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Concurrence of Decreases in Barometric Pressure and Spontaneous Rupture of Membranes in Term Gravid Women

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**Concurrence of Decreases in
Barometric Pressure and Spontaneous
Rupture of Membranes in Term Gravid Women**

by

Linda M. Owen

A Thesis

Grand Valley State University

Kirkhof School of Nursing

1999

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ABSTRACT

CONCURRENCE OF DECREASES IN BAROMETRIC PRESSURE AND SPONTANEOUS RUPTURE OF MEMBRANES IN TERM GRAVID WOMEN

BY

LINDA M. OWEN

A retrospective design was used to examine the relationship between spontaneous rupture of membranes in term gestation gravid women and decreased barometric pressure of ten millibars or greater in the twenty-four hours preceeding the rupture of membranes. Delivery logbooks and charts of all women who were admitted to a Midwestern Hospital in 1997-1998 with spontaneous rupture of membranes (N-533) were examined and data from the Midwest Climate Center was utilized to determine the changes in barometric pressure within the twenty-four hours preceeding the documented rupture of membranes.

No correlation was elucidated between the timing of spontaneous rupture of the amniotic membranes and atmospheric pressure changes. If such a cause and effect relationship exists, it remains to be determined.

DEDICATION

*God give us hearts to understand our brother,
Lips that speak in love of one another.
Seeing earthly ways, open our eyes
And make us very slow to criticize.*

Lois Rowe

This thesis is lovingly dedicated to my children Sara, Jenna, and Mark Owen and to my family and friends who have given me encouragement to press on. Your prayers have lifted me up and strengthened me. Praise God and give him the glory. In his heart of hearts I'll dwell.

ACKNOWLEDGMENTS

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CHAPTER ONE

INTRODUCTION

For years, nurses working in obstetric and emergency units have insisted there is a correlation between environmental factors such as lunar cycles and changing weather patterns and the initiation of labor in pregnant women. Observations dating back to Greek civilizations postulated a relationship between atmospheric conditions and physiological changes in the human body.

Studies of the effects of atmospheric changes have demonstrated conflicting evidence in substantiating relationships among these phenomena. Noller, Resseguie, and Voss (1996) found no significant association between falling barometric pressure and onset of labor. In contrast, King, Fleschler and Cohen (1997) demonstrated an increased number of labor onsets within 24 hours following a significant drop in barometric pressure. Other studies demonstrated conflicting evidence (Polansky, Varner, & O’Gorman, 1985; Driscoll & Merker, 1984; Kardong-Edgren, 1995).

Boyle’s Law describes the expansion of gases. It states that “...when the temperature remains constant, the volume of a given mass of gas varies inversely to its pressure...” (Blumen, Abernethy, and Dunne, 1992). Barometric pressure is defined as the force exerted on a surface of unit area by the weight of the atmosphere. As barometric pressure decreases, the volume of gas within an enclosed space expands. The effect of sudden expanding mass within the womb during periods of decreased

barometric pressure and the integrity of the amniotic sac has not been adequately addressed.

It has been demonstrated that onset of labor occurs within 24 hours of spontaneous rupture of membranes in 80-90% of pregnant women (Varney, 1987). If a link between barometric pressure and spontaneous rupture of membranes is supported, then increasing client awareness during prenatal education can have an impact on her prenatal care. She can make arrangements to have access to medical care available if needed when possible storms are forecast. She may also be better prepared psychologically for the process of labor.

The ability to predict with greater reliability the need for additional nursing staff in the hospital environment has the potential for great clinical and financial benefit. Quality patient care can be maintained when increased patient loads can be anticipated.

Problem Statement

This study will attempt to answer the question: “ What is the relationship between decreased barometric pressure and spontaneous rupture of membranes in term gestation pregnant women?”

Purpose

The purpose of this study was to examine the records of term deliveries to ascertain if significant decreases in barometric pressure contribute to higher incidences of spontaneous rupture of membranes (SROM). Steinman and Kleiner (1978) identified a statistical correlation between the timing of spontaneous rupture of amniotic membranes and the ambient atmospheric pressure, as well as the rate of decrease of pressure. This study endeavored to uphold their conclusions by determining the

percentage of cases of spontaneous rupture of membranes that were preceded in a 24-hour period by a decrease in barometric pressure of 10 millibars or more. A greater sample size was used and the time period of the study included two years of data.

CHAPTER TWO

REVIEW OF LITERATURE AND THEORETICAL FRAMEWORK

Theoretical Framework

Martha Rogers' Science of Unitary Human Beings was first presented as *An Introduction to the Theoretical Basis for Nursing* in 1970. It has been described as "an eclectic synthesis of idealism, progressivism, and humanism that moves away from rationalism and scientific realism" (Fawcett, 1995, p.380). She conceptualized that humans are dynamic energy fields who are integral with environmental energy fields and who are constantly evolving. Man is the central phenomenon of interest to the discipline of nursing. She also focused on the environment as an equally important phenomenon (Fawcett, 1995, p.377).

The individual is viewed as a unique irreducible pandimensional energy field who is integral with a unique environmental energy field. This entity is a unified whole, demonstrating characteristics that are more than and different from the sum of his or her parts. The individual and the environment are continually exchanging matter and energy with each other, resulting in changing patterns in both the individual and the environment. This evolution is unidirectional. These changes are increasingly diverse and unpredictable.

Health and illness are not two separate conditions but are part of the same continuum. Health occurs when patterns of living are in harmony with environmental

change while illness occurs when patterns of living conflict with environmental change and are considered unacceptable. Rogers stated, "Well being is a value, it is not an absolute" (Fawcett, 1995, p.386). Families have their own definitions of what constitutes sick or well.

Rogers' Science of Unitary Human Beings encompasses four concepts. 1). The fundamental level of unitary humans and the environment is that they are dynamic energy fields having no certain boundaries. 2). As energy fields, the individual and environment are continuously open and extending to infinity. 3). Pattern and organization characterize human and environmental fields and are continuously changing unidirectionally and becoming more diverse. 4). Reality is pandimensional and provides for an infinite domain without limits.

There are three principles of homeodynamics that postulate the nature and direction of unitary human development. *Helicy* is the "continuous, innovative, unpredictable, increasing diversity of human and environmental field patterns" (Fawcett, 1995, p.385). *Resonancy* is the "continuous change from lower to higher frequency wave patterns in human and environmental fields" (Fawcett, 1995, p.385). *Integrality* is the "continuous mutual human and environmental field process" (Fawcett, 1995, p.386).

The correlation between changes in barometric pressure and spontaneous rupture of membranes specifically addressed and tested an aspect of Martha Rogers' Science of Unitary Human Beings by demonstrating the principles of integrality and resonancy between person and environment. Humans and their environment are irreducible, indivisible wholes that manifest as energy fields. This may be visualized as the

continuation of the beach and the ocean. The human energy field is regarded as an active organism who is integral with the environmental energy field. (Fawcett, 1995, p.380). These energy fields are in a state of flux, always in the direction of increasing diversity. The movement of tides and the impact of ocean storms continually changes the conformation of the shore. Resonancy, the continuous change from lower to higher frequency wave patterns, can be pictured as waves building in intensity as they impel to the land. Integrality accentuates the relationship of the continuous mutual human field and the environmental field process. Hence, as waves shift significantly in the environmental field, they should be reflected in shifts in the human field. We are familiar with houses that are built at the edge of the water toppling into the sea. The interaction of human and environmental energy fields is propulsive and transitional. These wave shifts in pregnant women may alter the integrity of the amniotic membrane resulting in the spontaneous rupture of the maternal amnion.

The integrity of the amniotic sac may be compromised due to the nature of Boyle's Law on the human and environmental energy fields. For example, if we squeeze a toothpaste tube in one place, it bulges out at another. The body's immediate response to the fluid shift in space is to eliminate the excess fluids it thinks it has. The temperature within the womb remains constant. When there is a decrease in barometric pressure, the mass of gas within the enclosed confines of the womb expands, thereby influencing the integrality of the human field and the environmental field.

Review of the Literature

Research examining the relationship between barometric pressure and spontaneous rupture of membranes is sparse. A summary of the general studies reviewed is presented after each study has been individually critiqued.

Studies have focused on the influence of lunar phases, only incidentally measuring barometric pressure and its effect on the onset of labor in pregnant women (Stern, Glazer, and Sanduleak, 1988; Kardong-Edgren, 1995). The retrospective study performed by Kardong-Edgren (1995) tested the association between moon phase, barometric pressure and birthrate. This study explored the 72-hour periods around a full moon and compared the birthrates on these and other days of the month. The effects of changes in barometric pressure were also included in this study. Barograms (24-hour records of barometric pressure recorded in graph form) were examined and cross-referenced with an almanac to compare periods of full moon with average barometric pressure, no full moon with decreased barometric pressure, and full moon with decreased barometric pressure. A drop in barometric pressure of 2 millibars in an hour was considered significant. It was hypothesized that birthrates would increase during times these environmental factors were present. Chi-square analysis was used to analyze all combinations of data gathered in the study. Of 453 births meeting the study criteria, no association was revealed.

A similar study done by Stern et al. (1988) attempted to show a correlation between the moon, the onset of labor, and SROM. Onset of labor was defined as uterine contractions of sufficient frequency, intensity, and duration to bring about readily demonstrable effacement and dilation of the cervix resulting in the admission of the

woman into the labor and delivery unit. The 1999 admissions studied identified the onset of labor rather than the time of birth as the significant factor. Information on the lunar phases of the full moon and new moon, as well as that of barometric pressure, were recorded. Low barometric pressure readings were considered less than 29.100 inches. There was a significant positive correlation ($\chi^2=5.018$, $df=1$, $p=.025$) between the full moon and onset of labor when not controlled for barometric pressure. The same did not hold true for SROM when it occurred before the onset of labor. There was a nonsignificant relationship of both the new moon and full moon to onset of labor ($\chi^2=0.968$, $df=1$, $p=.325$) and spontaneous rupture of membranes ($\chi^2=0.004$, $df=1$, $p=.948$) when barometric pressure was controlled. Limitations of this study included the subjective nature of the determination of the onset of labor, the use of one geographical location, the collection of data for one year only, and that the study was done retrospectively.

A retrospective study examining the association between weather and the onset of human parturition was done by Driscoll and Merker (1984). The hospital records of 1169 women were examined to elicit the time they indicated they first felt labor contractions. Associations with weather data were analyzed using three tests. First, daily onsets of contractions were tested evidence of weather characteristics of persistence and variability. Persistence is the continuation of a uniform weather pattern from one to three days. Variability is a lack of uniformity in the weather patterns. Autocorrelation coefficients for persistence were not significantly different from zero. Variability of weather expressed as seasonal indexes found little difference. Second, the frequency

distributions of nine weather variables were mathematically calculated and onsets of labors calculated for each of these divisions. The weather variables examined included departure from the normal of daily maximum temperature, temperature change from previous day, barometric pressure at 0600 local time, pressure change from previous day, dewpoint temperature change from previous day, precipitation (no rain, or trace, or more), sky cover (stratified as clear, overcast, and neither), wind direction (plus variable and no wind), wind speed, and number of hours with wind gusts. The chi-square test was used to determine the significance of the differences. Days in the cool season of October to March, with relatively low pressure, a marked drop in temperature from the previous day, and high wind speeds were coupled with above average onset means. When all three phenomena were present, the mean onset was 34 percent above the average for all days of the two year study period. Third, the weather data were organized into periods of pre-frontal, post-frontal, or both. The average number of daily onsets of labor were significantly increased (18%) before passage of a cold front. A cold front was defined as a dew point decrease, change in wind direction, and drop in barometric pressure. These three variables were not always present, but there must have been an appreciable decrease in dewpoint to indicate that a front had passed.

Limitations to the study of Driscoll and Merker include statistically adjusting the number of women being delivered upward to develop a linear trend for their probability calculations. Also, it is not possible to determine the actual number of women who experienced labor during the study period.

Noller et al. (1996) challenged the findings of Driscoll and Merker in a study

relating the effect of changes in atmospheric pressure to the occurrence of the spontaneous onset of labor in term pregnancies. The date and time of onset of contractions was drawn from the patient admission sheet and this information was utilized as onset of labor. A total of 2435 women were included in this study. Least-square regression was used to develop a probability equation that could be used to determine expected number of labor occurrences during each day of the observation period. Data failed to demonstrate an increase in the occurrence of spontaneous onset of labor with falling barometric pressure.

Trap, Helm, Lindegaard, and Helm (1989) investigated 1516 births over a two year period to determine whether premature rupture of membranes (PROM) could be correlated with the phases of the moon or barometric height. Deliveries with PROM numbered 254. No association was observed between the phases of the moon and deliveries beginning with PROM or with deliveries beginning without PROM. No relationship was found between the frequency of PROM and the barometric height. Variations in barometric height up to 9 hours before the fetal membranes ruptured did not influence the frequency of PROM. PROM occurred more frequently during the night-time and a larger number of primiparous women experienced PROM. Another study of the effects of barometric pressure and lunar phases on premature rupture of membranes was done by Marks, Church, and Benrubi in 1983. This study of 117 patients found no evidence that membrane rupture is influenced by these phenomena. However, it is unclear whether the patients were from the same geographic areas at the time of PROM. The period of this study encompassed only a six-month time frame.

A retrospective study of 32 women with premature rupture of membranes was undertaken by Steinman (1978) to evaluate the possible relationship of spontaneous rupture of fetal membranes to ambient atmospheric pressure. Variables were controlled by excluding multiple gestations and fetal weights greater than 4000 grams to reduce the possible effects of uterine overdistention. It was found that the atmospheric pressure was significantly lower (29.97 versus 30.02 inches of mercury) in the SROM group than the control group with a 97.5 percent level of confidence. The results of this study suggested that environmental conditions, such as decreasing atmospheric pressure, may be considered in determining factors behind the etiology of SROM.

Another study of the effect of barometric pressure changes and premature rupture of membranes was conducted by Polansky, Varner, and O'Gorman in 1985. One hundred nine women with premature rupture of membranes who lived within a 100 mile radius and were subject to the same barometric pressure changes were compared to 109 control patients in the same area. There were no differences in other obstetric complications or neonatal outcome. Control and study groups were matched to prevent skewing of the sample. Statistical analysis included two-by-two frequency tables, chi-square analysis and the Bonferroni multiple comparison procedure when appropriate. Significant differences were assumed when $p < 0.01$.

The relative association of barometric pressure change with PROM or onset of labor (OOL) was assessed by correlating barometric pressure change within a given number of hours prior to PROM (the study population) and OOL (the control population). PROM occurred more often when the barometric pressure had fallen during

the preceding three hours. Onset of labor, which was defined as the time at which regular contractions began, did not demonstrate this association.

Summary

Review of the literature revealed some correlation between atmospheric changes and physiological processes (refer to Table I for a comparison summary of the literature review). Four studies examined lunar phases and their effect on spontaneous rupture of membranes, and/or onset of labor or birth. Three of these studies incidentally looked at effects of barometric pressure on these phenomena. The lunar phases and barometric pressure changes were found to influence spontaneous rupture of membranes and/or onset of labor in one of these studies. Three additional studies investigated the effects of atmospheric pressure on spontaneous onset of labor and childbirth. Two of these studies determined a positive association between decreases in barometric pressure and onset of labor. Two studies specifically searched for a correlation between falling barometric pressures and premature rupture of membranes. One of these studies found an association between falling barometric pressures and premature rupture of membranes.

The sample populations from the studies varied in composition. Steinman and Kleiner excluded women with multiple gestations, polyhydramnios, or infants >4000 grams whereas the study by Driscoll and Merker was conducted with no restrictions. Common exclusions in all studies were inductions of labor and scheduled cesarean sections.

Variations in definitions produced inconsistency in comparing studies. For example, Polansky defines onset of labor as regular contractions within five-minute

intervals that had to be associated with progressive effacement and dilation of the cervix. (Polansky et.al., p.189). In contrast, Driscoll and Merker (1984) considered the time of first reported contractions as the time of onset of labor. A commonality of all studies required delivery upon hospitalization of all the women. However, studies performed in tertiary centers included maternal transports from outlying areas, thus the possibility of varying barometric pressures could not be excluded from the results.

The studies examining the relationship of barometric pressure changes to spontaneous rupture of membranes are limited in number and scope. Six studies followed a six-month to one year time span. Only two studies encompassed a two year time span. These two research studies (Driscoll, et. al., 1984. and Trap, et. al., 1989) reached differing conclusions. Therefore, further investigation using an extended time period is needed.

Table 1**Literature Review Table of Relationships**

Author	Decreases in Barometric Pressure	Lunar Phases	Onset of Labor/Birth	Spontaneous Rupture of Membranes
1. Driscoll, Merker	Yes	NA	Yes	NA
2. Kardong-Edgren	Yes	Yes	No	NA
3. King, Cohen, Flescher	Yes	NA	Yes	NA
4. Marks, Church, Benrubi	Yes	Yes	NA	No
5. Noller, Rosseguie, Voss	Yes	NA	No	NA
6. Polanski, Varner, O'Gorman	Yes	NA	NA	Yes
7. Steinman, Kleiner	Yes	NA	NA	Yes
8. Stern, Glazer, Sanoulek	Yes	Yes	Yes	Yes
9. Trap, Helm, Lidgaard, Helm	Yes	Yes	NA	No

Note. NA= not applicable

Hypothesis/ Research Question

The effect of sudden expanding mass within the womb during periods of decreased barometric pressure and the integrity of the amniotic sac has not been adequately addressed. This study attempted to answer the question, “What percent of cases of spontaneous rupture of membranes are preceded in a 24- hour period by a decrease in barometric pressure of 10 millibars or more?” It was hypothesized that in those cases of spontaneous rupture of membranes, more than 50% will have been preceded by a decrease in barometric pressure of 10 millibars or greater.

Definition of Terms

Spontaneous rupture of membranes (SROM): The leakage of amniotic fluid from the vagina without the use of artificial intervention. Evidence of leakage is documented by the visual confirmation of pooling of amniotic fluid in the vaginal vault, positive phenolphthalein (nitrazine) paper test, and positive microscopic ferning test (Steinman et al., 1978; Varney, 1987). These tests are each 90-98% conclusive.

Barometric pressure changes: Barometric pressure is recorded on an hourly basis and entered into a logbook by the Midwestern Climate Center. Their records are available for public use. Normal barometric pressure is 1013.3 millibars at sea level. A significant decrease equals 10 millibars or more within a 24- hour period of time. Barometric pressure that stays within a 5 millibar range over a 24- hour period is considered stable (personal communication with WFFX meteorologist Peter Chan and verified by WKZO meteorologist Ron Boyd).

Onset of labor: When uterine contractions of sufficient frequency, intensity, and duration to bring about readily demonstrable effacement and dilation of the cervix are attained resulting in the admission of the woman into the labor and delivery unit (Stern, et al. 1988).

CHAPTER THREE

METHODOLOGY

Research Design

This study was designed to explore the relationship between barometric pressure and spontaneous rupture of membranes, based on a woman's integrality with the environment. A retrospective, descriptive correlational design was chosen. A review of delivery room logs and charts was utilized to obtain data retrospectively. The information was correlated with official barometric pressure readings obtained from the Midwest Climate Center for the region served by the hospital at which the deliveries occurred.

The use of a retrospective chart review eliminated the threat of recall bias. Factors which may compromise the integrity of the amniotic sac and increase the incidence of spontaneous rupture of membranes include infection, multiple gestation, polyhydramnios, a large fetus (>4000grams) and trauma. Preterm premature rupture of membranes is also associated with genital tract infection or colonization with various microorganisms, coitus, low socioeconomic status, poor nutrition, smoking and bleeding in pregnancy. Therefore, all preterm deliveries were excluded from the study. Although the records of all women who experienced spontaneous rupture of membranes were examined, the records of women who experienced any of these factors were eliminated from the sample. The use of original records decreased transcription error.

The greatest limitation of this design is the reliance on the accuracy of recording

from the sample. The use of original records decreased transcription error.

The greatest limitation of this design is the reliance on the accuracy of recording when spontaneous rupture of membranes occurred. This depends on the pregnant woman's observational skills and the accuracy of the provider's recording of the information. Time constraints and restrictions on funding are other limitations. A single site data collection was a threat to external validity.

A factor that may influence the integrity of the fetal membrane is mechanical trauma. This can occur by the doctor stripping the membranes during an office visit or by sexual intercourse shortly before rupture of membranes occurs. A retrospective study prevents the acquisition of this information as this data is generally not available from the patient record.

Population and Sample

A target population must be identified when examining a correlation between barometric pressure changes and spontaneous rupture of membranes. Criteria for inclusion in the study were the records of gravid women at term gestation (37 weeks or greater) with live singleton pregnancies whose membranes rupture spontaneously prior to delivery. These women were primiparous or multiparous, but must have exhibited no evidence of sexually transmitted disease or infection. The records of gravid women who experienced spontaneous rupture of membranes, although reviewed, were excluded from this study if they were preterm or had their labor induced or had multiple gestation or evidence of sexually transmitted disease or infection. The records of women who had their membranous sacs ruptured using artificial methods were excluded from this study.

The accessible population were all those women who have delivered at term in the obstetrical unit of a 250- bed level two Midwestern community hospital, from January 1997 through December 1998, who meet the eligibility criteria. The relative ease of data collection made the gathering of two years worth of data desirable and feasible and this time frame reduced the chance of seasonal variations in barometric pressure, which might affect the findings.

A convenience nonprobability sample was used. This Midwestern hospital experiences approximately 1000 births each year. The exclusion of inductions of labor and scheduled cesarean sections still allowed a large sample of greater than 500 records to be considered. By looking at the total number of deliveries concurrently with those that occurred with significant barometric pressure decreases allowed the study to determine if there is an association between SROM and significant decreases in barometric pressure. Restrictions on funding made a true heterogeneous sample, across all geographic areas and including all cultural and ethnic groups, impracticable at this time.

Instrument

A data collection form was developed for this study. Initially a participant identification number was assigned to each record to ensure confidentiality. Data collection from subject records included: age, date of delivery, type of delivery, gestational weeks, gravida, para, spontaneous rupture of membranes prior to onset of labor, time of SROM, time of onset of labor, temperature on admission, documentation of sexually transmitted disease, and sex of the infant.

Hourly records of the barometric pressure in Grand Rapids for the years 1997 and 1998 were obtained from the Midwestern Climate Center. A decrease in barometric pressure of 10 millibars or more within 24 hours was considered significant.

Human Subjects

Prior to collection of data on these human subjects, permission was obtained from the Grand Valley Human Research Review Committee and from the Institution Review Board of the hospital being used as the study site. Patient confidentiality, an ethical consideration, was maintained through the use of a numbered coding system to prevent personal identification. Pertinent information from the patient's medical record was transcribed onto the data-coding sheet.

No information obtained from medical records was recorded or reported in a manner that identified an individual subject. Steps to safeguard the confidentiality of subjects included:

1. Assigning an identification number to each subject and attaching the ID number rather than other identifiers to the actual research information.
2. Entering no identifying information into the computer files.
3. Restricting access to identifying information to the investigator and personnel in the health information department (medical records).
4. Limiting the transcription of information from the medical record to the data-coding sheet to the investigator who has signed a pledge of confidentiality to the hospital.
5. Keeping delivery logbooks in a locked cabinet.
6. Reporting research information in generalized group terms. All information transcribed on the data collection sheet were grouped into generalized data. Length of

time of gestation was grouped according to weeks of gestation when data were analyzed. Other data from the coding sheet were grouped according to result of two choices including yes or no, elevated or not elevated, male or female, and type of delivery. The date and time of spontaneous rupture of membranes, onset of labor, and delivery were compared to the barometric pressure fluctuations that occur during that period.

CHAPTER FOUR

DATA ANALYSIS

The setting for this study was a 250- bed hospital located in Grand Rapids, Michigan. The Obstetrical Unit consists of 14 labor/delivery/recovery/postpartum (LDRP) rooms. There were 1,078 births in 1997 and 1329 births in 1998.

In 1997 there were 278 women or 26% who presented to the obstetrical unit with spontaneous rupture of membranes and 380 women or 28.5% in 1998 whose membranes ruptured spontaneously. These 658 women represented twenty-seven percent of the 2407 total deliveries that occurred at this hospital in 1997-1998. Of these, 533 records met the criteria for this study. They were 37 weeks gestation or greater with no evidence of infection and without multiple gestation, polyhydramnios, or >4000 gram infant who ruptured spontaneously.

Readings of barometric pressure were obtained from the official recording station of the Midwest Climate Center. Meteorologic factors are recorded from the Kent International Airport hourly and published records are available to the public upon request. During 1997 there were thirty-nine days when the barometric pressure dropped 10 millibars or more (from midnight to midnight) and nineteen days in 1998 when this event occurred. This phenomenon presented itself less than eight percent of the time studied.

Techniques

A review of delivery room logs and charts of the 533 records that met the criteria for this study was completed and pertinent information was entered on the data coding sheet. The rupture of membranes was documented with a positive phenolphthalein swab, a positive microscopic finding of ferning, and presence of amniotic fluid in the vagina at the time of admission. All records utilized were complete enough to allow adequate evaluation. All infants were liveborn. There were no known uterine anomalies and no malpresentations.

A chi-square statistic was used to compare the number of times when spontaneous rupture of membranes (SROM) occurred when the pressure decreased by 10 millibars or greater in a 24 hour period of time with the number of times SROM occurred when the barometric pressure did not decrease. The chi-square statistic was also used to compare the observed and expected frequencies of onset of labor without a decrease in barometric pressure and onset of labor with a 10 millibar decrease in barometric pressure in 24 hours. The level of significance was set at .05 alpha.

Characteristics of Subjects

This study included the records of women who delivered at 37 weeks gestation or greater. The mean gestation period was 39 weeks, (standard deviation 1.1) with 13 women delivering at exactly 37 weeks gestation to one woman delivering at exactly 42 weeks gestation. The age of these women ranged from 15 years old to 46 years old. Thirty-three women were under 18 years of age and eleven women were over 40 years of age. The mean age of women studied was 26 years with a standard deviation of 5.9

years. Over 90% of these women were 34 years of age or less, under the age when the risk for genetic defects increases. Thirty-seven percent of these women experienced their first pregnancy and less than ten percent of women were grand-multiparas (5 or more pregnancies). The mean number of pregnancies was 2.3 with a standard deviation of 1.5. For two-thirds of these women it was their first or second pregnancy. Nearly half (48%) of women delivered their first child. Less than eight percent of these mothers had three or more children. Vaginal births after spontaneous rupture of membranes totaled 489 (over 90%) and 44 women were delivered by cesarean section. Eighty percent of the women studied were White, eleven percent Black, six percent Hispanic, two percent Asian and the remainder Native American or undetermined.

Table 2

Demographic Characteristics of Sample (N = 533)

Characteristics	(n) portion of total sample	Percent of total sample
Age (in years)		
Range = 15-46		
X = 26.1		
SD = 5.9		
Parity:		
Primiparous	198	37%
Multiparous*	290	55%
Grandmultiparous**	45	8%
Types of Delivery:		
Vaginal	489	92%
Cesarean	44	8%

* 2 to 4 pregnancies

** 5 to 9 pregnancies

Hypothesis/Research Question

The research question for this study asked: What percent of cases of spontaneous rupture of membranes are preceded in a 24- hour period by a decrease in barometric pressure of 10 millibars or greater? This study was undertaken to determine whether a higher percentage of spontaneous rupture of membranes occurred coincident with the meteorologic phenomena of barometric pressure decreasing 10 millibars or greater in 24 hours. During the years 1997-1998 studied, 533 women who met the criteria for this study had spontaneous rupture of membranes prior to delivery. There were 45 women who experienced rupture of membranes after a 10 millibar or greater decrease in the barometric pressure in the 24 preceding hours. For 488 women, no significant decrease in barometric pressure was experienced prior to the rupture of membranes.

It was hypothesized that more than 50% of the cases of spontaneous rupture of membranes that were studied would have been preceded by a decrease in barometric pressure of 10 millibars or greater in 24 hours. However, only 8.4% of the cases of spontaneous rupture of membranes were preceded by a decrease in barometric pressure of 10 millibars or greater in 24 hours. Therefore, the hypothesis was rejected.

Table 3
Summary of Comparisons (N = 533)

Phenomenon	Occurrence
Decreased barometric pressure without spontaneous rupture of membranes	488
Decreased barometric pressure with spontaneous rupture of membranes	45
Decreased barometric pressure without onset of labor	485
Decreased barometric pressure with onset of labor	48

Other findings of interest

This study evaluated the records of gravid women during the years 1997 and 1998. During this period, the barometric pressure decreased 10 millibars or greater only 58 days out of 730 days or less than 8%. These two years encompassed a phenomenon known as "El Nino".

El Nino is a disruption of the ocean-atmosphere system in the tropical Pacific Ocean having important consequences for weather around the world. The strongest episode occurred in 1982. The year 1997 began with an almost equally powerful episode that produced warmer and drier conditions than are normal in several midwestern states. The Upper Peninsula of Michigan and western Michigan experienced the second warmest winter with reductions of snowfall of nearly 20 inches. This profound decrease in variability of weather patterns may have been a factor in the minimal number of significant decreases in barometric pressure that occurred.

Information regarding the occurrence of spontaneous rupture of membranes prior to onset of labor was recorded on the coding sheet. Fifty-one percent of membranes ruptured before onset of labor and forty-nine percent of ruptures occurred at the onset or during labor. The onset of labor did not appear to be influential in the spontaneous rupture of membranes. Of those cases of spontaneous rupture of membranes when the barometric pressure fell 10 millibars or more before the rupture, 75% did experience spontaneous labor.

The sex of each infant born was recorded on the coding sheet. For every 100 females born, there are on the average 102 males born. Over the two-year period reviewed at this hospital, 296 girls were born (56%) and 237 boys (44%) were born from the women in this study.

CHAPTER FIVE

DISCUSSION AND IMPLICATIONS

The hypothesis that there is a relationship between the sudden fall in barometric pressure and gravid women was based on the assumption that within the womb the pressure remains constant while the atmospheric pressure modulates continuously. A sudden alteration in pressure supposedly gives rise to a deviation, an expansion of gases within the womb, which results in the spontaneous rupture of the membranes.

Meteorologists sometimes say, “the barometer is falling” when they are predicting bad weather. In a falling pressure system, the lowest air pressure spins inward. This movement creates a pileup of air in the center of the spinning air mass. The air in the center is forced upward, cools, and condenses, creating clouds. In warmer months, lows can mean thunderstorms and severe weather. In winter, this creates heavy snowfalls or ice storms. Decreases in barometric pressure affect the gases within the enclosed space of the womb. The turgidity within the womb collides with the amniotic membrane, straining its integrity.

The research question for this study was: What percent of cases of spontaneous rupture of membranes are preceded in a 24- hour period by a decrease in barometric pressure of 10 millibars or more? A decrease of 10 millibars in barometric pressure is considered to be significant per agreement with meteorologists in Grand Rapids. Previous studies examining the relationship of barometric pressure changes to

spontaneous rupture of membranes reported conflicting outcomes. Marks, Church, and Benrubi (1983) and Trap, Helm, Lidgaard, and Helm (1989) reported no association. Stern, Glazer, and Sanouleak (1988); Steinman and Kleiner (1978) and Polanski, Varner, and O'Gorman (1985) presented a positive connection.

The results of the 1989 study by Trap, Helm, Lidgaard, and Helm suggested that the causes of premature rupture of membranes are not correlated to the phases of the moon or to meteorological variations. Twenty percent of deliveries from that study began with spontaneous rupture of membranes, whereas twenty-seven percent of the women who delivered at the Grand Rapids hospital ruptured spontaneously. Unlike the gestational age limit in this study, preterm deliveries were included in the study by Trap, et al.

Noller, Resseguie, and Voss (1996), over a twelve-month period, failed to demonstrate the occurrence of spontaneous labor with falling barometric pressure. They did observe a statistically significant association between falling barometric pressure and onset of labor. However, the magnitude of the difference is not of clinical significance. In the current study, only 9 out of every 100 gravid women who spontaneously ruptured experienced spontaneous labor when the barometric pressure decreased 10 millibars in 24 hours. This is neither clinically nor statistically significant. The study by Marks, Church and Benrubi (1983) ascertained the outcome of membranes rupturing randomly, without clustering around any particular barometric pressure. Premature rupture of membranes was unrelated to variations in barometric pressure. Indeed, only eight of each one hundred women in the current study experienced rupture of membranes with

significant decrease in barometric pressure. Because 488 women ruptured without a significant decrease in barometric pressure, the current study bolsters their conclusion.

The 1985 study by Polansky, Varner, and O’Gorman also excluded patients with polyhydramnios and multiple gestations. They included gravid women of 36 weeks gestation or greater. Women in this study with premature rupture of membranes did not experience rupture when the largest decreases in barometric pressure occurred. A significant number of membrane ruptures occurred within three hours after pressure decreases, and changes in prostaglandin concentrations or other biochemical parameters could be involved.

Kardong-Edgren (1995) found no link between rapid drops in barometric pressure and human birth. This was a twelve-month study and included high-risk pregnancies. Regardless, no association was found, even when a full moon and decreasing barometric pressure were considered concurrently. The present study of two consecutive years deleted higher risk gravid women; yet the conclusion is analogous.

Driscoll and Merker (1984) found a positive correlation between sudden drops in barometric pressure, cold frontal passages, and premature rupture of membranes. Onsets of labor were especially above average in the twelve hours prior to the front. Their findings established a weak, but statistically significant indication that human parturition is influenced by weather. They were unable to support high onsets when variable weather persisted, or low onsets when uniform weather patterns persevered. The present study found no decrease in spontaneous rupture of membranes during stable weather patterns.

King, Fleschler, and Cohen (1997) found significantly more occurrences of onset of labor in the 24 hours following a decrease in barometric pressure of 0.06 inches of mercury within one hour. A decrease in barometric pressure of 0.3 inches in the current study is considered significant. Therefore, the change in barometric pressure in the King et al. study would not be considered significant when measured over a 24-hour period. The 1989 study by Steinman and Kleiner evaluated an average pressure drop of 0.01 inches within three hours and 0.024 inches within six hours. These values would not be considered significant in the present study.

Martha Rogers theorized that human beings are energy fields that are open continuously to be entered and acted upon by environmental energy fields. The energy patterns change continuously, and the nature of change is unpredictable and increasingly diverse (Fawcett, 1995, p.384-385).

The alteration of the environmental energy field by decreasing barometric pressure and introducing a shift in the human energy field was hypothesized to be visible through its influence on the integrity of the amniotic membrane causing a rupture of the membrane. Although 27% of the women who delivered at the hospital experienced spontaneous rupture of the amnion prior to delivery, only 8.4% of these ruptures were preceded by a decrease in barometric pressure of 10 millibars or greater in 24 hours. There was no visible positive correlation of the symbiosis of the human and environmental energy fields.

Martha Rogers' principle of resonancy manifested by new patterning was not clearly evidenced by a spontaneous rupture of membranes. The constant flux of the

human energy field and the environmental energy field evolves into a fresh innovative form according to Rogers. Although the direction of the change is invariant, the rate of change may vary for an individual (Fawcett, 1995, p. 384). The decrease in barometric pressure in the environmental energy field did not apparently have an impact on the human energy field in 92% of the pregnant women who delivered after spontaneous rupture of membranes in 1997 and 1998.

The principle of integrality is defined by Rogers as the “continuous mutual human field and environmental field process” (Fawcett, 1995, p.385-386). There are no boundaries and no equilibrium. This process is demonstrated by accelerating change. The barometric pressure decreasing 10 millibars or greater did not produce a demonstrable change of spontaneous rupture of membranes. It should be noted that 75% of the women whose membranes ruptured spontaneously did experience spontaneous labor.

Martha Rogers’ Science of Unitary Human Beings encompasses components including “irreducible wholes”, “indivisible energy fields”, and “unpredictable and increasingly diverse changes”. These human and environmental energy fields are pandimensional. The hypothesis utilized in this research sought concrete visualization of the new reality. Fawcett states that “strict experimental designs are of questionable value given the fact that the unitary system is a noncausal model of reality” (Fawcett, 1995, p.394). Perhaps we need to construct new tools that measure appropriately these new paradigms.

Application to Practice

No change in staffing during periods of unstable weather patterns is justified in the labor and delivery area of the obstetrical unit, reflected by the findings of this study. The belief that more babies are born during the time of a full moon or storms may still be discussed by childbirth educators with discussion of the results of scientific studies. Although not warranted by this study, preparation for adverse weather phenomena should be included for all gravid women near the expected date of confinement.

Limitations

This study focused on the possible connection between spontaneous rupture of membranes and changes in barometric pressure. Possible trauma in the doctor's office from stripping of the membranes prior to admission to the hospital could not be assessed from the patient's record. Also, recollection of time of rupture may not be accurate.

A control group of term gravid women would have been helpful and provided valuable information when analyzing the data. These normal term gravid women who spontaneously experienced labor without spontaneous rupture of membranes would have provided insight regarding the impact of weather changes when no spontaneous rupture occurs.

The fact that weather is not controllable and many times unpredictable may have had a negative impact on the study with the occurrence of El Nino. The weather in Grand Rapids is continuously influenced by the Great Lakes and may also distort the results. Since all data was gathered from one site, the results can not be generalized to other areas and climates.

There is no consensus among meteorologists regarding what is a significant

change in barometric pressure. Some studies used a change of as little as 0.01 inches within three hours as a significant finding. A common agreement among researchers and weather forecasters would facilitate a more accurate comparison.

Suggestions for Modifications

This retrospective study examined only those records of women who ruptured spontaneously and then evaluated the barometric changes that occurred in the previous 24 hours. The advent of computer charting in hospitals and physician's offices will allow for easy access to information and programs can be designed for ongoing data collection and analysis. This study could progress from several different sites to encompass a broad area.

The causes for spontaneous rupture of membranes appear to be multifactorial. The exact etiology remains unknown, but when it is discovered, as indicated by this study and others, meteorological phenomena will probably not be included in the explanation.

APPENDICES

APPENDIX A

Data Coding Sheet

APPENDIX A

Data Coding Sheet

- _____ 1. Participant ID# (1-2000)
- _____ 2. Age
- _____ 3. Gestational weeks
- _____ 4. Gravida
- _____ 5. Para
- _____ 6. Type of delivery 1) vaginal 2) cesarean section
- _____ 7. Date of delivery
- _____ 8. Date of SROM
- _____ 9. Time of SROM
- _____ 10. SROM prior to onset of labor 1) yes 0) no
- _____ 11. Time of onset of labor (OOL)
- _____ 12. Decrease in barometric pressure of 10 milibars or more within 24 hours
prior to SROM 1) yes 0) no
- _____ 13. Decrease in barometric pressure of 10 milibars or more within 24 hours
prior to OOL 1) yes 0) no
- _____ 14. Participant temperature on admission 1) elevated 0) not elevated
- _____ 15. Documentation of sexually transmitted disease 2) yes 0) no
- _____ 16. Sex of infant 1) female 2) male
- _____ 17. Race 1) White 2) Black 3) Hispanic 4) Asian 5) Native American

APPENDIX B

Metropolitan Hospital Institutional Review Board Approval Letter

Metropolitan Hospital

1919 Boston, S.E.
P.O. Box 158
Grand Rapids, Michigan 49501-0158
(616) 247-7200

April 10, 1998

Linda M. Owen,, R.N.C.
5434 Hall St., SE
Grand Rapids, MI 49546

Dear Ms. Owen:

Thank you for submitting your research project on Decreased Barometric Pressure and its Relationship to Spontaneous Rupture of Fetal Membranes to the March 26, 1998, meeting of the Metropolitan Hospital Institutional Review Board (IRB). Please note that the IRB recommended that you add the categories of Hispanic and Asian to your coding sheet to capture these two races.

We wish you well on conducting your research. At the conclusion of your study, the IRB recommends that you present your findings on this topic. When you have completed your research, please contact my office to set up an appointment for a future IRB meeting.

Sincerely,



William C. Cunningham, D.O., M.H.A.
Vice President and Chief Medical Officer
Chairperson, Metropolitan Hospital Institutional Review Board

WCC:SJH:ed

APPENDIX C

Human Research Review Committee Approval Letter



**GRAND VALLEY
STATE UNIVERSITY**

I CAMPUS DRIVE • ALLENDALE, MICHIGAN 49401-9403 • 616/895-6611

June 30, 1999

Linda Owen
5726 Clements Mill Drive
Grand Rapids, MI 49546

Dear Linda:

Your proposed project entitled ***Spontaneous Rupture of Membranes and Decreased Barometric Pressure*** has been reviewed. It has been approved as a study which is exempt from the regulations by section 46.101 of the Federal Register 46(16):8336, January 26, 1981.

Sincerely,

Paul Huizenga, Chair
Human Research Review Committee

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