Original Article

Indian Journal of Maternal-Fetal and Neonatal Medicine
Volume 2 Number 1, January - June 2015
DOI: https://dx.doi.org/10.21088/ijmfnm.2347.999X.2115.4

# A Spectrographic Analysis of Infant Cry

**Bhushita B. Lakhkar Guru*, Nilesh Guru**, Bhavana B. Lakhkar*****

**Author's Affiliation:**
*Postgraduate in Radiodiagnosis, JNMC Wardha. **Assistant professor of Surgery, Index medical college Indore. ***Professor of Pediatrics, Dean School of advanced studies, J N M C, Wardha maharashtra.

**Reprint Request:**
**Bhavana B. Lakhkar,**
Professor of Pediatrics, Dean School of advanced studies, Jawaharlal Nehru Medical College, Sawangi, Wardha, Maharashtra 442005

E-mail:
blakhkar@yahoo.co.in

**Abstract**

*Objectives:* 1. To study the spectrographic picture of the infant cry due to different reasons after changing it into waveform. 2.To co-relate the waveform pattern with the cause. *Study population:* Babies of any sex between 0-8 weeks. *Study design:* Prospective cross- sectional Observational study . *Methods*: Babies in the postnatal ward were selected for recording of hunger (20) and discomfort cry (20). Whenever a baby cried the cry was recorded , diaper was checked If found soiled was changed. if baby stopped crying it was labeled as discomfort cry. If diaper was dry, the baby was put to breast and if baby stopped crying it was labeled as a hunger cry.

Babies (20)for DPT immunization was recorded for pain cry. Record was taken 5-10 seconds from start. Recording was done using APPLE I pod, software using a microphone. The sound spectrogram was converted to pressure wave form using computer software ACOUSTIC ANALYSING SYSTEM 5E. *Result* : Total 60 babies were recruited between 0 to 8 weeks. Typical wave forms could be correlated with cause of cry. *Conclusion*: The sound spectrogram of infant cry can be converted to pressure waveforms which are typical and specific for the cause of cry. An instrument can be made which will record baby cry and correlate it with cause.

## Introduction

All the babies cry and it is surprising that very little work has been done on nature of cry. Everybody who cares for baby recognizes feeble cry of weak baby, hoarse cry of hypothyroid baby or baby with laryngeal infection and high pitch cry of cerebral irritation [ 1] .

Buhler (1930) (2) argues strongly for expressive function of pre verbal vocalization. Works by other authors [3] have shown spectrographic findings of baby cry which are different in healthy and unhealthy babies.

Hence; it is hypothesized that cry of a healthy baby will also be different in different situations like hunger, pain, discomfort and can be picked up spectrographically.

Nurses in special care nursery are always troubled by "why a baby is crying"? Specially while dealing with new young mothers.

This study is an effort to analyze the cry and relish the idea of making of a cry monitor , looking at which nurses in the hospital can make out the cause for the baby cry so that baby can be put to comfort as early as possible.

## Aims and objectives

1. To study the spectrographic picture of the infant cry due to different reasons after changing it into waveform.
2. To co-relate the waveform analysis of the infant cry with the cause.

## Methodology

*Study setting*

This study was done in ACHARYA VINOBHA BHAVE RURAL HOSPITAL Sawangi (M) Wardha Maharashtra India . This is a hospital attached to Jawahar lal Nehru Medical college Wardha.

*Study population*

Babies of any sex between 0-6 months.

©Red Flower Publication Pvt. Ltd.

*Study design*

Prospective cross- sectional Observational study.

*Sample size*

Total of 60 babies were included in the study. Out of which 40 newborns were from postnatal ward and 20 babies from pediatric OPD who have come for immunization.

*Inclusion criteria*

full term healthy babies between 0-8 weeks, irrespective of gender.

*Exclusion criteria*

1. Sick babies
2. Babies with neurological problems.
3. Babies with oral lesions till oral lesions have healed.
4. Babies with major or multiple anomalies.

**Methods**

Babies in the postnatal ward were selected for recording of hunger and discomfort cry. Whenever a baby cried the cry was recorded, diaper was checked to see whether child has passed urine or stool. If the diaper was found soiled it was changed. Now if baby stopped crying it was labeled as discomfort cry.

If diaper was not wet, the baby was put to breast and if baby stopped crying it was labeled as a hunger cry.

If baby kept on crying and did not stop on offering breast , that particular record was deleted.

In this manner 20 records (of discomfort and hunger each) were recorded.

Babies coming for immunization were selected for pain cry. Cry of baby coming for DPT immunization was recorded. As baby started crying after injection, record was taken 5-10 seconds from start and total recording of minimum 20 seconds were done . Total of 20 such records were taken.

Recording was done using APPLE I pod, software using a microphone which was kept 5 cm from babies mouth. Recording was done in a sound free room to avoid disturbance. The sound spectrogram was converted to pressure wave form using computer software ACOUSTIC ANALYSING SYSTEM 5E.

The graph was analyzed in the following manner:

1. Number of spikes per second –which representedfrequency.
2. Amplitude of smallest and largest waves for pitch
3. Length of silence(if any)
4. Appearance of waveform
    a. In relation to baseline
    b. Regularity and any recognizable pattern

The analysis was kept manual and simple, as the main user planned for this interpretation were nurses.

**Results**

Total of 60 babies were included in the present study. Forty babies (60%) were from post natal ward and 20 (40%) from Out Patient Department. Post natal ward babies were between 3-7 days. Out patient babies were between 6 weeks to 2 months . There were 33 males and male-female ratio was 1.2:1.

Each spectrogram was of 20 second duration. The part of spectrogram after initial 10 second and before last 5 seconds was converted to wave form using computer soft ware named acoustic analyzing system 5E. Each waveform was analyzed manually.

Mean age of hunger cry babies was 4 days ( range 3-7 days), in discomfort cry group it was 5 days (range 3-7 days) and in pain cry group it was 7 weeks (range 6 weeks- 8 weeks). Homogenous sample could not be taken as, to cause pain in normal newborn would have been ethically incorrect.

*There were 20 babies in each group. Males predominated (60%) in hunger and discomfort group (65%)and females(66%) in pain cry group*.

Waveform characteristics of all cry types were compared.They were analysed as per amplitude, frequency and patterns of waves(table no 1) .

The maximum variability(based on minimum and maximum amplitude) was in the pain group and minimum variability was in hunger group. Frequency was maximum in babies who cried with pain.( i.e 6/ second) whereas, in discomfort and hunger it were almost equal.

The waveform pattern of discomfort cry in 70% of cases showed some recognizable pattern for example; regularly appearing high amplitude wave (every 4$^{th}$ wave high amplitude), ascending or descending pattern etc.

**Table 1:** Waveform characteristics

| Waveform characteristics | | Discomfort | Hunger | Pain |
|---|---|---|---|---|
| Amplitude | Minimum (cm) | .5 | 1.2 | .2 |
| | Maximum (cm) | 3.1 | 3.3 | 5 |
| Frequency | Waves/sec Mean(range) | 3.5 (2-5) | 3.6 (2-5) | 4.3 (2.5-6) |
| Pattern of waves | Recognizable form | 70% | 20% | 05% |
| | Uniform | 10% | 60% | 80% |
| | inconsistent | 20% | 20% | 15 |

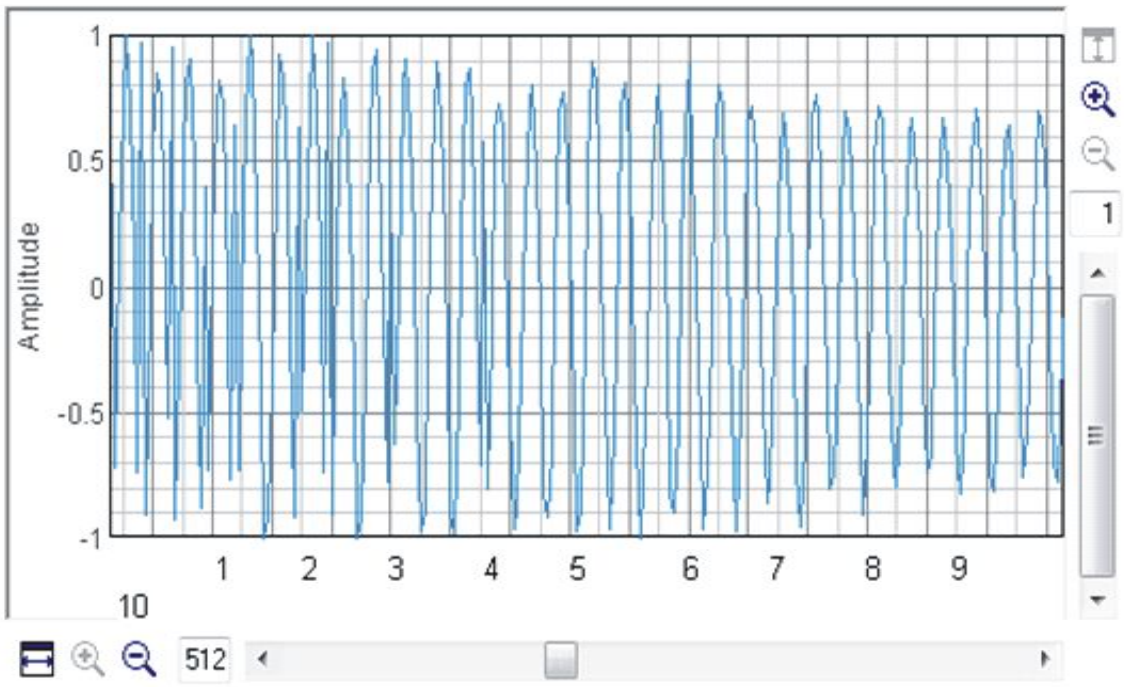
Pain cry was characterized by uniform appearance (80%). In hunger cry though majority (60%) showed uniform pattern 20% showed recognizable pattern also. One more interesting observation was relation of waves to baseline (positive or negative waves) which suggests creation of positive or negative air pressure by the sound waves changing the atmospheric pressure. Majority (60%)of discomfort cry waves were on positive side or were equal on each side (25%). In 50% of hunger cry waveforms were equal on each side whereas, in (35%) were on positive side. In pain cry, mostly they were equal on each side of baseline ( 60%) and were on negative side in 30%.

In nutshell, the following were characteristic of different cries:

*1. Pain cry*

Waves were of high frequency and high amplitude and uniform appearance. [Fig 1.]

**Fig. 1:** Pain cry



*2. Discomfort cry*

The frequency and amplitude were less than pain cry but some recognizable patterns were present. [Fig 2.]

*3. Hunger cry*

Low amplitude, low frequency waves with uniform appearance [Fig 3.]

**Fig. 2:** Discomfort cry

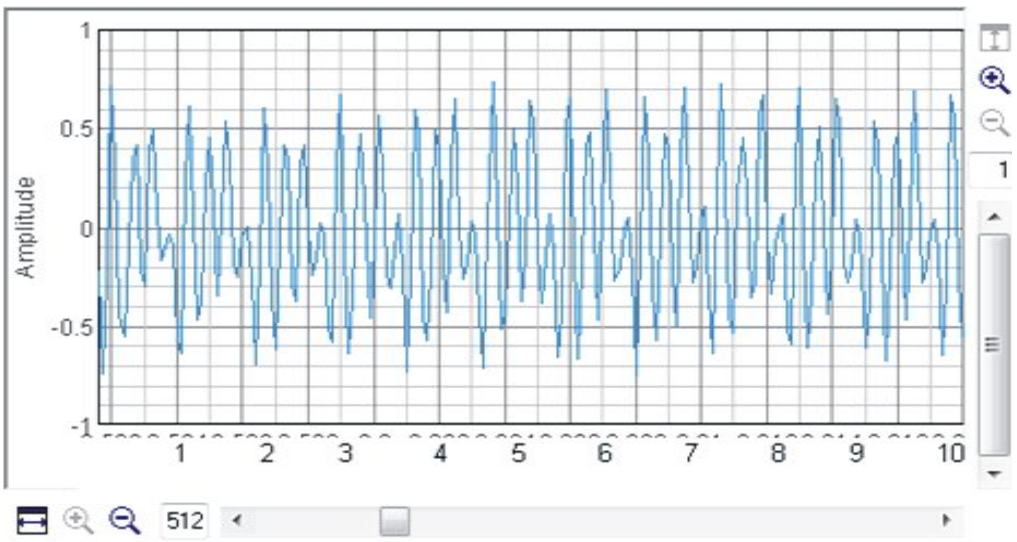
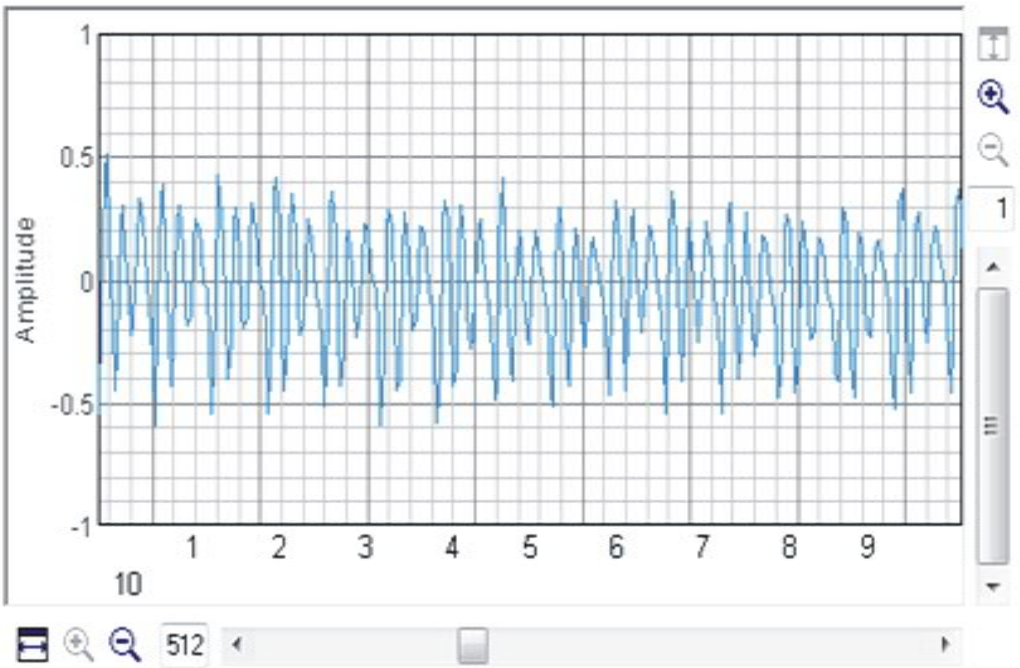



**Fig. 3:** Hunger cry




## Discussion

The infant's cry is a way of communication, although more limited; it is similar to adult's speech. Parents and specialists in the area of childcare learn to distinguish among different kinds of baby cries, by using their own auditive perceptions for differentiating and interpreting an infant cries. This type of differentiation and interpretation are mainly subjective, and depend upon individual exposure and perceptive capacities. This study finds an objective way of dealing with the proble.

This study also give us a hope that a monitor can be developed which can help the observer to recognize the common causes of infant cry.

Sound spectrogram was used way back in 1970[4] to study cry characteristics in sick babies. Angelo et al (5) studied audio signals of babies after heel prick, hunger and sleep .They did frequency analysis and found it very informative. Present study also shows important differences in frequency of different cries.

It is difficult for a common person to understand spectrogram but if it is converted to simple graph ,can be understood by anybody including nurses. Hence, in this study pressure waveforms have been used.

Atmospheric pressure is 100000 pas/kal. It is taken as a base line and whatever changes sound waves create in this pressure is recorded in waveform considering atmospheric pressure as 0 or baseline.

We converted sound spectrogram into pressure wave form and studied cry in 3 situations : Discomfort ,hunger and pain .

The waveform differs in these 3 situations and looking at graph it is possible to say why a baby is crying.

The characteristic finding of *Pain* cry (high frequency, high altitude uniform pattern) must be due to sudden stimulation of child, giving rise to strong vibration of vocal cords thus giving above picture.

*Discomfort* cry finding (typical patterns and low to medium size amplitude wave that are smaller than pain cry) must be because of absence of shock like stimulation of child where the baby want to communicate that he is not comfortable.

The features of *Hunger* cry (low amplitude, low frequency uniform waves) suggest that the child is not over excited and is used to this feeling and the cry is just signal for the mother to fulfill his demand.

Angelo et al[5] who recorded cries of several full term neonates while blood sampling, showed non linear irregular pattern during pain.

Arakawa made a system for recoding and displaying baby cry and its correlation with cause[6]. This type of system will be of use in an institutional set up and is possible to make. This is similar to present study but in present study cry record is simplified to waveform.

One more similar effort was made by Mahmoud and Sadjedi , they created a System for differentiating Infants with Pain from normal infants based on Multi-band spectral entropy of baby cry successfully [7].

Katarina and Oliver Michelsson in 1999 [8] demonstrated that frequency and malody contour of baby cry on a sound spectrogram changes if baby is sick . They could show different spectrograms in cases of birth asphyxia ,hypothyroidism and also in meningitis. This shows effect of change of physiological status on baby cry.

Some authors showed that a pain threshold exists at which cry features change. Thus, the acoustic features of crying help to discriminate between different degrees of pain as well[9]. The finer differences in wave forms of pain group in the present study may be due to different degrees of pain in different children.

The observations in the present study and in other studies show that definitely the cry has meaning and a cause. If a large study is conducted using the finer changes a very useful information can be obtained. The world famous suspense "why a baby is crying" can be solved using the graphical records.

Use of computers in analyzing the waveforms can further improve the understanding of records. The day is not far away when nurses working at their station can calm down a baby as they would know exactly why the baby is crying.

*Authors' contribution*

Bhushita Lakhkar- Recruited the cases, analysis,writing manuscript

Dr Nilesh Guru- Helped in managing software and analysis of waveforms

Dr Bhavana Lakhkar – helped in planning analysis and manuscript writing.

*Competing interest*

None

*Funding*

Nil

**Conclusions**

1. The sound spectrogram of infant cry can be converted to pressure waveforms .
2. The waveforms are typical and specific for the cause of cry.

3. An instrument can be made which will record baby cry and the graphics will inform care taker about the reason for which the baby is crying.

**References**


1. Wasz, O. Vuorenkoski, V. Valanne.E 'The vocalization of a new born brain damaged child.' Ann. paediat, Fenn 1965 ; 11: 32.
2. Brazelton, T.B. 'Crying in infancy' Pediatrics: 1962 (32) 301-302.
3. Orozco. J , Carlos A., Reyes G. Detecting Pathologies from Infant Cry Applying Scaled Conjugate Gradient Neural Networks. ESANN'2003 proceedings - European Symposium on Artificial Neural Network Bruges (Belgium), 23-25 April 2003.
4. Varrayala . G. Future prospects of the application of the infant cry in the medicine .Periodica polytechnica ser .el.eng.vol.50,no 1-2,pp. 47-62 (2006).
5. Angello f, Nadia M,federico MP.Relating pain intensity of newborn to onset of nonlinear phenomenon in cry recordings.Physics letter A 2005 ( 338) 3-5 ,332-335.
6. Arakawa, Kaoru. System and method for analyzing baby cries available at http :/ www.freepatentomline.com 6496115,12/17/ 2002.
7. Mahmoud M J, Hamed S, "A System for Detecting of Infants with Pain from Normal Infants Based on Multi-band Spectral Entropy by Infant's Cry Analysis," iccee, vol. 2, pp.72-76, 2009 Second International Conference on Computer and Electrical Engineering, 2009.
8. Katarina ,M Oliver M . Phonation in the newborn, infant cry . international journal of pediatric Otolaryngology 1999 , Supplement 1,S297-S301.
9. Belliene, C V, Sisto, R, Coedelli D M., Buonocore, GIiuseppe Cry Features Reflect Pain Intensity in Term Newborns: An Alarm Threshold . Pediatric Research; 2004; 55:( 1) 142-145.
10. LaGasse LL,Neal AR, Lester BM :assessment of Infant cry : acoustic cry analysis and parental perception.Mental retardation and developmental disabilities research reviews 2005 (11); 83-93.