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Introduction

To reduce hospital overcrowding and its negative effects on the safety and quality of care provision, we use a management model that takes into account the hospital as a whole. The key is to understand that the groups of patients “competing” for beds are either those scheduled for surgery or medical admission as well as those that come from the Emergency Department (ED) and the Pediatric Intensive Care Unit (PICU). The main objective of the bed management system is to minimize the periods of saturation, which result in significant alterations in the ED, the surgical area, the PICU and the own inpatient area.

In the particular case of our hospital, from 2012 onwards, it was decided to intensify the effort to increase the activity of high complexity. This fact determined the risk that, without there being a parallel increase in the number of beds, overcrowding would increase. Especially in the ED, that has only an Observation Area with 6 beds for stays of less than 24 hours.

In this framework, our current bed management system was conceived and implemented progressively. And nowadays is the central piece of our operational management. In 2015 we already had all its components at full capacity. Since then, we have been testing and re-evaluating the system introducing adjustments that have led to the good results presented and that helps us a lot in our day to day.

Results

• Reliability of the PREDIL formula

- When the formula foresees that the balance of patient inputs and outputs will create a balanced situation (maximum of 6 patients without bed in our particular case given our set infrastructure) the prediction is successful in 97% of the days.
- In the event that the formula predicts a deficit of more than 6 beds, since we carry out various corrective actions we can avoid this situation in 62% of the cases.

• We also have evaluated different hospital **overcrowding indicators**: despite the increase in the complexity of the inpatients activity, with an increase in the average weight of our hospitalization case-mix (measured with DRG APR32) from 1,0627 in 2011 to 1,1818 in 2017 and the increase of ED activity (From 93.738 ED visits in 2011 to 104.099 ED visits in 2017), overcrowding indicators have improved or remained stable, mainly:

1. % patients attended in ED by a doctor within adequate time range depending on Triage Level:	<ul style="list-style-type: none"> • Level 2 Triage <15 minutes: 71% in 2011; 78% in 2017 • Level 3 Triage <30 minutes: 65% in 2011; 65% in 2017
2. % patients visited in ED with episodes of duration >4h:	• 17% in 2017
3. EDWIN index*: (we measured the EDWIN index every hour in 2017)	<ul style="list-style-type: none"> • 7 days out of 365 with at least a measurement of the EDWIN index >2 (overcrowded) • 45 days out of 365 with at least a measurement of the EDWIN index >1,5 (busy)
4. Surgical operation suspensions on the last day due to the lack of conventional beds:	• Only 5 in 2017

* Emergency Department Work Index

Methodology

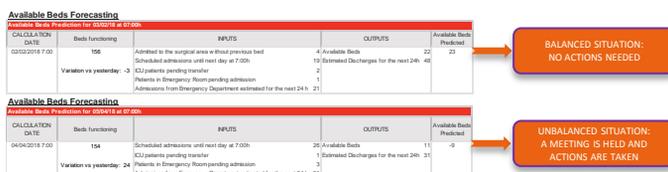
We use two simple easy-replicable tools, but at the same time innovative since we use them in a coordinated way:

• **QUIRPLAN**: this is a computer tool that integrates diverse Electronic Health Record (EHR) information related to scheduled surgical activity. It facilitates daily, weekly and annual planning. It allows the establishment of a maximum number of daily beds that can be used for surgeries. This value is variable throughout the year depending on the prediction of the volume of patients admitted from the ED. This allows making compatible the need of beds for patients admitted from ER and to ensure that planned activity is carried out annually.

• **PREDIL Formula (Prediction of Beds Availability)**: We use an algorithm that predicts daily beds available at 7:00AM, 24 hours in advance, using real-time data from EHR combined with an estimate of the other variables necessary to obtain the expected balance sheet for which there is no certainty: inpatients discharges and admissions from the ED that will occur during the next 24 hours. This estimate is constructed by combining recent historical data with information extracted from EHR (inpatients with pre-discharge and inpatients that match or exceed the expected stay in their diagnostic group) in such a way that a prediction is obtained that uses the combination of variables that allow the best adjustment.

Forecast 24h in advance	Type of variable
Beds available in 24h in advance	Real Data
INPUTS	Real Data
Admitted to the surgical area without previous bed	Real Data
Scheduled admissions until next day at 7:00h	Real Data
ICU patients pending transfer	Real Data
Patients in Emergency Room pending admission	Real Data
Admissions from Emergency Room estimated for the next 24h	Forecast
OUTPUTS	Forecast
Estimated Discharges for the next 24h	Forecast
Beds prediction	Forecast
Admissions from Emergency Room estimated	Forecast
Forecast uses an algorithm that ponders, based on the day of the week:	
Work days:	last 3 equivalent days of week and last 3 labor days
Weekend or off day:	last 3 equivalent days of weekend or off day
Forecast uses discharge record if it exists or compares the current stay with LOS standards for each incoming diagnose and ponders this prediction with:	
Work days:	last 3 equivalent days of week and last 3 labor days
Weekend or off day:	last 3 equivalent days of weekend or off day

We have defined a threshold given our established structure and when the forecast exceeds it, we gather a group of professionals to take appropriate action, such as increase available beds, changing surgical activity with admission for outpatients surgeries, etc.



Conclusion

- ✓ We benefit a lot from a prediction tool focused on helping whether to take corrective actions or not.
- ✓ We prevent overreaction to take decisions when they are not needed.
- ✓ We anticipate overcrowding situations and take appropriate measures to reverse them.
- ✓ Suspension of scheduled activity is greatly reduced.