

The Circadian Rhythm of "Urgent" Operative Deliveries

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Abstract

Background: Even operative deliveries defined as "urgent" show marked diurnal variation with a significant increase during regular working hours.

Objective: To investigate the diurnal variation of urgent operative deliveries and its potential implications on the outcome of newborns.

Methods: We conducted a retrospective study of all deliveries in a public hospital from 1 January 1990 to 31 December 1998. Delivery mode variables analyzed were spontaneous vaginal delivery, urgent cesarean section and operative vaginal delivery. Deliveries were stratified hourly throughout the day. The rate of operative deliveries was calculated and the analysis was then performed according to the daily routine shifts of the medical staff. Birth weight and Apgar scores at 1 and 5 minutes were retrieved as outcome measures.

Results: The rate of urgent cesarean deliveries increased significantly between 8 a.m. and 2 p.m. (150%–230%) from that predicted. The lowest rate of urgent cesarean sections was found between 5 a.m. and 6 a.m. (5.3%). Mean birth weight in spontaneous deliveries was higher in the morning hours than during the night shift ($3,293 \pm 520$ g vs. $3,277 \pm 510$ g, respectively, $P < 0.005$). Apgar scores of newborns delivered by urgent cesarean section during the morning were higher compared to those delivered during night shifts and the rate of low Apgar scores was lower in the morning than in evening and night shifts.

Conclusions: Our results indicate a marked diurnal variation in urgent operative deliveries, caused perhaps by varying definition of "urgency" according to the time of day.

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The hour of delivery is determined by the time the process of labor begins, a phenomenon that is supposed to be distributed randomly along the day, and by decisions and interventions made thereafter by healthcare providers. The latter may be influenced by multiple factors, such as private vs. non-private patients, fatigue, and others [1–3]. Regular working hours and physician's convenience are perhaps the more prominent among these aspects [4–6], causing a lower rate of non-acute cesarean sections at night, especially in private hospitals [4]. Availability of full-time obstetricians, operating rooms, anesthesiologists and neonatologists was found by some authors to decrease the rate of procedures performed at night [4], while others found no such changes [6].

These confounding factors may alter our decisions and shift the normally distributed Gaussian curve (common in random processes) to a premeditated, more "convenient" distribution along the day. By definition, urgent operative deliveries should not be affected by convenience factors, therefore their distribution should

follow the circadian delivery rate. However, the definition of "urgent" may vary according to the time of the day and the particular situation [5,6].

The aim of the present study was to determine whether diurnal variation exists in urgent operative deliveries and the implication of that variation for the outcome of newborns.

Methods

Rambam Medical Center is a tertiary care level teaching public hospital with an annual delivery rate of 4,600 deliveries. The morning shift in the delivery ward is between 8 a.m. and 4 p.m. Between 4 p.m. and 8 a.m. (night shift), a resident team is on duty with senior obstetricians on call. In this retrospective analysis we included all deliveries from 1 January 1990 to 31 December 1998 with the exact time of birth known. During the above-mentioned period there were no alterations in the daily shift routines of the staff.

Delivery mode variables were: spontaneous vaginal delivery, urgent cesarean section, and operative vaginal delivery. Elective cesarean sections and deliveries with unknown time of birth were excluded from the study. The definitions of "urgent" cesarean deliveries were all the cesarean sections that were performed for fetal or maternal indications after labor progressed to active phase, in cases that were not previously scheduled for elective cesarean delivery. Deliveries were stratified hourly throughout the day. The rate of operative deliveries was calculated as a proportion of total deliveries during the specific time interval. Additionally, we defined two shifts (day and night) according to the daily routine of the medical staff. Outcome measures in neonates included birth weight and Apgar scores at 1 and 5 minutes.

Statistical analyses were performed with the Student *t*-test for continuous variables and the chi-square test for discrete values. The level of significance was set at $P < 0.05$.

Results

A total of 41,626 deliveries with known hour of birth was recorded (mean 4,625 deliveries per year). Of these, 7,417 deliveries (17.8%) were non-spontaneous: 5,289 urgent cesarean sections (12.7%), 1,803 vacuum extractions (4.3%) and 325 forceps deliveries (0.8%).

There were 16,249 deliveries (39%) during the day shift and 25,377 (61%) during the night shift [Table 1]. The rate of non-elective cesarean sections during the day was almost doubled compared to the night shift (17.5% vs. 9.6%, $P < 0.001$). The rate of vaginal operative deliveries was similar during the day shift and the night shift (5.2% vs. 5.1%, NS). However, there was a significantly higher rate of forceps delivery during the morning than during the night.

Table 1. Mode of delivery according to the daily routine of medical staff

Time of delivery	Total deliveries	Cesarean			Total operative vaginal deliveries	Total non-spontaneous deliveries
		(urgent)	Forceps deliveries	Vacuum extractions		
08:00–15:59 (day shift)	16,249	2,848 *	150 **	690	840	3,688 *
		(17.5%)	(0.9%)	(4.2%)	(5.2%)	(22.7%)
16:00–07:59 (night shift)	25,377	2,441 *	175 **	1,113	1,288	3,729 *
		(9.6%)	(0.69%)	(4.4%)	(5.1%)	(14.7%)

* $P < 0.001$ ** $P < 0.01$ **Table 2.** Five minute Apgar scores and apgar scores < 7 by mode of delivery and time of day

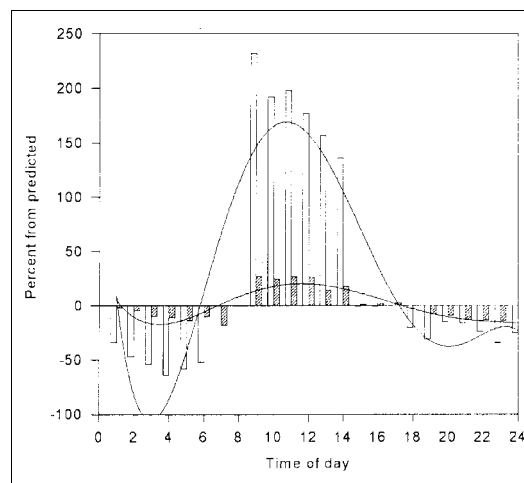
	Morning deliveries	Evening and night deliveries
	08:00–16:00	16:00–08:00
Spontaneous deliveries		
Apgar at 5 min	9.87 ± 0.56	9.88 ± 0.55
Apgar at 5 min < 7	50 (0.37%)	98 (0.43%)*
Cesarean sections		
Apgar at 5 min	9.72 ± 0.8	9.6 ± 0.1*
Apgar at 5 min < 7	28 (1%)	39 (1.6%)*

* $P < 0.001$

The mean Apgar scores of newborns delivered spontaneously during morning and night shifts were similar. However, a comparison of Apgar scores of newborns delivered by urgent cesarean section revealed a small but statistically significant difference between the morning and night shifts [Table 2]. The rate of low Apgar scores (less than 7) was also lower in the morning than at night shifts, both for spontaneous deliveries and cesarean sections ($P < 0.001$).

With a theoretical even distribution of deliveries, the expected delivery rate was calculated to be approximately 1,734 each hour. Yet, we noted a circadian change in the actual number of deliveries and of urgent cesarean sections throughout the day. Figure 1 illustrates these hourly changes, expressed as percent from predicted deliveries and cesarean sections. Fitted to the data points, the polynomial curve clearly shows a highly significant variation according to the hour of birth. The rate of urgent cesarean deliveries increased significantly between 8 a.m. and 9 a.m., peaked between 9 a.m. and 10 a.m. and remained high until 2 p.m. The lowest rate of cesarean deliveries was found between 5 a.m. and 6 a.m. (5.3%), in accordance with the rate of total non-spontaneous deliveries. It is evident that between 9 a.m. and 2 p.m. the total numbers of deliveries increased by approximately 20% from that predicted, however the simultaneous rise of cesarean sections was 150–230%! Between 2 a.m. and 6 a.m. the number of deliveries was very close to that predicted, yet the cesarean section rate decreased by approximately 50%.

In the group of spontaneous deliveries the mean birth weight observed in the morning was higher than that in the night shift ($3,293 \pm 520$ vs. $3,277 \pm 510$ g, respectively, $P < 0.005$). Although

**Figure 1.** Actual percent of deliveries and cesarean sections performed from that predicted. Filled bars indicate total number of deliveries, and open bars the number of urgent cesarean sections. A third order regression line was fitted to the numbers and superimposed on the graph.

this difference is statistically significant, it does not have any clinical significance. The delivery rate of very low birth weight infants (<1,500 g) and of macrosomic newborns (>4,000 g) was significantly higher during the morning shift (1.18 vs. 1.09%, $P < 0.001$, and 7.75 vs. 6.52%, $P < 0.001$, respectively).

Discussion

The results of our study show that the distribution of deliveries along the day at our institution is uneven, both for spontaneous and for intervened deliveries. This variability is probably accounted in part by biological factors affecting the initiation time and length of delivery [1,2] but also by other factors such as medical decisions to intervene during the process. We use prostaglandin gel to induce labor in the evening hours and, if necessary, to augment labor contractions with oxytocin during the day. The largest contribution to non-spontaneous deliveries in our series is granted to urgent cesarean sections. It is well known that elective induction of labor is associated with an increased rate of cesarean section for dystocia [7]. This may explain the cesarean section peak that was observed between 9 a.m. and 3 p.m. [Figure 1].

Comparing morning to evening and night, the hourly rates of vacuum extractions and forceps deliveries revealed no statistical difference. This probably reflects the absolute urgency of these operations, and not the influence of convenience factors of the attending staff. The higher rate of forceps deliveries between 9 a.m. and 12 p.m., and the very low rate between midnight and 9 a.m. are probably due to the lack of experience of young residents with this type of procedure that, in our institute, is used 10 times less frequently than vacuum extractions.

We found significantly fewer low Apgar scores during the morning shift, and a higher mean 5 minute Apgar score for babies born by non-elective cesarean delivery during morning hours.

However, we could not document a statistical significant difference in Apgar scores of newborns by spontaneous delivery at different hours of the day. This observation is enhanced by the fact that more “problematic” deliveries occurred in the morning shift, implying that better care is offered in the morning shift, when a full staff of obstetricians, perinatologists and pediatricians is available. In contrast, at night shifts, the personnel on call are usually less experienced. Other investigators have also discussed this circadian pattern of quality care [8].

The results of the present study also indicate that decisions regarding interventions in the process of labor and delivery are influenced by the time of day when they are taken. The very low incidence of cesarean sections towards the end of the night shift clearly demonstrates an effect of fatigue on clinical judgment, unconsciously deferring decisions to the fresh day staff. The converse is reflected by the very high rate of intervened delivery that follows in the next couple of hours. It is apparent that the quality of care during night shifts is lower than that conferred during usual working hours, probably due to physical and mental fatigue of medical care providers, with a more liberal attitude to defer decisions or even to err and misjudge various clinical situations. The less favorable outcome of babies born at night was reported in the past [9–11] and confirmed also in the present study. Thus, the tendency to avoid, if possible, interventions for semi-acute indications at night may even be beneficial. However, this certainly does not refer to acute, absolute indications for intervention, where deferral may put the fetus in jeopardy. Wisdom, experience and alertness will allow us to differentiate between these two situations.

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