting time medical and nursing procedure
Litigations	Average time of activities supporting diagnosis
Complaint rate	Average cycle time of patient per category
Average rate of staff satisfaction	Average medical treatment time by category
Average quit or transfer rates by request	
Training rate (RSP and infectious IAAS)	

Table 2. KPIs for EDs (continue)

Category 3: Economic indicators	Category 4: Capacity indicators
Subcategory: cost	**Subcategory: supply**
Cost for resuscitation activities	Quantity of assets
Cost for admission activities	Use of diagnosis support
Cost for triage activities	Use (cots, wheelchairs, beds)
Cost for primary medical treatments	Non-available equipment
Cost for calling activity and visit of internal consulting physician	Staff endowment per shift (physicians, nurses, paramedic and others)
Cost for medical and nursing procedure activities	Absenteeism rate (physicians, nurses, paramedic and others)
Cost of activities that support diagnosis	Weekly overtime work rate (physicians, nurses, paramedic and others)
Cost of diagnosis review activities	**Subcategory: demand**
Cost for patient discharge activities	Average daily census
Cost for logistic support activities	Patient rate morning
Cost for maintenance and cleaning activities	Patient rate evening
Average patient cost per category	Patient rate night
	Category 5: Outcome indicators
	Rate of hospitalized patients
	Discharged patients
Subcategory: financial	Total abandonment rate
Outstanding patient accounts	Total abandonment rate after triage
Budget implementation	Rate of referred patients
Rate of patients that regularize their financial situation	Short-term mortality, after visit to the ER

Application in Dr. Luis Calvo Mackenna Hospital

The full set of indicators was tested during one month in Dr. Luis Calvo Mackenna Hospital (HLCM), located in the city of Santiago, Chile. HLCM is a pediatric teaching hospital founded in 1942 that provides medical consultation, emergency and hospitalization services among others for highly complex pathologies. The ED of the hospital admits 150 patients on average per day. The results of the KPIs application are shown in Table 3 to Table 7.

Table 3. Performance Indicators for HLCM´s Emergency Department (Quality indicators)

Category 1: Indicators of quality		
Subcategory: errors		
Indicator	**Frequency**	**Value**
Reported error rate in medical and nursing procedures	Annual 2015	7
Patient readmission rate	Monthly	7%
Rate of deceased patients waiting to be hospitalized	Monthly	0
Rate of sentinel events	Monthly	0
Rate of medical complications*	Monthly	2%
Patient accident rate (falls or others)	Annual 2015	0
Personal accident rate (medical sharps , splatters)	Monthly	0
Medication error	Annual 2015	2
Non-applicable hospitalization rate	Monthly	2%
Applicable referral rate due to school accidents	Monthly	NI
Subcategory: standard compliance		
Standard compliance rate of treatment times according to triage classification C1	Monthly	NI
Standard compliance rate of treatment times according to triage classification C2	Monthly	100%
Standard compliance rate of treatment times according to triage classification C3	Monthly	92%
Standard compliance rate of treatment times according to triage classification C4	Monthly	99%
Standard compliance rate of treatment times according to triage classification C5	Monthly	100%
Standard compliance rate of treatment times according to triage classification	Monthly	81%
Existence of unit protocols	Annual	1
Getting quality certificates or renewing quality certificates	Annual	1
Subcategory: satisfaction		
Average patient satisfaction rate	Monthly	NI
Litigations	Annual	0
Complaint rate	Monthly	NI
Average quit or transfer rates by request	Annual 2015	2%
Training rate (RSP)	Annual	43%
Training rate (IAAS infeccioso)	Annual	33%

Table 3 shows the results of quality indicators, some of them were computed using the information from the year 2015 because the information from this year was not available.

Table 4. Performance Indicators for HLCM´s Emergency Department (Time indicators)

Category 2: Time indicators Subcategory: waiting time		
Indicator	**Frequency**	**Value**
Average admission waiting time.	Monthly	0:01:08
Average triage waiting time.	Monthly	0:08:19
Average examination room waiting time.	Monthly	0:32:31
Average examination room waiting time for C1 patients	Monthly	
Average examination room waiting time for C2 patients	Monthly	0:12:00
Average examination room waiting time for C3 patients	Monthly	0:24:03
Average examination room waiting time for C4 patients	Monthly	0:39:38
Average examination room waiting time for C5 patients	Monthly	0:41:00
Average waiting time for medical procedure	Monthly	0:14:45
Average waiting time for nursing procedure	Monthly	0:16:18
Average waiting time for activities that support the diagnosis	Monthly	0:15:15
Average waiting time for results of supporting activities	Monthly	0:09:12
Average waiting time for medical discharge	Monthly	0:06:51
Average waiting time for internal and external transportation	Monthly	
Average waiting time for bed hospitalization	Monthly	0:03:00
Average waiting time	Monthly	0:48:17
Subcategory: process time		
Average resuscitation time	Monthly	NI
Average admission time (collection)	Monthly	0:02:22
Average triage time	Monthly	0:04:43
Average examination room time	Monthly	0:17:40
Average waiting time medical procedure	Monthly	0:13:05
Average waiting time nursing procedure	Monthly	0:21:43
Average time of activities supporting diagnosis	Monthly	0:06:39
Average cycle time of patient per category	Monthly	1:38:42
Average medical treatment time by category	Monthly	0:50:27

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

Table 5. Performance Indicators for HLCM´s Emergency Department (Economic indicators)

Category 3: Economic indicators Subcategory: cost		
Indicator	**Frequency**	**Value**
Average patient cost per category	Monthly	NI
Subcategory: Finance		
Outstanding patient accounts (FONASA patients)	Quarterly	40%
Outstanding patient accounts (Isapre and private patients)	Quarterly	81%
Budget implementation	Annual 2015	101%
Rate of patients that regularize their financial situation	Quarterly	NI

Some of the cost indicators included in the set of KPIs are based on activity based costing. Hospitals with a different costing methodology will not be able to monitor those KPIs.

Table 6. Performance Indicators for HLCM´s Emergency Department (Capacity indicators)

Category 4: Capacity indicators		
Subcategory: supply		
Indicator	**Frequency**	**Value**
Quantity of assets	Biannual	
Instrumentos Técnicos	Biannual	
Infusion pump	Biannual	10
Defibrillator	Biannual	1
Vital sign monitor	Biannual	4
Notebook	Biannual	2
Ophthalmoscope	Biannual	4
Weighing scale	Biannual	2
Saline stand	Biannual	2
Measuring rod	Biannual	2
Refrigerated glass display	Biannual	1
Furniture for operating services	Biannual	
Weighing scale	Biannual	4
Room divider	Biannual	10
Stretcher	Biannual	27
Stretcher to transport patients	Biannual	6
Clinical cart	Biannual	19
Cradle	Biannual	10
Footstool	Biannual	11
Lamp of procedure	Biannual	1
Overbed table	Biannual	13
Light box	Biannual	12
Clinical stools	Biannual	2
Saline stand	Biannual	19
Wheel chair	Biannual	6
Immobilizing table	Biannual	1
Bedside table	Biannual	29
Use (cots, wheelchairs, beds)	Monthly	NI
Non-available equipment	Monthly	0
Staff endowment per shift (physicians, nurses, paramedic and others)	Monthly	23
Absenteeism rate (physicians, nurses, paramedic and others)	Monthly	1,8
Weekly overtime work rate (physicians, nurses, paramedic and others)	Monthly	
Physician	Monthly	NI
Nurses	Monthly	0
Paramedic, asssistant and administratives	Monthly	17%
Subcategory: demand		
Average daily census	Monthly	158
Patient rate morning	Monthly	36%
Patient rate evening	Monthly	41%
Patient rate night	Monthly	23%

Most of the capacity indicators for the hospital were measured.

Table 7. Performance Indicators for HLCM´s Emergency Department (Outcome indicators)

Category 5: Outcome indicators		
Indicator	**Frequency**	**Value**
Rate of hospitalized patients	Monthly	9%
Discharged patients	Monthly	91%
Total abandonment rate	Monthly	22%
Total abandonment rate after triage	Monthly	21%
Rate of referred patients	Monthly	0
Short-term mortality, after visit to the ER	Monthly	NI

Currently the hospital does not track short-term mortality after the patient visit the ED. 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.

Discussion

Why an ED needs to measure 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.

For instance, in the ED of HLCM most of the indicators 23 (31%) of them are quality indicators. Some interesting results among the quality indicators in HLCM were found when analyzing the compliance rate of treatment with the triage standards. We found that there were none C1 patients during the month of analysis, 100% of C2 patients meet the standards, 92% of C3 patients were treated according to the triage standards, and 99% of C4 patients meet the triage criteria. In addition, patients should be classified by the triage in the first 10 minutes from their admission time; according to the results the ED of HLCM achieved this goal just 81% of the time. Also the readmission rate was of 7% for patients that were readmitted for a similar or equal medical condition. In relation to satisfaction indicators, there was not monthly information available about patient satisfaction or personnel satisfaction, and the staff-training rate was lower than 50% during the year 2015. The monitoring system provides information that helps managers to shed lights on opportunities for improvement; for example, improve the compliance rate for C3 patients and reduce the readmission rate of 7% of patients. This is a starting point for managers to prioritize the indicators and find improvement opportunities for the unit.

There are 20 KPIs in the time category (27%); experts classified 18 of them as very important indicators. Some of the results for the HLCM's ED included that the average cycle time of a patient, i.e. the average time that the patient stays in the ED is 1 hour 39 minutes approximately, and the average treatment time is close to 50 minutes, having an average waiting time of 49 minutes in total. In the next category, we have the economic indicators with 15 KPIs defined but just 2 of them described as 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. 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. HLCM had 40% of outstanding patient accounts from the FONASA beneficiaries and over 80% of outstanding patient accounts from the Isapres beneficiaries or private patients. Also, during the year 2015 the ED exceeded in 1% their budget. These results are indicating the cash flow problems that the ED is facing, and therefore a crucial indicator to be prioritized and improved.

The following category includes capacity indicators, totalizing 11 KPIs and all of them classified as very important. The average daily census of HLCM's ED is 158 patients, with a rate of patients by morning, evening and night of 36%, 41% and 23% respectively. Finally, there are 6 outcome indicators and all are very important. The total percentage of discharged patients was 91%, and the difference, 9%, was hospitalized. In addition, 22% of patients left the ED without medical attention, 21% after the triage. This is another example of an indicator that emphasizes the need of improvement strategies.

In sum, the ultimate goal of this set of KPIs is to provide EDs with good measures of the effectiveness of their system. We propose that the set of 75 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. An example is shown in figure 1.

Figure 1. Example of KPIs for ED improvement strategies
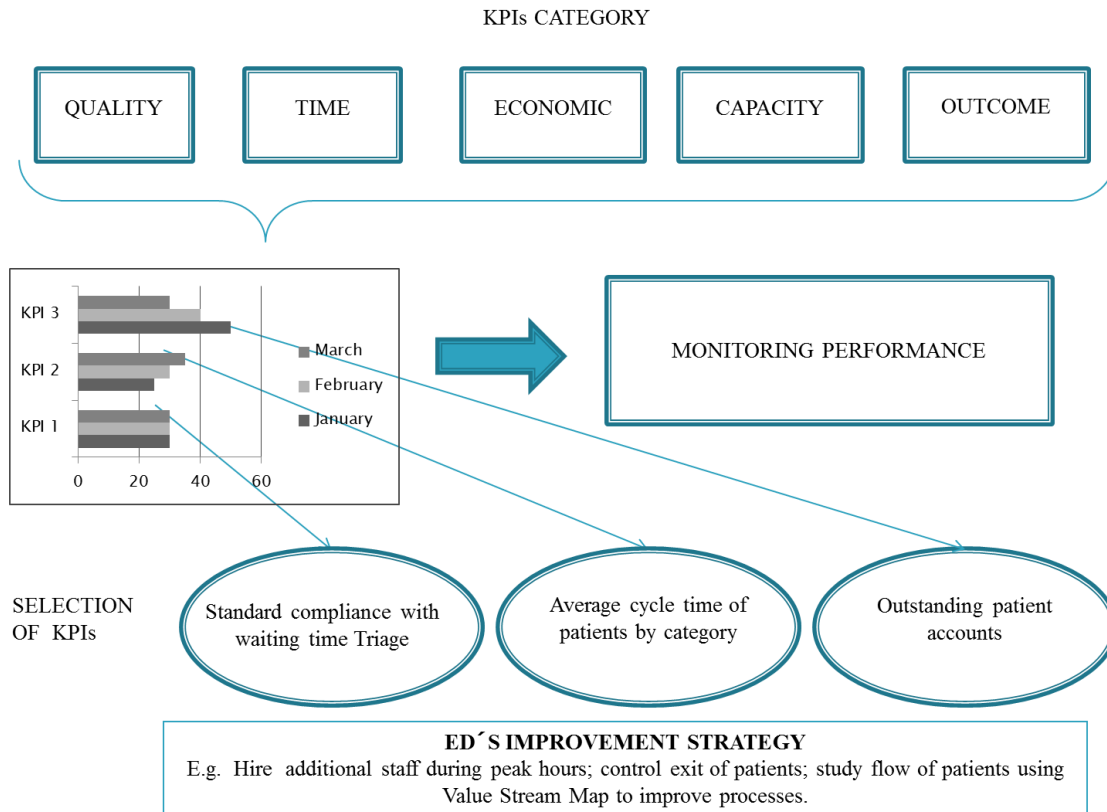
Conclusion

Feasible metrics to assess the performance of an ED were identified. The set of 75 indicators is valid and have practical application in any ED. Even though these KPIs were applied during one month in the "Dr. Luis Calvo Mackenna" Hospital, 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 health care 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. Finally, all the information collected from these KPIs have a huge potential to be useful in public policy decision making to improve the health care system overall.

References

Abo-Hamad, W. and Arisha, A. (2013).Simulation-based framework to improve patient experiencein an emergency department.European Journal of Operational Research. 224: 154-166.

Bisbe, J. and Barrubés, J. (2012). El Cuadro de Mando Integral como instrumento para la evaluación y el seguimiento de la estrategia en las organizaciones sanitarias. Revista Española de Cardiología, 65(10): 919-927.

Brailsford, S. and Vissers, J. (2011). OR in healthcare: A European perspective. European Journal of Operational Research, 212(2):223-234.

Fieldston, E., Zaousti, L. B., Agosto, P. M., Guo, A., Jones, J. A. and Tsarouhas, N. (2014). Measuring Patient Flow in a Children's Hospital Using a Scorecard with Composite Measurement. Journal of Hospital Medicine, 9(7): 463-486.

Gauld, R., Al-wahaibi, S., Chisholm, J., Crabbe, R., Boomi, K. Oh, T., Palepu, R., Rawcliffe, N. and Sohn S. (2011). Scorecards for health system performance assessment: The NewZealand example, Health Policy, 103: 200-208.

Grigoroudis,   E.,   Orfanoudaki,   E.   and   Zopounidis,   C.   (2012).   Strategic performancemeasurementinahealthcareorganisation:Amultiplecriteria approach based on balanced scorecard. Omega, 40: 104-119.

Ioan, B. Nestian A. S. and Tita, S-M. Relevance of Key Performance Indicators (KPIs) in a Hospital Performance Management Model. Journal of Eastern Europe Research in Business & Economics, Article ID 674169, 15 pages. http://www.ibimapublishing.com/journals/JEERBE/jeerbe.html.

Ismail, K., Abo-Hamd, W. and Arisha, A. (2010).Integrating Balanced Scorecard and Simulation Modeling to Improve Emergency Department Performance in Irish Hospitals. Proceedings of the 2010 Winter Simulation Conference, 2340-2351.

Khalifa, M. and Khalid, P. (2015). Developing Strategic Health Care Key PerformanceIndicators: A Case Study on a Tertiary Care HospitalThe 5th International Conference on Current and Future Trends of Information and Communication Technologies in Healthcare, Procedia Computer Science 63: 459 – 466.

Madsen, M. M., Eiset, A. H., Mackenhauer, J., Odby, A. Christiansen C. F., Kurlan, L. and Kirkegaard, H. (2016). 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 24(11): 1-8.

Mutale, W., Godfrey-Fausset, P.,Tembo, M., Kaesese, N., Chintu, N., Balabanova, D., Spicer, N. and Ayles, H. (2013).Measuring Health System Strengthening: Application ofthe Balanced Scorecard Approach to Rank the BaselinePerformance   of   Three   Rural   Districts   in   Zambia.   Plos   One,   8(3):   1-11. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0058650.

Nikjoo, R. G., Beyrami, H. J., Jannati, A. and Jaafarabadi, M. A. (2013). Selecting Hospital's Key Performance Indicators, usingAnalytic Hierarchy Process Technique. Journal of Community Health Research, 2(1):30-38.

Safdari, R., Ghazisaeedi, M., Mirzaee, M. Frazi, J., andGoodini, A. (2014).Development of Balanced Key Performance Indicators for Emergency Departments Strategic Dashboard Following Analytic Hierarchical Process. The Health Care Manager, 33(4): 328-334.

Shohet, I. M. (2006).Key Performance Indicators for Strategic Healthcare Facilities Maintenance. Journal of Construction Engineering and Management, 132(4): 345-352.

Trotta, A., Cardamone, E., Cavallaro, G. and Mauro, M. (2012). Applying the Balanced Scorecard approachin teaching hospitals: a literature reviewand conceptual framework. International Journal of Health Planning and Management, 28: 181-201.

Welch, S. J., Brent, R. A., Stone-Griffith, S. Davidson, S. J., Augustine, J. and Schuur. J. (2011). Emergency Department Operational Metrics, Measures andDefinitions: Results of the Second Performance Measures andBenchmarking Summit. Annals of Emergency Medicine, 58(1): 33-40.