



Under-the-mattress movement sensor (Babysense*) versus cardiorespiratory monitor to alarm in apnea of infancy

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Abstract:

Background: Infant home monitors are recommended in high risk infants. While direct monitoring of respiration and heart rate requires attaching surface electrodes to the infant, movement sensors may be placed under the mattress and detect respiratory cessations without touching the infant.

Purpose: To study the accuracy of a movement sensor placed under the mattress in alarming for apnea and bradycardia in infants.

Methods: 54 high risk infants who presented to the emergency room with Apparent Life Threatening Event (ALTE) underwent a whole night simultaneous monitoring by both cardiorespiratory monitor (intellivue MP20 junior, Phillips) and under the mattress movement monitor (Babysense II, Hisense). The cardiorespiratory monitor was set to alarm when detecting no respiration for 20sec, heart rate below 90/min, and oxygen saturation below 90%. The Babysense was set to alarm when detecting no respiration (movement) for 20sec.

Results: 54 infants (age 47±40 days) who presented to Rambam (n=49) or Carmel (n=5) emergency rooms after ALTE participated. During 80 nights of monitoring (18 infants were monitored for 2 nights, 4 infants were monitored for 3 nights) there were 8 events of alarming (10%), simultaneously in both systems. In all other cases there were no alarms in both systems.

Conclusions: Under the mattress movement sensing is accurate in alarming for apnea and bradycardia in infants. Since the usage of this system is simple and without direct contact with the infant, it may be a convenient useful method for certain infants.



Introduction:

Sudden infant death syndrome (SIDS) is defined as the sudden death of an infant younger than one year of age, which remains unexplained after a thorough case investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history. It is considered as the most prevalent cause of infant deaths between the ages of 1 month and 1 year (1). The prevalence of SIDS has substantially decreased in recent years in the developed world and in Israel. While the prevalence in Israel used to be 100 cases per year, it dropped to 40 per year (despite increase in deliveries). This reduction is predominantly attributed to education of the population to avoid risk factors such as prone position, excess clothing, over-heating, soft mattress, smoking and bed sharing. The usage of pacifier may also reduce the risk of SIDS (2,3).

The pathophysiology of SIDS is still unknown and most probably does not represent one disease but rather a combination of various factors including respiratory control immaturity, arrhythmias, brainstem/pons abnormalities, and potentially yet undefined factors (1, 4-10). Due to the unclear pathophysiology and etiology, along the importance of understanding respiratory maturation and infants' breathing patterns, and evidence of previous apneas in victims of SIDS, a trend of monitoring infants' respiration have been emerged (11-25). Although the literature is not completely decisive of monitor usage to prevent SIDS, these are definitely recommended in high risk infants. Although the reduction in the prevalence of SIDS is justifiably attributed to the "back to sleep" campaign, it is plausible that the ongoing increase in home alarm-monitors contributes as well to this observed reduction of SIDS. From our clinical experience, not negligible amount of infants were brought for assessment due to alarms of the Babysense they used in their home, and were found to have immature respiratory control.

Several studies have assessed the relevance of cardiorespiratory monitoring in high risk infants and some have reported that such monitoring can identify apneas early and potentially prevent death (15, 26). However, while direct monitoring of respiration and heart rate requires attaching surface electrodes to the infant, movement sensors may be placed under the mattress and detect respiratory cessations without touching the infant, since infants' breaths are associated with movements. Thus, we have planned the current study to compare between alarms of a cardiorespiratory recorder with that of under the mattress sensor recorder. We hypothesized that both monitors will be accurate in alarming in cases of apneas.

Methods:

54 consecutive high risk infants who presented to the emergency room with Apparent Life Threatening Event (ALTE) underwent a whole night simultaneous monitoring by both cardiorespiratory monitor (intellivue MP20 junior, Phillips) and under the mattress movement monitor (Babysense II, Hisense). The cardiorespiratory monitor was set to alarm when detecting no respiration for 20sec, heart rate below 90/min, and oxygen saturation below 90%. The Babysense was set to alarm when detecting no respiration (movement) for 20sec. The study was approved by the Rambam Medical Center IRB for studies in humans, and parents' of the infants have signed an informed consent prior to participation. Inclusion criteria consisted of all high risk infants who were admitted to the hospital, in ages below 1 year (e.g. infants with apparent life threatening event (ALTE), infants with Babysense alarms in their home). There were no specific exclusion criteria.



Intellivue MP20 junior, Phillips recorder:

The Intellivue MP20 monitor (Phillips Electronics, Eindhoven, Netherlands) is a portable monitor with various functions which can be individualized and fit to the patients (Fig 1). In the current study 3 channels were recorded and utilized: Heart rate (driven from 2 specific chest ECG electrodes attached to the studied infant), respiratory rate (driven from the same electrodes), and oxygen saturation (driven from a sensor placed on one of the studied infants' fingers). The monitor was connected to the infant throughout the study in parallel to the Babysense recorder (see below), and was set to alarm when specific threshold were crossed (no respiration for 20sec, heart rate below 90/min, and oxygen saturation below 90%).



Fig 1: Intellivue MP20 junior, Phillips Electronics, Eindhoven, Netherlands.

Babysense recorder:

The BabySense monitor (Hisense health monitor technologies, Rishon Le Zion, Israel) is an ambulatory infant monitor which detects respiration by movement sensors placed under the mattress of the studied infant (Fig 2). These are two highly sensitive sensor pads which detect micro movements through the mattress and was set to alarm when the were cessation of respiratory movements for 20sec.



Fig 2: The BabySense monitor, Hisense health monitor technologies, Rishon Le Zion, Israel



Study data collection:

The following parameters were recorded in the study:

Demographic parameters (age, gender, gestational age at birth, parental smoking), diagnoses (such as ALTE, Bordetella Pertusis, Respiratory Syncytial Virus, gastro esophageal reflux, respiratory control immaturity), medical treatment (respiratory stimulants such as methylxantines, antibiotics, oxygen, H2-blockers), and a detailed nocturnal event log (i.e. time of any alarm by any of the recorders, and manual measurement of heart rate and oxygen saturation at the time of the alarm (by the nurse is shift).

Statistical analysis:

All events were recorded and a chi-square test for proportions was used to compare the alarms of the two recorders. $P < 0.05$ was considered to be significant.

Results:

Fifty four infants (aged 47 ± 40 days) who presented to Rambam ($n=49$) or Carmel ($n=5$) emergency rooms after ALTE participated. Altogether, there were 80 nights of monitoring (18 infants were monitored for 2 nights, 4 infants were monitored for 3 nights). During these nights, alarm was noted in 8 nights. The demographic and monitored parameters of those with alar and without alarms, and for the whole cohort are presented in table 1. There were no statistically significant differences between the alarming and non-alarming infants with regard to age, gestational age, weight, birthweight, gender, fever or oxygen saturation upon admission. Heart rate at rest was lower in alarming infants compared to non-alarming infants (145 ± 11 vs 161 ± 19 , $p=0.05$). While alarming, both heart rate and oxygen saturation were marked and were significantly lower (82 ± 9 BPM and $77 \pm 9\%$, respectively). Overall there were 8 events of alarming (10%), in all cases simultaneously in both monitoring systems. In all other cases there were no alarms in both systems. These results are shown in table 2.

Conclusions:

Under the mattress movement sensing is accurate in alarming for apnea and bradycardia in infants. Since the usage of this system is simple and without direct contact with the infant, it may be a convenient useful method for certain infants.



Table 1:

	NON-ALARM INFANTS	ALARMED INFANTS	ALL COHORT
Gender	23m, 24f	4m, 3f	27m, 27f
Gestational age at birth (weeks)	38± 2	37± 2	38± 2
Age at study (days)	51± 41	25± 7	47± 40
Birth weight (gr)	3180± 548	2971± 364	3153± 530
Parental smoking	14	0	14
Primary diagnosis	37 Bronchiolitis, 10 ALTE	2 Bronchiolitis, 5 ALTE	39 Bronchiolitis, 15 ALTE
heart rate	161± 19	145± 11	159± 20
Fever on admission	37.3± 0.7	36.9± 0.2	37.3± 0.7
O2Sat (%) at admission	92± 5	96± 3	93± 5
heart rate on alarm		82± 9	
O2Sat (%) on alarm		77± 9	

Table 2:

	ALARMS WITH BABYSENSE	NO ALARMS WITH BABYSENSE
Alarms with CardioRespiratory Monitor	8	0
No Alarms with CardioRespiratory Monitor	0	72

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