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Original Article

Post Discharge Cardiorespiratory Events in Preterm Infants

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ABSTRACT

Background*: Home monitors designed to identify cardiorespiratory events are frequently used for premature infants who suffer from persistent apneic and/ or bradycardic events after they are otherwise ready for discharge home.*

Objective*: We have hypothesized that using event recording monitor will characterize the events during home monitoring and identifies at what postconceptional age (PCA) the infants are event free.*

Materials and Methods*: 12 hours bedside four channel pneumogram was performed on 452 preterm infants born at ≤34 weeks of gestational age before hospital discharge. 108 infants had at least one episode of apnea≥20 second and/ or one episode of bradycardia< 80 beats per minute (BPM) for ≥5 second and they were considered symptomatic and discharged on event recording monitor. The monitor documented transthoracic impedance, electrocardiogram and heart rate. The monitor was downloaded at least once a month. An event was considered to be significant when an apnea lasted ≥20 seconds or when the heart rate was <80 BPM for ≥5 seconds for PCA <44 weeks and <60 BPM for PCA ≥44 weeks. Each infant was monitored for at least one month after the last event. Infants who were monitored for <50% of available days or <8 hours per day were excluded from the study.*

Results*: Duration of post discharge monitoring ranged from 4-30 weeks (median 7 weeks). When the patients were events free PCA ranged from 34-55 weeks (Median 39 weeks). Compliance for the usage of monitor for available days was 50-100% (median 100%). For daily use the time range was 8-12 hours (median 19 hours). During 152,664 hours of home monitoring 1,240 events were recorded. Of these events only 184 were apnea more than 20 seconds 47% of infants did not have apnea ≥20 seconds after discharge. 80% of infants with apneic episode had ≤5 episodes during home monitoring. Bradycardia without apnea of at least 20 seconds represented 32% of the events. 75% of bradycardiac episode were associated with short apnea (10±4 seconds).*

Conclusions*: Preterm infants discharged home on event recording monitor had low incidence of apnea ≥20 seconds. Using event record monitor will characterize the events during home monitoring and is helpful in determining the appropriate time of discontinue monitoring.*

Keywords*: Apnea, Home monitoring, Event recording*

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INTRODUCTION

Apnea and bradycardia are common in premature infants (1,2). It usually ceases by 37 weeks post conceptional age (PCA), but may persist beyond term especially in preterm infants with gestational age of less than 28 weeks at birth (3,4). The evaluation and management of preterm infants with apnea or bradycardia events after they are otherwise ready for discharge home remain controversial and practice varies considerably among institutions (5). The current demand for shortening the length of stay and the persistence of cardiopulmonary events at the time of discharge, have resulted in widely use of cardiorespiratory home monitoring for preterm infants (6). Recent data reveals that monitor use is not associated with earlier hospital discharge (7). As clinical bedside monitoring during the hospitalization is not very reliable, at our institution, all preterm infants ≤34 weeks at birth will have an overnight 4-channel pneumogram before discharge (8). After discharge false apnea and bradycardia alarms, which are often considered real by caregivers, have lead to prolongation of home monitoring (9, 10). We conducted a prospective study to follow these infants after discharge on events recording monitor. We hypothesized that using event recording monitor will characterize the events during home monitoring and identifies at what postconceptional age the infants are event free.

MATERIALS AND METHODS

We routinely perform overnight four channel pneumogram recording in all preterm infants' ≤34 weeks of gestational age at birth prior to discharge from our level 3 neonatal ICU. Impedance breathing movement, nasal airflow oscillometry via a thermister and heart rate were recorded with the Eden Trace II pulse monitor (Mallinckrodt, Pleasanton, CA). Recording of arterial O2 saturation (SPO2) were performed with Nellcor NP203 B pulse oximeter (Mallinckrodt). Data were stored in memory and subsequently printed. Infants were eligible for inclusion in this study if they had at least one of the following criteria:

1) Apnea of at least 20 seconds
2) Heart rate <80 bpm for at least 5 seconds
3) On caffeine for apnea of prematurity and,
4) Staff in neonatal ICU documented apnea and bradycardia within 5 days of discharge.

Infants were excluded if they had an intraventricular hemorrhage ≥ grade 3, periventricular leukomalacia, seizure, chronic lung disease or major congenital malformations. Infants were discharged on event recording monitors after caregivers were trained for PCR and monitor use. The event recorder documented transthoracic impedance, electrocardiogram and heart rate signals 30 seconds before an event, during the event and for at least 30 seconds after the event had terminated. It was programmed to record apnea lasting more than 15 seconds and bradycardia (<80 bpm). Information was automatically stored in the recorder's memory if the apnea or bradycardia setting limit was violated, or when recorder detected the presence of loose leads or movement. The event recorder also recorded date, time and duration of the events, as well as when monitor was switched on or off. Monitors were downloaded every month or sooner if the memory was full. The stored data were printed and the printouts were reviewed and each event categorized as true or false. A true event was defined as one for which visual inspection of transthoracic impedance and electrocardiographic and heart rate tracing, verified apnea or bradycardia. Depending on which signal fist violated the preset limits of the monitor, the event was classified as either apnea or bradycardia. A false event was classified as one for which visual inspection of transthoracic, electrocardiographic and heart rate signals did not verify apnea or bradycardia or there was evidence of movement or loose leads. An event was considered

to be significant when apnea lasted for more than 20 seconds or when the heart rate was less than 80 bpm for at least 5 seconds for PCA <44 weeks, and less than 60 bpm for PCA ≥ 44 weeks.

Each infant monitored for at least 4 weeks after the last true events. For infants on Caffeine therapy at discharge, medication discontinued if they were event free for 2 weeks. Monitoring was terminated when they were asymptomatic for at least 4 weeks after discontinuation of Caffeine. Families received ongoing support for home monitoring mainly by phone calls and were informed when the results of downloads were available. Infants who were monitored for less than 50% of the available days or less than 8 hours per day were excluded from the study. The study was approved by institutional review board. Statistical analyses were performed using Sigma Stat 3.1 for windows statistical package (*Systat Software, Inc. Point Richmond C*A). Comparison between groups were done using *Student T-test* and *Mann-Whitney Rank Sum test*. The difference was considered significant at p-value<0.05.

RESULTS

Of 452 infants with gestational age ≤34 weeks at birth, 136 infants were discharged on monitor. 108 infants fulfilled the inclusion criteria. Table 1 provides the characteristics of the infants included in the study. 63 infants (53%) received methylxanthine during the hospitalization and the medication discontinued if the infant was asymptomatic for 5-7 days. 48 infants (44%) were discharged home on Caffeine.

Table 1. Patients characteristics

Patients characteristics (n=108)	Range and median
Gender (M/F)	56/52
Birth weight (grams)	640-2706 (1500)
Gestational age at birth (weeks)	24-34 (31)
GA at discharge (weeks)	33-42 (35)

Our patients were monitored at home for 15664 hours. The range and the median duration of montoring per for each patient was 420-4620 (1120) hours. Duration of post discharge monitoring ranged from 4 to 30 weeks with median of 7 weeks. The median PCA when the patients were event free was 39 weeks (range 34-55 weeks). Infants who were discharged on Caffeine received medication for a median duration of 7 weeks (range 4-9 weeks) after discharge. There was no difference in gestational age between infants discharged with Caffeine and/or infants without Caffeine (30.6±2.5 weeks vs. 31.0±2.6 weeks). Infants who were discharged on Caffeine took significantly longer time to become event free (PCA 41±4.0 weeks, compared PCA 38±4.3 weeks in the infants without Coffein, p-value<0.001, P=0.009) also the infants who were discharged on Caffeine required monitoring for significantly longer time (PCA 49±5.6 weeks vs PCA 44±4.2, P<0.001).

Only 3 patients were excluded due to inadequate use of monitor according to our criteria. Compliance in the usage for available days was 50-100% with median of 100% and for the daily use was 8 to 23 hours with median of 19 hours.

We analyzed 1,240 events that exceeded our criteria for significant events (table 2). Thirteen infants (12%) had no apnea or bradycardia events after discharge. 57 infants (53%) had apnea at least 20 seconds. The number of apneic episodes ranged from 1-28 (median 2) and 80% of the infants had less than 5 episodes of apnea (≥ 20 seconds) during home monitoring. 72% of apneic events were without bradycardia. 35 infants (32%) had only bradycardia episodes during the course of monitoring. The number of bradycardia events ranged from 1-290 (median 8). 75% of bradycardia events were associated with short apnea (10±4 seconds). No infant died during the course of monitoring.

Table 2. Cardiorespiratory events characteristics.

Apnea	
≥20 seconds	173
≥ 25 seconds	9
≥30 seconds	2
Bradycardia	1056
Total events	1240

DISCUSSION

The result of this study was that the majority of our preterm infants discharged home on monitor had few episodes of apnea ≥20 seconds. Forthy percent of the patients did not have any episode of apnea ≥ 20 seconds after discharge. Seventy nine percent of infants with episodes of apnea of ≥ 20 seconds had less than 5 events during home monitoring. Two episodes of extreme apnea (apnea ≥30 seconds) occurred in patient with gestational age of 30 weeks at birth (11). This patient was asymptomatic at 43 weeks of PCA. We used customary transthoracic impedance monitoring which detect central apnea. Recent studies using *respiratory inductive plethysmography* (RIP) reveals a high frequency of obstructive or mixed apnea (11, 12). These findings suggest that current home monitors may miss many events. The *Collaborative Home Infant Monitoring Evaluation* (CHIME) study showed that apnea and bradycardia at conventional alarm threshold occurred in 76.3 of symptomatic preterm and 63.7 of asymptomatic preterm as well as 43.2% of term healthy infants (11). Using RIP which can identify obstructed breath, they observed more apnea than currently available home monitors, which detected effort during obstruction. This limits direct comparison of these findings to data based on customary impedance monitoring.

Although detection of bradycardia might provide alternative opportunity to detect events, 32% of out patients had only episodes of bradycardia without any episode of apnea ≥ 20 seconds during home monitoring. Majority of bradycardia events (75%) were associated with short apnea (10±4 second). In CHIME study half of extreme events had no bradycardia event when associated with desaturation. Bradycardia without significant apnea may occur in preterm infants after discharge and healthy term infants up to 6 months of age (13, 14). These events may be normal reflex response. Alternatively, high incidence of bradycardia episodes may be attributed to increased vagal tone in symptomatic preterm infants (15). It is likely that some of the bradycardia events were associated with mixed or obstructive apnea that remained undetected by transthoracic impedance technology.

The median PCA when the infants became events free was 39 weeks although events persisted beyond that time in some infants. Using a monitor with event recording and establishment of a specific plan for periodic review was helpful in determining the appropriate time for discontinuation.

In conclusion, our study reveals that majority of preterm infants have few episodes of prolonged apnea (at least 20 seconds), and extreme apnea (at least ≥30 seconds) is a rare event after discharge from hospital. Home cardiorespiratory monitoring may be prescribed for preterm infants with frequent events especially with extreme events. Using a monitor with event recording is helpful to characterize the events and in determining the appropriate time for discontinuation of monitoring.

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