

Supplementary material S1

Extended information about measured endpoints

Variables	Long description	Formula and parameters	How it was measured	Example
Theatre utilisation (TU)	This is the time a theatre is busy with a patient out of the total time available in the surgical session (in the case of Vall d'Hebron: 8:30 am to 3pm).	$TU = \sum_1^{N \text{ Theatres}} \frac{ttwp}{ttss}$ <p><i>ttwp = time theatre with patient</i> <i>ttss = total time surgical session</i></p> <p>To build the overall TU of the surgical block, the average TU for all the surgical sessions in that year have to be aggregated.</p>	Theatre time with patient / Theatre time per surgical shift	3 surgical interventions of 1.5 hours in a shift from 8:30h to 15h would be $= 3 \times 1,5 \text{h} \times 60 \text{min} / 6,5 \text{h} \times 60 \text{min} = 270 / 390 = 69,23\%$
Late starts (LS)	Delays at the start are those situations in which the time the surgery starts is later than the time agreed by the surgical committee (usually 8:30 am in the morning and 3:30 pm in the afternoon)	<p>1) $LS_1 = \frac{dd}{nwd}$ <i>dd = days with delay</i> <i>nwd = number of working days</i></p> <p>2) $LS_2 = \frac{\sum ddm}{nwd}$</p>	Two indicators: 1) % delay days with respect to the total. 1) In order to measure how much delay, we have in the surgical block the RTLS solution indicates when the patient enters the operating theatre and	1) 22 days of activity with 18 delays = 81.81%. 2) in day 1, a surgical block with 8 theatres started 35 minutes late on average. In day 2, average late start across the 8 theatres was 25 minutes. After two days of work, the average late start = $35 + 25 / 2 = 30$ minutes.

	<p>when there is no continuous surgery). The minutes of delay with respect to the scheduled time are counted.</p>	<p>$d d m = \text{days with delays in minutes in each theatre}$ $n w d = \text{number working days}$</p>	<p>when the start of surgery is marked. The indicator is per day and operating theatre (yes/no), and the objective is 0 delays in the start. The result is given in % according to the number of days of opening of the operating theatre.</p> <p>2) average delay in minutes per operating theatre or surgical block. Average number of minutes of delay per day, and average number of minutes over total days worked.</p>	
Early finishes	<p>Early finishes. When the programmed surgical activity ends at a time that would still allow a new surgical intervention to be performed</p>	$EF = \sum \frac{dfot}{nwd}$ <p>$dfot = \text{days finished out of time}$ $nwd = \text{number working days}$</p>	<p>To measure how many early finishes in the surgical block, the RTLS solution indicates when the last scheduled patient leaves the operating theatre during the shift. The indicator is per day and operating theatre (yes/no) and the objective is that the</p>	<p>22 days of activity with 11 days of sessions ending before target times</p>

			last patient in the morning shift finishes the operation between 14:00 and 15:00, or between 20:00 and 21:00 for the afternoon shift. The objective is 0 early finishes.	
Turnaround time (TAT)	TAT was defined as the interval in minutes between the end of surgical dressing and knife-to-skin time for the subsequent patient, i.e., time during which no surgery is taking place	$TAT = \frac{\sum twns}{npss - 1}$ <p><i>twns = time with no surgery</i> <i>npss = number of patients surgical session</i></p> <p>The overall surgical block TAT is the aggregation of all the values for each theatre.</p>	Time between surgeries has to be added up and the result divided by the number of patients in that surgical session minus 1. The RTLS system made it possible to record these events automatically by capturing the interactions with the applications.	If we have 3 scheduled patients and the times between surgeries are 25 minutes and 35 minutes, the TAT percentage would be: (25 + 35) / (3 patients - 1) = 60/2 = 30 min.
Turnover time (TOT)	TOT was defined as the interval in minutes between the patient's departure from the operating theatre and the arrival of the subsequent patient in the operating theatre.	$TOT = \frac{\sum tet}{npss - 1}$ <p><i>tnpit = time empty theatre with no patient</i> <i>tpd = time patient departure</i></p> <p>The overall surgical block TOT is the aggregation of all the values for each theatre.</p>	The time in which no patient was in the operating theatre was automatically recorded by the RTLS system by subtracting the time the new patient enters the operating theatre by the time the previous patient left it.	If we have 3 scheduled patients and the times of empty theatre are 15 and 25 minutes, TOU = (15 + 25) / (3 patients - 1) = 20 min.

Downtime between cases (DBC)	Inactive time once the operating theatre has been cleared of the first patient until the next patient arrives.	$DBC = TOT - ct$ $ct = \text{Average cleaning time was 12 min}$	DBC= TOT – cleaning time	If the TOT is 25 min and the cleaning time is 12 minutes, the DBC is 13 min.
Surgical activity	Number of operations	$SA = \sum_1^{nwdy} ndo$ $nwdy = \text{number working days year}$ $ndo = \text{number daily operations}$	Number of operations carried out in a year.	9200 operations were carried out in 2019.
Cancellations on the day	Number of surgical interventions scheduled for the day that have had to be cancelled or rescheduled for various reasons	$COD = \frac{\sum nc}{noss}$ $nc = \text{number of cancellations}$ $noss = \text{number operations in surgical sessions}$	No. of cancellations or rescheduling of patients compared to total number of scheduled patients (%)	If there are 10 programmed operations in a day and 5 have been reprogrammed, then COD = 50%.
Economic gains	Two indicators. 1) Extra turnover due to increased activity due to the time recovered by process improvements + cost reductions. 2) Average gain of 9.750€ per each 1% of improvement of theatre	$EG_1 = \frac{ta - tp}{tp}$ $EG_2 = agtm \cdot nt \cdot nmy$ $agtm = \text{average gain per theatre month,}$ $nt = \text{number of theatres}$ $nmy = \text{number months year}$	1) Achieved turnover at the end of the year / forecast turnover at the beginning of the year (%) (according to fixed and variable costs of the surgical activity). 2) According to HIMSS, per each 1% of improvement of theatre utilization below	1) If turnover achieved is 100 M€ and the planned turnover was 95M€, the economic gain is 5M€, EG = 5.26%. 2) If theatre utilisation has been improved 10% in a year in 14 theatres, then $EG_2 = 10 \times 14 \text{ theatres} \times \text{€}9,750 = \text{€}1,365,000$.

	utilization below the optimal 85%.		the optimal utilisation of 85%, there is an average gain per month of €9,750.	
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