Reducing Uncertainty in Operating Room Management

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Introduction

A management challenge for perioperative managers is to decide when surgical procedures conclude and accordingly coordinate the use of staff, equipment, and available space over time to minimize error and the ‘idle time’ of ORs during scheduled surgical hours. Existing techniques for obtaining surgical durations include averaging durations pertaining to specific surgeons and/or procedures over months and using upper 95% prediction levels [1]. However, such methods yield a loose bound on the ORT prediction and have very high uncertainty involved, which is undesirable in real-time scenarios. We describe a technique for reducing these uncertainties using vital signs data such as blood pressure, ECG, temperature, oxygen etc [2].

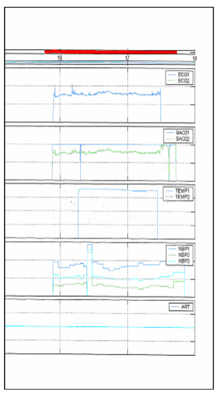

Figure 1: Lead Time is the most stable of all vital signs

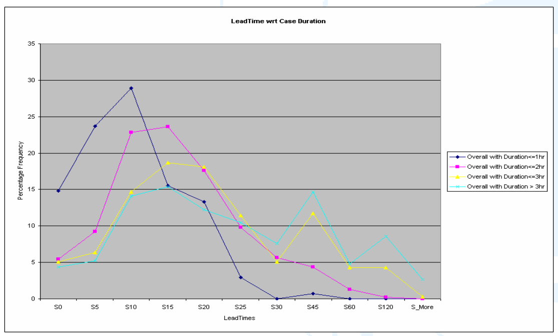

Figure 2: Lead Time distribution with respect to varying case duration

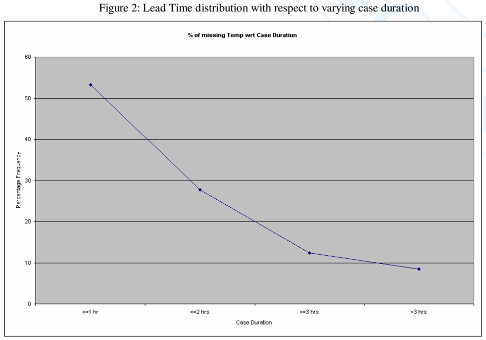

Figure3: Plot of distribution of missing temperature with respect to varying case duration

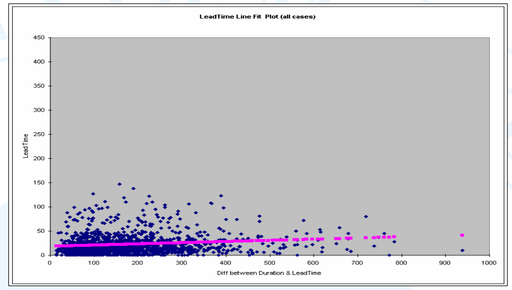

Figure 4: Regression of lead time with respect to the elapsed time

Method

Data collected from operating rooms during a two month period show that, of the different vital signs signals, temperature is the most stable. It has also been observed that there is a certain perceptible time gap between switching off of the temperature probe and the patient leaving the OR. We refer the time gap as lead time. We statistically model the lead time so that we can predict the time at which we expect the patient to leave the OR.

We have first partitioned our data with respect to case durations into the following categories.

1. Cases < 1 hour
2. Cases >1 hour & < 2 hours
3. Cases >2 hours & < 3 hours
4. Cases >3 hours & < 5 hours
5. Cases >5 hours

Initial feasibility was tested with linear regressions over elapsed time of a case (start time to prove off time) and the scheduled duration of the case to predict lead times. The regression model we built is the following:

$$LeadTime = 0.2934*ElapsedTime + .2598*ScheduledDuration + 5.2664$$

Discussion

The results produced with this model closely approximate the observed values of the lead times in the real dataset. The standard error for this regression model is 6.43 which means that we can accurately predict the lead times for the different cases with an error of ± 7 minutes .

OR		ET	Number of Cases (n)	10%	50%	90%	0-5 min	0-10 min
20	Total Cases: 218 w/o Temperature : 36	<=1 hr	80	3	13	34	13%	30%
		>1 hr & <=2 hrs	71	3	11	21	24%	43%
		>2 hrs & <=3 hrs	20	2	11	29	25%	45%
		>3 hrs & <=5 hrs	11	-	-	-	-	-
		>5 hrs	0	-	-	-	-	-
21	Total Cases: 98 w/o Temperature : 14	<=1 hr	9	-	-	-	-	-
		>1 hr & <=2 hrs	11	5	19	20	10%	45%
		>2 hrs & <=3 hrs	19	4	16	34	16%	37%
		>3 hrs & <=5 hrs	29	12	25	76	0%	9%
		>5 hrs	16	6	21	74	9%	19%
22	Total Cases: 113 w/o Temperature : 26	<=1 hr	8	-	-	-	-	-
		>1 hr & <=2 hrs	25	0	17	34	14%	33%
		>2 hrs & <=3 hrs	24	3	18	70	15%	21%
		>3 hrs & <=5 hrs	23	9	23	57	0%	11%
		>5 hrs	7	-	-	-	-	-
23	Total Cases: 95 w/o Temperature : 17	<=1 hr	8	-	-	-	-	-
		>1 hr & <=2 hrs	27	1	16	25	15%	33%
		>2 hrs & <=3 hrs	10	6	14	59	0%	30%
		>3 hrs & <=5 hrs	17	8	34	60	0%	12%
		>5 hrs	16	6	21	42	8%	19%

Figure 5: Results showing the 10, 50 and 90 percentile of lead times for different ORs having different proportions of cases with variable case durations

Acknowledgements

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References

[1] F. Dexter. Application of prediction levels to OR scheduling – managing operating room usage time, *AORN*, March 1996

[2] Y. Xiao, P. Hu, H. Hu, D. Ho, F. Dexter, F.C. Mackenzie, J.F. Seagull, and P.R. Dutton. An algorithm for processing vital sign monitoring data to remotely identify operating room occupancy in real-time. *Anesthesia and Analgesia*, 101(3):823-829, September 2005.