THE DEVELOPMENT OF A NEONATAL VITAL SIGNS DATABASE

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ABSTRACT

Modern intelligent monitoring systems use digital computer technology to analyze and evaluate physiological vital signs. This analytical and evaluative process is performed by algorithms developed for this purpose. The degree of 'intelligence' of the monitoring system is dependent on the 'sensitivity' and 'specificity' of these algorithms.

In order to develop robust and clinically valid algorithms, a database of representative waveforms is required. The aim of this thesis was to create a neonatal vital signs database to be used for this purpose, by means of a computer-based central station.

The computer was interfaced to a number of neonatal monitors (Neonatal ICU, Groote Schuur Hospital). The monitors were interrogated to obtain patient condition, ECG waveforms and respiration waveforms using the impedance technique. When possible, percentage oxygen saturation was also captured. The database contains 509 documented clinical records obtained from 35 patients and 20 records containing examples of technical alarm conditions and high frequency noise. Additional patient record data is included. Clinical events recorded include apnoea, bradycardia, periodic breathing tachycardia, tachypnea and normal traces. These events were recorded

against a variety of signal quality conditions that have been characterized in Appendix C. A prototype rate detection algorithm was checked using samples from the database.

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LIST OF ABBREVIATIONS

ADC; A/D Card - Analog to Digital Converter

AGA - Appropriately grown for Gestational Age

ECG - Electrocardiogram

EMG - Electromyogram

GER - Gastroesophageal Reflux

HRV - Heart Rate Variability

I/O - Input/Output

ICU - Intensive Care Unit

IVH - Intraventricular Haemorrhage

LGA - Large for Gestational Age

PMNS - Peninsular Maternal and Neonatal Service

PVC - Premature Ventricular Contraction

PVH - Periventricular Haemorrhage

RDS - Respiratory Distress Syndrome

RSA - Respiratory Sinus Arrhythmia

SAO_2 - Oxygen Saturation

SIDS - Sudden Infant Death Syndrome

SGA - Small for Gestational Age

TTL - Transistor/Transistor Logic

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CHAPTER 1

INTRODUCTION

Modern intelligent monitoring systems use digital computer technology to analyze and evaluate physiological vital signs in order to assist clinicians in making their diagnoses. This analytical and evaluative process is performed by algorithms developed for this purpose. The reliability of the monitoring system is dependent on how sensitive and specific these algorithms are to clinical anomalies.

In order to develop robust and clinically valid algorithms, a database of representative waveforms is required. The aim of this thesis was to create a neonatal vital signs database by means of a computer-based central station. This database could then be used to test ECG and respiration rate detection algorithms.

A neonatal database was chosen because a need for appropriate neonatal monitoring equipment has been identified as being valuable in secondary level hospitals. If this monitoring equipment was available:

(i) patients could receive a more sophisticated level of treatment closer to home;

(ii) academic hospitals would be relieved of cases that could be classified as being routine and handled at a lower level. Thus academic hospitals would have more time to devote to specialised cases and research so that this move would contribute to the improvement in the quality of neonatal health care offered.

To date this equipment has not been available in secondary level hospitals due to financial constraints. The cost of an imported neonatal monitor currently ranges between R10000 and R15000 so that these units are only supplied to academic/tertiary level hospitals. A locally manufactured unit which fulfills basic monitoring requirements could reduce the cost considerably and consequently secondary level hospitals would also be in a position to be equipped.

The data acquisition system is not only useful in a biomedical engineering research and development context. The system may also be adapted for clinical use as a PC-based research or diagnostic tool. Using a PC for this purpose makes economic sense because they are more versatile than dedicated instruments in the sense that they may be programmed to perform a variety of functions. The programs themselves can be modified to extract different information from the raw data should this be required.

In this dissertation:

(i) A clinical rationale is presented to justify the choice of parameters being monitored.

(ii) Available literature is explored to investigate:

- (a) the techniques and current technologies available for monitoring important neonatal parameters.
- (b) existing medical waveform databases.

(iii) The data acquisition system and database structure are described and evaluated in the context of the clinical requirements detailed above.

(iv) A critical evaluation of the accumulated data is undertaken to determine whether algorithms tested on the database will have been subjected to a sufficient range of conditions.

(v) In conclusion, in the light of the system and data evaluation, recommendations are made for modifications that would improve the system and future investigations are suggested.

CHAPTER 2

A CLINICAL OVERVIEW OF NEONATAL HEALTH CARE

2.1 Introduction.

Most infants are born between 37 and 42 weeks after conception and are referred to as term infants. The normal range for the weight of a term infant is 2500 - 4200g. These infants require minimal clinical intervention. The neonate may possibly require suctioning to clear the airway but apart from that, clinical intervention is limited to clamping and cutting the umbilical cord, ensuring heat conservation, routine prophylaxis against ophthalmia neonatorum and administering an intramuscular injection of vitamin K_1 to prevent haemorrhagic disease of the newborn. The mother is encouraged not only to hold but also to suckle her baby immediately after delivery as this is not only of psychological benefit but also stimulates uterine contractions (Ruysch Van Dugteren et. al., 1985).

The main reason for the medical problems encountered in neonatal intensive care units is immaturity. When babies are born prematurely their physiology is not ready for the extrauterine environment. A premature infant may experience functional difficulties arising from the instability of its various control systems. This is partly due to the immature development of the different organs of the body and partly due to the fact that the control systems have not adjusted to the new circumstances. Because of its large surface area to mass

ratio, the infant readily loses heat. The problem is compounded by the inadequacy of the body's thermoregulatory mechanisms during the first few days after birth. Thus the infant is susceptible to hypothermia. Low energy stores can give rise to hypoglycaemia. These infants are prone to apnoea and convulsions and often require supplementary doses of dextrose. Abnormalities of gas exchange with associated disturbances of the blood gas levels and acid-base status are very common in critically ill infants. Deviations from normal biochemical homeostasis can cause a number of problems requiring clinical intervention.

Premature infants are those born before the end of the 37th gestational week, regardless of birth weight. The majority of babies who weigh less than 2500g and almost all infants below 1500g are born prematurely. Most of them are appropriately grown for gestational age (AGA); some are small for gestational age (SGA). On the other hand, many premature infants of diabetic mothers weigh over 2500g at birth, large for gestational age (LGA) (Korones, 1986).

2.1.1 **Prenatal Factors.**

The obstetric conditions that play a role in the initiation of premature labour include chronic hypertensive disease, toxemia, placenta previa, abruptio placentae, multiple gestation, and cervical incompetence. Other factors that have been implicated are low socioeconomic status, short maternal

stature, absence of prenatal care, malnutrition, and a history of previous premature delivery. These conditions usually occur in some sort of combination with each other. Thus mothers of short stature are often malnourished, do not receive prenatal care, and are the same women who deliver premature infants repeatedly. Furthermore, these particular factors are inseparable from poverty, of which they are the essence (Woods, 1984).

2.1.2 **Mortality and morbidity.**

Mortality rates are highest among premature infants, and these rates increase as birth weight and gestational age decrease. Premature infants are poorly equipped to withstand the stresses of extrauterine life. The lungs may not be ready for air exchange; the digestive tract fails to absorb 20% to 40% of the fat contained in milk feedings. Defenses against infections are relatively ineffective, and an increased rate of heat loss creates serious thermoregulatory problems. The capillaries are relatively sparse so that perfusion of tissues is at best marginal. Increased capillary fragility predisposes to haemorrhage, especially in the ventricles of the brain (Bennett et al, 1983).

Premature infants, whether AGA or SGA, are predisposed to the following postnatal disorders amongst others: hyaline membrane disease (and immature lung syndrome in the smallest babies), patent ductus arteriosus, intraventricular and periventricular

haemorrhage and hydrocephalus, necrotizing enterocolitis, thermal instability, undernutrition, nosocomial bacterial infection, anaemia of prematurity, vitamin E deficiency anaemia, inguinal hernia, recurrent apnoea, and retinopathy of prematurity (Vohr and Oh, 1983).

2.1.3 Postneonatal outcome.

Premature infants have a relatively high incidence of mental retardation, and abnormal neurological signs. Microcephaly, spastic diplegia, convulsive disorders, and abnormal electroencephalograms are the most frequently encountered signs of brain disorder. The incidence of neurologic abnormality has diminished substantially since the advent of intensive care techniques (Vohr and Oh, 1983).

Expert care of newborn patients requires, among other things, an understanding of the abnormalities of intrauterine growth patterns as they relate to gestational age. An infant's course in the nursery is in large measure determined by these factors, and the illnesses that develop postnatally are often peculiar to a particular type of aberrant intrauterine growth pattern. Thus hyaline membrane disease, for all practical purposes, is confined to preterm babies, whereas hypoglycemia is a frequent hazard in SGA infants. With knowledge of maternal factors and with the ability to categorize babies in terms of growth status, clinicians can readily recognise a large proportion of high-risk infants and plan their

management accordingly.

2.2 The Respiratory System.

There is universal agreement that pulmonary disorders are the most frequent cause of neonatal morbidity and mortality. They result from prematurity, perinatal complications that impair adaptation to extrauterine life, to prenatal and postnatal infections, to congenital anomalies, and to extrapulmonary disorders such as cardiac failure, which secondarily give rise to respiratory dysfunction (Korones, 1986).

The most important immediate adjustment that the newborn infant must make is the initiation of spontaneous breathing and the expansion of its lungs (Guyton, 1986). This may not occur because of a depressed respiratory centre or because of cardio-pulmonary disease. The former may be due to prematurity, oversedation of the mother or prenatal hypoxia. Causes of the latter include hyaline membrane disease and pneumonia. Either may give rise to respiratory failure with a severe deficiency in the infant's blood oxygenation and the impairment of the critical exchange between inspired air and blood gases. Hypoxia can be minimized by keeping the infant oxygenated, either by running oxygen into a perspex hood which covers its head or via a respirator directly attached to its airways. Many of these infants are prone to apnoea.

Apnoea is the cessation of regular breathing. In one form or another, these pauses in respiration compose the most common

day-to-day problem encountered in the neonatal intensive care unit. The clinical categorization of apneoic events is as follows.

Periodic breathing occurs in premature infants whose birth weight is below 1800g. It is characterized by recurrent failure to breathe for intervals that are no longer than 10 to 15 seconds. The timing is not as important as the absence of associated responses such as bradycardia, cyanosis, limpness, and the infant's capacity to resume regular respirations spontaneously. Periodic breathing generally appears on the second to the fifth day after birth. Obviously it cannot be identified in infants who require mechanical ventilatory support for the first few days of life. Periodic breathing has a tendency to disappear by the end of the third week of life, regardless of gestational age (Korones, 1986).

Apnoea is the more serious manifestation of an infant's failure to breathe. Apnoeic spells are distinguished from periodic breathing by their longer duration, but more significantly by associated manifestations such as bradycardia (below 100 beats per minute), cyanosis, and limpness. The vast majority of apnoeic episodes require some form of stimulation for the resumption of respiration. Thus the mildest spells can be terminated by simple tactile stimulation to the skin, or more painful stimulation by flicking the fingers on skin. In the extreme, apnoeic episodes require endotracheal intubation,

assisted ventilation, and ultimately, sustained mechanical support. Aminophylline, a respiratory stimulant which can cause tachycardia, helps to control apnoea due to an immature respiratory centre. Clinically there are two broad categories of apnoea:

(i) the apnoeic episodes are secondary to underlying disorders;
(ii) the apnoeic episodes are unassociated with identifiable underlying disease but rather a manifestation of incomplete respiratory centre development (Korones, 1986).

2.2.1 **Apnoea associated with underlying disorders**

Apnoeic spells occur at some time during the course of the clinical disorders listed below. Often they are the first manifestation of an underlying disease.

Impaired oxygenation: anaemia, shock, pulmonary oedema, patent ductus arteriosus, cardiac failure, hyaline membrane disease, immature lung, and dysfunction of oxygen delivery equipment.

Thermoregulation: hypothermia, hyperthermia, and rapid fluctuations in either direction.

Infection: septicemia, meningitis, and pneumonia.

Brain disorders: perinatal asphyxia, intraventricular-periventricular hemorrhage (IVH/PVH), seizures, and acute ventricular dilation secondary to IVH.
Metabolic disorders: hypoglycaemia, dehydration and acidosis, hyperammonemia, hypernatremia and hyponatremia.
Abdominal distention: necrotizing enterocolitis, perforated viscus, and other surgical emergencies such as volvulus and other intestinal obstructions, and gastroesophageal reflux (GER).

The abrupt appearance of serious apnoeic episodes requires investigation for the possibilities listed above. Identification of underlying disease is particularly urgent in infants who suddenly become apnoeic after satisfactory progress for days (Korones, 1986).

2.2.2 **Apnoeic episodes not associated with underlying disease.**
The majority of apnoeic episodes cannot be attributed to underlying disorders. They are considered manifestations of incomplete development of the respiratory centre of the medulla oblongata. Immaturity of the respiratory centre is associated with diminished afferent (input) impulses, and thus a reduction or unpredictable fluctuation of efferent (output) impulses. Morphologically the immature respiratory centre is composed of a diminished quantity of synapses, fewer dendritic processes, and minimal central nervous system myelinization (Gerhardt and Bancalari, 1984).

It is generally believed that hypoxemia precedes apnoeic episodes, that it depresses function of the immature respiratory centre. Although studies have failed to demonstrate this association the strong suspicion persists that diminished oxygenation often precedes apnoea.

While the data explaining apnoea of prematurity have only begun to appear in the last few years, it has become apparent that immaturity of the respiratory centre is largely manifested by a diminished response to elevated levels of $PaCO_2$. The term infant increases depth of respiration (greater tidal volume) and alveolar ventilation in response to some elevation of $PaCO_2$. Premature infants with apnoea fail to respond to increased $PaCO_2$ levels to the same extent as control infants who are not apnoeic. Preterm infants with apnoea exhibit a diminished inspiratory effort - hypoventilation and hypercapnia ensue. Apnoea of prematurity may well be an abnormality in the control of breathing patterns by the respiratory centre. The inadequacy of respiratory centre function increases as gestational age shortens. Blunted respiratory centre response to CO_2 is unusual in infants over 33 weeks gestational age (Gerhardt and Bancalari, 1984).

2.2.3 **Oxygen Saturation**

Nothing is more critical to tissue metabolism than an adequate supply of oxygen. The most important aspect of total therapy

for respiratory insufficiency is the provision of oxygen. Once the need for such therapy is apparent for any disorder, its adequacy must be ascertained and its hazards averted by continuous monitoring of arterial oxygen saturation.

(i) Physiology of oxygen transport: the basis for rational oxygen therapy.

The erythrocyte is the vehicle for transport of oxygen. Its basic function is to take up oxygen from the lungs and deliver it to the tissues, carrying sufficient quantities to effect rapid diffusion from capillaries to tissue cells. The performance of this function depends on a number of factors that include an adequate fraction of inspired oxygen (FiO_2) and normal pulmonary function, blood volume, cardiac output, and perfusion. Other aspects are intrinsic to blood. They involve arterial pH and temperature, red haemoglobin cell concentration, and the affinity of haemoglobin for oxygen.

Oxygen saturation is given as a percentage value that is calculated by dividing the amount of oxygen bound to haemoglobin (content) by the maximal amount that can be bound (oxygen capacity). Normal oxygen saturation is 96% to 98%. Oxygen saturation is governed by the PO_2 and by the affinity of haemoglobin for oxygen.

(ii) **Oxygen-haemoglobin dissociation curve.**

Normally there is a predictable correlation between oxygen saturation and PO_2. As illustrated by the oxygen-haemoglobin dissociation curve (figure 2.1) the saturation of fetal haemoglobin is higher than the adult's at all PO_2 levels because there is a greater affinity for oxygen. Stated differently, the same percentage of saturation occurs at a lower PO_2 in fetal haemoglobin than in the adult's. Cyanosis is apparent when blood is between 75% and 85% saturated with oxygen. These saturations occur at PO_2 levels of 32 to 41 torr in the neonate and 42 to 52 torr in the adult. The dissociation curve demonstrates why the newborn is considerably less oxygenated than the adult when cyanosis first becomes discernible. The fetal dissociation curve is said to be shifted to the left of the adult's.

Oxygen-haemoglobin dissociation curves

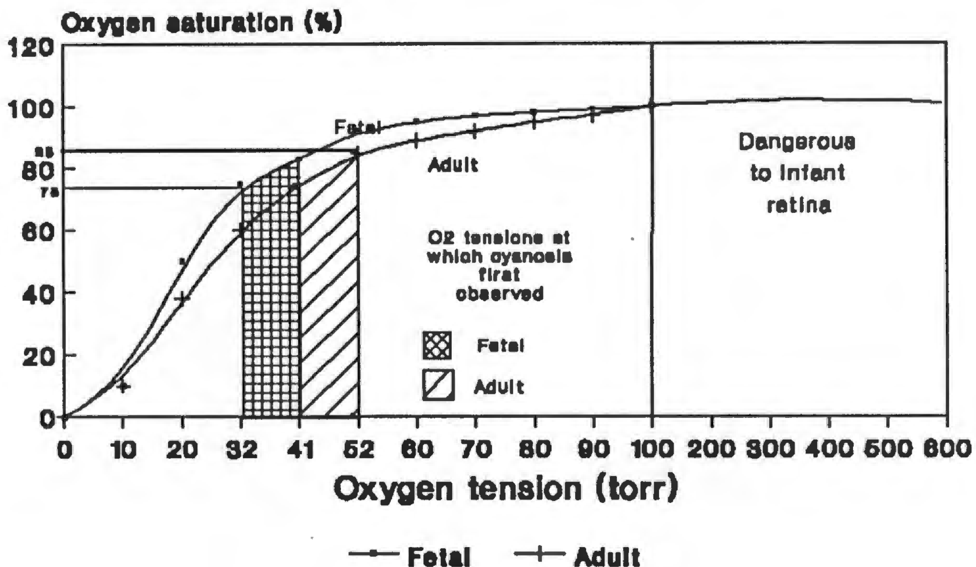


Figure 2.1 (Adapted from Korones, 1986)

The position of the curve actually indicates the affinity of haemoglobin for oxygen. When the affinity is decreased, as in the adult, more oxygen is released to tissues at any given oxygen tension.

Two factors intrinsic to blood exert a major influence on affinity of haemoglobin for oxygen. Affinity diminishes as blood pH decreases and as temperature increases; the curve shifts to the right. Affinity increases as blood pH rises and temperature falls; the curve shifts to the left.

(iii) **Hypoxia:detection,prevention and penalties.**

Generally, a PO_2 less than 50 torr is considered hypoxemic. The clinical recognition of hypoxemia on the basis of *cyanosis* is not simple. Several factors influence the recognition of cyanosis, including colour and thickness of skin, number of capillaries, haemoglobin level, and serum bilirubin. The complexity is exacerbated still further by variables such as the type and intensity of light, as well as the differences in perception among observers. The clinical diagnosis of hypoxia is unreliable. Cyanosis may be absent in hypoxic babies, and it may be present in those who are well oxygenated. Its presence over different parts of the body is variable, and there is little consistency among observers in the ability to recognize it (Korones, 1986).

Cyanosis is not visible until saturations fall between 75% and 85%. At these saturations the neonate's PO_2 is between 32 and 42 torr. Cyanosis in the older child and adult is identifiable at higher PO_2 levels. The clinical message of the dissociation curve is clear. The pink baby in respiratory distress may be hypoxemic; when cyanosis finally appears, the PO_2 may already be as low as 32 torr. The ill effects of hypoxemia had transpired while the baby was pink. In this context the value of continuous oxygen saturation (SAO_2) monitoring is apparent.

Diminished tissue oxygenation causes metabolic acidosis resulting from overproduction of lactic acid during anaerobic glycolysis. Peripheral vasoconstriction resulting from

acidosis and hypoxemia may cause pallor and a transient rise in blood pressure.

Anaerobic glycolysis also depletes glycogen stores rapidly because more glycogen is required for glucose production. Hypoglycemia is therefore another penalty of hypoxia.

The most immediate response to a drop in oxygen tension is constriction of pulmonary arterioles, which is greatly accentuated if metabolic acidosis is also present. Hypoxemia worsens because ventilation is impaired by the resultant pulmonary hypoperfusion. Furthermore, surfactant production may diminish as a consequence of alveolar ischemia. There is a tendency towards the fetal cardiopulmonary state being reestablished: pulmonary artery blood pressure rises, and a shunt is re-established from the right atrium to the left atrium through the foramen ovale. In the extreme , as in sudden asphyxia from aspiration, a right to left shunt also appears across the ductus arteriosus.

The thermogenic response to cold stress is reduced or eliminated at PO_2 levels of 30 to 40 torr. Thus hypothermia may develop while the baby is pink. Babies who are marginally hypoxic may become extremely restless. They cry and move continuously.

Brain damage from hypoxia may be evident either while the baby

is still in the nursery or not until several months later. There is no PO_2 level that can be regularly correlated with central nervous system damage. Acute and protracted periods of hypoxia are known to injure brain tissue, but the duration of episodes, the extent to which arterial oxygen tension must decline, and the influence of other variables, such as acidosis and hypoglycemia, has not been defined precisely.

(iv) **Hyperoxia: oxygen toxicity.**

The detection of oxygen overdosage is as important as the identification of oxygen deprivation. Here the concern is with the etiological relationship between retrolental fibroplasia and high arterial oxygen tensions. The absolute upper limit of safety and the length of time oxygen therapy is benign have not been documented. At present the consensus is that an arterial PO_2 in excess of 100 torr increases the likelihood of eye injury and is of no value in the treatment of hypoxemia.

2.3 The Circulatory System.

Circulatory disorders are a common pathological state. In order to determine the condition of the cardiovascular system, haemodynamic examinations are performed; these include measurement of blood pressure, blood flow and blood volume. A record of the electrical activity of the heart indicates the state of the heart muscle. The circulatory system of the foetus undergoes a major change at birth to reroute blood

through the lungs and liver, while stopping the flow to the umbilical vessels. There are concurrent changes in the vascular pressures and resistances. Congenital heart defects or incomplete readjustments of these vascular shunts may require surgical intervention or pharmacological treatment (Korones 1986).

Some form of heart disease - usually but not invariably a structural malformation - is present in upwards of 1 in 200 newborn babies; thus it constitutes a relatively common problem (Davies et al., 1972).

Heart disease may be suspected in the case of:

(i) a cardiac murmur heard on the routine examination of an apparently healthy baby;

(ii) (rarely) an abnormality of cardiac rate or rhythm also found on routine examination;

(iii) cyanosis;

(iv) respiratory distress;

(v) feeding difficulty and failure to thrive.

None of these five are necessarily indicative of heart disease, although a combination of two or more increases the likelihood. Thus one positive finding should make for careful examination of the other four (Davies et al., 1972).

Cardiac output (heart rate x stroke volume) is the quantity of blood pumped into the systemic circulation each minute by the heart and is perhaps the most important parameter relating to the circulation.

The heart is well supplied with both sympathetic and parasympathetic (vagal) nerves. These nerves affect cardiac pumping in two ways:

(i) by changing the heart rate;
(ii) by changing the strength of contraction of the heart.

Parasympathetic stimulation decreases heart rate and sympathetic stimulation increases heart rate.

2.4 **Temperature.**

There are two important body temperatures. Core temperature is a function of metabolic activity and is kept constant by thermoregulatory mechanisms. The peripheral or skin temperature is related to the environmental thermal conditions and to the necessity for heat loss (or retention) in order to maintain a constant core temperature. The temperature differential indicates whether the infant is in heat balance with the surroundings. For example, a low peripheral temperature implies that there is a nett heat loss. The energy that the baby expends on producing the heat that is dissipated to the environment could be better utilized in fostering

growth. There is also a limit to the amount of energy that the infant can use for heat production. If this threshold is reached, then the core temperature will drop, resulting in hypothermia.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction.

The neonatal period is defined as the first 28 days of extrauterine life. This period has a higher mortality than at any other time of life. In 1988 the neonatal mortality rate recorded by the hospitals in the Peninsular Maternal and Neonatal Service was 10.6/1000 (de Groote et al, 1988). The neonatal period is fraught with dangers that threaten to damage an individual both physically and intellectually. The consequences of this damage may be problematic for the individual and his/her family for the course of his/her life (McIntosh, 1983).

Many babies who require medical care immediately after birth do so because of respiratory problems resulting from pre-term delivery. Such babies, born around 28-30 weeks of gestation, are immature in many respects and in particular have an inadequate production of surfactant in the lungs. This leads to increasing work of breathing and the infant has difficulty in maintaining safe blood gas and acid-base status. Ventilatory support of varying degrees is often needed, from simple administration of increased oxygen concentrations, to comprehensive mechanical ventilation. Some full-term infants may be asphyxiated at birth and therefore require investigation and treatment (Rolfe, 1986).

Efficient, comprehensive physiological monitoring is an essential component of neonatal intensive care. Many important advances have been made since the late 1960s. The direct contributions of neonatal respiratory disease to mortality and morbidity have diminished progressively, but brain haemorrhage and ischaemia, now the main causes of death and handicapped survival, may well be indirectly related to the respiratory problems of the pre-term infant (Daily et al, 1969). New and improved measurement and monitoring techniques are needed, firstly to assist research in this field, and ultimately to complement clinical management (Rolfe, 1986).

Home monitoring for apnoea is used to prevent sudden infant death syndrome. The criteria for using home monitoring are controversial. Guidelines for its use can be found in textbooks such as the *Handbook of Neonatal Intensive Care* by Henry L Halliday, Garth McClure & Mark Reid, 3rd edition, Ballière Tindall, London 1989.

3.2 **Techniques available for monitoring breathing.**

There are *direct* and *indirect* methods of sensing breathing effort. The direct methods are those in which the sensor is coupled to the airway and measures the movement or other properties of the air transported into and out of the lungs. In the indirect methods, the sensor detects variables related to breathing but not the air movement itself. Usually, indirect methods are

Some of the principle direct variables measured include:

- flow / volume
- temperature
- turbulence

The methods employed to measure these variables are not appropriate for clinical monitoring since they involve direct connection to the infant airway through the use of a mask over the mouth and nose or an endotrachial cannula. In other cases a sensor must be located at the nasal-oral area for signal detection. These methods are, however, useful in some cases for diagnostic studies (Webster, 1988).

There are a wide variety of *indirect* measures of ventilation that can be applied to monitoring infants as tabulated in table 3.1.

The main advantage of the indirect methods is that attachment to the subject is easier than for the direct measurements and less likely to interfere with breathing patterns. The principles governing the application of these techniques are outlined below.

Indirect Sensors & Techniques Of Ventilation Detection

Contacting Motion Sensors	Noncontacting Motion Sensors	Other
Strain gauge Air filled capsule or vest Inductance respirometer	Motion sensing pad Radiation reflection Variable capacitance sensor Stereo-photogrammetry	Electromyography Intraesophageal pressure Extracting respiratory signal from the ECG Transthoracic electrical impedance Breath sounds

Table 3.1

3.2.1 Transthoracic Electrical Impedance.

Of the methods listed above, the transthoracic electrical impedance method is the one used in most respiration-apnoea monitors for both hospital and home use (Webster, 1988) and is the method used in the neonatal intensive care unit at Groote Schuur Hospital.

Transthoracic electrical impedance or *impedance pneumography* is based upon the observation that the

electrical impedance of the thorax is modified by the presence of both air in the lungs and fluids such as pulmonary oedema, pleural effusion, pericardial effusion and haemothorax. An increase in the volume of air (a poor conductor) in the lungs would be expected to increase the impedance while a decrease in the volume of air or an increase in the volume of fluids (good conductors) would decrease the impedance. The impedance measurements are made by applying to the thorax a low intensity sinusoidal current ranging in amplitude from a few microamperes up to 5mA in the frequency range from 20kHz to 100kHz. By maintaining a constant current, the impedance between two points on the thorax is directly proportional to the potential between these points ($v=i_k |Z|$). It is the potential difference that is recorded and displayed as the change in impedance (Webster, 1978).

A fundamental problem associated with impedance pneumography is the relatively small changes in impedance associated with the measurement.The volume of the heart varies during the cardiac cycle, and so the contribution of the blood to the overall transthoracic impedance will change from systole to diastole. To a lesser extent the vascular component of the chest wall and lungs will also change in volume during the cardiac cycle. These blood volume changes manifest as an impedance variation occurring at the heart rate known as *cardiogenic artifact*.

Cardiogenic artifact is not always small compared to impedance changes due to breathing and in these circumstances it is difficult to determine which impedance variations are due to breathing and which are due to cardiovascular sources. It is only possible to identify periods of respiration and artifact when the recording is compared with a simultaneous recording of respiration using a different technique.

3.2.2 Contacting Motion Sensors

Sensors can be placed upon and attached to an infant to measure ventilatory movement. These contacting motion sensors pick up movements of the chest and/or abdomen. There are several types of sensor falling within this category.

(i) Strain Gauge Displacement Sensors.

Most strain gauges used for general measurements are made of thin metal foils or wires and are useful for measuring only very small displacements due to their lack of compliance. A special type of strain gauge consisting of a compliant, thin walled, rubber capillary tube filled with mercury was developed by Whitney as a limb plethysmograph (Whitney, 1953). This compliant device can be positioned around the chest or abdomen of an infant so

that breathing movements cause it to stretch and contract without offering significant mechanical constraint to the breathing efforts of the infant. The changes in electrical resistance of the gauge can then be used to monitor infant breathing movements. Simple electronic resistance measurement circuitry can be used for processing the signal (Webster, 1988).

This technique is used primarily in research and in some cases for in-hospital monitoring and recording of infant respiration patterns. Its limitations are related to use of a toxic substance that could escape from the sensor and put the infant at risk. In addition, the mercury column frequently becomes discontinuous after several days of use, thereby limiting the sensor's reliability for infant monitoring. Nevertheless, workers who use this sensor for monitoring purposes are enthusiastic about its reliability in picking up high-quality respiration patterns (Webster, 1988).

(ii) **Air-filled Capsule or Vest.**

Breathing efforts can be determined from chest or abdominal movements by a sensor consisting of an air-filled compliant tube, disk or entire vest attached around an infant. The tube and disk can be taped to the infant's chest or abdomen and the structures will be stretched or compressed by the infant's breathing movements. This causes the pressure of the air within to

increase or decrease, and this pressure can be measured by coupling the sensor to a sensitive pressure transducer through a fine-gauge flexible tube. The advantage of this system is that the sensors on the infant are simple and inexpensive and thus can be considered disposable devices. Since only air is contained within the sensors, they are not toxic (as is the case with mercury strain gauges) and they are also more reliable (Webster, 1988).

(iii) **Displacement Magnetometers.**
The magnetic field from a permanent magnet or an electromagnet decreases as one gets farther from the magnet. By placing such a magnet on an infant's chest or abdomen with a detector located on the back of the subject or underneath the infant, differences in separation between the magnet and the detector can be sensed as the infant breathes (Rolfe, 1971). It is important that such a system be designed so that it will only respond to breathing movements and will be insensitive to other movements of the infant. Unfortunately, this is not always the case, and sensors of this type can respond to infant limb movement as well as movement between the infant and the pad upon which it is placed (Webster, 1988).

(iv) **Inductance Respirometry.**
The inductance of a loop of wire is proportional to the area enclosed by that loop. If a wire is incorporated in

a compliant belt in a zigzag fashion so that the wire does not interfere with the stretching of the belt, such a belt can be wrapped around the chest or abdomen of an infant to form a loop. As the infant inspires or expires, the area enclosed by this loop will change, so the inductance of the loop will also change. These changes can be detected by appropriate electronic circuitry and used to indicate breathing efforts. This technique has been used in adults to measure tidal volume as well as respiratory effort (Sackner et al., 1980). Although the system is simple in concept, realizing it in practice can involve complicated and therefore costly electronic circuitry. Often as the subject moves to a new position, the calibration constant between inductance and volume changes thereby making the instrument less quantitative, yet still allowing it to be suitable for qualitative measurements. The instrument can also be sensitive to moving electrical conductors or other magnetic materials in the vicinity of the infant which may induce a voltage/current in the loop and affect the measurement.

3.2.3 Noncontacting Motion Sensors

These sensors detect infant breathing movement without direct patient contact. They consist of devices that are placed under the infant or can sense movement of the infant by means of a remotely located sensor. Devices in this category have special appeal for monitoring systems used outside the hospital, such as for instruments used

in the home. With many of the noncontacting sensors the infant-sensor interface can be established by individuals who do not have specialized training.

(i) **Motion Sensing Pad.**

Movements of neonates and infants can be sensed by a flexible pad that responds to compression by producing an electrical signal when the infant is placed on top of the pad. There are two different forms of this sensor that can be used for motion detection.

The first utilizes a piezoelectric polymer film, polyvinylidene fluoride, that has its surfaces metalized to form electrical contacts. Depending upon the piezoelectric properties of the film, an electrical signal is produced between the metalized layers when the polymer is either compressed or flexed. In the former case, the polymer film and its metalized electrode need only to be packaged in an appropriate pad structure, while in the latter case the package must be more complex with the polymer film positioned between two corrugated, flexible layers so that compression of the structure causes the piezoelectric polymer to be flexed (Fraden, 1986).

The second form of the pad uses an electret material to generate the electrical signal. The actual pad structure

is similar to that for the piezoelectric material (Webster, 1988).

The sensitive portion of the motion sensing pad structure is usually smaller than the overall size of the infant and is located under the thoracic and/or lumbar regions. Infant breathing efforts result in periodic compression of the pad as the centre of mass of the infant shifts with respiratory motion. This generates a periodic electrical signal related to breathing effort (Webster, 1988).

The major limitation of the motion sensing pad is its sensitivity to movements other than those related to respiratory efforts of the infant. Other body movements can be picked up by the sensor, and the device can even respond to movements that are not associated with the infant at all, such as small movements of the crib (Webster, 1988).

This type of device is used in the observation wards of the Neonatal Unit and on non-critical infants in the Neonatal Intensive Care Unit at Groote Schuur Hospital.

(ii) **Radiation Reflection.**

Electromagnetic radiation in the microwave range or in the visible light band can be reflected from the surface of an infant. Ultrasonic radiation (sonar) may also be

used for this purpose. If the surface is moving, as, for example, would be the chest or abdominal wall during breathing efforts, the reflected radiation will be shifted in frequency according to the doppler effect and, in some cases, in amplitude as well, because of this motion. These changes can be detected and used to sense breathing efforts without actually contacting the infant. The visible spectrum may be utilized in the technique of stereo-photogrammetry which permits monitoring of the 3 dimensional infant chest topology and correlation of topological change with breathing effort (Adams and Klein, 1986).

The problem with these methods is that the movement of any surface that reflects the radiation will be detected. Body movements of the infant that are unrelated to breathing movements can be detected and mistakenly identified as breathing effort. In some cases movement of objects in the vicinity of the infant, such as a sheet of paper shifting due to air currents, will also be detected as infant respiration. A commercial monitor based on this principle is available but the technique has not gained wide acceptance (Webster, 1988).

(iii) **Variable Capacitance Displacement Sensor.**

A parallel plate capacitor can be fabricated so that an infant is placed between the parallel conducting planes. This can be done in an incubator by having the base on which the mattress and infant are placed serving as one

plate of the capacitor and having the second plate just inside the top of the incubator (Barrow and Colgan, 1973). The top plate should consist of a transparent conductor, such as a thin tin oxide film, so that it does not interfere with the clinician's ability to observe the patient. Since a major component of the infant's tissue is water, and water has a relatively high dielectric constant compared to air, movements in the infant will produce changes in capacitance between plates that can be electronically detected. Such changes can be the result of breathing movements, but they can also result from other infant movement or movement of some other materials in the vicinity of the conducting plates. Thus this indirect motion sensor suffers from the same problems as other sensors in this category: the lack of specificity for breathing movements.

3.2.4 **Breath Sounds.**

Listening to chest sounds through a stethoscope is a common method for assessing breathing. The technique can be used for infant monitoring by placing a microphone over the chest or trachea at the base of the neck and processing the electrical signals from this sensor. In addition to the sounds associated with air transport and ventilation, the microphone will pick up other sounds in the body and the enviromment. Thus for this type of monitoring to be efficacious, it must be done in a quiet

environment. This puts a serious constraint on the practical use of this technique (Webster, 1988).

3.2.5 Intraesophageal Pressure.

The pressure within the thorax decreases with inspiratory effort and increases with expiratory effort. These changes can be measured by placing a miniature pressure sensor in the thoracic portion of the esophagus or by placing a small balloon at this point and coupling the balloon to an external pressure transducer through a small diameter flexible tube. While this method is invasive, it is not considered a direct method since there is no contact with the flowing air (Webster, 1988).

An important aspect of intraesophageal pressure measurement is that it represents a standard method that is accepted by physiologists as a measure of respiratory effort. Thus, by combining intraesophageal pressure measurement and the pneumotachograph, one is able to monitor both gas flow and breathing effort. Although both of these methods are generally too complicated for clinical monitoring, they can be used in conjunction with other monitoring methods as standards against which to assess other techniques (Webster, 1988).

3.2.6 **Extracting the Respiratory Signal from the ECG.**

The ECG signal contains certain interfering components which are related to respiratory activity: (Pallas-Areny and Canals Riera, 1985)

(i) the diaphragm is the principal muscle for pulmonary ventilation so, when surface ECG electrodes are used, related activity (EMG) is present in the ECG baseband;

(ii) thoracic motion during breathing contributes to electrode movement, an easily detectable 'artifact' which modulates the ECG baseband;

(iii) the respiratory rhythm influences the cardiac rhythm through vagal reflexes. This is manifest by alterations in the R-R interval.

These interfering components in the ECG are verifiable by means of spectral analysis and signal extraction, through the utilization of suitable filtering and detection circuitry, permits respiratory monitoring. It has been shown that the simultaneous use of the three techniques allows the recognition of apnoea (Pallas-Areny and Canals Riera, 1985).

3.2.7 **Electromyography.**

The difference between this technique and extraction of the respiratory signal from the ECG is that, in this case, the diaphragm electromyographic signal is captured

directly from the electrodes and is the only parameter of interest. Unfortunately, other muscles in the vicinity of the electrodes that are not involved in breathing also produce electromyographic signals. These signals can severely interfere with those associated with respiration, and this is especially true when the infant is moving. This represents a serious limitation of this method for clinical infant respiration monitoring (Webster, 1988).

3.3 Monitoring Blood Gases.

The prevalence of respiratory disease in the pre-term infant makes the efficient assessment and control of blood gas and acid-base status essential. Arterial levels of oxygen, carbon dioxide and pH can change very rapidly and only continuous *in vivo* monitoring can provide a true picture of events (Rolfe, 1986). Invasive monitoring is problematic in terms of where and when sensors can be applied. While the umbilical arteries are convenient conduits to the central arterial circulation, they are only patent for a few hours after birth in most neonates. Following this time it is very difficult to obtain continuous arterial samples since other vessels must be used. The use of intravascular sensors increases the risk of infection and care must be taken with intraarterial sensors to avoid serious haemorrhage due to system components becoming disconnected. Noninvasive methods

carry less risk to the patient and are easier to apply clinically (Webster, 1988).

3.3.1 **Pulse Oximetry.**

Pulse oximeters have rapidly achieved a major role in neonatal and adult intensive care medicine replacing transcutaneous blood gas tension measurement as the noninvasive method of choice. Oximetry differs from oxygen tension measurement in that it tells how much oxygen is carried by the haemoglobin. To know total oxygen transport one needs to know the amount of haemoglobin in the blood as well as the perfusion of the tissue in question. Thus, oximetry can with some additional data be useful in determining whether adequate amounts of oxygen are being supplied to vital tissues.

Pulse oximeters function by producing two wavelengths of light (about 660 and 940nm, i.e. red and infrared light) directed through a vascular bed. Each pulsation of this bed causes a change in the light path length which alters the light absorbance. At 660nm the absorbance of oxyhaemoglobin is greater than that of deoxyhaemoglobin, at 940nm the opposite is true. The absorbance ratio of the two wavelengths therefore varies with the ratio of oxy- to deoxyhaemoglobin in arterial blood. Beat-to-beat calculation of $SaPO_2$ (pulsed oxygen saturation) is possible without interference from nonpulsating blood or other tissues (Barrington et al., 1988).

Pulse oximetry is not a sensitive guide to gas exchange in patients with high baseline PaO_2 (arterial oxygen tension) values due to the peculiar shape of the oxy-haemoglobin dissociation curve. On the upper horizontal portion of the curve, large changes in PaO_2 may occur with little change in SAO_2 (arterial oxygen saturation). Thus to truly protect the patient from retrolental fibroplasia, one must measure oxygen tension and not haemoglobin oxygen saturation (Tobin, 1988).

Because pulse oximeters rely on pulsatile fluctuations in transmitted light intensity in order to estimate SAO_2, they are all adversely affected by movement. The processing techniques used by some oximeters (including the model used in this study) do not allow for a distinction to be drawn between 'true' and 'false' pulsations thus introducing a degree of non-specificity into the system (Barrington et al., 1988).

Certain newly available oximeters (for example, Model N-200 manufactured by Nellcor Inc., Haywood CA) have a unique feature of ECG "synchronization" which should make the instrument less movement sensitive. The device requires an ECG signal in order to use this feature and this can be derived from the analog ECG output of a bedside monitor or directly from independent electrodes. This design improvement is related to the temporal delay between ECG R-wave detection and plethysmograph detection

of a pulsation. When an absorbance fluctuation appears which is unrelated to the R-wave, it is "ignored". Studies have revealed that the N-200 is a significant advance and is able to remove significant movement-associated pulsation from the signal (Barrington et al., 1988).

Pulse oximeters are a significant advance in the continuous noninvasive monitoring of oxygen saturation. They are easy to apply, have a rapid response time, require far less technical support than transcutaneous monitoring, and will not burn the skin. As a result the probes need not be moved once an adequate application is achieved. Their major drawback in the neonatal ICU is their movement sensitivity, which results in significant periods during which the output is not reliable. This requires that clinicians ensure that the patient is immobile, or that an appropriate waveform is being displayed before placing any credibility on the output of such devices. The use of ECG synchronization appears to reduce motion sensitivity in situations where R-wave discrimination is operating reliably but further improvements in ECG signal detection and processing are required (Barrington et al., 1988).

3.4 Neonatal Cardiac Monitoring.

3.4.1 Introduction

The primary use of cardiac monitors for infants is in determining heart rate and conditions of bradycardia (<130 beats/min) or tachycardia (>160 beats/min). In the case of infants with heart disease, other arrhythmias may be detected (Webster, 1988).

The electrical activity generated by the heart can be modelled as a dipole source. Biopotential electrodes detect the projection of the cardiac electrical field onto the body surface. The ECG is recorded by placing several (3-10) electrodes on the body. Electrodes distributed around the thorax and the limbs are needed to provide a complete picture of the underlying electrical activity of the heart. Several lead systems have evolved. Among these, the Orthogonal Frank Lead System and a clinically standard 12-lead system are the most accepted ones (Webster, 1988). In terms of monitoring, the focus is on the rate rather than the morphology of the neonatal ECG signal at this time (Rolfe, 1986).

If a reduced level of sophistication and detail is acceptable, 1 to 3 lead recordings may be done. This is common in intensive care units.

Cardiac monitors designed for use with infants frequently incorporate respiratory monitors that include

instrumentation for determining breathing rate and apnoea (Webster, 1988) by using the ECG electrodes. In these combined monitors a modified lead I configuration is normally used and the electrodes placed as far as possible from each other laterally on each side of the lower rib cage (Huch et al, 1983).

Cardiac monitors for use on neonates are very similar to those for use with adults, however, there are some major differences as outlined below.

(i) **Infant Electrodes**

Biopotential electrodes (usually silver/silver chloride) are used as sensors for both infants and adults but in the case of infants the interface between the electrode and the patient has more stringent requirements (Webster, 1988).

The infant electrodes are scaled down versions of the adult electrodes but the scale factor does not correspond to the body size ratio between the neonate and an adult. The smallest available skin surface electrodes for neonates only approach about one-fourth the size of those used in adults. For this reason, electrodes can cover a large portion of the neonatal thorax. This is especially true with the small premature infant and can interfere with direct observation of chest wall movements, an important traditional diagnostic method (Webster, 1988).

In addition to size, shape and flexibility of the electrode are important. Stiff, flat electrode surfaces will not conform well to the curved, flexible surface of the infant. This means that optimal electrical contact is not always possible and it therefore becomes more difficult to hold electrodes in place. This problem is further complicated by the fact that neonatal skin can be sensitive to the electrode adhesive. It is not unusual to find skin irritation and ulceration at electrode sites (Webster, 1988).

(ii) **Noise Sources**

In systems that employ impedance pneumography to monitor respiration (where a high frequency current is passed between the active electrodes), high frequency components may be introduced to the ECG by the respiratory channel's circuitry. Artifacts are also introduced by muscular activity (myographic signals fall in a range from 30 to 2000Hz). Motion-related artifacts introduce unwanted low frequency components below 0,05Hz (Webster, 1988).

This interference must be eliminated to provide an optimal signal-to-noise ratio without introducing any noticeable frequency distortion as would occur if the low cut-off frequency was too high or if the high cut-off frequency was too low.

(iii) **Bandwidth**

It has been shown that the neonatal ECG has a larger bandwidth than the adult signal (probably due to a higher heart rate). (Riggs et al, 1979).

Lowering the upper cut-off frequency results in an attenuation of the QRS complex but spectrum analysis of the ECG signal reveals that most of the energy of a QRS complex is found between 10 and 15Hz (Berson et al, 1977).

The American Heart Association Scientific Council (AHA) (1989) has made certain recommendations regarding bandwidth requirements and filter specifications for cardiac monitors. The recommended bandwidth (for diagnostic ECGs) is 150Hz. An analog 0,05Hz single pole high pass filter has been found to be suitable in terms of eliminating baseline wander due to respiratory variation and most movement artifact. No specification has been defined for low pass filtering (in this document). For purposes of paediatric QRS detection, monitors should detect QRS complexes with slopes of 6 - 300 mV/sec, and durations of 40 - 120 msec. An amplifier bandwidth of 0,5 - 40Hz has been recognised as being adequate in situations where the need to detect transient ST segment shifts does not arise (American Heart Association Scientific Council, 1989). At present there are no standards defining *neonatal* ECG monitoring bandwidth.

3.4.2 Rate Detection

Two types of cardiotachometer can be used (Webster, 1988).The averaging cardiotachometer determines the mean number of heartbeats per predetermined interval to establish the heart rate. In such systems the heart rate is calculated by averaging over from as few as three to as many as fifteen or more heartbeats. An instantaneous or beat-to-beat cardiotachometer determines the heart rate for each measured R-R interval. This type of cardiotachometer must be used when one is interested in beat-to-beat variability of the heart rate. Although the majority of infant cardiac monitors use an averaging scheme, interest in instantaneous cardiotachometers is increasing and researchers are investigating the use of beat-to-beat heart rate variability as a parameter in monitoring infants (Webster, 1988). It has been shown (by several authors) that the HRV (heart rate variability) power spectrum provides a non invasive tool to monitor the autonomic control on the heart both in normal and pathological subjects (Merri et al, 1990). By definition, instantaneous neonatal heart rate (NHR) is that heart rate computed for successive R-R intervals by a cardiotachometer which has a processing time of 1 millisecond or less (Hon et al, 1975).

3.4.3 The Relationship Between the ECG and Respiratory Waves.

The waveshape of the electrocardiogram (ECG) varies with respiration (Einthoven et al, 1950). Respiration, by changing the position of the heart in the chest, as well as lung conductivity and ventricular blood volumes, causes variations in the surface potential.

In addition, the instantaneous heart rate, arterial blood pressure, and other haemodynamic parameters fluctuate on a beat-to-beat basis. This beat-to-beat variability was first identified by Stephen Hales in the 18th century and has become known as "the normal sinus arrhythmia" or respiratory sinus arrhythmia (RSA). Its direct clinical importance was perhaps first demonstrated in the area of fetal monitoring (Akselrod et al, 1981). The decrease of the beat-to-beat variation in the fetal heart rate during labour signifies fetal distress and the need for rapid delivery.

The frequency content of heart rate fluctuations has been analyzed by measuring their power spectrum. It has been shown that, in addition to the fluctuations in heart rate associated with the respiratory cycle, there are also periodic fluctuations in heart rate occurring at lower frequencies. Accordingly, the power spectrum (see figure 3.1) of the heart rate fluctuations contain not only a peak centered at the respiratory frequency but also peaks

at two lower frequencies, typically 0.04 and 0.12Hz (Sayers, 1973).

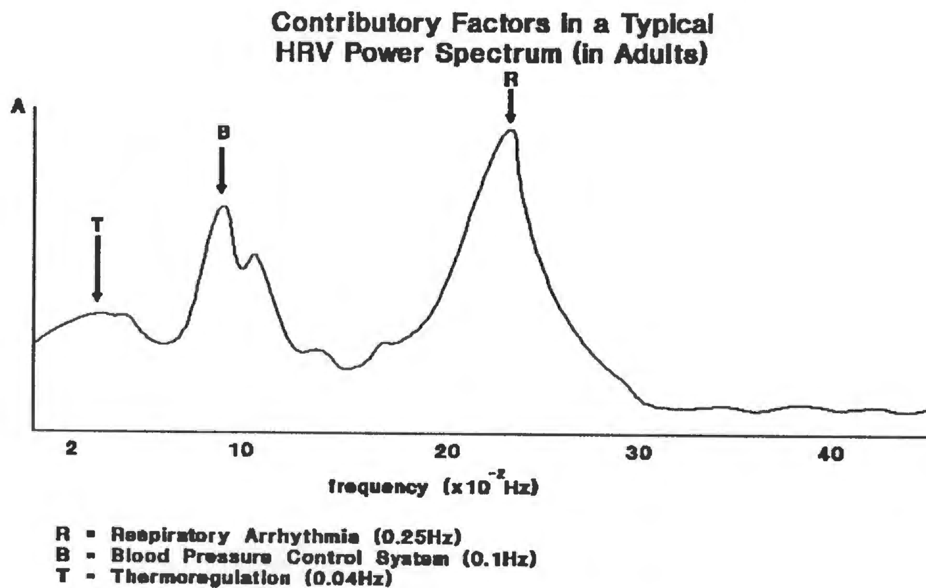


Figure 3.1 (Adapted from Kitney & Rompelman, 1980)

It has been confirmed that sympathetic and parasympathetic nervous activity make frequency-specific contributions to the heart-rate power spectrum, and that renin-angiotensin system activity strongly modulates the amplitude of the spectral peak located at 0.04Hz (Akselrod et al, 1981).

As illustrated in figures 3.2 and 3.3, the sympathetic and parasympathetic nervous systems are directly responsible for modulating heart rate in response to fluctuations in sensed variables such as arterial blood pressure. However, the response time of the parasympathetic nervous system is much shorter than that

The Effect Of The Autonomic Nervous System On Heart Rate Variability

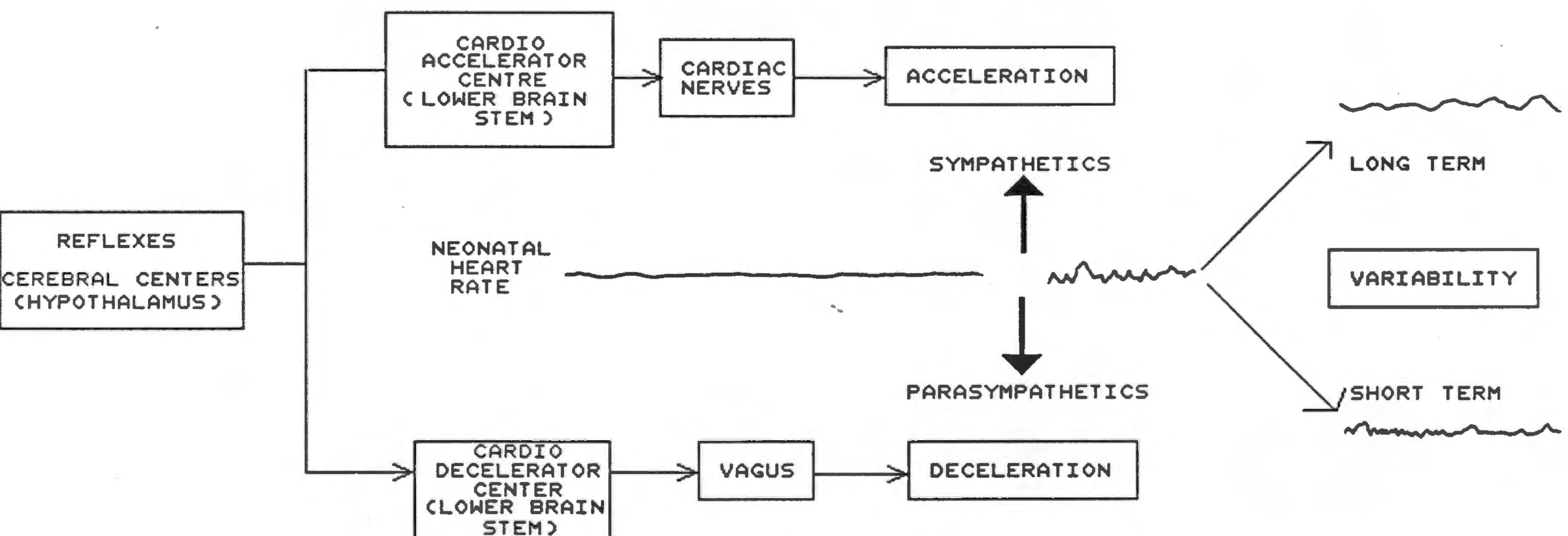


Figure 3.2

of the sympathetic nervous system (Akselrod et al, 1981). Therefore, only the parasympathetic nervous system reacts rapidly enough to mediate high frequency fluctuations in heart rate corresponding to the mid- and high-frequency peaks of the spectrum. Both the sympathetic and the parasympathetic systems are capable of mediating heart rate fluctuations in the range of the low frequency peak at 0,04Hz (Akselrod et al, 1981). The normal baseline neonatal heart rate (NHR) is between 120 and 160 beats per minute. A long-term variability (3-5 cycles per minute) and a short term variability due to differences in successive R-R intervals are superimposed on this basal rate. These perturbations in NHR are due to the continuous interaction of the sympathetic and parasympathetic divisions of the autonomic nervous system which, because of their continuing changing tone and different time constants, cause a series of perturbations on the baseline NHR. Hence, if such perturbations are absent, some compromise of the nervous mechanisms controlling the heart may be present (Hon, 1975).

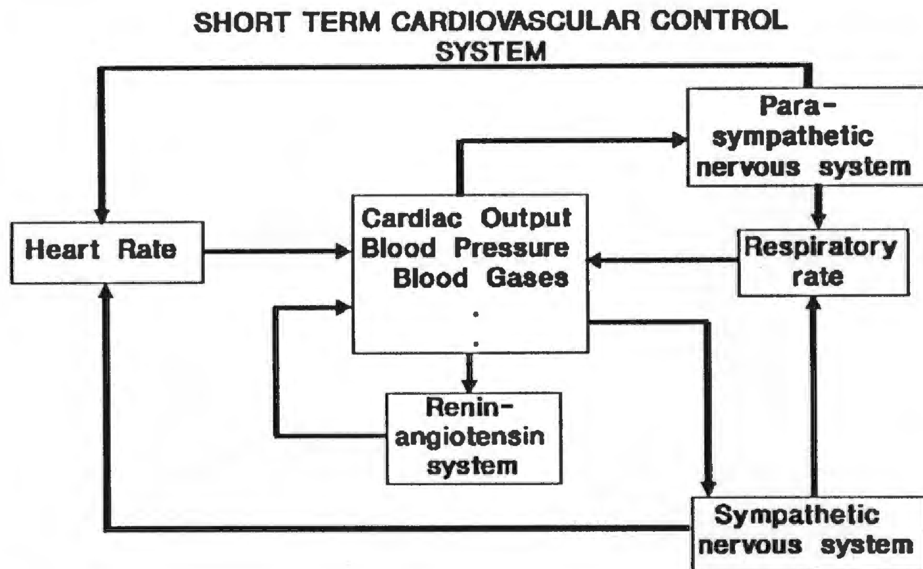


Figure 3.3 (Adapted from Akselrod et al, 1981)

3.4.4 Application of HRV Research to Neonatal Monitoring.
Respiratory Sinus Arrhythmia (RSA) is characterized by increased heart rate during inspiration and slowing of the heart during expiration (Schechtman et al., 1989). Two major types of heart rate variation have been identified in infants: a high-frequency oscillation around 0.42Hz that is correlated with the respiratory cycle (RSA) and lower frequency oscillations in a wide band of frequencies variously reported to range from 0.034 to 0.2Hz (Schechtman et al., 1989).

In a study undertaken by Gordon et al (1984), spectral analysis revealed enhancement of low frequency power in the 0.02 to 0.1Hz band of the heart rate power spectrum in a group of 8 infants who subsequently died from sudden

infant death syndrome (SIDS). The data suggests that a predisposition to SIDS manifests itself in an abnormal pattern of fluctuations in heart rate and respiratory activity.

Continuous fluctuations in heart rate are temporarily attenuated in respiratory distress syndrome (RDS) (Äärimaa et al., 1988) (see figure 3.4). By means of spectral analysis it is possible to establish the periodic components of heart rate variability (HRV) and visually compare the power spectra of the ECG and the respirogram (Äärimaa et al., 1988). This technique is being incorporated in prototype neonatal monitor designs because the technique provides reliable warning of RDS (Mitchell et al., 1991).

Trend in Spectral Density for Normal Term Infants and Infants with RDS.

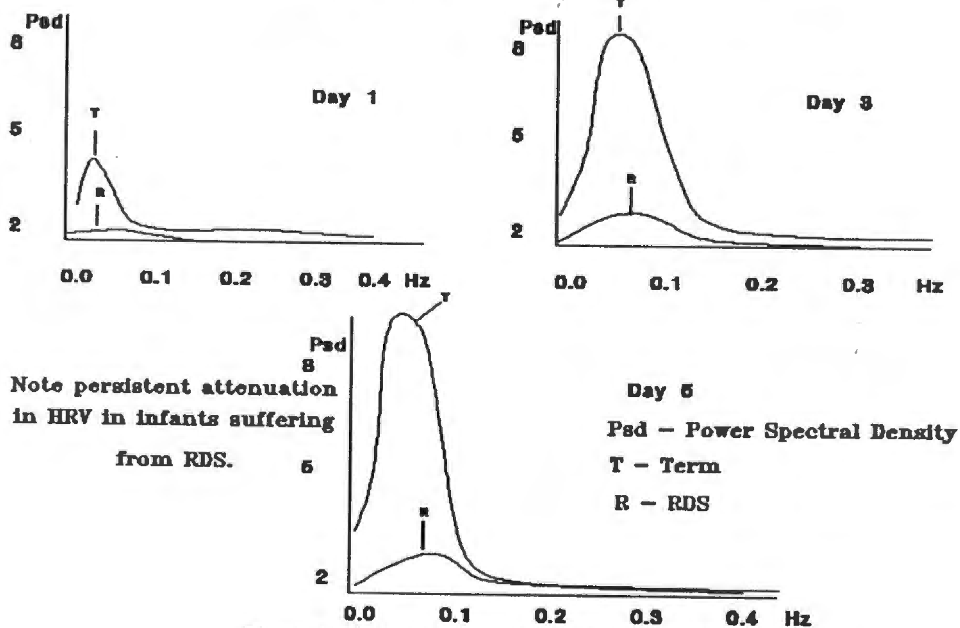


Figure 3.4 (Adapted from Aarimaa et al., 1988)

3.5 Blood Pressure.

The measurement of blood pressure is important since any changes in it - hypertension and hypotension - usually indicate conditions that call for medical treatment. Blood pressure may be measured noninvasively with an inflatable rubber cuff (Riva-Rocci cuff) attached to a sphygmomanometer but this is sometimes inadequate for a thorough investigation in an ICU setting. Instead, a direct method is used in which the vessels are punctured. The use of umbilical artery catheters allows direct continuous measurement of arterial pressure with hydraulically coupled pressure transducers. The advent of disposable transducer domes has greatly simplified the clinical use of these transducers, by eliminating the need for sterilization. Currently available electronic monitors used with blood pressure transducers further simplify use by performing automatic zero correction. Reliable long-term monitoring can only be achieved if the catheter remains patent, and continuous low-rate infusion of heparinized saline is therefore often carried out by means of 'intra-flow' devices.

Frequent noninvasive assessment of arterial pressure can be of clinical value in some babies who have not been catheterized or have had the catheter removed (Rolfe, 1986).

3.6 Temperature.

Continuous or intermittent thermometry is common practice in neonatal ICUs. Babies have relatively large surface area to body weight ratios making them particularly susceptible to thermal stress induced by fluctuations in environmental conditions. Reducing these changes can dramatically improve the baby's growth rate. Core temperature is most accurately assessed from an axillary or a rectal measurement (Korones, 1986). The function of an incubator is to ensure a thermoneutral zone around the infant. Abdominal skin temperature is used as the servocontrol feedback variable to the incubator heating system ensuring a thermal environment in which the infant expends minimal energy on maintaining body temperature.

3.7 A Description of Established ECG Waveform Databases.

During the past three decades, numerous computer programs have been developed for the automatic interpretation of the ECG. Computer-aided analysis generally relies on developing algorithms for the following:

(i) ECG filtering and artifact rejection
(ii) QRS detection and rate calculations
(iii) Identification of P and T waves and ST segments
(iv) Ectopic beat identification (PVC, paced etc.)
(v) Arrhythmia classification based on rate (bradycardia, tachycardia, etc.)

(vi) Classification of disorders based on morphology (hypertrophy,infarct, etc)

Diagnostic ECG interpretation requires noise-free signals with proper gain and bandwidth. Classification of morphologically based disorders such as ischaemia and hypertrophy requires signals recorded from several channels. Neonatal electrocardiography is generally concerned with arrhythmia analysis for which a single channel recording is adequate.

Methods and independent data bases to test the reliability of such programs are still scarce. All ECG computer analysis programs are basically composed of two parts which respectively deal with measurement and diagnostic interpretation. The main task of the measurement part is to find the location of the major reference points (that is , the onsets and offsets of P, QRS, and T waves and the ST-segment) and their amplitudes and polarities. These features are then used to classify the measured ECG according to diagnostic category.

The performance of computer programs for diagnostic ECG needs to be verified using a recognized authoritative standard database rather than by independent cardiologists so as to avoid inconsistencies and disagreements between them. Some of the available databases are described below.

3.7.1 The CSE Database.

In a large cooperative project (Common Standards for Quantitative Electrocardiography [CSE]), test procedures and reference libraries have been developed to assess the precision and accuracy of such measurements (Willems et al, 1987). A reference library was first developed for the evaluation and improvement of programs analyzing three ECG leads at a time. A new study has been undertaken for multilead ECG in which all leads are recorded simultaneously (Willems et al., 1987). The developers of the database applied methods to ensure maximum signal quality so noise has been intentionally excluded from the database.

The 'primary' database consists of a sample of 250 digitized adult ECG's selected because they represented a wide variety of ECG morphologies. The data were collected at 500 Hz with a resolution of at least 10 bits and a minimum quantization level of 5μV (Willems et al., 1985a).

Some ECG measurement programs select 1 beat for analysis while others base results on an average beat, so 'artificial' ECG's were also created to facilitate both types of analysis. This was done by selecting 1 beat from each of the lead groups of each of the 250 original recordings and by creating strings of identical beats

with stable RR intervals over 10 seconds for the XYZ leads, and over 5 seconds for each three-lead group of the conventional 12 leads. The selected beats were chosen by eye in such a way as to be close to the dominant beat with the least possible baseline shift, noise and artifact. A variable segment was interlaced between the beats to correct for possible offset artifacts. Another group of 60 artificial ECGs was composed from additional beats selected for a study of beat-to-beat variation, so the total artificial ECG library was composed of 310 recordings (Willems et al., 1985a).

The 250 original and 310 artificial ECGs were randomly divided into two sets containing nearly equal samples of each pathologic entity. The beats selected for the artificial library were analyzed by a board of referee-cardiologists from 5 different countries. The referees had experience in computer assisted ECG interpretation, but to avoid bias had not been involved in program development.

3.7.2 **The MIT-BIH Arrhythmia Database.**

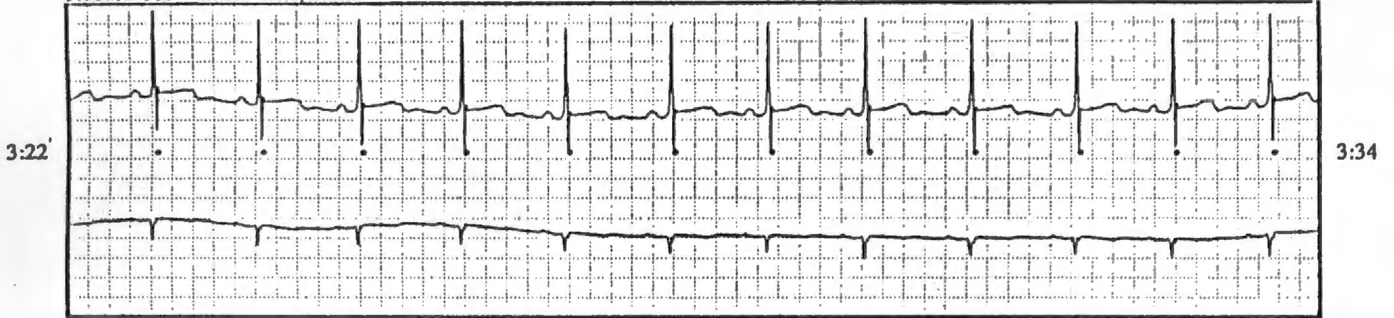
The source of the ECGs included in this database is a set of over 4000 long-term Holter recordings. The database contains 23 records chosen at random from this set, and 25 records selected from the same set to include a variety of rare but clinically important phenomena which would not be represented by a small random selection of Holter recordings. Each of the 48 records is slightly over 30 minutes long (MIT-BIH

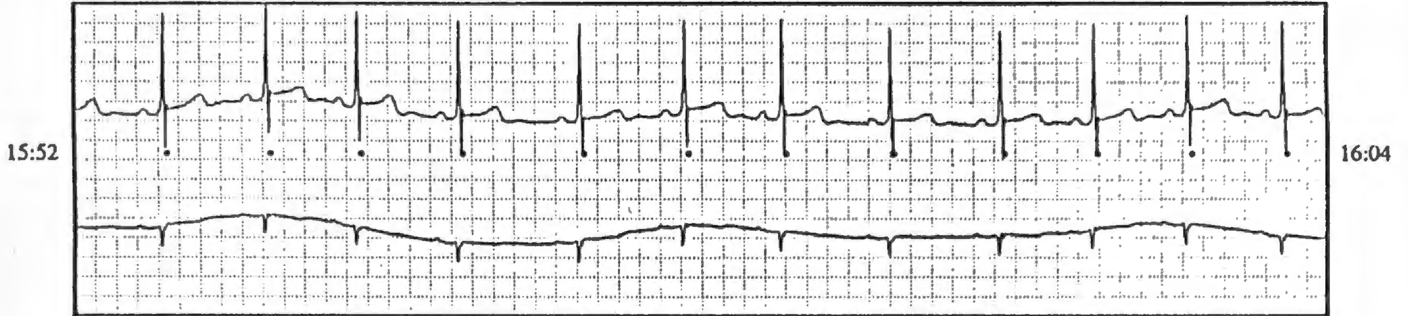
Biomedical Engineering Centre, 1988).

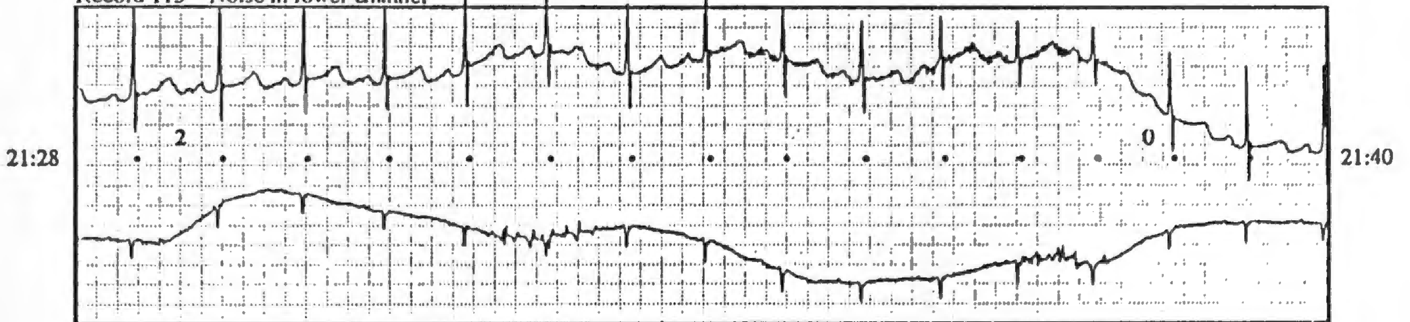
The first group is intended to serve as a representative sample of the variety of waveforms and artifacts which an arrhythmia detector might encounter in routine clinical use. Figure 3.5 illustrates the different noise sources that have been characterized in the database. Records in the second group were chosen to include complex ventricular, junctional, and supraventricular arrhythmias and conduction abnormalities. Several of these records were selected because features of the rhythm, QRS morphology variation, or signal quality may be expected to present significant difficulty to arrhythmia detectors. The subjects were 25 men aged 32 to 89 years, and 22 women aged 23 to 89 years (MIT-BIH Biomedical Engineering Centre, 1988).

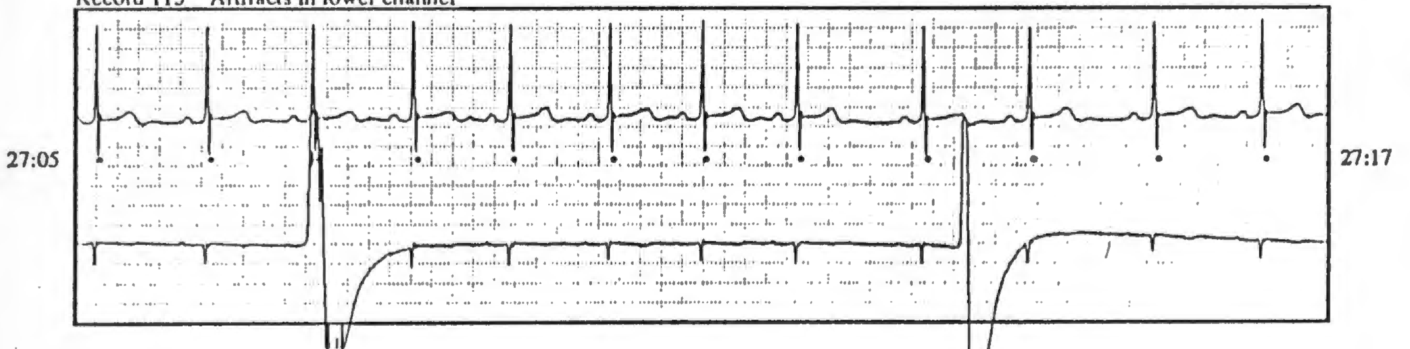
In most records, the upper channel is a modified limb lead II obtained by placing the electrodes on the chest. The lower channel is usually a modified lead VI chest.

The original tracings are all analog recordings that have been digitized. The use of analog recording equipment introduces a number of frequency-domain artifacts related to specific mechanical components of the recorders and the playback unit. No compensation has been made for wow









Examples of Noise/Artifact Characterisation in the MIT-BIH Database.

Figure 3.5(Adapted from the MIT-BIH Arrhythmia Database).

and flutter in these recordings so these components need to be identified in the context of HRV studies.

The analog outputs of the playback unit were filtered to limit analog-to-digital converter (ADC) saturation and for anti-aliasing, using a passband from 0.1 to 100Hz. The bandpass-filtered signals were sampled at 360 Hz per channel relative to real time. The sampling frequency was chosen to facilitate implementations of 60Hz digital notch filters in arrhythmia detectors.

Samples were acquired from each channel almost simultaneously (the interchannel sampling skew was of the order of a few microseconds). The ADCs were unipolar, with 11 bit resolution over a ±5mV range. In order to economize on mass storage, the 11-bit samples were recorded in 8-bit first difference format.

Each record has been annotated by two cardiologists who worked on them independently.

3.7.3 Noise Stress Test Database

This database consists of 15 thirty-minute records. Three of these contain noise of the types typically observed in ECG recordings. They were obtained using a Holter recorder on an active subject, with leads placed so that the subject's ECG is not visible (Moody et al, 1984). Two signals were recorded simultaneously. Types of noise captured include:

(i) baseline wander, caused by motion of the subject or the leads;

(ii) electrode motion artifact, usually the result of intermittent mechanical forces acting on the electrodes;

(iii) muscle noise (EMG), with a spectrum that overlaps that of the ECG but which extends to higher frequencies.

Electrode motion artifact is usually the most troublesome type of noise for arrhythmia detectors since it can closely mimic characteristics of the ECG (Moody et al, 1984).

3.7.4 ST Change Database

This database consists of 28 unannotated records ranging in length from 13 to 67 minutes, obtained from 28 subjects. These records exhibit transient ST depression in response to exercise induced ischemia (Albrecht, 1983).

3.7.5 Malignant Ventricular Arrhythmia Database

This database consists of 22 thirty-five minute records, obtained from Holter tapes of 16 subjects. It is annotated with respect to rhythm changes, which include 89 episodes of ventricular tachycardia, 60 episodes of ventricular flutter, and 42 episodes of ventricular fibrillation (Greenwald et al., 1985).

3.7.6 Atrial Fibrillation/Flutter Database

This database may be useful for development and evaluation of atrial fibrillation/flutter detectors which rely on timing information only. It consists of 25 ten-hour records (obtained from Holter tapes of 25 subjects) containing about 300 episodes of atrial fibrillation and 40 episodes of atrial flutter (Moody and Mark, 1983).

A five year retrospective Inspec Database search unearthed no evidence of a *neonatal* waveform database in the literature. Other sources, where one would expect to find, by association, details of such a database (eg the MIT-BIH and CSE databases) contained no such references.

A FEATURE COMPARISON OF CURRENTLY MARKETED NEONATAL MONITORS

COMPANY /MODEL	ECG BANDWIDTH		RESPIRATION TYPE			* BLOOD PRESSURE	TEMPERATURE	OXYGEN SATURATION	tcpO2/tcpCO2	TRENDS	HRV ANALYSIS
	MONITORING	DIAGNOSTIC	IMPEDANCE	NASAL THERMISTOR	PNEUMATIC ABDOMINAL						
AIR SHIELDS System VI/VI-S	●		●					●		●	
COROMETRICS MEDICAL SYSTEMS Neo-Trak 515A		●	●			●	●		●	●	
HEWLETT PACKARD 78834A		●	●			●	●		●	●	
INVIVO RESEARCH Omni-Track	●	●	●			●	●			●	
IVY BIOMEDICAL SYSTEMS 701		●	●			●	●			●	
IVY BIOMEDICAL SYSTEMS 303A		●	●							●	
KONTRON INSTRUMENTS Minimon 7136B	●	●	●			●	●			●	
KONTRON INSTRUMENTS Minimon 7134B	●	●	●			●	●			●	
MARQUETTE ELECTRONICS INC. Series 2330N	●		●			●	●			●	
MEDICAL DATA ELECTRONICS 101	●	●	●			●	●	●		●	
NIHON KOHDEN AMERICA OEC-8120A		●	●	●		●	●		●	●	
NIHON KOHDEN AMERICA OEC-6120A		●	●	●			●			●	
RIGEL MEDICAL ELECTRONICS Multicare 309	●				●		●				
RIGEL MEDICAL ELECTRONICS Multicare 409		●	●		●	●	●			●	
SIEMENS MEDICAL SYSTEMS 404N		●	●			●	●		●	●	
SPACELABS INC. 90622A Series	●	●	●			●	●	●	●	●	
SPACELABS INC. 90303B PC	●	●	●			●	●		●	●	
SPACELABS INC. 90721 Series	●		●				●		●	●	

* Invasive Monitoring

TABLE 3.2

3.8 Current Technologies on the Market for Neonatal Monitoring

Table 3.2 illustrates the range of parameters monitored and some of the techniques used by different manufacturers. Most manufacturers offer the diagnostic ECG bandwidth (0,05Hz - 100 Hz) often together with a monitoring bandwidth option (0,05Hz - 30Hz). For respiration monitoring impedance pneumography is generally the technique of choice (the implemented bandwidth is typically 0,2Hz - 3Hz). In some cases other techniques have been included as options. Most monitors offer invasive blood pressure monitoring at various catheter sites. Temperature measurement to a resolution of ±0,1°C is generally offered. A trend facility is normally included which generally logs up to 24 hours of ECG rate data but varies in sophistication. Air Shields, for example, offer trend displays of apnoea, apnoea coupled with bradycardia and associated changes in percentage oxygen saturation. Some monitors offer transcutaneous gas monitoring but generally as an optional module. Relatively few manufacturers have, to date, integrated oxygen saturation into their systems and no models in the survey possess an HRV analysis facility.

CHAPTER 4

VITAL SIGNS DATA ACQUISITION SYSTEM.

4.1 Choice of Parameters for the Vital Signs Database

Previous research (Gordon, 1985) has proposed that an appropriate neonatal monitor in the South African context should detect apnoea, heart rate, temperature and respiration rate. On the basis of this research, the clinical context outlined in Chapter Two and the relevance of certain parameters to the purpose of the database it was decided to monitor the following parameters:

(i) respiratory rate. Respiratory rate is an important indicator because apnoea provides a warning of underlying disorders and/or incomplete respiratory centre development.

(ii) oxygen saturation data because of the crucial role that oxygen plays in tissue metabolism. Monitoring oxygen saturation is essential for the prevention of hypoxia.

(iii) Cardiac monitoring was chosen because the condition of the heart muscle has critical implications for the functioning of the circulatory system as a whole. Also, HRV monitoring gives an indication of the autonomic nervous system control mechanism.

It was decided that these three parameters should as far as possible constitute a linked data set to facilitate any further trend analysis the data may provide occasion to offer. Linked data provides information that is temporally related. An event in one channel may be observed to precede an event in another channel and a causal hypothesis may be proposed on this basis.

4.2 *A Priori* Specification of the Database.

Prior to data collection, the envisaged database was quantitatively defined in a clinical context. It was decided that the data should represent an even distribution over the neonatal gestational age spectrum (including a specified number of patients) and contain patient records, representing each relevant clinical condition within each gestational age class. The specification is outlined below:

Gestational Age:	32 Weeks	34 Weeks	36 Weeks
No.of Patients:	10	10	10

Clinical Cond.:	Apnoea	Bradycardia [1]	Normal	Periodic Breathing	Tachycardia [2]
Patients/ Condition:	10	10	10	10	10
Max. Records/ Patient:	10	10	10	10	10

1 Bradycardia defined as less than 130 beats/min.
2 Tachycardia defined as greater than 160 beats/min.

In addition to obtaining records of clinical conditions, technical alarm states also required inclusion. The specified requirements were:

Technical Alarm:	**Lead-off Alarm**	**Dry Electrodes**
No. of Records:	**10**	**10**

The total number of records would be 1520 (assuming it was possible to obtain the stated number of recordings per condition per patient).

4.3 **The Infrastructural Context.**

The system was customized to function within the technical constraints imposed by the monitoring equipment available at the time.

The neonatal intensive care unit at Groote Schuur Hospital is a 14 incubator facility which possesses only 5 functioning cardiac/respiratory monitors, ie. only 5 patients can be monitored for these parameters on a continuous basis. The unit also possesses 2 Ohmeda Biox 3700E Pulse Oximeters which are utilized on a rotational basis. Nursing staff manually record vital parameters hourly on patient charts. The vital parameters of interest generally include heart rate, oxygen saturation, respiratory rate, temperature of patient, temperature of incubator, patient colour and details of medication, feeding and intravenous fluids.

Of the five available cardiac/respiratory monitors there are three Hellige Servomed SMK 155 monitors, one Spacelabs 526 Patient Monitor and one Vitatek Neonatal Monitor. A decision was taken to design the system around the Hellige monitors because these are the only monitors in the unit with a facility to communicate with a central station providing rate information, alarms as well as analog signals to a remote location. The other two monitors only have a facility for transmitting analog data. In addition, the analog signal output levels from the Hellige monitors are compatible with the input signal specifications for the analog to digital conversion (A/D) card which requires that the maximum signal variation be 10V (between -5V and +5V or between 0V and +10V).

The rate information was regarded as being useful as a control measurement when testing rate detection algorithms on the raw data. The alarm information could be used to flag the system and enable the automatization of data collection.

This rate and alarm information is transmitted by means of a non-standard communication protocol - the Hellige Data Bus. It was thus necessary to write software that would enable the extraction of this digital data. Some technical literature describing general features of the communication protocol was generously provided by Mannesmann Medical (Pty) Ltd. (local agents for Hellige) and on the basis of this information a simulator was designed and built to generate

signals with the same protocol so that the data capturing software could be developed [Appendix A]. With this tool, software that could read free-running data on the Hellige data bus was successfully developed. This free-running data contains alarm and heart rate information but unfortunately not respiration rate. The problem is that the Hellige data bus is bi-directional. Any additional data that is transmitted by the bedside monitor is in response to a data request code sent by the central station. Information concerning these request protocols was not provided.

The database also had to include oxygen saturation data for each patient being monitored. From a technical perspective this was not a problem because the Ohmeda BIOX 3700E pulse oximeters in service in the ICU use the industry standard RS232 asynchronous communications protocol which allows data transmission/reception through the computer's serial port. For this purpose, a shareware library of interrupt driven routines (MG_COMM) was adapted for use and integrated into the system. A difficulty that was encountered was simply that there are too few oxygen saturation monitors (SATS monitors) in the unit to allow dedicated monitoring of the three patients being monitored on the Hellige cardiac/respiratory monitors. These SATS monitors need to be available on a 'floating' basis for all the patients in the unit. This meant that software had to be designed to monitor each of the three patients individually as this was the only

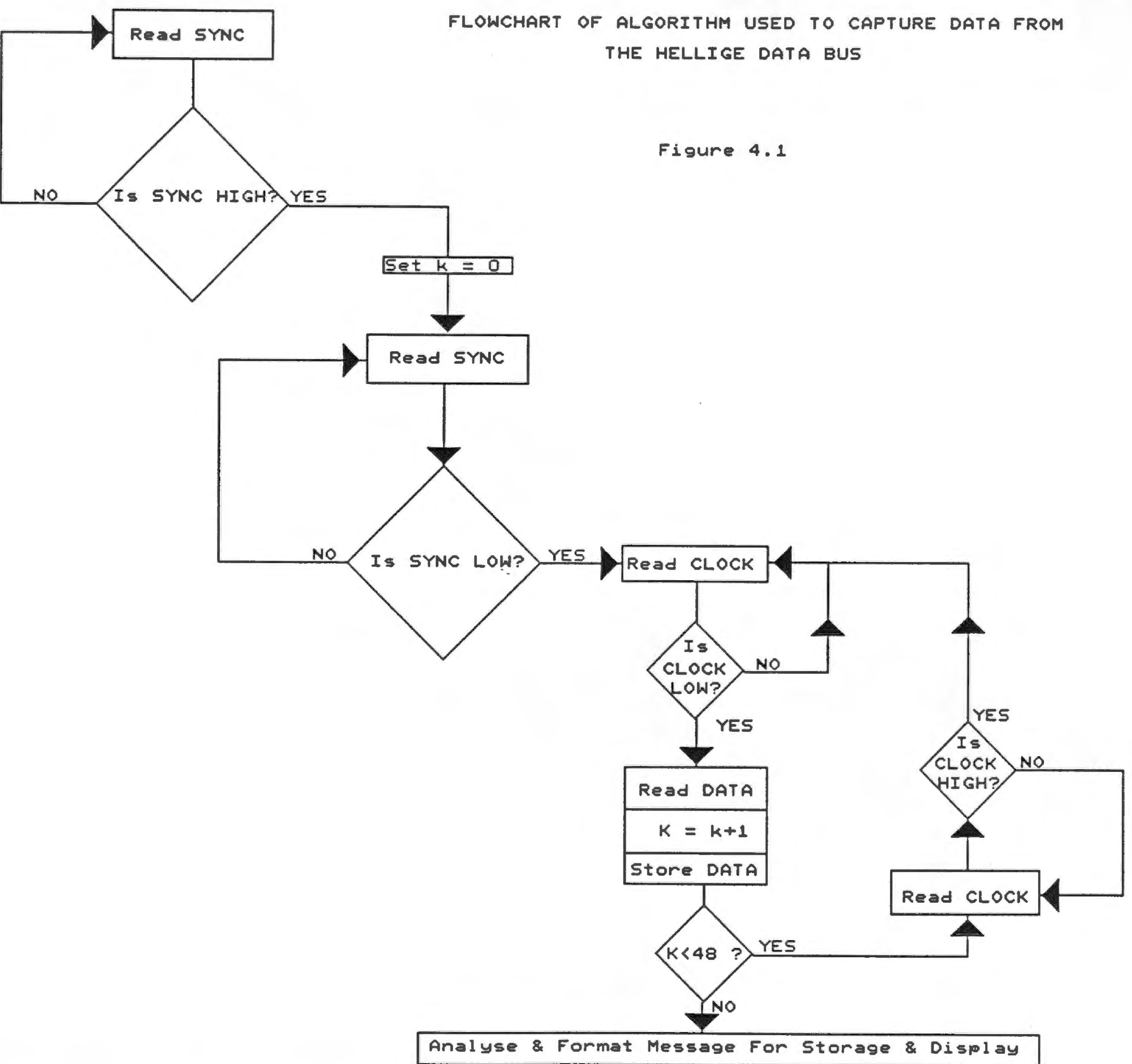
way to ensure that all the required parameters were being simultaneously monitored on a specific patient.

4.4 The Hellige Data Bus.

Communication with the Hellige Data Bus was made possible by the utilization of the 8255 peripheral interface adapter on board the PC30D (Eagle Electric, Cape Town) A/D interface card. This chip has the capability of receiving/transmitting data through three ports each comprising 8 digital I/O lines.

The Hellige Data Bus [Appendix B] consists of three digital lines so a total of nine digital lines are required to maintain communication links with the three monitors. An additional three lines are used to access the General Alarm signal output from each monitor. Since the output levels of the General Alarm lines idle at 14,2V it was necessary to buffer these signals through 5V voltage reference zener diodes to make the signals TTL compatible.

The software was required to monitor the three bus lines in sequence as they each achieved their active state in turn as illustrated in figure 4.1.



FLOWCHART OF ALGORITHM USED TO CAPTURE DATA FROM THE HELLIGE DATA BUS

Figure 4.1

4.5 Analog Data Capture Considerations.

The size of a disk file recording depends upon sampling rate, recording time and storage format. The sampling rate must be at least twice the highest significant frequency component of the signal being recorded. This rate is known as the *Nyquist* rate. If one uses a sampling frequency below the Nyquist rate, a phenomenon known as aliasing results. The consequence of aliasing is the presence of additional low-frequency components in the acquired signal. These components constitute artifacts, thus distorting the original signal. An unavoidable consequence of this problem is that the sampling rate cannot be set for individual channels; a single global sampling rate applies to all channels. Therefore, one must sample at a rate equal to twice the maximum component frequency of the physiological signal with the largest bandwidth. This limitation becomes apparent when monitoring ECG signals with lower-frequency impedance pneumography signals. The higher the sampling rate, the larger the data file will be for a given time, and consequently more disk space will be required to store the information. More efficient utilization of disk space has been achieved by storing the data in unformatted binary files.

Six of the available sixteen analog channels on the A/D card are being used so there is adequate spare capacity for system expansion. These six channels are being sampled at an effective 100Hz/channel which means that the respiratory

channels are being oversampled at almost 17 times the requisite Nyquist rate (±6Hz). Storing data captured with this degree of oversampling is uneconomic in terms of hard disk utilization so software was written to eliminate redundant respiratory samples without compromising the temporal integrity of the data. A flowchart of this algorithm is illustrated in figure 4.2. Eight pole Bessel low pass filters were used for anti-aliasing purposes (30Hz and 3Hz for the ECG and respiratory channels respectively) and a spectrum analyzer was used to check that the signal bandwidths would not be affected by the filters. Bessel filters were chosen because of their linear phase response. These filters eliminate spurious high frequency signal components which could otherwise result in aliasing of the signal.

4.6 **Data capture Software Design.**

The original design was based on the principle of automatization. An attempt was made to make the system run itself. Briefly, data is captured on all 6 channels for a set sampling period (see figure 4.3). Incoming data on the Hellige bus is then analyzed to determine if any alarm condition is active on a particular monitor. If no alarm condition is detected, the data in the sampling buffer is transferred to the first buffer in a temporary storage chain. The monitors are sampled again (three times) for the same period and data is transferred down the storage chain each time new data needs to be moved to the first buffer. A search for a normative data

FLOWCHART ILLUSTRATING CORRECTION FOR OVERSAMPLING
OF THE RESPIRATORY CHANNEL

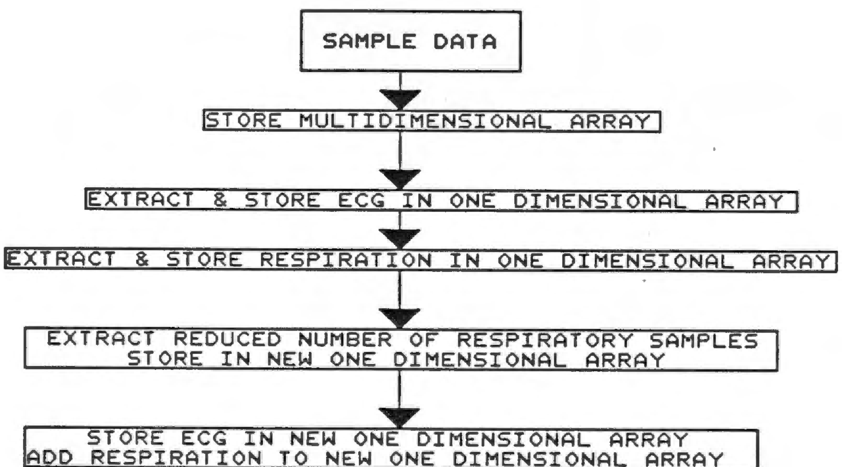
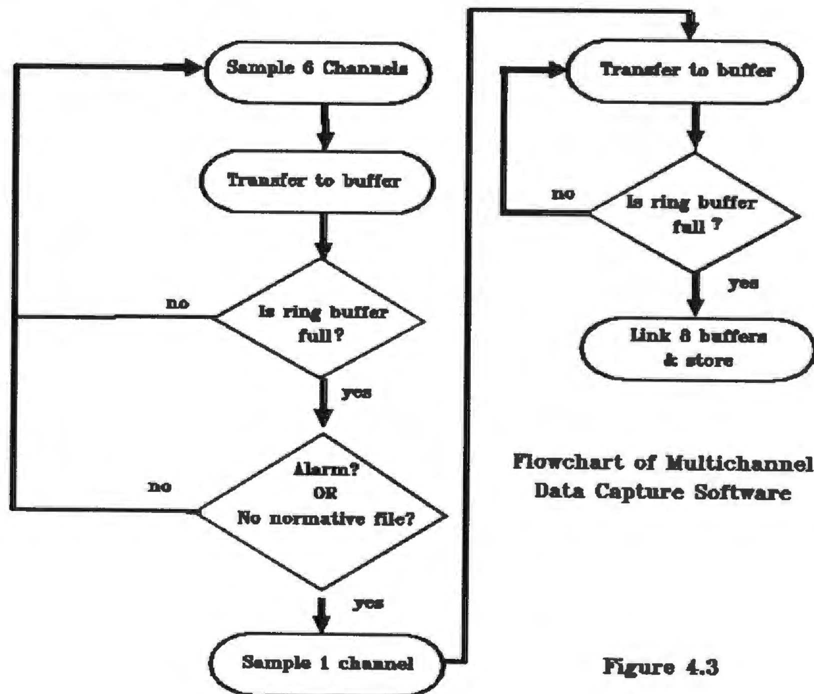


Figure 4.2

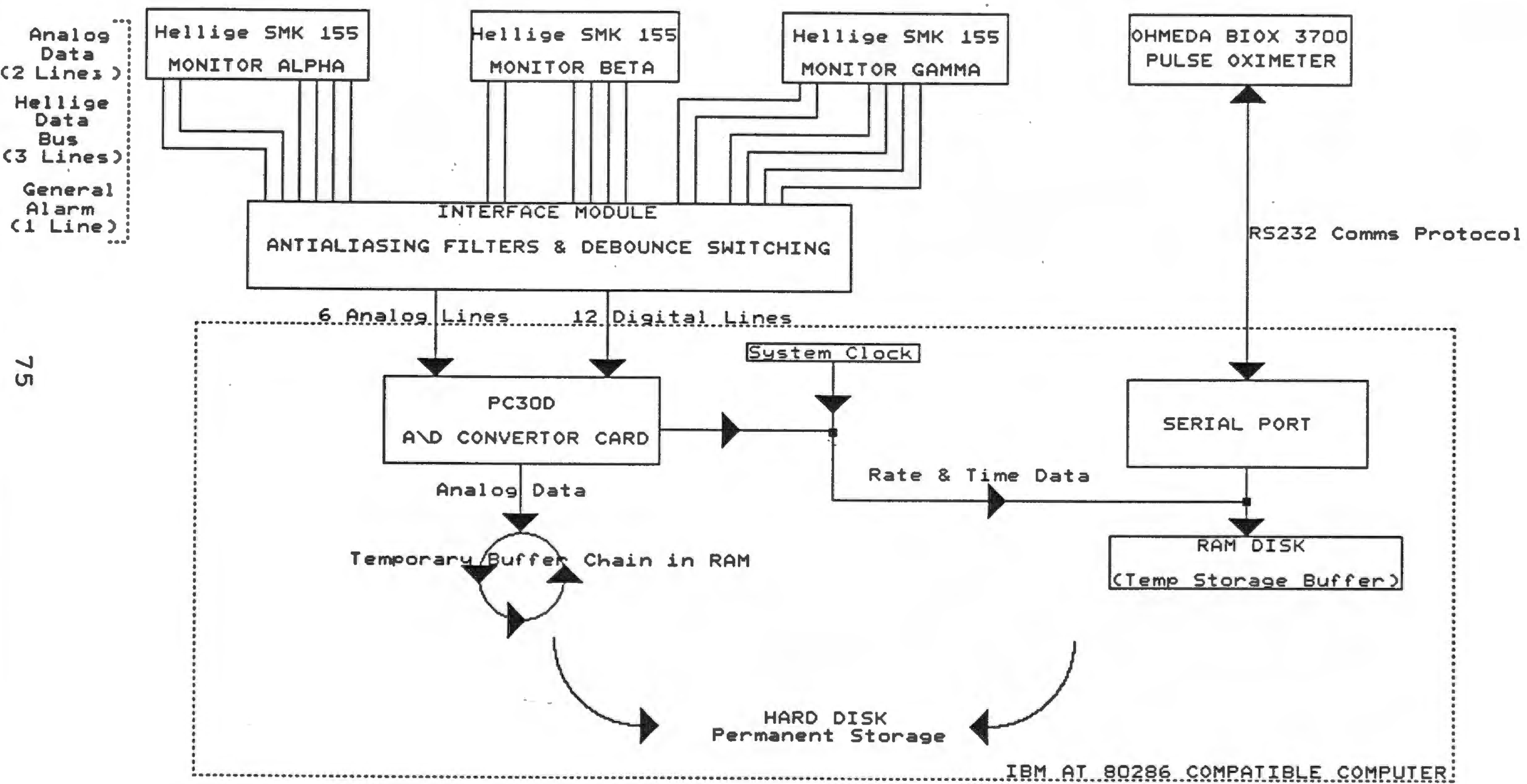
record (a record containing no abnormal event) is undertaken. If the record is found the program recycles by clearing the sampling buffer and resampling on all channels, again three times. If no normative record is found or an alarm condition detected, the process is repeated, filling an *additional* four buffers. Finally the resultant eight storage buffers are linked together in a final buffer from which relevant elements can be extracted to be stored on disk.



Flowchart of Multichannel Data Capture Software

Figure 4.3

Once the system had been set up in the ICU it became apparent, due to a number of reasons, that it would be necessary to be able to monitor patients individually. Monitors often emit false alarms and may also alarm simultaneously due to factors such as signal artifacts. Also, as mentioned previously there are too few pulse



Schematic Diagram of System Configuration

Figure 4.4

oximeters to allow concurrent SATS data collection on all three patients. Finally, it was valuable to have the flexibility of being able to focus on a particular patient who was experiencing recurrent abnormal events or who's condition was likely to deteriorate, resulting in abnormal data.

The screen display is implemented in graphics mode - this enables a page to be displayed without scrolling the screen. It also allows colour coding and the consistent arrangement of information in specific spatial locations on the screen. A diagram illustrating the complete system is shown in figure 4.4.

4.7 **Textfile Database Design.**

Each text record is defined as an object called a 'card'. Three different cards have been designed:

- a Patient Record card
- a Data card
- an Alarm card

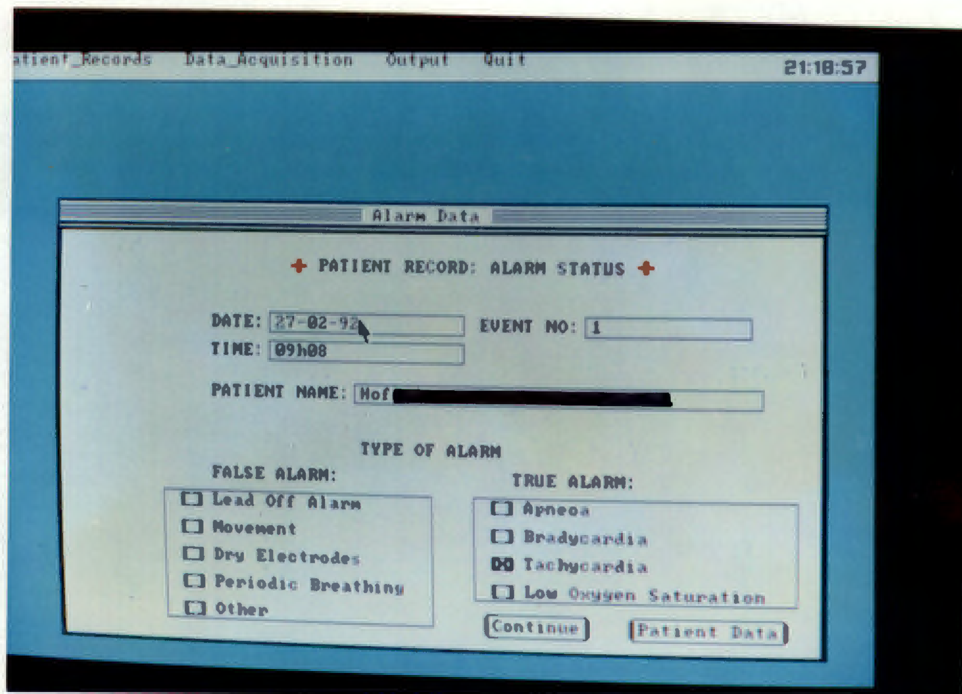
These cards are illustrated in figure 4.5.

Different Features Of The User Interface

a) A Patient Record Card

(b) Additional Information Concerning A Particular Record

Figure 4.5



(c) An Alarm Card

(d) Menu Options

Figure 4.5(*continued*)

The *Patient Record* card has delineated fields for patient name, sex, gestational age, date and time of birth, mother's and infant's folder numbers and diagnosis and outcome.

The *Data* card has delineated fields for patient name, an event field to link the card with a particular waveform record, date and time of data capture, patient folder number and a scrolling field for diagnosis and outcome with reference to each recorded event (clinically significant incident eg an apnoeic attack).

The *Alarm* card has delineated fields for patient name, date and time of event, and checkboxes to indicate the type of true or false alarm that occurred for a particular event.

Each record is stored in a cardfile, so three cardfiles exist - one for each card type. Individual cards can be linked to one another either within the same 'cardfile' or to a card in a different cardfile. Accessing linked cards is achieved by activating symbolic icon link 'buttons' drawn on the card. Links can be created by means of a utility program built into the system. The linking structure that has been adopted is illustrated in figure 4.6. A circular linked list links related cards within the same cardfile while a simple direct one way link links related cards in different cardfiles.

LINK STRUCTURE OF TEXTFILE DATABASE

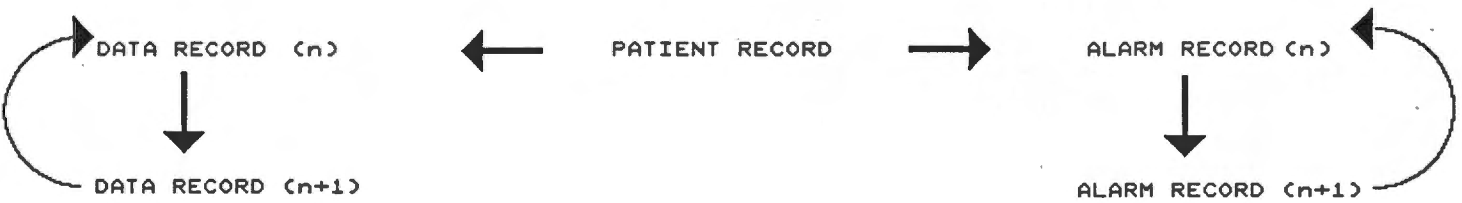


Figure 4.6

Card editing is possible both during keyboard entry and after the card has become integrated into the database. The system supports insert editing, overwriting and has mouse support. The mouse can be used to mark checkboxes, position the cursor and to retrieve and store cards. The cursor automatically selects the next field when the operator hits 'Return' and can operate with or without the mouse. More sophisticated editing techniques, such as block editing, are not really necessary in this type of database because the quantity of text information required is limited.

Utilities included in the system include facilities to:

- add a card to a cardfile;
- delete individual cards from a cardfile;
- search for a particular *patient record* card by keying in the first few letters of the patient surname;
- search for a particular *alarm* card by keying in the first few letters of the patient surname;
- sort the *patient record* cardfile chronologically or alphabetically.

4.8 Graphic User Interface.

All subprograms integrated into the system are accessed from a graphic user interface which utilizes a mouse or keyboard driven pop-up menu system (see figure 4.5). Each subprogram returns to the graphics 'shell' on completion so it behaves as a home-base and thus orientates the operator. This process is executed by utilization of a series of batch

files. This method is not ideal but was chosen because of the technical limitations imposed by the overlay linker that was available for program development. The Microsoft Overlay Linker (version 3.61) requires that the data segments of all overlays be resident in the primary layer. Since arrays are statically defined and their sizes are large in this particular application, the linker could not successfully create a system that initiated disk-based subprograms.
In addition to the subprograms specified as being part of the textfile database, the following facilities are accessed from the main menu:

- a subprogram to permit viewing of patient waveform files;
- a subprogram to permit viewing of text data associated with each patient waveform file i.e., rate data, SATS data and time;
- a subprogram for multichannel data capture;
- subprograms for individual patient data capture;
- subprograms for printing out waveform files and card files;
- a subprogram to calculate rate information for a selected record.

The textfile database and the graphic user interface were designed using a software development tool called *Matrix Layout* (version 2.01) while the data capture software was written in 'C' using Microsoft C (version 5.0). The waveform viewing facility was written in 'C' using graphics libraries

purchased from Quinn-Curtiss Inc.(USA). in a package called *Scientific and Engineering Tools for Microsoft C 5.1, 6.0 & Quick C.*

CHAPTER 5

A DESCRIPTION AND ANALYSIS OF THE DATA OBTAINED

5.1 A Survey of the Collected Data [1]

Ideally the database should have consisted of 1520 records. This was not achieved due to time constraints and clinical priorities in the ICU. Patients experiencing conditions such as apnoea required immediate clinical intervention and under these circumstances it was difficult to capture data.

The database contains 509 documented clinical records obtained from 35 patients over a four month period. There are also 10 records containing samples of high frequency noise due to dry electrodes and 10 records where a lead-off condition was deliberately instigated. A summary of database contents is given in figure 5.1.

Each record has a duration of 164 seconds and consists of ECG and respiration waveforms stored at 100Hz and 12.5Hz respectively. This amounts to approximately 23 hours of recorded data stored in unformatted binary files to economize on available memory. Each file occupies 36 Kbyte of memory so that the complete documented waveform database occupies approximately 18 Mbytes. An additional 4 Mbyte of data is stored in the database but has not

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[1] The page references in this section all refer to Appendix C. The records referred to may be viewed in the sample from the database on the accompanying diskette.

A SUMMARY OF CLINICAL/TECHNICAL FEATURES RECORDED
IN THE DATABASE

Events	APNOEA	BRADYCARDIA	PERIODIC BREATHING	NORMAL	TACHYCARDIA	TACHYPNEA	DRY ELECTRODES	LEAD-OFF
32 WEEKS								
PATIENTS	2	8	4	10	7	1		
RECORDS	24	34	27	56	65	3		
34 WEEKS								
PATIENTS		3	1	7	5			
RECORDS		47	1	55	61			
36 WEEKS								
PATIENTS		6	3	8	4			
RECORDS		36	16	47	37			
Total Records	24	117	44	158	163	3	10	10

Figure 5.1

been documented because sufficient data for these categories had already been included. The principle of collecting only 10 records/patient was not strictly adhered to because of the difficulty in obtaining abnormal data from a sufficiently broad range of patients (for example, data containing samples of recurrent apnoea could only be obtained from 2 patients). Under these circumstances the policy was to collect as much data as possible, whenever it could be found.

Associated with each waveform record is a textfile containing information describing heart rate, respiration rate and the starting time for each sampled buffer in the record. Where possible, oxygen saturation, pulse rate, time of pulse oximeter sample and any relevant comments that may have been necessary for that particular record, have been included. The waveform display routine links the textual data and waveforms by accessing available textfile data for display along with the waveforms. Additional information including patient record data and patient status at time of recording are filed on graphic 'cards'. The entire database is accessed through a menu driven graphic user interface. The database has been structured as illustrated in Figure 5.2 primarily according to gestational age with subdirectories for each clinical category under each age group.

DIRECTORY STRUCTURE OF NEONATAL VITAL SIGNS DATABASE

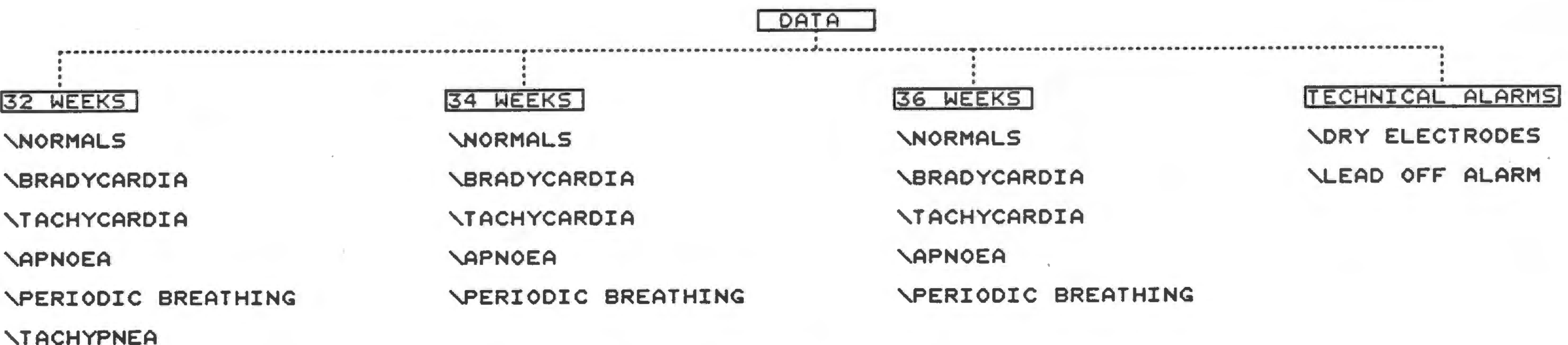


Figure 5.2

SUMMARY OF SIGNAL QUALITY STATISTICS
FOR THE WAVEFORM DATABASE

No. of :	Total	Legible	Illegible	Partly Legible
Records :	509	224 (44%)	40 (8%)	244 (48%)
Frames :	8144	5212 (64%)	2932 (36%)	

Figure 5.4

The following information, for each patient, record and frame is given in Appendix C and presented in the manner shown in Figure 5.3:

(i) number of heart beats/frame;
(ii) number of breaths/frame;
(iii) clinical event/frame;
(iv) signal quality/frame;
(v) date & time of recording/patient and record;
(vi) pathname/patient and record;
(vii) patient status at time of recording/patient.

Method of Data Presentation in Appendix C

Figure 5.3

This information is derived from the ECG and respiration signals by counting the number of heart beats/breaths in each record and visually analysing each record.

The clinical condition and signal quality codes used in Appendix C are defined in Table 5.1 below:

Clinical Condition Codes	Signal Quality Codes
Ap - Apnoea	0 - Both Signals Clear
B - Bradycardia	1 - ECG Clear,Respiration Noisy
N - Normal	2 - Respiration Clear,ECG Noisy
PB - Periodic Breathing	3 - Both Channels Noisy But Readable
T - Tachycardia	4 - Extreme Noise Or Signal Loss In One Or Both Channels
TAp - Tachypnea	
Miscellaneous Codes	
M - Movement Artifact	
EC - ECG Crosstalk	
RC - Respiratory Channel Crosstalk	
We - Weak QRS Complex	
Wr - Low Amplitude Respiratory Trace	
qT - Accentuated T-Wave	
! - Isolated QRS-like Artifact	
LO - Lead-Off	
?? - Illegible Signal	

Table 5.1

The waveform data for each record is accessed through a display routine that shows the record as a sequence of sixteen 10.25 second 'frames'. The data has been described in this frame-by-frame context. Signal quality can vary from frame to frame within a single record so any quantitative evaluation has to use a frame rather than a record as a basic element.

From this premise it was determined that 36% of the frames in the database contain a level of interference that renders at least one channel unreadable with the display routine that has been implemented. Sixty four percent of the frames contain waveforms that can be clearly identified. Figure 5.4 summarizes the various signal quality characteristics of the database.

About 80% of the noise-plagued waveform segments of the database are confined to the respiratory channel. The remaining 20% are found in 40 records in which both channels are indecipherable for most of the record.

The data captured covers a broad range of signal conditions and, embedded in this continuum, are examples of all the specified clinical conditions. Sorting of clinical conditions and storing files by directory proved difficult in certain cases because one record may have included as many as three possible clinical states. For example, record 14 on page C.2 (patient Van) contains frames indicative of apnoea, bradycardia and periodic breathing against a background of various signal conditions.
Typically, records containing clinical events commence with a data segment representing the event followed by a period of movement artifact during which time the patient is being stimulated/resuscitated. Subsequently,the

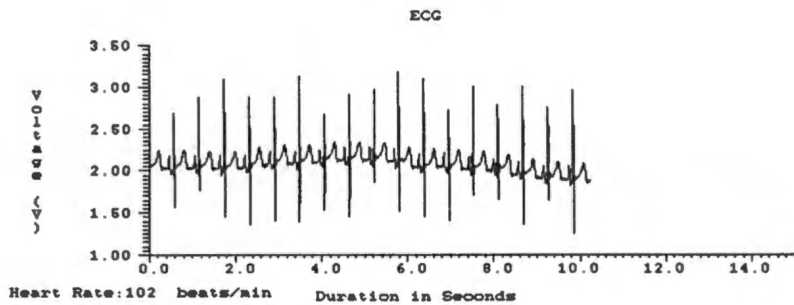
record depicts a gradual stabilization of the waveforms into a normal pattern. There was one case of a terminal patient where clinical intervention had ceased when family was present at the cotside during the last hour of life. In this case, extended periods of apnoea/bradycardia were recorded (page C.3, patient Ale, records 1 - 7).

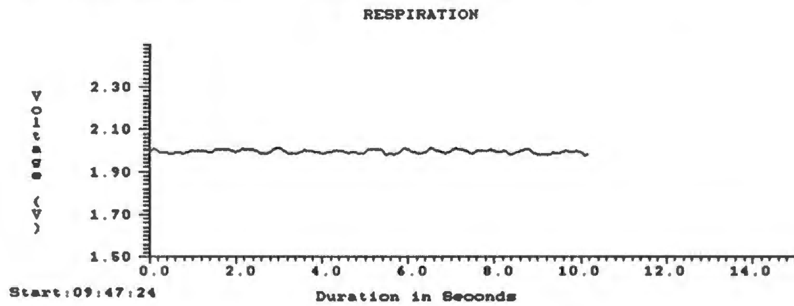
In certain instances where tachycardia occurred, it was not diagnosed as being brought about by an inherent physiological abnormality but rather by iatrogenic factors such as medication (page C.15), medical examination (page C.16) or other factors such as crying. Those cases of tachycardia that were attributed to a physiological abnormality were diagnosed as possibly being due either to immaturity or to shock (patient Bo on page C.9).

Periods of bradycardia/apnoea sometimes occurred when a patient was intubated or due to a blockage of the endotrachial tube (page C.3). There are numerous records in the database where the patient is being ventilated (page C.4). These records may be useful for calibrating a rate detection algorithm against a known ventilation rate. Figures 5.5 and 5.6 illustrate samples of the different event and noise categories recorded, respectively.

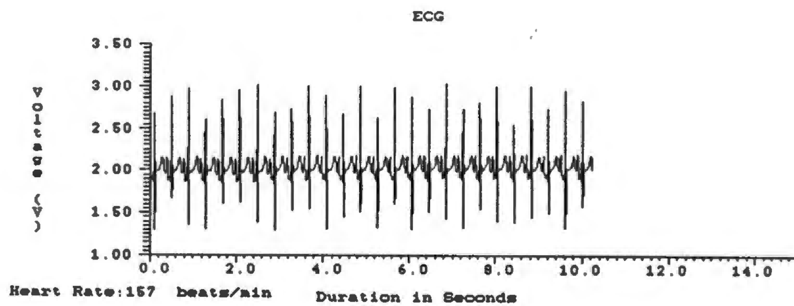
There are examples in the database where SAO_2 data supports the information obtained from the cardiac and apnoea monitors (page C.3, patient Ma. and page C.11, patient Ji.).

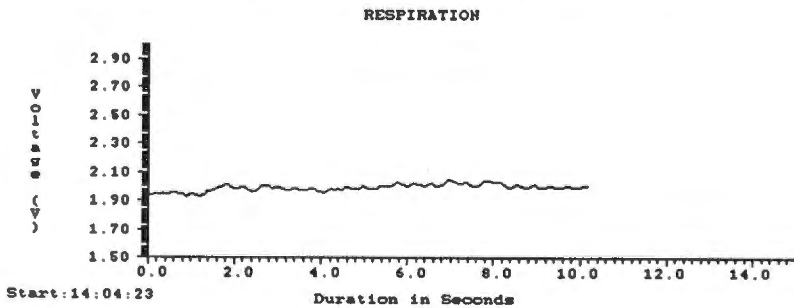
Unfortunately insufficient SAO_2 data was collected due to the practical constraints encountered in the ICU. As a result the corroboration of SAO_2 data with the information acquired off the Hellige databus is not as thorough as had been hoped.





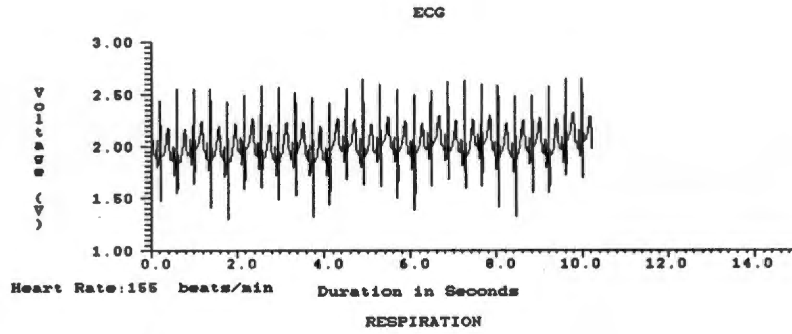
(i) Apnoea/Bradycardia

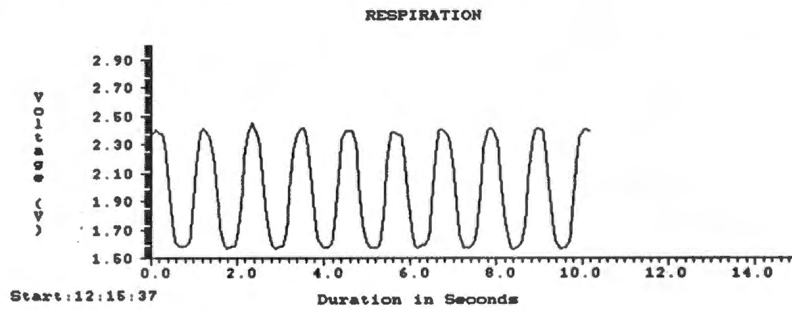




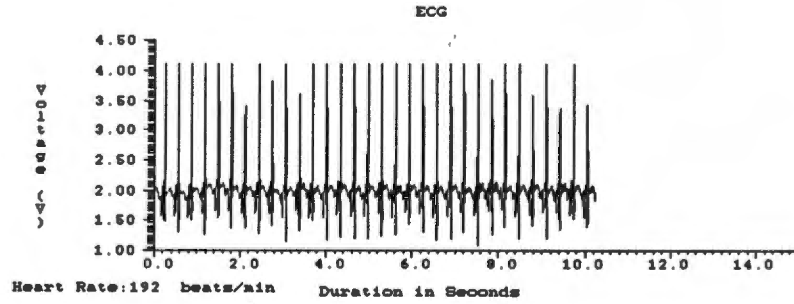
(ii) Periodic Breathing

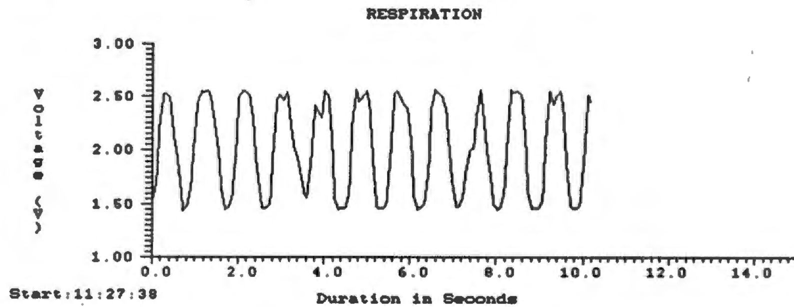
Figure 5.5
Examples of different event categories recorded





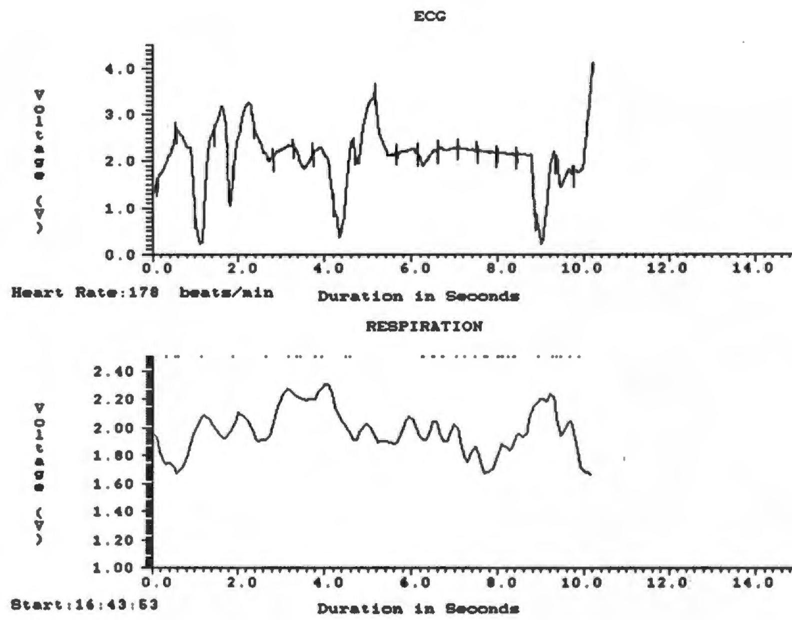
(iii) Normal



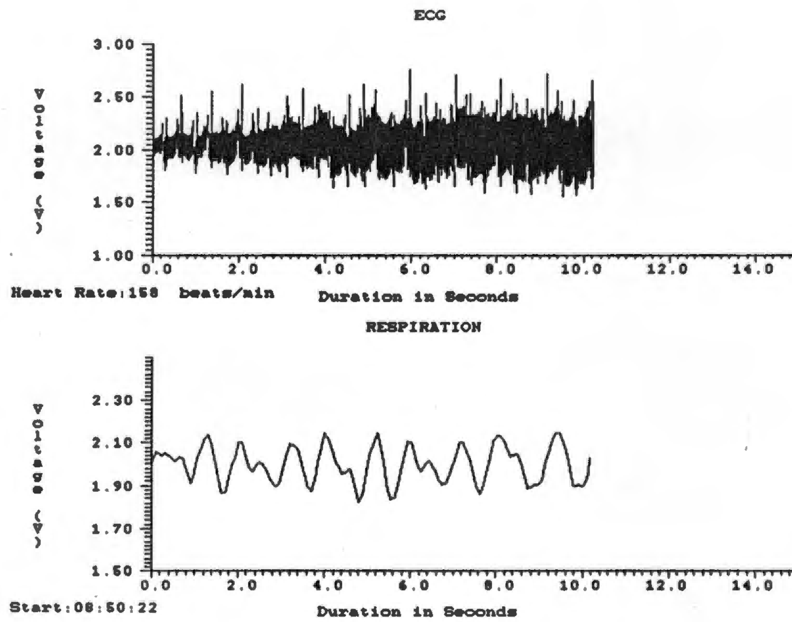


(iv) Tachycardia

Figure 5.5 *(continued)*

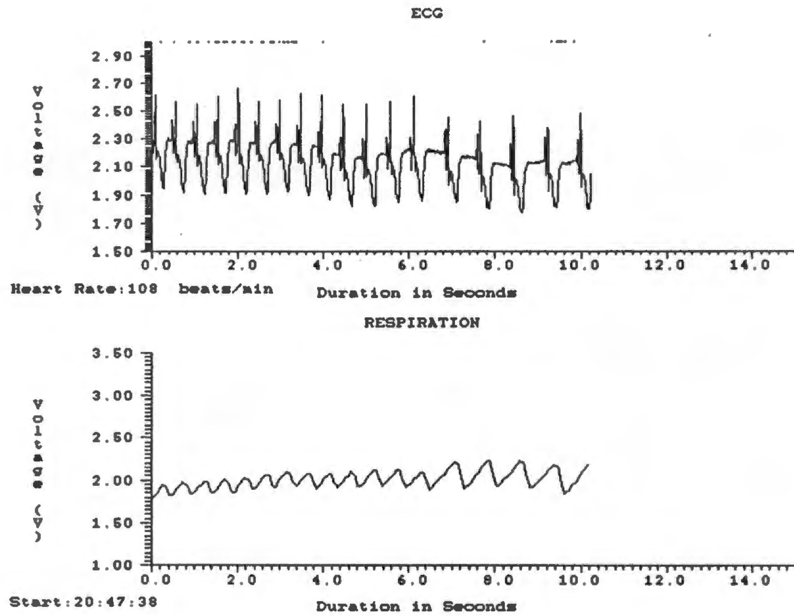


(i) Movement Artifact

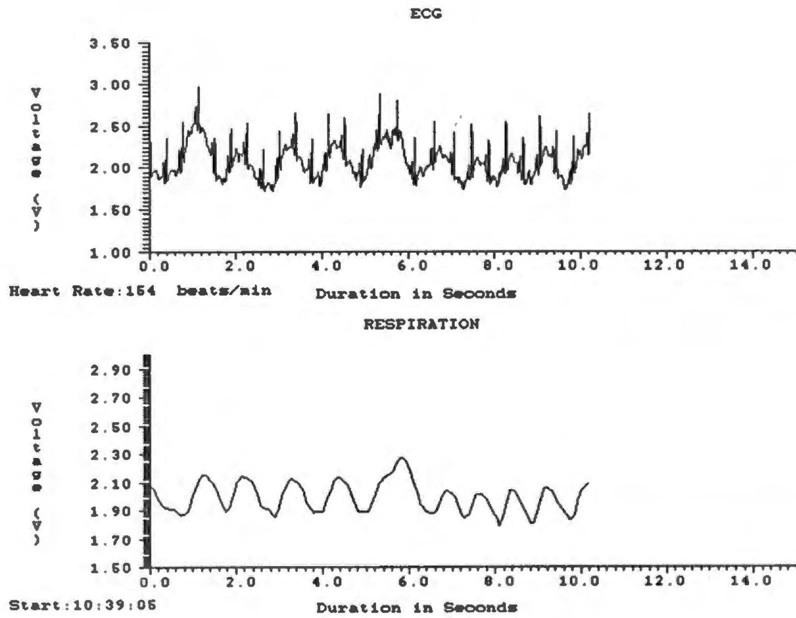


(ii) High frequency noise in ECG Channel due to dry electrodes

Figure 5.6
Examples of different noise categories recorded



(iii) Reciprocal Crosstalk: Cardiogenic artifact in respiratory channel and respiration channel noise reflected in ECG channel



(iv) Respiratory channel crosstalk in ECG channel

Figure 5.6 *(continued)*

5.2 An Analysis and Evaluation of the Rate Information.

Heart rate information, calculated as an average over 12 beats, was obtained from the monitors off the Hellige data bus. In certain cases, pulse rate, averaged over six seconds, was obtained from a pulse oximeter attached to the patient. Validation was undertaken by subjecting the recorded waveforms to an independent rate detection algorithm. This algorithm was implemented primarily as a check on the rate information received from the Hellige monitor but also to suggest one approach for analysis of rate information contained in the database. Respiration rate information was not available from the monitor.

5.2.1 Rate Detection Algorithm.

The design of the algorithm follows a well established methodology as explained in Pahlm and Sornmo (1984). The algorithm has two components: a preprocessor and a decision rule.

The preprocessor is designed to enhance the features of the signal required by the decision making process. This is done by:

(i) implementing a digital bandpass finite impulse response (FIR) filter to eliminate frequency components not within the QRS or respiration bandwidths. In the case of the ECG signal, a 5Hz bandwidth was chosen between 15

and 20 Hz as the high-pass and low-pass (-3_{dB} cut-off) frequencies respectively (Thakor et al, 1984). For the respiratory signal, the approach was that of trial and error and a 0.78Hz bandwidth was implemented between 0.78 and 1.56Hz;

(ii) performing a non-linear transformation on the filtered signal in order to obtain a feature corresponding to the (averaged) rate. This was done by calculating the power spectrum periodogram of the filtered signal. A simple peak detector was then used by the decision rule to extract the averaged rate.

Since the signal has been transformed into the frequency domain, the peak power frequency correlates with the period of the QRS complex/breath signal so the heart/respiration rate is determined by simply multiplying this value by 60 to obtain beats/breaths per minute. Clearly this algorithm will provide *long-term* HRV information. Should *short-term* variability be required, time-domain non-averaging techniques would be used.

This algorithm differs from the Hellige rate detection in that the average is calculated over a defined period rather than over 12 beats, typically corresponding to a period of ±5 seconds. In order to accurately correlate the two methods, the samples ideally need to be

identical. In records where HRV is low (heart rate more or less constant) this is not a problem but where HRV is high, it is important to pinpoint what segment of the signal the Hellige rate detection routine is processing. The rate detection routine was written to average the recorded waveform over different periods i.e. 20 second, 10 second and 5 second intervals.

5.2.2 **Comparison Tests.**

For purposes of this study a performance index has been defined as a ratio of:

(Ave. Visually Determined Rate) / (Ave. 'Test Algorithm' Rate)

for both heart and respiration rate

An index of 1 would indicate identical rate calculation and the relative deviation from 1 would indicate a deterioration in performance.

The records chosen for testing purposes include pulse oximetry readings which also give an indirect indication of heart rate. These readings are a useful indicator of heart rate in situations where the ECG is buried in electrical noise.

(i) Heart Rate Comparison

Test One.

PatientRecordPathname:32_Weeks\Normal\Ale\Norm_10.Dat

This low noise, clearly discernible record is also distinguished by a low HRV. The performance of the test algorithm as measured against those built into the production monitors is clearly illustrated in figure 5.7. A high performance index was obtained in all three cases.

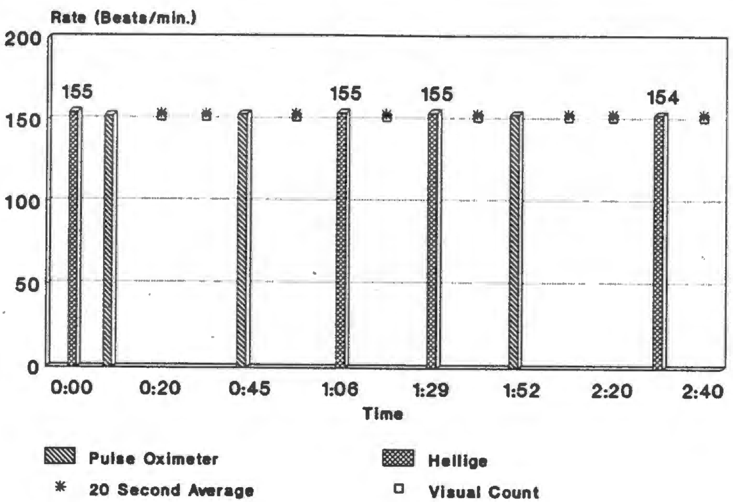
Test Two.

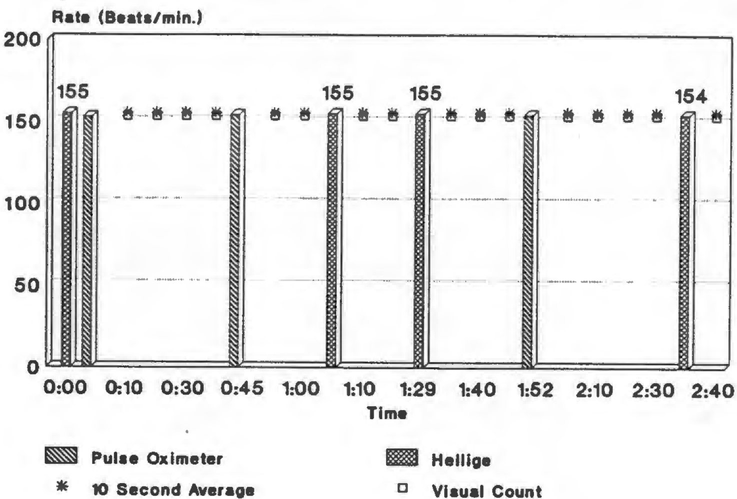
Patient Record Pathname:32_Weeks\Brady\Ada\Event_1.Dat

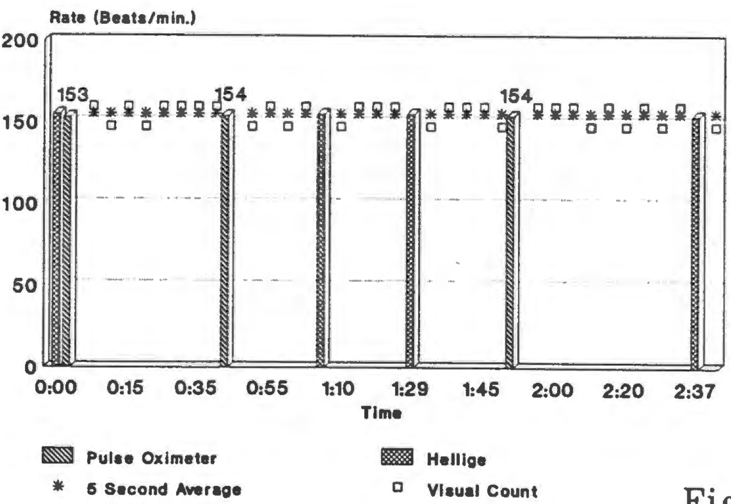
This record has a poor signal/noise ratio and a greater degree of HRV than preceding records. The results still indicate a high performance index on average but individual discrepancies are discernible in test 2.3 (figure 5.8).

(ii) Respiration Rate Comparison

It was not possible to obtain respiration rate data from the Hellige databus for the reasons given in chapter 4 so the test algorithm is compared to a visual rate determination for each tested record. In these comparison tests, both the visual and the 'test algorithm' counting periods were made over the same period so no discrepancies due to different frames of reference can mar the comparison (figure 5.9).



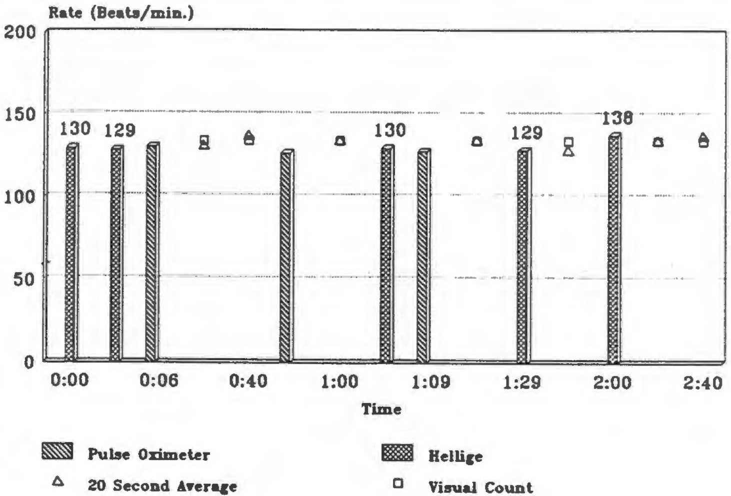


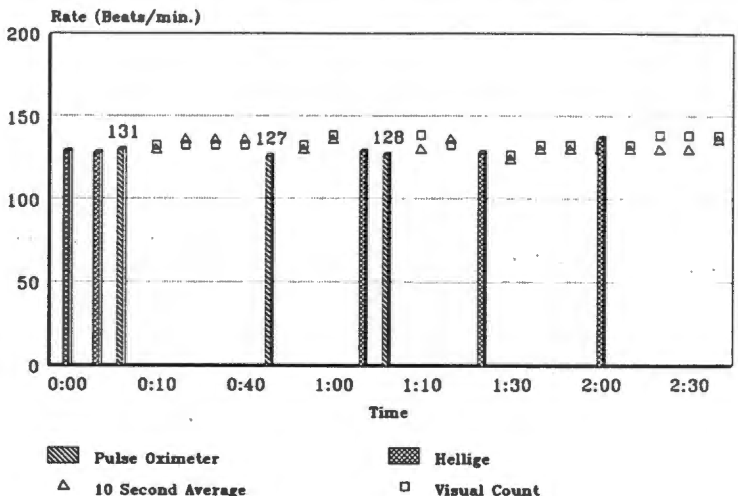


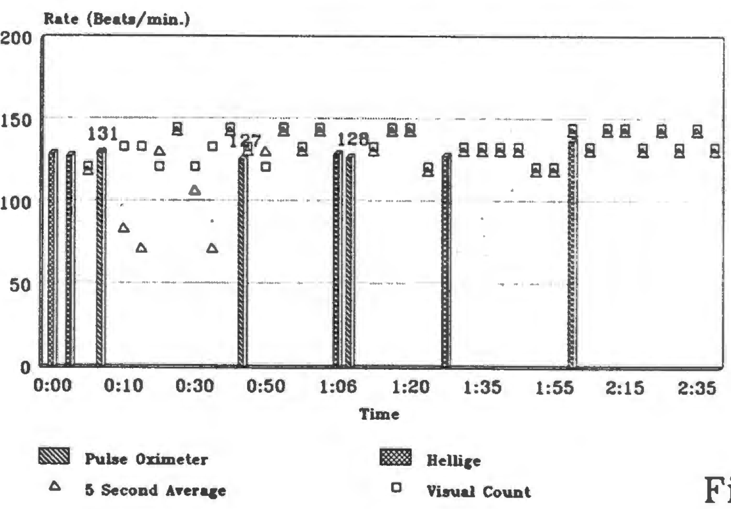
Rate Comparison Test 1

Source of Algorithm	Av. Rate (Record)		Comparison Index
Ohmeda Pulse Oximeter	153.7		
			0.99
Hellige Monitor	154.75		
'Test' vs Visual	Test	Visual	
20 sec. average	152	150	0.987
10 sec. average	152	150	0.987
5 sec. average	152	152	1.0

Figure 5.7







Rate Comparison Test 2

Source of Algorithm	Av. Rate (Record)		Comparison Index
Ohmeda Pulse Oximeter	129		
			0.983
Hellige Monitor	131.2		
'Test' vs Visual	Test	Visual	
20 sec. average	131	132	0.992
10 sec. average	131	133	0.984
5 sec. average	126	134	0.940

Figure 5.8

Test 1.

Patient Record Pathname:32_Weeks\Normal\Ale\Norm_10.Dat

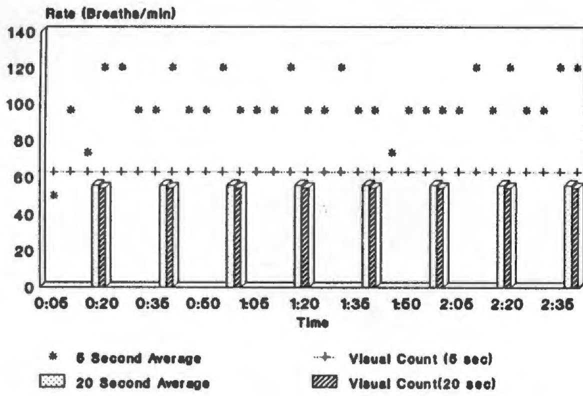
This record has a clearly discernible, low noise respiratory trace. The patient is being ventilated at a rate of 60 breaths/minute. The performance of the algorithm deteriorates when the averaging period is reduced. The visual count confirms the ventilation rate over a 5 second period but is consistently lower over a 20 second period. The visual counts for both periods track one another within a narrower range than the algorithmic counts.

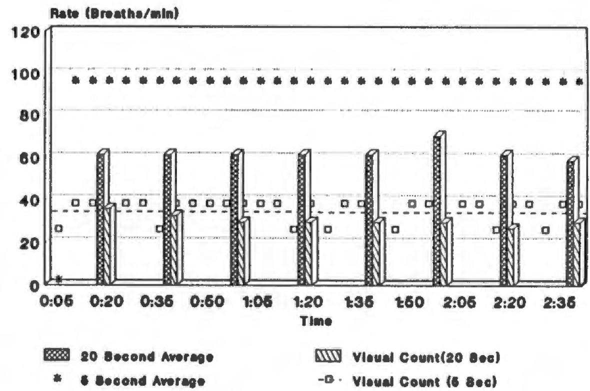
Test 2.

Patient Record Pathname:32_Weeks\Brady\Ada\Event_1.Dat

This example illustrates a high noise signal with a poor performance index over both averaging periods. As is the case for the previous record, the visual counts for both periods track one another within a narrower range than the algorithmic counts.

The table in Figure 5.9 summarizes the results of the respiration rate tests. Figure 5.10 shows a representative frame from each of the two records used to test the algorithm.





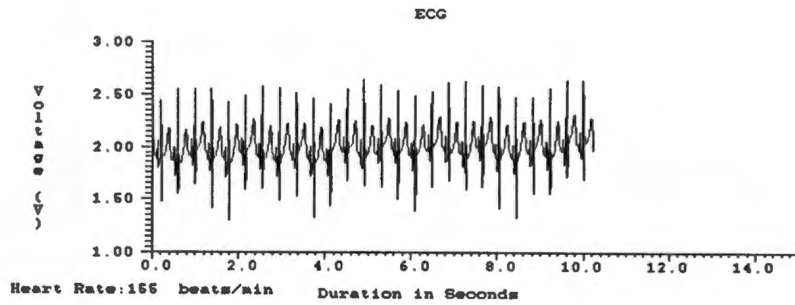
Respiration Rate Comparison

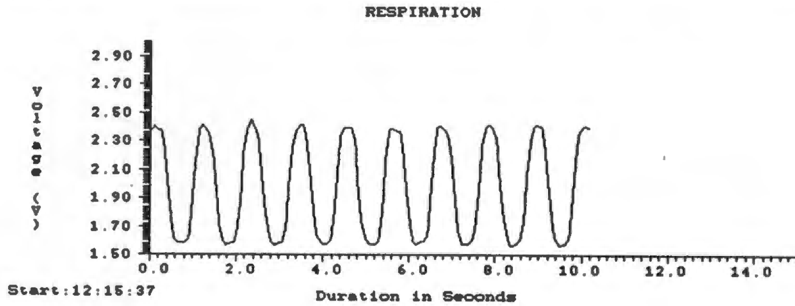
Test Results

20 Second Average	Visual Average	Comparison Index
Test 1: 55.66	54	0.97
Test 2: 62.25	30.75	0.494

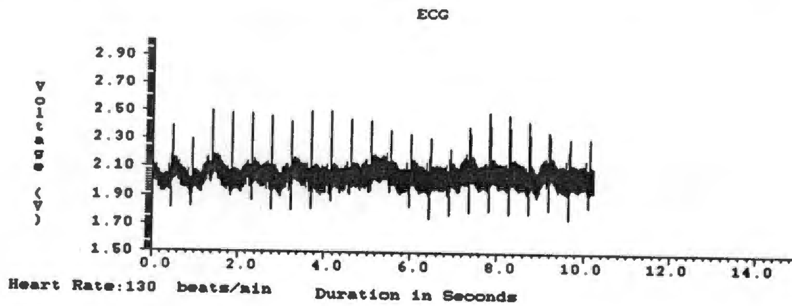
5 Second Average	Visual Ave.(5 sec)	Comparison Index
Test 1: 97	60	0.62
Test 2: 91	32	0.35

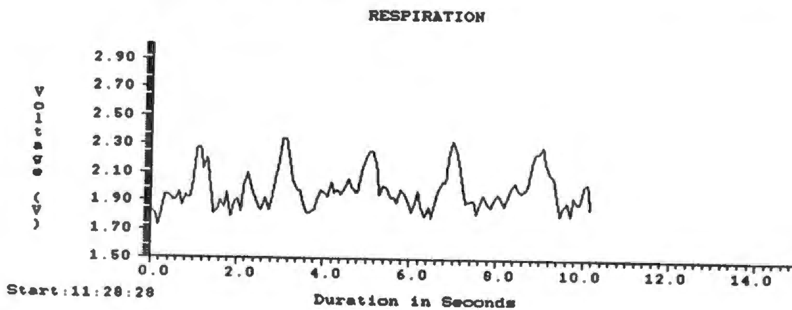
Figure 5.9





(i) 32_Weeks\Normal\Ale\Norm_10.dat





(ii) 32_Weeks\Brady\Ada\Event_1.dat

Figure 5.10

Representative frames from two records used to test the rate detection algorithm

CHAPTER 6

DISCUSSION

6.1 The Database

This database was designed primarily for the purpose of testing heart and breathing rate algorithms, it contains recordings of apnoea, bradycardia, periodic breathing, tachycardia and normal data. The database has been shown to be capable of its function by permitting the effective testing of a rate detection algorithm under different signal conditions.

The database can be used to develop instantaneous rate algorithms to be used in HRV studies but it is not comprehensive enough for *clinical* studies on HRV which would require additional information regarding medication and the monitoring of many other parameters (temperature, blood pressure, blood gas, etc.).

Ethical considerations result in certain practical difficulties when compiling a database in a clinical setting. Patients in an ICU have fragile or malfunctioning physiological systems. They need intensive care. When a patient has, for example, an apnoeic attack he/she requires immediate stimulation or if a patient is susceptible to apnoea then he/she must be prescribed preventative medication. These priorities make it difficult to acquire a large database of abnormal waveforms. Similar difficulties have been experienced

by the authors of other databases such as the MIT-BIH ECG Arrhythmia database.

The database contains a relatively high percentage (±36%) of frames with a significant noise component. Possible noise sources that have been identified and referred to in Chapter Five and later in this discussion are:

- (i) movement artifact;
- (ii) poor electrical contact at the skin-electrode interface (dry electrodes);
- (iii) inappropriate placement of electrodes;
- (iv) technical faults inherent in the monitors themselves;
- (v) cardiogenic artifact;
- (vi) EMG artifact.

The inclusion of noisy records in a database is valid in the context of algorithm development because the ability of an algorithm to extract the signal is a measure of its reliability. The results of rate detection tests support this argument.

The database should provide more detail concerning the background to each record. It may, for example, be of possible interest to know what medication the patient had been administered prior to an event and what the patient's activity

state (eg sleeping, awake, active etc.) was at the time of the recording. The waveform records should also be annotated to display type of event and signal condition.

It was unfortunate that capture of SAO_2 data was not more consistent. This was unavoidable due to practical realities in the ICU.

The database represents an important addition to the current library of clinical waveform databases because it is the only known neonatal vital signs database to have been developed for the purpose of algorithm development.

6.2 Rate Detection Tests

In the heart rate detection tests, the rate detection algorithms generally track the visual count over all three averaging periods. Over 20 and 10 second averaging periods no HRV was observed but some variation is apparent in the 5 second averaging period. It is likely that this is due to the analysis technique that has been implemented rather than authentic HRV.

The independent algorithm generally correlates well with the Hellige rate detection algorithm when applied as a QRS detector but functions poorly as a breath detector because the algorithm lacks the ability to discriminate between breaths and noise occurring within the respiratory bandwidth. This is

evident from the performance of the algorithm applied to good quality records as compared with noisy records as illustrated in Chapter Five. The discrepancy between the ventilation rate of 60 breaths/minute and the 20 second visual count referred to in Chapter 5 is possibly due to the tolerance (percentage error) allowed by the specifications of the ventilator.

Clearly more sophisticated techniques can be applied for both short-term and long-term heart and respiratory rate variability studies, looked at independently or concurrently. Such studies are beyond the scope of this thesis but it is hoped these will be performed using this database.

6.3 The Acquisition System

(i) Hardware

The monitors currently in service in the ICU are old and unreliable so it was unfortunate to be reliant on them as the primary signal source. This became evident when intermittent clean signals occurred between bouts of high frequency noise without any patient movement (eg Appendix C, page C.20, patient Jo, record 1).

(ii) Software

The records in this database have discontinuities 2 seconds long built into them between the end of one buffer and the start of the next. Since each buffer is approximately of 20

seconds duration these discontinuities do not significantly affect the usefulness of the database.

The records have time-skew between linked channels due to a 10msec delay in sampling instant between channels. This effect is not significant in this particular application or in any other biological context where processes and system interactions are relatively slow.

A higher sampling frequency - say 500Hz as recommended by the American Heart Association (AHA), (1989) - could have enabled the database to be used for the development of diagnostic algorithms which rely on pattern recognition of ECG waveform components not clearly discernible at the implemented sampling frequency (100Hz). The database was, however, specifically designed with QRS detection in mind and for this purpose 100Hz is adequate. Extending the database to include records of morphological abnormalities would also place more stringent requirements on electrode placement, lead configuration and data compression techniques.

An attempt has been made to make the program reliable in its acquisition mode and friendly with respect to keyboard interaction and data display for medical and nursing staff. One weakness is that no automatic linkage of waveform data to patient record data has been built into the system and this unfortunately gives the database a disjointed structure

requiring the user to inefficiently 'navigate' the user interface.

In retrospect, it is questionable whether the alarm card of each patient record had any value. It was designed to enable the system to be easily used by the nursing staff in the unit. As it turned out, the nursing staff were not actively involved in data collection.

The routine written to display a record does not employ a suitable scaling technique and this sometimes results in an illegible trace. This does not necessarily imply that the waveforms are unrecoverable. These waveforms may become legible when processed by a display routine that employs a dynamic scale modification technique. High amplitude noise during the autoscaling operation at the beginning of a record results in a low (signal) gain for the remainder of the record.

6.4 The Recording Environment

The recommended location of electrodes as defined in Chapter Two was not strictly followed due to factors such as tissue injury. This could have played a role in reducing signal quality, particularly in the respiratory channel because the position of electrodes determines the current path and hence the components that constitute the changing impedance.

Electrodes were sometimes placed:

(i) on the back on/between the scapulae;
(ii) on the front diagonally from the chest to the lower abdomen;
(iii) transthoracically.

Electrode positioning noticeably affected the shape of the ECG waveform and lower amplitude breathing waveforms were evident when electrodes were placed on the back.

The Neonatal ICU at Groote Schuur Hospital is a congested zone and patient access was on occasion hampered by routine activities in the ward such as X-Ray capture, ultrasound diagnostics and ward rounds.

Capture of SAO_2 data from a single patient on a long-term basis was not possible due to the limited number of units (two) in the ward that had to be available to all patients on a rotational basis.

The recording environment did not make any obvious contribution to noise. It was expected that electrical interference (50Hz) would be a problem in this environment because of large number of electrically operated devices in the unit. Screened cable that was used throughout the system

and the low pass antialiasing filters successfully eliminated this noise source.

6.5 Further Work/Development

It is hoped that this database will now fulfill its *raison d'être* and that algorithms will be successfully developed and tested against it.

The computer system was situated in a laboratory adjoining the ICU so that data acquisition did not interfere with routine nursing duties in a congested area. Using a computer in this manner provides flexibility with respect to the role in which it is employed. For example, the system may be refined further to be used as a central station at a remote location to permit multichannel monitoring of selected parameters. For this purpose fast, real-time, digital signal processing with more stringent hardware requirements may be necessary.

Although the system was developed particularly for neonatal application, it could be used equally well to acquire a database of adult vital signs. It could also be integrated into a PC-based system to perform a specific clinical procedure where prolonged signal acquisition is a requirement.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions.

(i) This thesis has established that there is a need for a neonatal vital signs database which may be used as a development tool in designing a neonatal cardiopulmonary monitor.

(ii) A computerized system was developed to both acquire and access the database. The acquisition process was designed as an automatized system with a manual override capability. An attempt was made to create a user friendly system by implementing a graphic user interface to access the data.

(iii) A database was acquired. It contains 509 clinical records in total distributed over 3 gestational age groups (32-34 weeks, 34-36 weeks and >36 weeks). Recordings of apnoea, bradycardia, periodic breathing, tachypnea, tachycardia and normal data have been captured. These clinical conditions have been recorded against a continuum of signal conditions from good quality signals to extremely noisy signals with noise emanating from a variety of sources including movement, dry electrodes, EMG and cardiogenic artifact.

(iv) A 'prototype' algorithm was tested and found to merit further testing as an average heart rate detector. It was found to be inadequate for detection of breathing rate.

(v) By implication, this spectrum of patient waveforms with its variety of clinically significant features, permit the database to be used as a 'testbed' to verify the reliability of heart and breathing rate detection algorithms.

(vi) The *acquisition system* may be adapted for other purposes. The system could be used to acquire a database in some other clinical area. It may be adapted to operate as a central station for multichannel monitoring purposes in an ICU setting. It may also be integrated into a PC-based system to perform a specific clinical procedure where long-term physiological data acquisition is a requirement.

7.2 **Recommendations.**

A neonatal vital signs database has been established. It is hoped that this database will be put to the use for which it was intended, ie. to assist further research in algorithm development for neonatal heart and breathing rate detection and monitoring.

Developing a database cannot be regarded as a finite project. There will always be some justification for extending the database or refining the existing system. Numerous

improvements that may enhance its function are suggested below.

(i) The database could be extended to cover a broader range of temporally linked parameters including temperature and blood pressure to permit trend analysis in the context of investigating the clinical significance of heart rate variability.

(ii) The database itself could be extended to include a greater number of noise free recordings with closer attention paid to record commentaries including more detailed information on patient medication and activity state as well as the noise characteristics of the waveform record.

(iii) The user interface could be improved in terms of streamlining data retrieval by permitting access to the waveform record directly from the patient record card and ensuring correct scaling of waveform displays.

(iv) A higher sampling frequency would permit the system to be used for a wider range of clinical applications such as diagnosis of morphology based disorders and in this connection it is also worth employing data compression techniques to economize on storage space.

(v) The software could be revised to use the burst-mode sampling feature available on the PC30D A/D card to enable absolutely synchronous multichannel sampling in situations where this is necessary.

(vi) Two second gaps exist between each 20 second segment of a record. The software could be revised to fill these gaps by utilizing the dual DMA feature available on the PC30D A/D card.

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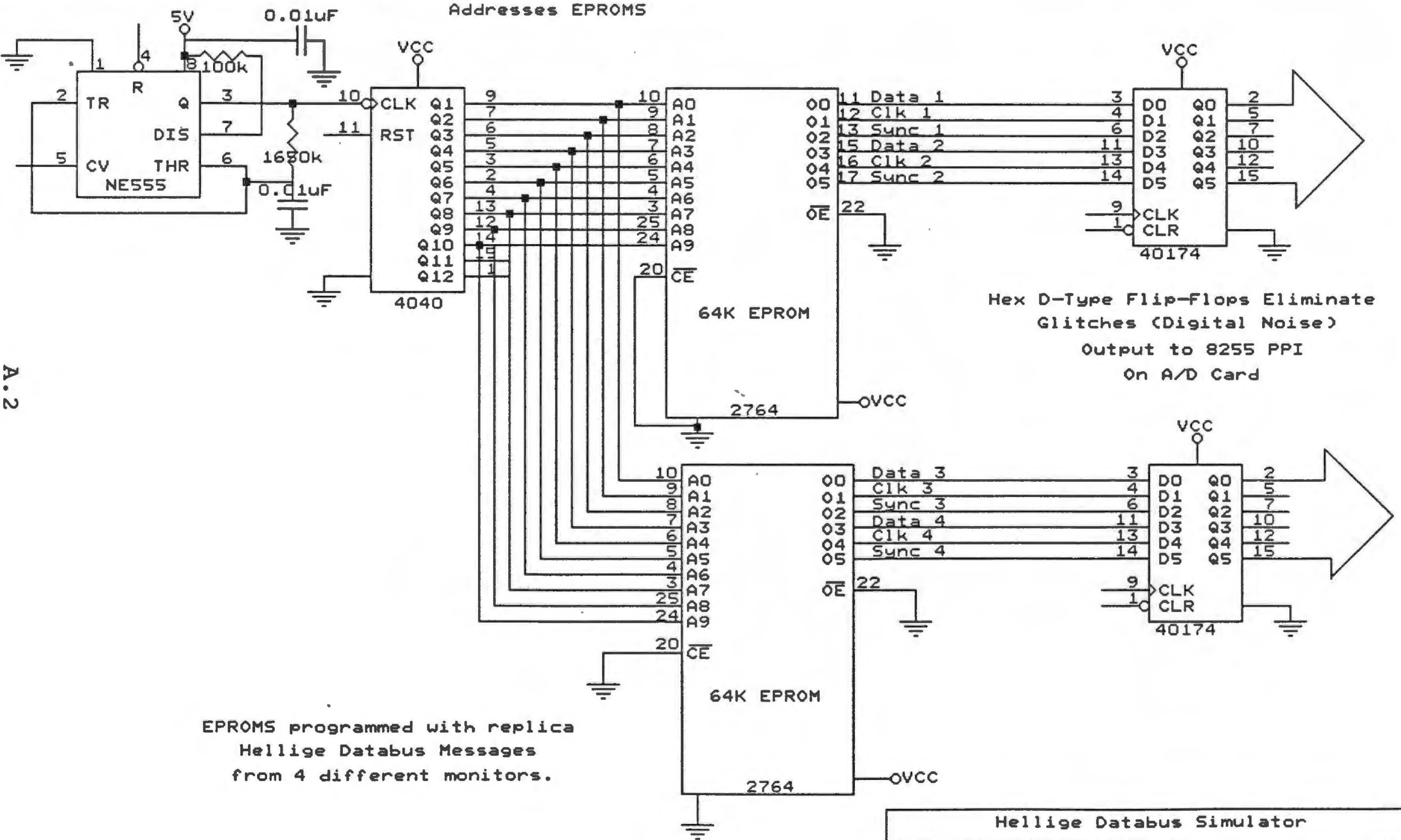
APPENDIX A

Circuit Diagram of the Hellige Bus Simulator

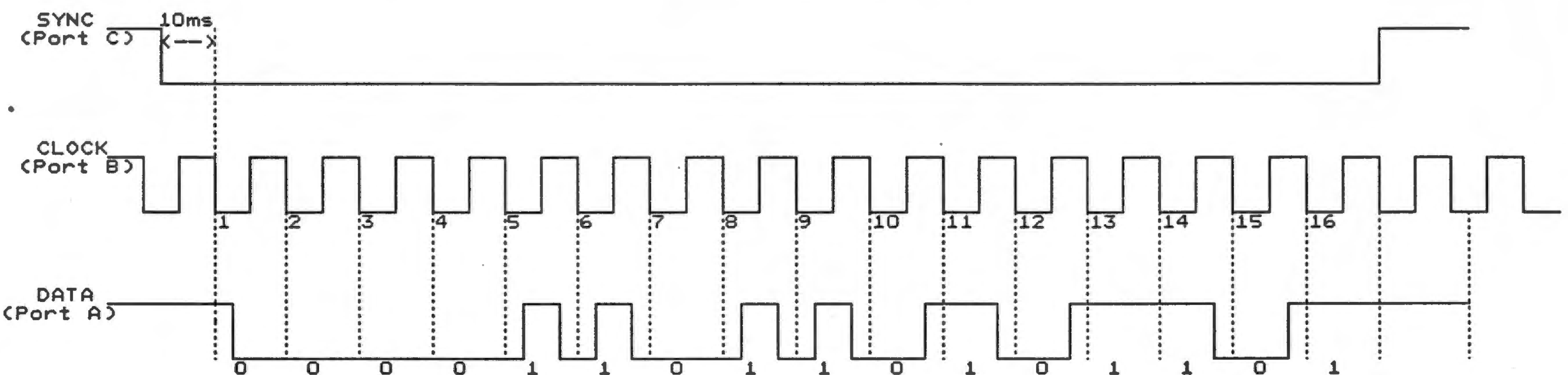

Timer Output:5kHz square wave
12 Stage Binary Ripple Counter
Addresses EPROMS
5V
0.01uF
100k
1650k
0.01uF
NE555
TR
R
Q
DIS
CV
THR
4040
CLK
RST
VCC
64K EPROM
2764
Data 1
Clk 1
Sync 1
Data 2
Clk 2
Sync 2
Data 3
Clk 3
Sync 3
Data 4
Clk 4
Sync 4
40174
Hex D-Type Flip-Flops Eliminate
Glitches (Digital Noise)
Output to 8255 PPI
On A/D Card
EPROMS programmed with replica
Hellige Databus Messages
from 4 different monitors.
Hellige Databus Simulator
Size
A
Document Number
1
REV
0
Date: August 6, 1992
Sheet 1 of 1

APPENDIX B

Hellige Databus Timing Diagram

THE HELLIGE DATA BUS

SIGNAL TIMING DIAGRAM



F_{Ck} = 5kHz

DATA line idles HIGH

Note that DATA is valid after the negative going edge of the clock pulse.

CLOCK pulses are valid 10ms after the negative going edge of SYNC

Each 16 bit DATA pulse train constitutes a word.

There are three words in a message.

APPENDIX B

APPENDIX C

A Textual Description of Records in the Database.

KEY

Clinical Condition Codes

Ap - Apnoea

B - Bradycardia

N - Normal

PB - Periodic Breathing

T - Tachycardia

TAp - Tachypnea

Miscellaneous Codes

M - Movement Artifact

EC - ECG Crosstalk

RC - Respiratory Channel Crosstalk

We - Weak QRS Complex

Wr - Low Amplitude Respiratory Trace

qT - Accentuated T-Wave

! - Isolated QRS-like Artifact

LO - Lead-Off

?? - Illegible Signal

Signal Quality Codes

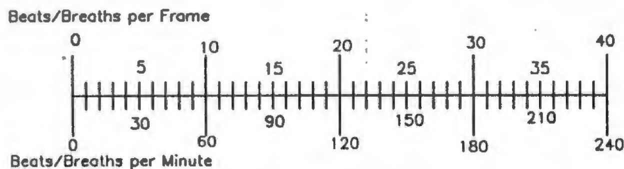
0 - Both Signals Clear

1 - ECG Clear,Respiration Noisy

2 - Respiration Clear,ECG Noisy

3 - Both Channels Noisy But Readable

4 - Extreme Noise Or Signal Loss In One Or Both Channels



NAME: Mac Directory:32_weeks\apnoea Time:21H00->23H05 Date:04-05-92 Comments:Recurrent apnaeic episodes prior to intubation and CPAP.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Ap B 20/00 0	Ap B 20/02 0	26/13 0	T 28/11 0	T 28/13 0	T 27/13 0	T 27/13 0	T 28/09 0	T 28/13 0	T 28/14 0	T 28/13 0	T 27/07 0	T 28/15 0	T 28/12 0	T 28/13 0	T 28/14 0
2	T 29/13 0	T 28/13 0	25/10 3	T 29/15 0	T 29/13 0	T 28/12 0	T 28/08 0	T 28/12 3	T 28/02 0	T 27/02 0	PB 25/00 0	PB 26/00 0	PB 25/01 0	26/12 0	T 28/13 0	23/13 3
4	27/14 0	28/14 0	27/11 0	28/13 0	27/10 0	28/04 4 M	Ap B 21/00 4 M	Ap B 17/00 4 M	Ap B 18/00 4 M	B 16/04 3	Ap 23/00 3	Ap B 07/00 4	Ap ??/00 3	24/14 3	27/14 0	28/13 4
5	Ap B 22/00 0	Ap B 21/00 0	Ap B 19/00 0	Ap B 17/00 0	Ap B 15/00 3	23/?? 4	20/?? 4	??/?? 3	15/?? 4	26/12 4	27/09 4	26/?? 4	27/11 4	26/11 4	27/07 4	B 17/?? 3
6	PB 25/01 0	PB 23/00 0	PB 24/00 0	25/03 0	23/09 0	25/?? 3	22/?? 0	26/09 3	27/?? 0	26/?? 0	??/?? 0	24/?? 0	??/?? 0	??/?? 0	??/?? 0	Ap B 21/02 0
7	T 32/07 0	PB T 31/01 0	PB T 30/00 0	PB T 30/00 4	PB T 30/01 0	PB T 30/01 0	T 29.04 4	25/02 0	T 28/02 0	T 28/02 4	T 27/05 0	T 27/10 0	T 28/10 3	T 28/10 4	T 28/10 4	T 28/10 4
8	T 27/07 0	T 27/07 0	T 27/07 0	??/?? 4	PB T 27/00 0	PB 26/00 0	PB 26/00 0	PB 25/00 0	PB 26/00 0	??/?? 4	25/07 0	T 27/07 0	23/05 3	??/?? 4	??/?? 4	??/?? 4

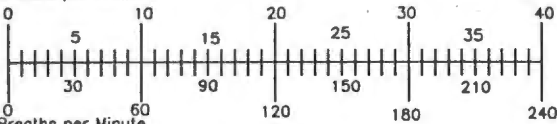
Directory:32_weeks\apnoea Time:Data capture discontinuous Comments:Low heart rate:120->98,gradually decreasing. No breathing during this period. Movement artifact at point of nurse intervention followed by normal breathing rhythm:40->60 breaths/min.

NAME: Van Date:14-04-92->16-04-92

1	B 20/02 0	B 19/02 0	B 20/03 0	B 20/02 0	B 19/01 0	B 19/01 3	B 19/01 0	Ap B 17/00 0	B 19/01 0	Ap B 18/00 0	Ap B 17/00 0	B 19/03 3	B 20/04 3	B 21/05 0	B 21/09 3	B 21/10 0
2	Ap B 21/00 0	Ap B 21/00 0	Ap B 20/00 0	Ap B 20/00 0	Ap B 21/00 0	B 20/02 0	B 21/02 3	B 22/01 0	Ap B 20/00 0	Ap B 19/00 0	Ap B 20/00 0	Ap B 20/00 4	B 20/?? 4	Ap B 20/00 0	B 21/09 3	B 22/11 3
3	24/04 3	23/13 0	23/12 0	23/07 3	??/?? 4	??/?? 4	24/?? 4	??/?? 4	25/06 3	25/09 0	24/04 3	PB 24/00 0	PB 23/00 0	23/03 0	23/03 3	25/?? 4
4	PB 23/00 0	PB 23/00 0	PB 22/00 0	PB 22/00 0	PB 22/00 0	Ap B 21/00 0	22/?? 0	Ap B 20/01 0	Ap B 19/00 0	Ap B 21/00 0	Ap B 21/00 0	Ap B 20/00 0	Ap B 20/00 0	Ap B 20/00 0	Ap B 21/02 3	Ap B 20/02 3
5	B 20/04 0	Ap B 18/00 0	A B 18/03 0	Ap B 20/00 0	A B 21/03 0	Ap B 21/00 0	Ap B 20/00 0	Ap B 18/00 0	Ap B 18/00 0	B 21/03 3 M	22/08 3 M	23/07 0	23/08 0	22/11 0	23/11 0	22/10 0
6	Ap B 17/00 0	Ap B 18/00 0	Ap B 19/00 0	Ap B 17/00 0	B 21/?? 0	24/06 4 M	24/03 0	24/00 0 M	23/?? 3	24/?? 4 M	24/07 4	25/04 0	24/05 0	23/02 3	Ap B 19/00 0	Ap B 19/00 0
7	24/?? 4	25/08 3	25/05 3	25/03 0	25/05 0	24/05 3	PB 24/00 0	PB 23/00 0	22/03 3 M	22/03 0	25/04 0	25/11 0	23/02 0	PB 23/00 0	PB 23/00 0	24/05 3 M
8	Ap B 18/00 0	Ap B 17/00 0	Ap B 17/00 0	Ap B 18/03 0	Ap B 20/00 0	Ap B 21/04 0	PB 23/00 0	PB 23/00 0	PB 23/00 0	PB 23/00 0	PB 23/00 0	23/12 0	24/12 0	24/12 0	25/11 0	24/10 0
9	26/01 0	25/02 0	24/02 0	PB 25/00 0	25/11 0	25/12 0	25/00 0 M	PB 22/01 0	PB 22/00 0	PB 24/00 0	PB 23/00 0	PB 22/00 0	PB 23/01 0	Ap B 19/00 0	Ap B 21/00 0	Ap B 20/00 0
10	PB 25/00 0 M	PB 25/00 0 M	PB 24/00 0 M	PB 24/00 0 M	PB 22/00 0 M	PB 23/00 0 M	Ap B 21/00 0 M	PB B 22/00 0 M	Ap B 21/00 0 M	Ap B 21/00 0 M	Ap B 19/00 0 M	Ap B 19/00 0 M	Ap B 19/00 0 M	Ap B 18/00 0 M	Ap B 18/00 0 M	Ap B 18/00 0 M
11	PB B 22/00 0	Ap B 21/00 0	Ap B 20/01 0	Ap B 19/01 0	Ap B 19/00 0	Ap B 19/01 0	23/13 0	24/14 0	25/14 0	25/14 3	25/04 4	25/03 3	25/05 3	26/04 0	26/06 0	26/01 0
13	Ap B 18/00 0	B 20/04 0	23/02 0	PB 24/00 0	PB 23/00 0	PB 23/00 0	PB 23/00 0	PB 23/00 0	PB 22/00 4	PB 22/00 4	Ap B 20/00 0	Ap B 20/00 0 M	B 20/04 0	23/05 0	PB 24/00 0	PB 23/00 0
14	Ap B 21/00 0	Ap B 19/00 0	Ap B 21/00 0	Ap B 18/00 0	Ap B 20/00 0	Ap B 19/00 0	Ap B 19/00 0	Ap B 18/00 0	B 20/?? 0	24/?? 4	PB 23/00 3	23/03 3	Ap B 21/00 3	PB 22/00 0	PB 22/01 0	B 21/01 0
15	PB 26/01 0	PB 26/00 0	PB 26/00 0	PB 25/00 0	PB 25/00 0	PB 25/00 0	PB 25/00 3	PB 24/00 0	PB 24/01 0	25/?? 0	25/04 0	26/05 0	27/04 0	27/03 0	PB 26/00 4	PB 26/00 4
16	Ap B 21/00 0	PB 23/00 0	PB 22/01 0	25/13 3	26/09 3	26/10 3	25/07 0	26/10 0	26/04 0	26/07 0	26/11 0	27/12 0	27/12 0	26/07 0	B 21/?? 0	26/?? 3
17	26/06 0	27/06 3	PB 24/00 0	PB 23/00 0 M	26/12 0	26/13 0	27/07 0	26/09 0	27/?? 4	27/03 3	28/05 0	27/?? 0	27/13 0	26/11 0	27/07 0	PB 27/01 0

Directory:32_weeks\brady NAME: Adams Time: 11h31 Date:03-02-92 Comments:Heart rate stable. Low HRV.

1	22/05 3	22/05 3	22/06 3	22/05 3	22/06 3	23/06 3	23/06 3	22/06 3	B 21/05 3	22/05 3	22/05 3	22/05 3	22/06 3	23/06 0	23/05 0	23/06 0



Directory:32_weeks\Brady NAME: Ale Date:30-03-92 Time: 21h11->21h49

Comments: Patient deteriorating with continuous bradycardia Monitoring halted due to nurse intervention. Patient died within 15 minutes of final data capture.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	B 11/11 0	B 12/11 0	B 12/12 0	B 12/12 0	B 12/11 0	B 12/11 0	B 11/11 0	B 10/10 0	B 09/09 0	B 10/?? 4 M	B 09/05 0 M	B 11/08 0 M	B 11/?? 4	B 12/13 0	B 12/11 0	B 11/12 0
2	B 10/09 0	B 09/09 0	B 09/?? 4	B 10/09 0	B 11/11 0	B 11/11 0	B 12/12 0	B 11/11 0	B 11/11 0	B 10/10 0	B 09/09 0	B 10/09 0	B 10/?? 4	B 08/07 0	B 10/10 0	B 11/11 0
3	B 09/09 0	B 10/09 0	B 09/07 0 M	B 09/?? 4 M	B ??/?? 4	B ??/?? 4	B 10/?? 4	B 11/09 4	B 10/07 0	B 09/?? 4	B 07/?? 4	B 07/?? 4	B 09/?? 4	B 09/08 0 M	B 09/07 0 M	B 09/09 0
4	B 09/?? 4	B ??/?? 4	B 00/00 3 LO	00/00 0 LO	00/00 0 LO	00/00 0 LO	00/00 0 LO	00/00 0 LO	00/00 0 LO	B 03/?? 4	B 09/06 0	B 08/08 0	B 02/?? 4	B ??/?? 4	B 08/08 0 M	B 08/08 0
5	B 08/08 0 M	B 07/07 0	B 07/06 0	B 07/08 0	B 07/06 0	B 00/?? 4	B 00/00 0	B 00/00 0	B 14/10 0	B 12/?? 4	B 07/05 0	B 06/05 0 M	B 07/07 0	B 08/07 0	B 06/06 0	B 06/05 0
6	Ap B 05/00 0	B 13/?? 4	B 06/?? 4	B 10/?? 4	Ap B 02/00 0	A B 09/?? 4	A B 08/04 0	B 07/05 0	Ap B 04/00 0	Ap B 11/00 0	Ap B 02/00 0	B 10/?? 4	Ap B 03/00 0	Ap B 12/00 0	Ap B 00/00 0	Ap B 02/01 0
7	Ap B 10/00 0	Ap B 09/00 0	Ap B 09/00 0	Ap B 02/00 0	Ap B 07/00 0	Ap B 02/00 0	Ap B 07/00 0	Ap B 12/00 0	Ap B 10/00 0	Ap B 06/00 0	Ap B 05/00 0	Ap B 08/00 0	Ap B 05/00 0	Ap B 05/00 0	Ap B 11/00 0	Ap B 10/00 0

Directory:32_weeks\Brady Date:24-02-92
NAME: Dyani Time: 12h25

Comments:Patient on a ventilator.Increasing SAO2:81%->92% finally stabilizing around 88%. Heart Rate:145->175. Noticable reduction in heart rate as SAO2 level increased.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	27/10 0	26/07 0	26/04 0	25/04 0	26/05 0	27/06 0	26/05 0	??/06 4	T 28/12 0	T 28/12 0	T 28/07 3	27/13 0	T 28/11 0	T 29/05 3	T 29/05 3	T 28/07 3

Directory:32_weeks\Brady NAME: Mac Date:04-05-92->08-05-92
Time: Data capture discontinuous

Comments:Recurrent bradycardia/apnoea prior to intubation & CPAP.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	B ??/?? 4	B ??/?? 4	Ap B 08/00 3	Ap B 12/00 0	Ap B 09/00 0 M	Ap B ??/00 4	Ap B 13/00 0	Ap B 12/00 0	Ap B 11/00 0	Ap B 06/00 0 M	Ap B 14/00 0	Ap B 19/00 0	A B 14/13 0	A B 12/12 0	A B 12/12 0	A B 09/09 0 M
2	B 14/14 0	B 13/12 0	B 12/12 0	B 18/15 0	B 13/13 0	B 12/10 0	B 12/12 0	B 11/08 0	B 20/10 0	B 14/13 0	22/17 0	B 11/11 0 M	B 17/13 0	B 19/08 3	B 14/13 0	B 18/13 3
3	22/?? 4	B 21/05 0	B 15/12 0	B 13/10 0	B 12/?? 4	B 04/04 3	24/07 0	26/04 0 M	T 30/15 0	27/13 0	26/05 0	27/10 3	T 28/08 0	27/11 0	T 28/12 0	27/11 0
4	24/10 0	25/11 0	24/13 0	24/10 0	24/09 0	25/11 0	25/09 0	26/12 0	26/08 0	25/09 0	24/?? 4	Ap B 16/00 0	Ap B 15/00 0	Ap B 14/00 0	Ap B 13/00 0	Ap B 12/00 0
5	Ap B 17/00 0	Ap B 17/00 0	Ap B 16/00 0	Ap B 20/00 0 M	23/09 0 M	24/?? 4	B 20/07 3	24/13 0	26/12 0	25/11 0	26/11 0	26/10 0	26/09 0	26/10 0	25/10 0	26/10 0

Directory:32_weeks\Brady NAME: Ma Date:28-04-92 & 08-05-92 Time: 08h55->09h18

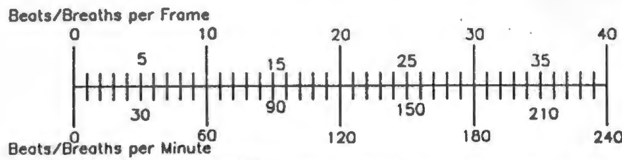
Comments:Patient being ventilated:80 breaths/min. ECG Channel crosstalk:breathing rate matches heart rate. Low SATS:56%->67%:Suspected blockage in endotrachial tube.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	B 18/15 3	B 19/13 0	B 20/13 0	22/12 0 M	B 20/14 0	B 21/14 0	B 20/15 0	B 16/13 0	B 09/07 0	B 21/20 0	23/22 0	B 20/14 0	B 21/08 0 M	22/?? 4	B 21/?? 4	B 21/?? 4
2	B 14/?? 4	B 13/?? 4	B 12/?? 4	B 18/10 1	B 13/?? 4	B 12/?? 4	B 12/?? 4	B 11/?? 4	B 18/?? 4 M	B 14/?? 4	22/07 3	B 11/?? 4	B 17/?? 4	B 17/?? 4	B 14/?? 4	B 18/?? 4
3	B 19/?? 4	B 19/?? 4	22/?? 4	B 18/13 1	B 20/13 1	B 21/13 1	B 18/13 1	B 20/14 1	B 20/13 1	B 19/13 1	B 21/10 1 M	B 20/13 1	B 19/12 1	B 20/12 1	B 19/13 1	B 20/13 1
4	B 20/12 1	22/?? 4 M	B 19/13 1	B 20/13 1	B 18/13 1	B 21/13 1	B 19/13 1	B 19/13 1	22/?? 4 M	B 18/13 1	B 20/13 1	B 20/13 1	B 19/13 1	B 21/?? 4 M	B 19/?? 4	B 20/13 1
5	B 21/13 1	B 19/13 1	B 21/13 1	B 20/13 1	B 18/14 1	B 20/13 1	B 18/13 1	B 20/13 1	B 20/13 1	B 18/?? 4 M	B 20/?? 4	22/?? 4	B 19/?? 4	B 18/14 1	B 21/?? 4	B 19/13 1
6	B 21/13 1	B 18/14 1	B 19/?? 4	B 19/13 1	B 21/13 1	B 19/13 1	B 19/13 1	B 19/13 1	22/16 1	B 19/13 1	B 20/14 1	B 19/13 1	B 21/17 1	B 20/13 1	B 20/13 1	22/?? 4 M
7	22/16 1	B 20/?? 4	22/?? 4 M	22/?? 4 M	B 21/?? 4	B 21/?? 4 M	B 20/14 1	B 20/14 1	B 21/?? 4	B 21/13 1 M	B 21/?? 4	B 21/?? 4	B 21/?? 4	B 21/?? 4	B 21/?? 4	B 21/?? 4
8	B 21/?? 4	23/?? 4 M	B 21/?? 4 M	B 21/?? 4	B 21/?? 4	22/?? 4 M	B 21/?? 4	B 21/?? 4	B 21/?? 4	23/?? 4	B 21/?? 4	B 20/13 1	B 20/13 1	22/?? 4	B 21/?? 4	B 20/14 1
9	22/?? 4 M	22/?? 4	B 21/?? 4	B 21/?? 4	B 20/?? 4	23/?? 4 M	B 21/?? 4	22/?? 4	B 20/?? 4	B 21/?? 4	22/?? 4	B 20/?? 4	23/?? 4	B 20/?? 4	B 20/?? 4	B 21/?? 4

Directory:32_weeks\Brady NAME: M Date:15-05-92 Time: 07h59->08h03

Comments:Bradycardia due to blockage in endotrachial tube. Patient responded to resusitation.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Ap B 10/?? 4	Ap B 09/?? 4	Ap B 10/?? 4	Ap B 10/?? 4	Ap B 09/?? 4	Ap B 09/?? 4	Ap B 11/?? 4	Ap B 10/?? 4	Ap B 06/?? 4	Ap B 08/?? 4	Ap B 09/?? 4	Ap B 09/?? 4	Ap B 10/?? 4	Ap B 09/?? 4 M	Ap B 12/?? 4	Ap B 14/?? 4
2	Ap B 10/?? 4	Ap B 10/?? 4	Ap B 13/?? 4	Ap B 16/?? 4	Ap B 21/?? 4	Ap B ??/?? 4	Ap B 24/?? 4	Ap B 27/?? 4	Ap B 26/?? 4	Ap B 28/?? 4	Ap B 26/?? 4	Ap B ??/?? 4	Ap B 24/?? 4	Ap B 27/?? 4	Ap B ??/?? 4	Ap B 27/?? 4



Directory:32_weeks\Brady NAME: Sohena Date:20-04-92 Time: 22h24

Comments:Normal heart & breathing rates until approximately 90 seconds into the recording where the patient displays a brief period of bradycardia and recovers spontaneously.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	26/14 0	26/14 0	26/14 0	26/15 0	26/13 0	25/?? 4 M	B 17/?? 4 M	24/07 0	26/13 0	27/13 0	27/13 0	28/?? 4 M	27/?? 4 M	26/?? 4 M	??/?? 4	??/?? 4

Directory:32_weeks\Brady NAME: Van Date:13-04-92 Time: 09h59->11h55

Comments:Chronic bradycardia (120->114) with little HRV. Records becoming marginally normal.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	B 18/?? 4	B 12/?? 4	B 19/?? 4	B 21/?? 4	B 19/?? 4	B 19/?? 4	B 19/?? 4	B 16/?? 4	B 19/03 1	B 18/?? 4	B 21/05 0	B 20/04 0	B 20/05 0	B 21/05 0	B 20/?? 4	B 20/05 0
2	B 19/01 0	Ap B 19/00 0	Ap B 17/00 0	Ap B 19/00 0 M	Ap B 19/00 0	Ap B 17/00 0	Ap B 19/00 0	Ap B 18/00 0	Ap B 19/00 0 M	B 19/?? 4 M	B 19/07 0	B 19/?? 4	B 20/05 0	B 20/06 0	B 20/08 0	B 20/07 0
3	22/?? 4 !	B 21/10 0 !	B 21/08 0 !	B 21/10 0 !	B 21/12 0 !	B 21/10 0 M	22/?? 4 !	B 21/09 0 M	B 21/?? 4 !	23/?? 4 !	B 20/?? 4 !	B 21/?? 4 !	22/08 0 !	22/?? 4 !	22/?? 4 !	25/?? 4 !
4	B 21/06 0	22/05 0	22/09 0 !	B 21/09 0	B 21/07 0	22/04 0	B 21/05 0	B 21/07 0	B 21/05 0	B 21/06 0	B 20/09 0	B 21/04 0	B 21/05 0	B 20/07 0 !	B 21/07 0 !	B 21/05 0
5	B 21/08 0	B 21/06 0	22/07 0	B 21/09 0	B 21/06 0	B 21/07 0	22/09 0	B 21/09 0	B 21/07 0 M	B 21/05 0	B 21/07 0	B 21/06 0	B 21/?? 4	B 21/06 0 M	B 21/06 0	B 21/06 0
6	22/?? 4 M	B 21/?? 4 M	22/?? 4	B 21/?? 4	B 21/08 1	B 21/?? 4	22/05 0	B 21/07 0	B 20/08 0	B 21/06 0	B 21/07 0	B 20/10 0	B 21/08 0	B 20/?? 4	B 21/?? 4	22/?? 4
7	B 21/06 0	B 20/05 0	B 20/05 0	B 21/05 0	B 21/06 0	B 21/05 0 M	B 21/05 0	B 21/06 0	B 21/05 0	B 21/05 0	B 21/05 1 M	B 21/04 1 M	B 21/?? 4 M	B 21/05 0	B 20/06 1 M	B 21/06 1 M
8	B 20/05 0	B 20/04 0	B 20/06 0	B 21/05 2	B 20/05 0	B 20/05 0	B 21/04 1 M	B 20/04 2 M	B 20/?? 4 M	B 20/05 3 M	B 21/05 0	B 20/05 1 M	B 21/05 1 M	B 19/?? 4	B 20/04 3	B 20/04 1

Directory:32_weeks\Normals NAME: Ada Date:02-03-92 & 09-03-92 Time: 09h49->11h44

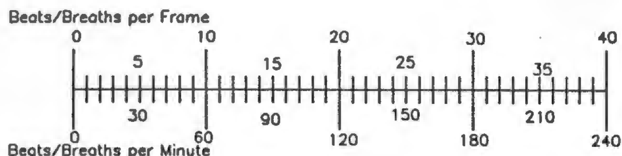
Comments:Patient on a ventilator:30.8 breaths/min Insp. Time:0.45sec;Exp. Time:1.5sec.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	27/13 0	27/13 0	26/11 0	27/12 0	27/12 1 M	26/11 0	26/10 0	25/12 0	25/11 0	26/10 0	26/12 0	25/11 0	25/09 0	23/09 0	25/11 0	25/10 0
2	T 28/09 1 M	27/09 0	T 28/10 0	27/11 0	27/10 0	T 28/09 0	26/09 0	26/09 0	26/09 1 M	25/10 0	27/13 0	26/13 0	26/12 0	26/11 0	27/10 0	27/10 0
3	25/?? 4 M	25/?? 4	24/?? 4	24/06 3	23/05 3	23/06 2	24/05 2	24/06 2	25/05 3	24/05 3	24/06 3	25/05 3	25/05 2	24/06 2	25/05 2	25/05 2
4	24/?? 4 M	22/04 1 M	??/?? 4	??/?? 4	26/?? 4	26/?? 4	26/05 3	25/06 2	24/05 3	23/05 3	25/06 3 M	23/05 3	23/05 3	22/05 2	23/05 2	24/05 2
5	23/05 3	23/06 3	23/05 3	24/05 3	23/05 3	24/05 2	25/05 2	24/05 2	24/05 3	23/05 4	??/?? 3	22/05 3	22/05 3	23/05 3	23/05 3	24/05 2
6	23/05 3	24/05 3	23/05 3	24/05 3	23/06 3	23/05 3	24/06 2	25/05 2	24/06 3	24/05 3	23/05 3	24/05 3	23/06 3	22/05 3	22/03 2	22/04 2
7	23/06 3	24/05 3	24/06 3	23/05 3	B 24/05 3	24/06 3	24/05 2	25/06 2	24/05 3	23/05 3	23/05 3	23/05 3	23/05 3	22/05 3	22/05 2	23/05 3 M
8	23/05 3	23/05 3	24/06 3	24/05 3	24/05 3	23/06 2	23/05 2	23/06 3	24/05 3	23/05 3	23/06 3	24/05 3	23/05 3	24/06 3	23/05 2	24/05 3 M
9	24/05 3	23/05 3	24/05 3	24/06 3	24/05 3	24/06 2	24/05 2	24/05 3	23/05 3	24/05 3	24/04 3	23/05 3	23/05 3	24/05 3	25/05 2	23/04 2

Directory:32_weeks\Normals NAME: Ale Date:27-03-92 Time: 11h35->12h14

Comments:Patient being ventilated. 60 breaths/min

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	24/12 0	25/11 0	25/11 0	24/10 0	25/10 0	24/10 0	24/10 0	24/10 0	25/10 0	25/10 0	24/10 0	24/10 0	24/10 0	24/10 0	24/10 0	24/10 0
2	24/10 0	23/10 0	23/10 0	24/10 0	24/10 0	24/10 0	24/10 0	24/10 2 M	23/10 0	24/10 0	24/10 0	23/10 0	24/10 0	23/10 0	23/10 0	24/10 0
3	24/10 0	23/10 0	24/10 0	23/10 0	23/10 0	24/10 0	23/10 0	24/10 0	23/10 0	23/10 0	23/10 0	23/10 0	23/10 0	24/10 0	24/10 0	23/10 0
4	23/10 0	23/10 0	23/10 0	23/10 0	24/10 0	23/10 0	23/10 0	24/10 0	23/09 0	24/09 1 M	24/09 0	24/08 1 M	24/08 0	24/09 0	24/08 0	24/08 0
5	24/08 0	24/09 0	24/08 0	25/09 0	24/08 1	24/09 0	24/09 0	24/09 3 M	24/09 0	24/09 1	??/?? 4 M	25/08 3 M	26/09 0	25/09 0	26/08 0	26/08 0
6	26/09 0	26/08 0	25/08 0	26/09 0	25/08 0	26/09 0	25/09 0	26/08 0	26/09 0	25/09 0	26/09 0	25/08 0	25/08 0	26/09 0	25/09 0	25/08 0



Directory:32_weeks\Normals NAME: Ale Date:27-03-92 Time: 11h35->12h14

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
7	25/09 0	25/08 0	25/09 0	26/09 0	26/08 0	25/09 0	25/09 0	25/08 0	25/08 0	25/09 0	25/09 0	25/09 0	25/08 0	25/09 0	25/09 0	25/09 0
8	Ap B 26/09 0	Ap B 25/09 0	Ap B 25/09 0	Ap B 26/08 0	Ap B 26/09 0	Ap B 25/05 0	Ap B 26/01 1	Ap B 25/07 0	Ap B 25/09 0	Ap B 24/08 3 M	Ap B 26/08 0	Ap B 25/09 0	Ap B 25/09 0	Ap B 26/09 0	Ap B 25/09 0	Ap B 26/10 0
9	26/10 0	26/09 0	26/10 0	26/09 0	25/10 0	26/09 0	26/10 0	26/10 0	26/09 0	26/09 0	26/09 0	26/10 0	27/10 0	26/10 0	26/10 0	26/09 0
10	26/09 0	26/09 0	26/09 0	26/10 0	27/10 0	26/10 0	27/09 0	27/09 0	26/10 0	26/09 0	26/10 0	26/09 0	26/09 0	26/10 0	26/10 0	26/10 0

Directory:32_weeks\Normals NAME: Bo Date:03-04-92 Time: 09h03 Comments:Patient on a ventilator:Breathing rate 67/min. Insp.Time0.45 sec Exp:Time:0.45sec I:E ratio:1:1

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	28/12 0	29/11 0	27/11 0	27/12 0	28/11 0	27/11 0	28/12 0	28/11 0	27/10 0	28/10 0	27/11 0	??/09 4	00/00 0 LO	00/00 0 LO	00/00 0 LO	00/00 0 LO

Directory:32_weeks\Normals NAME: Dy Date:24-02-92 Time: 11h56->12h21 Comments:Patient on ventilator. SAO2 increasing:81%->92% finally stabilizing around 88%. Heart rate:175->145 reducing as SAO2 level increased.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	26/05 0	26/12 0	27/13 0	27/08 0	27/10 0	27/10 0	26/01 0	25/05 0	27/11 0	27/12 0	PB 25/00 0	24/07 0	28/11 0	26/11 0	27/08 0	27/11 0
2	27/13 0	27/10 0	27/13 0	27/13 0	27/11 1	27/04 1	??/?? 4	26/11 3	27/13 0	27/12 0	27/09 0	27/12 0	27/07 1	27/06 0	25/02 1	27/?? 4
3	26/06 1	27/12 0	28/09 0	26/06 3	26/06 0	27/06 1	28/10 1	29/11 0	26/12 0	28/13 0	28/12 0	28/10 1	28/13 0	28/09 0	29/09 0	26/11 0

Directory:32_weeks\Normals NAME: Ma Date:28-04-92 Time: 09h53 Comments:Patient being ventilated: 80 breaths/min.

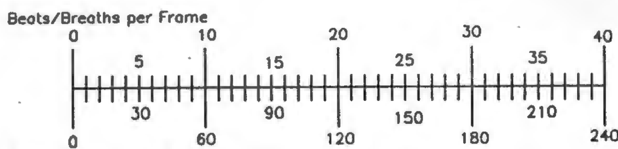
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	22/11 0	23/08 0	23/12 0	24/10 1	23/12 0	23/11 0	23/12 0	22/08 0	22/10 1	23/11 1	22/12 0	23/12 0	23/07 1	22/11 1	22/12 0	24/10 0

Directory:32_weeks\Normals NAME: Mng Date:05-04-92 Time: 17h48->21h56 Comments:Unassisted breathing:30->50 breaths/min

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	22/08 2	22/08 3	22/05 3	B 21/10 3	??/08 4	??/08 4	22/08 2	??/07 4	22/06 2	22/06 2	22/06 3	23/03 2	B 21/05 3	22/05 2	??/06 4	??/06 4
2	22/09 0	23/07 0	23/06 0	23/08 0	23/09 0	23/07 0	??/?? 4 M	23/09 0	22/08 0	23/07 0	23/07 0	22/09 0	22/08 1 M	23/07 0	23/09 0	22/08 0
3	23/10 0	23/07 0	23/07 0	??/10 4 M	B 21/09 2 M	23/08 0	23/10 0	22/09 0	??/?? 4 M	22/05 3 M	22/07 0	22/10 0	23/09 0	22/07 0	22/08 0	??/10 4 M
4	23/05 0	B 21/?? 4 M	??/10 4 M	22/09 2 M	??/09 4 M	22/06 2	??/09 4	23/09 2	??/05 4 M	22/08 2	22/06 2	??/10 4 M	??/09 4 M	22/06 2 M	B 21/08 2 M	B 21/10 3 M

Directory:32_weeks\Normals NAME: Nam Date:20-03-92 Time: 11h06->11h51 Comments:SATS data unavailable.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	25/12 0	24/13 0	24/12 0	25/14 0	25/15 0	24/12 0	25/14 0	24/13 0	24/13 0	24/15 0	24/14 0	25/14 0	24/14 0	25/14 0	25/15 0	24/14 0
2	26/13 0 M	25/09 0 M	26/10 0 M	26/09 0 M	26/09 0 M	26/10 0 M	26/11 0 M	??/07 0 M	26/10 0 M	26/08 0 M	26/08 0 M	26/08 0 M	26/09 0 M	26/11 0 M	26/10 0 M	26/14 0 M
3	27/08 0	26/06 0	27/14 0	26/10 0	27/13 0	26/12 0	26/11 0	26/14 4 M	26/10 3 M	26/14 2	26/15 3 M	25/12 2 M	26/14 3 M	26/12 2 M	25/13 2 M	26/13 2 M
4	25/14 0	25/13 0	25/13 0	25/15 0	25/14 0	24/12 0	25/13 0	25/12 0	24/13 0	25/14 0	25/12 0	24/13 3 M	25/15 0	24/15 0	25/16 0	24/14 0
5	25/12 0	25/11 0	25/07 0	25/09 0	26/10 0	25/11 0	26/07 0	26/11 0	25/10 0	??/11 0	??/?? 0	??/?? 0	??/?? 0	??/?? 0	27/13 0	25/?? 0
6	25/13 2	25/15 0	25/15 3 M	25/13 3 M	25/13 2 M	25/15 3 M	24/14 3 M	24/15 0	24/15 0	24/14 4 M	24/14 4	24/14 4	24/14 4	24/15 4	24/13 3 M	24/14 4 M
7	24/14 0	24/14 0	24/13 0	24/13 0	24/14 0	24/12 0	24/13 0	24/12 0	24/11 0	24/14 0	24/14 0	23/14 0	24/13 0	24/09 0	23/13 0	24/13 0
8	24/13 0	24/13 0	24/13 0	24/13 0	4 24/13 0	25/13 0	25/14 0	24/14 0	24/14 0	25/14 0	24/14 0	25/12 0	24/14 0	25/13 0	25/14 0	25/13 0
9	25/14 0	24/13 0	24/13 0	25/13 0	24/14 0	24/14 0	24/14 0	25/13 0	24/13 0	25/10 0	24/13 0	25/14 0	25/15 0	24/14 0	24/14 0	25/16 0
10	24/16 0	24/13 0	25/14 0	24/14 0	24/13 0	25/14 0	25/15 0	24/15 0	25/14 0	24/12 0	24/12 0	25/13 0	25/13 0	24/12 0	24/14 0	24/15 0



Directory:32_weeks\Normals NAME: Soh Date:15-04-92 Time: 12h26->16h19 Comments:Heart rate stable around tachycardia threshold.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	26/13 1	28/?? 4 T	27/02 0	20/02 1 B	23/11 0	24/11 1 M	27/?? 4	??/?? 4 M	28/11 0 T	28/?? 4 T M	??/?? 4	27/11 1 T	28/11 1 T	26/?? 4	27/13 1 T M	??/?? 4
2	25/?? 4	??/?? 4	??/?? 4	26/12 0	27/11 1	27/11 0	27/15 0	27/14 1	27/16 1 M	26/15 0	27/15 0 T	27/09 1 T	27/?? 4 T	27/?? 4 T	27/10 1 T	27/?? 4 T
3	26/12 2 M	??/?? 4	26/?? 4	23/13 3 M	??/?? 4	26/?? 4	23/13 1	24/13 1	??/13 4	??/?? 4	24/13 2	24/14 2	23/12 0	24/10 0	??/10 4	??/?? 4
4	25/09 0	24/10 1	24/15 0	25/13 0	24/13 0	24/15 0	25/14 0	24/11 0	24/?? 4 M	??/?? 4	25/?? 4	24/11 1	24/16 0	??/13 4 M	25/15 1 M	24/14 1 M
5	25/14 0	24/14 0	24/13 0	25/?? 4 M	??/?? 4	23/?? 4 !	23/15 2 !	23/13 3 !	22/13 3 !	22/15 2 !	26/14 2 !	26/13 2 !	26/14 3 !	24/11 2 !	23/12 2 !	24/11 2 !
6	26/13 0 !	24/12 1 !	24/14 0	26/13 0	24/15 0 !	24/14 0 !	25/12 0 !	25/12 0 !	25/09 1	??/?? 4	24/12 0 !	25/14 0 !	25/15 0 !	24/12 0 !	25/13 0 !	24/13 0 !
7	24/14 0 !	24/13 1 !	25/13 0 !	24/15 0 !	25/13 0 !	24/13 0 !	24/13 0 !	24/12 0 !	25/?? 4 !	24/12 1 M	25/13 0 !	24/14 3 !	25/12 1 !	25/13 0 !	24/13 0 !	25/?? 4
8	26/?? 4 !	??/?? 4	25/14 0 !	24/16 0 !	24/13 1 M	25/15 0 !	??/?? 4	??/?? 4	25/11 1 !	25/15 1 M	24/15 0	24/15 0	24/14 0	24/14 0	25/14 0	24/14 0
9	24/14 0	??/?? 4	??/?? 4	??/?? 4	25/14 0	24/13 0	??/?? 4	25/14 0	25/12 0	25/14 0	25/15 0	24/16 0	??/?? 4	??/?? 4	25/?? 4 M	25/?? 4 M
10	25/14 0	24/11 0	25/14 0	24/14 0	25/15 0	25/13 0	25/15 0	24/12 0	25/11 1	25/12 0	25/10 0	24/15 0	23/?? 4 M	??/?? 4	??/?? 4	??/?? 4
11	24/14 0	24/15 0	25/15 0	24/14 0 M	??/?? 4 M	24/?? 4	24/15 0	24/14 0	25/14 0	24/13 0	24/13 0	24/12 0	24/15 0	25/12 0	24/13 0	24/11 0

Directory:32_weeks\Normals NAME: Sol Date:24-02-92 Time: 14h09->14h21 Comments:Patient on a ventilator:Breathing rate:60/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	26/?? 4	26/?? 4	26/?? 4	26/?? 4	26/10 3	27/10 3	26/12 2	26/10 2	28/?? 4 T	27/?? 4	27/?? 4	27/?? 4	26/?? 4	27/?? 4	27/?? 4	27/11 2
2	28/?? 4 T	27/?? 4	28/12 3 T	26/10 3	26/11 3	26/12 3	26/?? 4	25/?? 4	26/?? 4	27/?? 4	26/?? 4	27/?? 4	27/?? 4	27/?? 4	26/?? 4	27/11 3

Directory:32_weeks\Normals NAME: Van Date:13-04-92 Time: 09h45->10h33 Comments:Unassisted breathing. Generally low HRV around 124 beats/min.

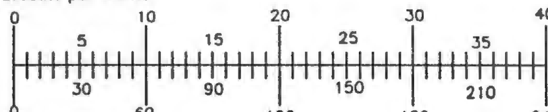
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	21/?? 4 B !	22/?? 4 !	21/08 0 B !	21/?? 4 B !	22/?? 4 !	21/07 0 B !	22/07 1 !	22/?? 4 !	22/?? 4 !	22/?? 4 !	22/?? 4 !	21/?? 4 B !	21/?? 4 B !	21/08 1 B !	21/08 1 B !	21/09 1 B !
2	21/11 0 B	22/09 0	22/?? 4	22/07 0	23/06 0	22/06 1	22/?? 4	22/05 3	22/07 0	21/11 0	21/06 3 B	22/05 1	21/10 0 B	??/?? 4	22/?? 4	21/06 0 B
3	23/06 0	23/?? 4	??/?? 4	23/06 1	23/06 0	23/06 0	23/?? 4	23/05 1	23/05 0	23/06 0	23/06 0	23/06 0	22/?? 4	23/05 1	23/05 1	23/06 0
4	23/?? 4	23/07 0	23/06 0	23/07 0	23/?? 4	24/?? 4	23/05 1	23/06 4	23/06 4	23/05 0	23/05 0	23/05 1	23/05 1	23/05 1	22/05 0	22/05 0

Directory:32_weeks\P_Breath NAME: Pon Date:23-04-92 Time: 14h49->14h55 Comments:Unassisted intermittant breathing Generally low HRV around 150 beats/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	27/15 1	26/14 1	25/18 0	26/15 0	25/11 0	26/12 0	27/16 1 M	26/16 0	26/10 1	25/00 0 PB	24/14 0	26/16 0	25/15 0	26/05 0 PB	26/13 1	26/18 0
2	26/16 0	26/13 0	25/19 0	27/?? 4	26/15 0	25/18 0	27/?? 4	26/?? 4 M	25/00 0 PB	24/14 0	24/00 0 PB	24/08 0 PB	26/19 0	25/18 0	25/17 0	26/16 0

Directory:32_weeks\P_Breath NAME: Soh Date:21-03-92->23-03-92 Time:Data capture discontinuous Comments:Heart rate generally within normal limits. Low HRV. Breathing rate eratic/intermittant

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	28/11 1 T	??/?? 4	27/?? 4 M	28/12 0	27/12 0	27/13 0	27/14 0	26/13 1 M	27/13 0	25/13 2	??/13 4	??/13 4	??/14 4	27/08 0 PB	25/07 0 PB	26/06 0 PB
2	25/?? 4	25/11 1	??/?? 4	22/09 1	25/12 0	24/00 3 PB M	25/?? 4 M	26/13 0	26/06 0 PB	25/04 1 PB	24/13 0	24/11 0	24/11 0	24/07 0	??/?? 4	??/?? 4
3	26/?? 4	26/?? 4	27/?? 4	27/?? 4	26/13 2	27/?? 4	26/10 0	24/12 0	25/12 0	25/06 0 PB	24/09 0 PB	24/14 0	25/11 0	25/04 0 PB	23/04 0 PB	24/01 0 PB
4	25/?? 4	25/?? 4	25/16 0	25/08 1 M	23/10 0	26/15 0	25/?? 4	??/?? 4	??/?? 4	23/?? 4	25/01 0 PB	26/00 0 PB	25/00 0 PB	25/05 0 PB	24/00 1 PB	19/02 0 Ap B
5	26/15 0	25/12 1	25/?? 4	25/?? 4 M	25/11 0	26/14 0	25/07 0	26/13 0	25/15 0	26/13 0	26/12 0	25/10 0	20/06 1 B	23/13 1	24/14 1	25/12 0



Directory:32__weeks\P__Breath NAME: Sol Date:25-02-92 Time: 12h14

Comments:Initial bradycardia/apnoeic attack. Resumed tachycardia:Low HRV

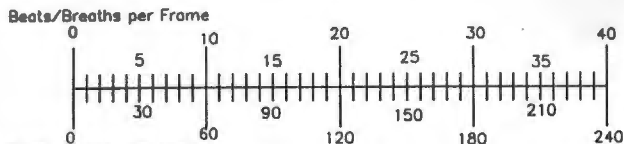
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Ap B 15/00 2	27/09 3 M	T 29/?? 4	T 30/?? 4	T 29/?? 4	T 29/?? 4	T 29/?? 3	T 30/07 2	T 31/?? 4	??/?? 4	T 30/?? 4	T 30/?? 4	T 30/?? 4	T 31/?? 4	T 30/?? 4	T 30/?? 4

Comments:Heart rate within normal limits.130->150 beats/min

Directory:32__weeks\P__Breath NAME: Van Date:14-04-92->16-04-92 Time:Data capture discontinuous

Low HRV
Breathing intermittant.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	23/05 0	Ap B 21/00 0	Ap B 21/00 0	Ap B 21/00 0	23/05 0	??/?? 4	23/?? 4	23/09 0	22/12 0	23/?? 4	22/10 1	22/?? 4	??/?? 4	23/10 0	23/10 0	22/10 1
2	PB 23/00 0	PB 23/00 0	PB 22/00 1	23/10 3	23/14 1	23/12 3	23/?? 4	??/?? 4	??/?? 4	24/11 3	23/12 0	23/11 0	23/10 0	23/?? 4	23/10 1	23/10 0
3	Ap B 21/00 0	PB 22/00 0	PB 23/00 0	PB 22/00 0	PB 23/04 1	22/13 0	22/13 0	23/?? 4	??/?? 4	24/?? 4	??/?? 4	25/?? 4	25/09 0	24/11 0	24/11 0	23/09 0
4	24/06 0	24/06 1	24/05 0	26/06 0	26/07 3	25/05 0	PB 24/00 0	PB 23/00 0	PB 23/00 0	PB 22/00 0	24/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
5	25/07 0	24/?? 4	PB 25/01 0	PB 24/00 0	PB 23/00 0	PB 24/00 0	24/?? 4	21/?? 4	24/05 3	??/?? 4	25/10 0	24/12 0	24/10 0	24/?? 4	24/08 1	24/08 0
6	PB 24/00 0	PB 24/00 1 M	PB 24/02 0	24/?? 4	??/?? 4	24/12 1	24/12 1	24/10 1	24/09 1	25/08 1	25/?? 4	25/09 1	25/09 1	25/09 1	25/09 1	25/08 1
7	PB 23/00 0	22/16 1	23/?? 4	22/?? 4	??/?? 4	25/07 1	25/07 3	25/07 0	24/07 0	24/07 0	24/?? 4	25/08 0	25/?? 4	25/?? 4	25/08 0	25/?? 4
8	PB 23/00 0	24/?? 4	23/05 1	PB 24/00 0	PB 23/00 0	B 21/?? 4	??/?? 4	23/?? 4	??/?? 4	23/11 0	23/08 2	24/09 0	23/08 0	24/?? 4	23/09 1	23/10 0
9	PB 24/00 0	PB 23/00 0	PB 23/00 0	PB 23/00 0	PB 24/00 1	23/09 1	24/?? 4	23/14 0	23/10 0	23/?? 4	23/11 0	23/11 0	22/08 0	23/08 0	24/09 0	23/11 1
10	23/04 0	23/13 0	23/12 0	24/09 0	23/10 0	24/09 0	24/09 0	23/08 0	23/?? 1	24/07 0	24/09 0	23/08 1	23/07 0	24/07 0	23/?? 4	??/?? 4
11	24/07 0	23/11 0	25/11 1	24/09 0	PB 24/00 0	PB 23/00 0	22/11 0	24/11 0	23/11 0	24/07 1	??/08 4	25/03 3	24/10 0	24/11 1	24/09 0	23/10 0
12	PB 23/01 0	PB 22/00 0	PB 23/02 0	23/?? 4	??/10 4	22/11 3	24/?? 4	24/11 0	23/09 0	24/07 1	24/16 0	23/14 0	23/10 0	24/07 0	23/08 0	23/08 0
13	Ap B 21/00 0	PB 23/00 0	PB 22/06 3	24/10 3	24/12 0	23/13 0	24/13 1	24/07 1	23/12 0	24/?? 4	23/07 3	24/?? 4	23/06 2	23/10 0	23/11 3	??/?? 4
14	PB 24/00 0	PB 23/02 0	PB 23/00 0	PB 22/02 0	23/13 0	24/12 0	24/10 0	24/10 0	23/11 1	24/12 0	23/10 0	24/12 0	23/08 1	23/07 0	23/11 0	??/?? 4
15	PB 23/00 0	PB 24/00 0	PB 23/00 0	PB 22/00 0	PB 22/00 0	Ap B 21/00 0	23/14 0	23/14 0	24/12 0	24/11 0	??/?? 4	25/?? 4	PB 24/00 0	PB 24/00 0	PB 24/00 0	24/13 0
16	PB 26/00 0	PB 24/00 0	PB 24/00 0	PB 24/00 0	PB 24/00 0	PB 23/00 0	PB 22/00 0	24/07 0	24/12 0	24/13 0	25/?? 4	PB 25/00 0	25/09 0	25/13 0	25/?? 4	26/?? 4
17	PB 25/00 0	PB 23/00 0	PB 25/06 0	25/15 0	26/14 0	26/13 0	26/12 0	??/?? 4	PB 26/00 0	PB 26/10 0	25/12 1	27/10 1	27/11 0	26/12 1	26/?? 4	27/12 0
18	PB 25/00 0	25/08 0	26/08 1	25/11 1	26/09 0	26/07 1	26/11 0	27/10 0	26/10 0	27/11 1	26/12 1	PB 26/06 0	26/10 0	26/08 0	26/11 1	26/09 0
19	PB T 28/03 0	PB 27/00 0	PB 26/07 1	27/08 0	26/?? 4	PB 27/05 0	27/05 1	PB 27/03 1	PB 27/06 0	26/12 1	27/12 0	27/09 1	26/12 0	27/02 1	27/10 0	27/07 0
20	T 28/?? 4	27/10 0	28/08 0	27/11 0	28/09 1	27/12 0	PB T 28/06 0	PB 27/00 1	PB 27/00 1	26/08 1	26/00 1	27/11 1	27/?? 4	27/09 1	PB 27/00 0	PB 27/00 0



Directory:32_weeks\Tachy NAME: Gor Date:07-04-92 Time: 09h22->10h27

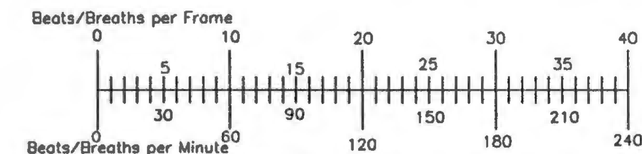
Comments:High degree of movement artifact.
Fast breathing rate:80->120 breaths/min.
Heart rate generally stable around 180 beats/min.Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	31/16 T 2	30/16 T 0	??/14 4	??/?? 4 M	30/08 T 0	??/?? 4	??/?? 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	31/09 T 3	31/15 T 0	31/08 T 3	31/03 T 0	30/08 T 0
2	??/10 4	??/08 4	??/?? 4 M	31/17 T 0	31/18 T 2	31/17 T 0	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/17 4	31/12 T 3	30/?? T 4	31/13 T 3	??/?? 4 M	??/?? 4 M	??/?? 4 M
3	??/?? 4 M	31/?? T 4	??/?? 4 M	30/06 T 2	32/13 T 3	31/18 T 0	31/19 T 0	31/17 T 0	31/?? T 4	30/12 T 1	31/19 T 0	30/15 T 0	32/?? T 4	31/?? T 4	31/17 T 0	??/?? 4 M
4	31/19 T 0	??/?? 4 M	??/?? 4 M	??/?? 4 M	31/?? T 4	32/11 T 1	31/14 T 3	??/?? 4 M	??/?? 4 M	??/?? 4 M	30/20 T 1	31/?? T 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	30/17 T 0
5	??/07 4 M	31/?? T 4	31/08 T 3	31/15 T 3	31/?? T 4	??/?? 4	??/?? 4	31/13 T 0	30/09 T 2	31/08 T 3	??/?? 4 M	31/14 T 0	30/08 T 1	30/15 T 0	30/14 T 0	30/?? T 4
6	??/?? 4 M	30/?? T 4	??/?? 4 M	29/?? T 4	29/?? T 4	??/14 4	30/19 T 0	30/17 T 0	29/18 T 0	29/19 T 0	29/16 T 0	29/16 T 0	??/?? 4 M	??/?? 4 M	29/16 T 3	29/16 T 1
7	30/16 T 3	29/?? T 4	30/?? T 4	??/?? 4 M	??/?? 4 M	30/14 T 1	30/15 T 1	??/09 4 M	30/?? T 4	30/?? T 4	30/13 T 3	30/21 T 3	29/17 T 0	29/17 T 0	29/17 T 3	??/?? 4 M
8	29/17 T 1	30/18 T 0	29/18 T 0	29/19 T 0	29/?? T 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	31/13 T 3	29/11 T 0	29/19 T 0	30/17 T 0	30/18 T 0
9	29/?? T 4	28/18 T 0	29/?? T 4	30/?? T 4	28/20 T 0	29/18 T 0	28/16 T 0	28/13 T 1	28/?? T 4	??/?? 4 M	29/?? T 4	29/18 T 0	28/18 T 0	28/17 T 0	28/16 T 0	28/16 T 1
10	28/18 T 0	28/17 T 0	29/?? T 4	29/?? T 4	29/09 T 1	??/?? 4 M	??/?? 4 M	29/18 T 0	30/?? T 4	??/12 4	30/?? T 4	??/?? 4	??/?? 4	30/?? T 4	??/?? 4 M	29/15 T 1

Directory:32_weeks\Tachy NAME: Ma Date:05-05-92 Time: 08h48->12h30

Comments:CPAP: 20.3 breaths/min.
Heart rate:180->200 beats/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	35/09 T 0	34/08 T 0	34/08 T 0	34/08 T 0	35/08 T 0	34/10 T 0	33/11 T 0	34/07 T 0	34/11 T 0	34/10 T 0	34/09 T 0	34/09 T 0	34/08 T 0	34/06 T 0	34/07 T 0	33/07 T 0
2	34/07 T 0	34/06 T 0	34/08 T 0	33/07 T 0	33/06 T 0	33/08 T 0	33/06 T 0	34/07 T 0	30/12 T 3	??/?? 4	32/?? T 4	33/?? T 4	??/?? 4	??/?? 4	32/13 T 0	32/13 T 0
3	32/06 T 0	??/?? 4	??/?? 4	32/14 T 0	32/13 T 0	32/15 T 0	31/15 T 0	32/15 T 0	31/14 T 0	30/16 T 0	30/14 T 1 M	31/15 T 0	??/?? 4	30/14 T 0	30/16 T 0	30/12 T 0
4	PB 30/09 T 0	PB 29/00 T 0	29/12 T 0	30/12 T 0	30/12 T 0	30/14 T 0	30/13 T 0	29/13 T 0	29/09 T 0	PB 29/07 T 0	PB 27/00 0	PB 28/04 0	PB 26/00 0	PB 27/00 0	PB 24/00 0	PB 25/00 0
5	32/?? T 4	31/?? T 4	31/?? T 4	31/10 T 1	31/?? T 4	31/?? T 4	31/?? T 4	32/?? T 4	30/05 T 3	30/04 T 2	32/?? T 4	??/?? 4	??/?? 4	31/?? T 4	29/03 T 2	30/03 T 2
6	32/05 T 2	30/04 T 0	31/03 T 0	31/04 T 0	32/04 T 1	31/04 T 2	31/04 T 0	31/05 T 0	31/?? T 4	32/05 T 3	30/03 T 2	30/04 T 0	31/03 T 0	31/04 T 0	31/04 T 0	31/04 T 0
7	32/04 T 0	30/03 T 0	32/04 T 0	31/04 T 0	31/03 T 0	32/04 T 3	32/03 T 2	31/04 T 2	32/04 T 0	31/03 T 0	32/04 T 0	??/03 4	30/04 T 0	??/03 4	31/04 T 2	32/03 T 2
8	32/04 T 0	31/03 T 0	31/04 T 0	32/03 T 0	32/04 T 0	31/04 T 0	31/04 T 0	31/04 T 0	30/03 T 0	31/04 T 0	??/04 4	31/03 T 2	??/04 4	30/03 T 2	30/03 T 2	32/04 T 0
9	Ap B 31/03 0	Ap B 31/04 0	Ap B 32/04 0	Ap B 31/04 0	Ap B ??/04 4	Ap B 32/03 0	Ap B 32/04 0	Ap B 31/03 0	Ap B 32/03 0	Ap B 31/04 0	Ap B 31/03 0	Ap B 32/04 2	Ap B 32/04 3	Ap B 32/04 3	Ap B 32/04 3	Ap B ??/?? 4
10	32/?? T 4	30/04 T 0	31/03 T 0	32/04 T 0	31/03 T 0	31/04 T 0	32/03 T 1	31/?? T 4	33/?? T 4	32/?? T 4	32/?? T 4	32/?? T 4	30/04 T 3	32/04 T 3	31/04 T 1	??/?? 4
11	36/03 T 0	36/03 T 0	36/04 T 0	35/03 T 0	36/?? T 4	36/?? T 4	35/01 T 0	34/04 T 0	35/04 T 0	34/03 T 0	35/04 T 0	35/03 T 0	35/04 T 0	35/03 T 0	35/04 T 0	35/03 T 0
12	35/03 T 0	34/04 T 0	34/04 T 0	35/03 T 0	35/04 T 0	35/03 T 0	??/?? 4	35/04 T 3	33/03 T 3	35/?? T 4	35/04 T 1	??/?? 4	36/?? T 4	35/04 T 0	??/?? 4	??/04 T 4
13	??/?? 4	37/05 T 3	36/?? T 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/04 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	36/08 T 1	36/?? T 4	36/?? T 4



Directory:32_weeks\Tachy NAME: Ale Date:30-03-92 Time: 07h28->07h36

Comments:Heart rate stable above 180 beats/min. Low HRV. Patient being ventilated.Breathing rate 66 breaths/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	30/08 0	31/10 3	31/04 0	32/04 0	31/07 0	31/03 0	30/06 0	31/05 0	30/09 3	32/05 0	32/07 0	??/?? 4	??/?? 4	31/08 0	32/07 0	31/08 0
2	30/10 0	30/10 0	30/08 0	31/10 0	30/08 1	30/07 0	30/07 0	30/08 0	30/04 0	30/04 2	31/09 2	31/11 0	30/10 0	30/09 0	30/11 0	30/09 0

Directory:32_weeks\Tachy

NAME: Bo Date:04-03-92 Time: 08h42->11h30

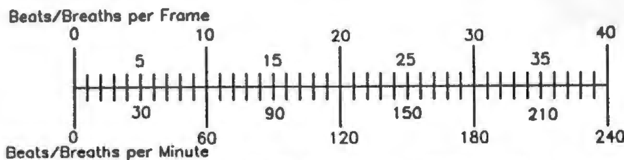
Comments:Patient on a ventilator
Insp.Time:0.45 sec Exp.Time:0.45 sec I:E ratio:1:1
Heart rate stable above 180 beats/min. Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	33/12 0	33/11	33/11	33/12	33/12	33/12 0	33/12 0	33/12 0	32/12 0	32/12 0	32/11 0	33/11 0	33/11 0	32/11 0	33/12 0	32/11 0
2	32/11 0	32/12 0	33/12 0	32/11 0	33/11 0	33/12 0	33/11 0	33/12 0	33/11 0	32/11 0	32/12 0	32/12 0	33/12 0	32/11 0	31/11 0	33/11 0
3	33/11 0	33/11 0	32/11 1	32/11 0	31/11 0	33/12 0	33/11 0	33/11 0	32/11 0	33/12 0	33/11 0	31/11 0	33/11 0	32/11 0	32/11 0	31/12 0
4	33/12 0	33/11 0	33/11 0	33/11 0	33/12 0	33/11 0	32/12 0	33/11 0	32/11 0	33/12 0	33/12 0	32/11 0	33/11 0	32/12 0	32/12 0	32/11 0
5	33/11 0	33/12 0	33/11 0	33/11 0	33/11 0	34/12 0	32/11 0	33/11 1	33/11 0	33/11 0	33/12 0	33/11 0	32/11 0	33/11 0	33/11 0	33/11 1
6	33/11 0 M	33/11 0 M	34/12 0 M	33/11 0 M	33/11 0 M	34/12 0 M	33/11 0 M	34/12 0 M	33/11 0 M	32/12 0 M	33/12 0 M	34/11 0 M	33/11 0 M	32/11 0 M	33/11 0 M	33/11 0 M
7	33/11 0	33/11 0	33/11 1	33/12 0	34/11 0	33/12 0	33/11 0	33/12 0	34/11 0	32/11 0	33/12 0	32/11 0	32/11 1	32/11 0	32/11 0	33/11 0
8	33/12 0	33/11 0	33/11 0	34/12 0	34/12 0	33/11 0	34/11 0	34/11 0	34/11 0	33/11 0	33/11 0	32/12 0	33/12 0	33/11 0	33/11 0	33/11 0
9	33/11 1	33/12 0	33/11 0	34/11 0	34/11 1	32/12 1	34/11 0	33/11 0	34/11 0	33/12 0	34/11 0	33/11 0	33/11 0	32/12 0	32/12 0	33/12 0
10	33/11 0	32/11 0	34/12 0	32/11 0	33/11 1	34/12 0	33/11 0	32/12 0	33/11 0	33/11 0	32/11 0	32/11 0	33/11 0	33/11 0	33/11 0	33/12 0
11	31/11 0	32/11 0	32/12 0	32/11 0	31/11 0	32/12 0	32/12 0	32/12 0	31/11 0	31/11 0	31/12 0	31/11 0	31/11 0	31/11 0	31/11 0	31/12 0
12	28/12 0	27/11 0	28/12 0	28/12 0	26/11 0	28/10 0	27/11 0	27/12 0	27/11 0	27/11 0	27/12 0	27/12 0	28/11 0	27/11 0	28/11 0	27/12 0
13	30/12 0	30/11 0	30/12 0	30/12 0	30/12 0	30/12 1	30/12 0	30/11 0	31/12 0	31/12 1	31/11 0	31/12 0	30/12 0	31/12 0	30/11 0	30/11 0
14	31/11 0	30/12 0	29/12 0	30/11 0	31/11 0	30/12 0	31/11 0	30/12 0	30/11 0	31/11 0	30/11 0	31/12 0	31/12 0	30/11 1	29/11 0	31/11 0
15	31/11 0	30/12 0	31/12 0	30/11 0	30/11 0	31/12 0	32/11 0	29/12 0	31/12 0	31/11 0	30/11 0	30/12 0	30/12 0	30/11 0	31/11 0	30/11 0
16	30/11 0	31/11 0	31/12 0	31/11 0	31/11 0	31/12 0	32/10 1	31/12 0	30/11 0	31/12 0	31/11 0	31/11 1	31/11 0	32/11 0	31/11 0	30/12 0

Directory:32_weeks\Tachy NAME: Dy Date:24-02-92 Time: 09h47->10h53

Comments:Heart rate generally stable above 180 beats/min. Low HRV.Waveforms display accentuated T wave.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	28/13 0	28/14 0	28/15 1	28/08 0	26/13 0	27/10 0	27/14 0	28/14 0	28/10 0	27/16 0	27/08 0	28/09 1	28/07 0	??/07 4	??/?? 4	28/14 2
2	29/10 0	28/05 0	30/12 0	30/10 2	30/10 0	30/09 0	30/06 3	30/11 0	30/14 0	29/10 0	??/05 4	29/08 0	30/17 0	31/09 0	30/10 0	30/11 0
3	31/13 0	30/12 0	30/12 0	30/10 0	30/12 0	30/14 0	30/10 0	30/12 0	30/12 0	30/12 0	30/10 0	28/07 0	30/13 0	30/11 0	29/09 0	30/08 0
4	30/10 1	30/07 1	30/08 0	30/15 0	30/10 0	30/07 0	30/11 0	30/09 0	29/08 0	30/15 0	30/13 0	30/10 0	28/09 0	30/13 0	30/13 0	30/13 0
5	29/11 0	30/14 0	30/12 0	29/10 0	29/04 0	??/14 4	29/11 0	30/13 0	29/10 0	30/14 0	30/11 0	29/11 0	29/09 0	30/11 0	30/12 0	29/14 0
6	29/12 0	30/12 0	30/13 0	30/13 0	30/11 0	30/09 0	30/13 0	29/12 0	29/12 0	29/14 0	30/13 0 B	30/14 0	30/14 0	30/12 0	30/13 0	30/10 0



Directory:32_weeks\Tachy NAME: Pon Date:01-04-92 Time: 21h04->21h22 Comments:Patient on ventilator. 30.8 breaths/min. Insp.Time:0.45sec;Exp.Time:1.5sec

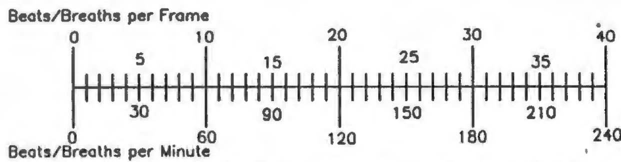
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	T 29/12 0	T 29/14 1 M	T 28/13 0	T 29/16 0	T 29/15 0	T 29/15 0	T 29/11 1 M	T 29/14 0	T 29/14 0	T 29/13 0	T 29/15 0	T 29/14 1	T 29/?? 4	T 30/?? 4	T 29/14 0	T 29/13 0
2	T 29/13 0	T 28/11 0	T 28/10 0	T 29/12 0	T 28/10 1	T 29/10 1	T 28/15 0	T 28/13 0	T 28/14 0	T 29/16 0	T 29/15 0	T 28/12 0	T 29/12 0	T 29/14 0	T 29/13 1 M	T 29/13 0
3	T 29/16 0	T 29/14 0	T 29/10 0	T 28/11 0	T 28/09 0	T 28/12 0	T 28/10 0	T 28/12 0	T 28/12 0	T 28/11 0	T 28/11 0	T 28/11 0	T 28/11 0	T 28/11 0	T 28/11 0	T 29/?? 4
4	T 28/11 0	T 28/13 0	T 28/15 0	T 28/11 0	T 28/13 1	T 28/13 0	T 29/13 0	T 28/16 0	T 28/14 0	T 28/14 0	T 28/14 0	T 28/11 0	T 28/12 0	T 29/14 0	T 28/14 0	T 28/?? 4
5	T 28/14 0	T 28/13 0	T 28/10 1	T 28/11 0	T 28/11 0	T 28/12 0	T 28/12 0	T 29/14 0	T 28/12 0	T 28/11 0	T 28/10 0	T 28/09 0	T 29/11 0	T 28/11 0	T 28/10 0	T 28/11 1
6	T 28/14 0	T 28/11 1	T 28/09 0	T 28/15 0	T 28/12 0	T 28/11 0	T 29/10 0	T 28/14 0	T 28/11 0	T 28/10 0	T 28/12 0	T 28/11 0	T 29/12 0	T 28/?? 4	T 29/12 1	T 28/?? 4
7	T 28/11 0	T 29/11 0	T 28/11 0	T 29/11 1	T 28/?? 4	T 28/13 1	T 28/12 1	T 29/13 1	T 28/13 1	T 29/14 0	T 29/15 0	T 28/11 0	T 28/12 0	T 28/13 0	T 29/12 0	T 28/14 0

Directory:32_weeks\Tachy NAME: Sol Date:25-02-92 Time: 09h42->12h39 Comments:Tachycardia due to crying. Heart rate:180->204beats/min. Electrode detatched on event 2. Intensive movement artifact

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	T 33/11 1	T 33/11 1	T 33/14 0	T 34/10 1	T 33/11 1	T 33/10 2	T 33/?? 4 M	T 34/?? 4 M	T 34/?? 4 M	T 33/?? 4 M	PB T 33/00 2	PB T 33/00 0	PB T 32/01 0	PB T 33/02 0	PB T 32/00 0	PB T 32/04 1
2	T 33/?? 4 M	T 33/?? 4 M	T 33/?? 4 M	T 33/?? 4 M	T 33/?? 4 M	T 32/?? 4 M	T 33/?? 4 M	T 32/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	00/00 0 LO	00/00 0 LO	00/00 0 LO
3	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	T 35/?? 4 M	T 34/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	T 33/?? 4 M	T 31/?? 4 M	T 31/00 2	T 32/08 3	T 31/?? 4 M	T 31/?? 4 M
4	T 32/08 3	??/?? 4 M	T 32/15 1	T 31/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	T 34/?? 4 M	T 31/?? 4 M	??/?? 4 M	T 33/?? 4 M	T 32/08 2	T 33/?? 4 M	T 31/?? 4 M	??/?? 4 M	??/?? 4 M
5	PB T 30/00 2	T 30/13 3	T 31/09 3	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 31/?? 4 M	T 30/21 3	T 30/10 3	T 30/?? 4 M	T 30/?? 4 M	T 29/?? 4 M	T 30/?? 4 M	T 30/?? 4 M
6	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/07 0	T 31/?? 4 M	T 31/?? 4 M	T 32/?? 4 M	26/?? 4 M	T 29/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 30/07 2 M	T 30/08 2
7	T 31/08 2	T 31/08 3	T 31/?? 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	T 32/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/08 0	T 31/08 4	T 30/08 4	T 31/?? 4	T 32/?? 4 M	T 31/?? 4 M	T 30/?? 4 M
8	T 31/08 0	T 30/09 0	T 32/?? 4 M	T 31/?? 4 M	T 32/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 30/?? 0 M	T 31/?? 4 M	T 30/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M	T 31/?? 4 M
9	T 30/11 2	T 30/08 2	T 31/12 2	T 30/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 30/?? 4 M	T 31/?? 4 M	T 30/08 2	T 31/08 2	T 31/11 3	T 30/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 30/?? 4 M	T 30/?? 4 M
10	T 30/17 0	T 30/12 0	T 31/13 0	T 30/08 0	T 30/?? 4 M	T 30/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 30/12 0	T 30/09 0	T 30/10 0	T 30/07 0	T 30/?? 4 M	T 29/?? 4 M	T 30/?? 4 M	T 30/?? 4 M
11	T 30/11 1	T 30/09 3	T 30/12 3	T 29/?? 4 M	T 30/?? 4 M	T 30/08 3	T 30/?? 4 M	T 30/09 1	T 30/?? 4 M	T 30/?? 4 M	T 29/?? 4 M	T 30/?? 4 M	T 31/?? 4 M	T 30/?? 4 M	T 29/?? 4 M	T 30/?? 4 M

Directory:32_weeks\Tachnea NAME: Mag Date:08-05-92 Time: 16h37->16h43 Comments:Abnormally high breathing rate:(around 120/min.) Heart rate stable around 180 beats/min. Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	TAp T 29/24 0	TAp T 29/24 0	TAp T 31/20 0	TAp T 31/19 0	TAp T 31/21 0	TAp T 31/19 0	TAp T 31/22 0	TAp T 31/22 1	TAp T 31/18 0	TAp T 31/20 0	TAp T 30/15 0	TAp T 30/24 0	TAp T 29/21 0	TAp T 29/21 0	TAp T 30/22 0	TAp T 30/16 0
2	TAp T 30/23 0	TAp T 31/22 0	TAp T 30/22 0	TAp T 29/18 0	TAp T 29/24 0	TAp T 29/21 1	TAp T 29/20 1	TAp T 29/21 1	TAp T 29/12 0	TAp T 28/22 0	TAp 27/22 1	TAp T 29/21 1	TAp 27/22 0	TAp T 28/23 0	TAp T 30/24 0	TAp T 29/25 0
3	TAp T 30/16 0	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 0 M	??/?? 0 M	??/?? 4 M	TAp T 32/19 3	TAp T 31/18 0	TAp T 32/19 0	TAp T 33/22 0	TAp T 32/24 0	TAp T 32/23 0	TAp T 31/23 2	TAp T 33/24 2	TAp T 29/26 2



Directory:34_weeks\Brady NAME: Hof Date:10-03-92->12-03-92 Time:Data capture discontinuous

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
22	46/?? 4	33/?? B 4	22/?? B 4	??/?? 4	43/?? B 4	43/?? B 4	37/?? B 4	49/?? 4	29/?? T 4	28/?? T 4	28/?? T 4	27/?? T 4	27/?? T 4	28/?? T 4	29/?? T 4	29/?? T 4
23	54/?? T 4	48/?? 4	44/?? 4	43/?? 4	56/?? T 4	56/?? T 4	54/?? T 4	49/?? 4	28/?? T 4	29/?? T 4	29/?? T 4	29/?? T 4	27/?? T 4	27/?? T 4	24/?? 4	21/?? B 4
24	32/?? B 4	29/?? B 4	??/?? 4	??/?? 4	32/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	25/?? 4	18/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
25	65/?? T 4	66/?? T 4	66/?? T 4	64/?? T 4	55/?? T 4	46/?? 4	38/?? B 4	42/?? B 4	28/?? T 4	28/?? T 4	29/?? T 4	29/?? T 4	29/?? T 4	30/?? T 4	28/?? T 4	29/?? T 4
26	59/?? T 4	52/?? 4	53/?? 4	56/?? B 4	58/?? T 4	59/?? 4	52/?? 4	54/?? T 4	26/?? T 4	26/?? T 4	27/?? T 4	27/?? T 4	26/?? T 4	26/?? T 4	26/?? T 4	27/?? T 4
27	55/?? T 4	56/?? T 4	56/?? T 4	55/?? T 4	57/?? T 4	58/?? T 4	57/?? T 4	56/?? T 4	28/?? T 4	??/?? 4	??/?? 4	28/?? T 4	27/?? T 4	27/?? T 4	??/?? 4	12/?? B 4
28	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	64/?? T 4	44/?? 4	36/?? B 4	17/?? B 4	15/?? B 4	15/?? B 4	15/?? B 4	16/?? B 4	28/?? T 4	31/?? T 4	31/?? T 4
29	64/?? T 4	64/?? T 4	59/?? T 4	??/?? 4	??/?? 4	??/?? 4	57/?? T 4	59/?? T 4	29/?? T 4	30/?? T 4	29/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4
30	63/?? T 4	62/?? T 4	64/?? T 4	59/?? T 4	62/?? T 4	57/?? T 4	57/?? T 4	43/?? 4	22/?? 4	29/?? T 4	27/?? T 4	17/?? B 4	22/?? 4	28/?? T 4	29/?? T 4	26/?? 4
31	61/?? T 4	63/?? T 4	62/?? T 4	61/?? T 4	58/?? T 4	59/?? T 4	54/?? T 4	55/?? T 4	25/?? 4	22/?? 4	20/?? B 4	21/?? B 4	19/?? B 4	19/?? B 4	17/?? B 4	16/?? B 4
32	32/?? B 4	33/?? B 4	38/?? B 4	??/?? 4	45/?? 4	40/?? 4	33/?? B 4	39/?? B 4	24/?? 4	20/?? B 4	17/?? B 4	20/?? B 4	22/?? 4	17/?? B 4	??/?? 4	??/?? 4

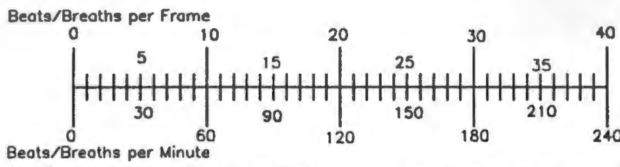
Directory:34_weeks\Brady NAME: Ji Date:14-02-92->21-02-92
Time:Data capture discontinuous

Comments:Serious bleeding in lungs. Noisy repiration channel. Bradycardia with progressive increase in heart rate. SA02 low:39% -> climbing to 76% during the sampling period. Improvement due to suction & clotting factor dosage.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	30/?? T 4	29/?? T 4	30/?? T 4	??/?? 4	??/?? 4	29/?? T 4	??/?? 4	31/?? T 4	30/?? T 4	29/?? T 4	30/?? T 4	??/?? 4	??/?? 4	29/?? T 4	??/?? T 4	31/?? T 4
11	27/?? T 4	28/?? T 4	28/?? T 4	27/?? T 2	27/?? T 2	28/?? T 2	28/?? T 3	28/?? T 3	27/?? T 4	28/?? T 4	28/?? T 4	27/?? T 2	27/?? T 2	28/?? T 2	28/?? T 3	28/?? T 3
2	07/?? B 4	Ap 10/00 B 4	Ap 09/00 B 4	Ap 10/00 B 4	Ap 10/00 B 4	Ap 09/00 B 4	Ap 08/00 B 4	Ap 09/00 B 4	Ap 06/?? B 4	Ap 10/00 B 4	Ap 09/00 B 4	Ap 09/00 B 4	Ap 09/00 B 4	Ap 08/00 B 4	Ap 09/00 B 4	Ap 09/00 B 4
3	09/11 B 4	09/11 B 0	08/10 B 0	09/?? B 0	09/11 B 0	07/?? B 0	08/09 B 0	07/10 B 0	09/11 B 4	09/11 B 0	08/10 B 0	09/?? B 0	08/11 B 0	07/?? B 0	08/09 B 0	08/10 B 0
4	07/10 B 3	09/10 B 3	08/10 B 3	09/10 B 4	09/09 B 3	09/?? B 4	09/?? B 3	13/?? B 3	07/10 B 3	09/11 B 3	08/10 B 3	09/10 B 4	09/09 B 3	09/?? B 4	09/?? B 3	13/10 B 3
5	21/11 B 2	21/11 B 2	22/11 2	22/10 3	23/11 3	22/10 4	23/10 4	23/10 4	21/11 B 3	21/11 B 3	22/12 3	22/10 3	22/11 2	22/10 4	23/10 4	23/10 2
6	??/11 2	??/12 2	??/11 2	??/11 3	??/?? 2	??/?? 2	26/11 2	??/?? 2	??/11 2	??/12 2	??/11 2	??/11 2	??/?? 2	??/?? 2	25/10 2	??/?? 2
7	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 2 w	??/?? 4 w
8	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/11 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/?? 4 w	??/11 4 w	??/?? 4 w
9	31/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	32/00 T 4	31/11 T 4	31/17 T 4	31/15 T 4	31/?? T 4 M	31/?? T 4 M	31/?? T 4 M	32/?? T 4	32/?? T 4	31/11 T 4	31/17 T 4	31/15 T 4
10	31/?? T 4	31/?? T 4	31/?? T 4	31/13 T 4	31/19 T 2	30/16 T 3	32/14 T 2	30/11 T 2	31/?? T 4 M	31/?? T 4 M	31/?? T 4 M	32/13 T 4	31/19 T 4	30/15 T 3	32/14 T 2	30/11 T 2

Directory:34_weeks\Normals NAME: Con Date:09-03-92 Time: 10h22->10h38 Comments:Heart rate generally within normal margins. Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4 M	??/?? 4 M	??/12 4 M	??/?? 4 M	??/08 4 M	27/14 T 0	??/12 4 M	??/?? 4 M	??/13 4 M	??/?? 4 M	??/11 4 M	??/12 4 M	??/?? 4 M	28/13 T 0	28/13 T 0	27/09 T 0
2	26/09 0	26/10 0	26/?? 4	26/10 0	26/10 0	26/10 0	26/?? 4 M	27/10 T 0	26/08 0	26/08 0	26/10 0	26/13 0	26/11 0	27/10 T 0	26/10 0	26/10 0



Directory:34_weeks\Normals NAME: Mn Date:12-04-92 Time: 22h35->23h22

Comments:Heart rate within normal range.
Fast breathing rate:90->110 breaths/min
Breathing unassisted.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4	??/?? 4	25/18 0	25/19 2	25/16 2	26/16 2	26/17 2	26/16 2	24/16 2	25/15 2	25/14 2	25/16 2	25/17 2	25/13 2	25/19 2	25/17 2
2	26/13 0	25/15 0	26/19 0	25/16 0	26/18 0	25/19 0	25/16 0	25/20 0	25/15 0	26/?? 4	26/18 0	25/10 0	25/13 0	25/19 0	24/19 0	26/18 0
3	28/?? 4 T	28/?? 4 T	28/?? 4 T	27/?? 4 T	27/?? 4 T M	27/?? 4 T M	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	27/?? 4 T	28/15 3 T	27/?? 4 T	27/?? 4 T	27/?? 4 T
4	26/18 2	25/16 2	??/?? 4	27/?? 4	27/13 2	27/16 2	26/17 2	26/?? 4 M	26/16 3 M	25/?? 4	25/14 2	26/15 2	25/16 2	25/18 2	25/17 2	25/16 2
5	25/?? 4	26/?? 4	25/16 2	26/17 2	25/14 2	26/15 2	25/16 2	??/?? 4	??/?? 4	??/?? 4	26/17 2	26/19 2	26/19 2	26/17 2	26/15 2	26/?? 4
6	26/16 2	??/?? 4	??/?? 4	27/17 2 T	??/?? 4	26/17 2	27/17 2 T	27/16 2 T	25/18 2	26/17 2	??/?? 4	26/?? 4	26/?? 4	26/?? 4	25/17 2	25/14 2
7	25/18 2	24/18 2	26/17 2	26/18 2	26/18 2	26/16 2	26/17 2	26/17 2	24/16 2	25/16 2	25/?? 4	26/15 0	25/17 0	25/16 0	25/15 0	25/16 0
8	26/?? 4	??/?? 4	26/18 2	27/17 2 T	26/17 2	27/?? 4 T	27/?? 4 T	26/17 2	26/17 2	25/16 2	??/?? 4	??/?? 4	??/?? 4	27/?? 4 T	??/?? 4	??/?? 4
9	??/?? 4	28/14 2 T	27/17 2 T	27/16 2 T	27/?? 2 T	27/17 4 T	26/?? 2	26/18 4	25/15 2	??/?? 2	27/13 4 T	25/18 2	26/18 2	26/18 2	25/16 2	26/18 2
10	26/18 0	25/18 0	25/18 0	25/17 0	??/?? 4	25/?? 4	25/18 2	25/18 2	25/15 2	??/?? 4	26/?? 4	25/18 2	25/18 2	25/16 2	25/17 2	25/17 3

Directory:34_weeks\Normals NAME: Mul Date:21-04-92 Time: 08h30->09h11

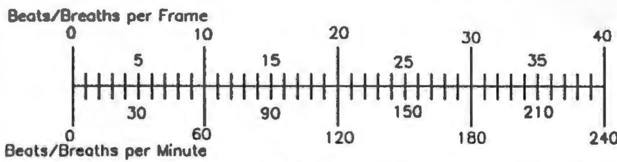
Comments:Heart rate stable around 150 beats/min.
Breathing rate fluctuating:90->50 breaths/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	25/17 0	26/15 0	27/15 0 T	25/15 0	25/15 0	28/16 0 T	27/17 0 T	26/14 0	26/15 0	26/15 0	26/16 0	26/16 0	26/17 0	27/17 0 T	27/16 0 T	28/18 0 T
2	28/?? 4 T	28/18 0 T	27/16 0 T	26/17 0	27/14 0 T	25/17 0	26/12 0	27/15 0 T	26/15 0	25/13 0	26/16 0	26/14 0	26/13 0	26/14 0	26/15 0	27/13 0 T
3	25/15 0	25/12 0	27/16 0 T	28/15 0 T	28/16 1 T	26/16 0	27/15 0 T	28/18 0	26/16 0	26/?? 4	23/?? 4	27/?? 4 T	27/?? 4 T	26/16 0	28/17 0 T	28/15 0 T
4	24/?? 4	28/17 0 T	27/16 0 T	29/15 0 T	25/16 0	28/15 0 T	26/13 0	26/13 0	27/?? 4 T	29/16 1 T	29/?? 4 T	30/?? 4 T	26/18 0	26/18 0	28/18 0 T	27/19 0 T
5	26/17 0	26/16 0	26/18 0	27/17 0 T	26/17 0	27/16 0 T	27/16 0 T	27/17 0 T	27/17 0 T	26/17 0	27/17 0 T	27/14 0 T	27/14 0 T	28/17 0 T	25/16 0	26/14 0
6	27/17 0 T	26/16 0	27/16 0 T	27/16 0 T	27/16 0 T	27/14 0 T	27/15 0 T	27/14 0 T	27/15 0 T	27/14 0 T	26/16 0	27/13 0 T	26/13 0	26/14 0	26/13 0	26/13 0
7	25/12 0	27/14 0 T	24/12 0	26/13 0	27/13 1 T	26/15 0	26/13 0	27/11 0 T	28/?? 4 T	27/11 1 T	26/13 1	27/12 0 T	27/13 1 T	27/16 0 T	25/12 0	26/11 0

Directory:34_weeks\Normals NAME: Wil Date:19-03-92 Time: 10h02->10h46

Comments:Record 2 should be classified 'APNOEA'.
Record 5 should be classified 'PERIODIC BREATHING'.
All records display marginally normal heart rate.
Records 3->10 exhibit crosstalk from respiratory channel.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	27/09 0 T	27/11 0 T	27/10 3 T	29/?? 4 T	23/13 0	26/?? 4	27/15 0 T	??/11 4 M	??/?? 4 M	27/15 0 T	28/12 0 T	??/?? 4 M	??/?? 4 M	??/13 4 M	27/12 0 T	27/13 0 T
2	28/10 0 B	27/11 0 T	27/12 0 T	??/?? 4 M	25/?? 4	25/11 0	26/11 2 B	26/09 2 T	??/06 4 M	??/?? 4 M	??/?? 4 M	PB 24/07 2	PB 24/03 2	Ap 20/00 0 B	Ap 13/02 0 B	Ap 11/00 0 B
3	27/11 2 T	27/10 2 T	25/09 2	26/10 2 T	27/11 2 T	26/11 2	??/?? 4 M	27/11 2 T	26/12 2 B	27/13 2 T	26/11 2	??/11 4 M	??/?? 4 M	??/?? 4 M	26/12 2	26/11 3
4	27/09 2 T	27/11 2 T	26/09 2	??/?? 4 M	26/07 3	PB 26/00 2	??/?? 4 M	??/?? 4 M	24/12 2	25/11 2	26/10 2	26/12 2	27/12 2 T	25/09 2	27/10 2 T	27/11 2 T
5	PB 22/00 0	PB 23/09 0	PB 25/05 0	25/11 0	26/03 2	26/13 2	27/10 2 T	??/?? 4 M	??/?? 4 M	??/?? 4 M	25/12 2	26/12 2	27/15 2 T	28/12 2	27/12 2 T	25/11 2
6	??/?? 4 M	??/?? 4 M	28/13 3 T	26/13 0	25/12 0	28/07 3 T	27/11 2 T	26/12 2	27/09 2 T	27/12 2 T	26/11 2	26/11 2	26/10 2	??/?? 4 M	??/?? 4 M	25/13 2
7	27/14 2 T	26/12 2	27/13 2 T	27/12 2 T	28/13 2 B	28/12 2 T	28/13 2 T	27/12 2 T	28/09 2 B	29/09 2 T	28/10 2 T	26/09 2	??/?? 4 M	27/09 2 T	25/10 2	27/11 2 T



Directory:34_weeks\Normals NAME: Wil Date:19-02-92 Time: 10h02->10h46

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
8	28/11 T 2	25/13 2	27/10 T 2	27/10 T 2	26/10 2	27/09 T 2	25/10 2	27/12 T 2	26/09 2	25/10 2	27/08 T 2	27/09 T 2	26/10 2	24/10 2	26/10 2	26/10 2
9	26/09 2	27/09 T 2	27/10 T 2	27/07 T 2	26/08 2	27/10 T 2	27/12 T 2	26/11 2	??/10 4 M	26/10 2	??/12 4 M	27/07 T 3 M	??/11 4 M	??/10 4 M	28/08 T 3 M	??/?? 4
10	28/11 T 2	27/09 T 2	??/?? 4 M	??/?? 4 M	30/10 T 2	27/?? T 4	??/?? 4 M	27/11 T 3	26/09 2	28/10 T 2	26/10 2	27/08 T 2	27/07 T 2	PB 27/00 T 0	26/11 0	PB 27/04 T 0

Directory:34_weeks\Tachy NAME: Hof Date:26-02-92 Time: 09h29->09h57 Comments:These records should be classified 'TACHYCARDIA'.

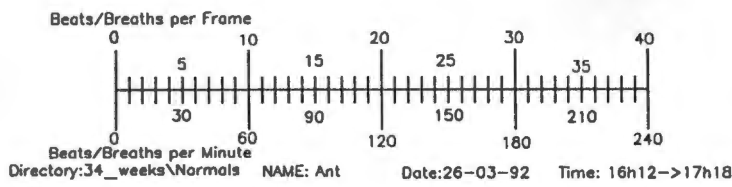
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	27/?? T 4	28/?? T 4	27/?? T 4	27/15 T 0	28/14 T 0	28/16 T 0	28/15 T 0	27/28 T 0	27/15 T 0	27/?? T 4	27/13 T 0	27/15 T 0	27/15 T 0	27/?? T 4	27/?? T 4	27/?? T 4
2	27/14 T 0	28/11 T 0	27/09 T 0	28/14 T 0	28/?? T 4	28/?? T 4	28/13 T 0	28/14 T 0	27/14 T 0	28/14 T 0	27/14 T 0	28/13 T 0	27/?? T 4	27/?? T 4	27/?? T 4	28/?? T 4
3	27/14 T 0	27/15 T 0	27/15 T 0	29/13 T 0	28/?? T 4	28/?? T 4	28/?? T 4	27/13 T 0	28/14 T 0	27/12 T 0	27/?? T 4	26/?? 4	27/?? T 4	28/?? T 4	27/11 T 0	27/11 T 0
4	28/?? T 4	28/?? T 4	27/?? T 4	29/?? T 4	28/12 T 0	28/13 T 0	29/13 T 0	26/?? 4	28/?? T 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4	??/?? 4	30/?? T 4
5	29/?? T 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	30/?? T 4	30/?? T 4	29/?? T 4	29/14 T 2	29/15 T 2	29/14 T 2	30/14 T 2	27/?? T 4	??/?? 4	??/?? 4	29/?? T 4
6	29/13 T 0	29/14 T 0	29/15 T 0	28/14 T 0	29/15 T 0	29/14 T 0	28/?? T 4	29/?? T 4	28/?? T 4	29/15 T 0	28/13 T 0	28/15 T 0	29/15 T 0	28/?? T 4	28/?? T 4	29/?? T 4
7	28/?? T 4	32/?? T 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4	??/?? 4	??/?? 4
8	30/?? T 4	29/?? T 4	30/?? T 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	30/?? T 4	29/13 T 0	30/12 T 0	29/14 T 0	29/14 T 0	29/?? T 4	??/?? 4	??/?? 4	??/?? 4
9	??/?? 4 M	??/?? 4 M	30/?? T 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	31/?? T 4 M	29/15 T 0	29/15 T 0	29/12 T 0	??/?? 4 M	??/?? 4 M	28/14 T 0	??/?? 4	??/?? 4	30/?? T 4
10	29/15 T 0	29/15 T 0	29/15 T 0	30/?? T 4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4	??/?? 4	??/?? 4

Directory:34_weeks\Tachy NAME: Kom Date:04-05-92 Time: 08h37->10h52 Comments:These records should be classified 'TACHYCARDIA'

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	29/?? T 4	28/?? T 4	??/?? 4 M	29/?? T 4	30/?? T 4	29/?? T 4	28/11 T 0	29/11 T 0	29/?? T 4 M	??/?? 4 M	??/?? 4 M	??/10 4 M	??/?? 4 M	??/?? 4 M	29/?? T 4 M	28/?? T 4 M
2	28/?? T 4	??/?? 4	28/?? T 4	29/?? T 4	??/?? 4	29/07 T 0	27/09 T 0	29/11 T 0	??/?? 4	??/?? 4	28/11 T 0	27/?? T 4	27/16 T 0	28/?? T 4	27/?? T 4	??/?? 4 M
3	??/?? 4	27/13 T 0	28/12 T 0	28/?? T 4	29/?? T 4	28/10 T 0	29/?? T 4	28/?? T 4	27/?? T 4	29/?? T 4	28/?? T 4	29/?? T 4	29/09 T 0	28/?? T 4	29/10 T 0	29/?? T 4 M
4	29/13 T 0	27/13 T 3	??/13 T 4 M	??/?? 4 M	??/?? 4 M	??/13 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	29/?? T 4 M	??/?? 4 M
5	31/08 T 0	31/07 T 0	31/07 T 0	30/06 T 0	31/?? T 4	30/08 T 0	29/?? T 4	30/?? T 4	31/10 T 0	30/10 T 0	30/10 T 0	30/07 T 0	31/10 T 0	30/07 T 0	30/08 T 0	26/06 T 0
6	30/07 T 0	29/07 T 0	29/07 T 0	29/?? T 4	31/?? T 4	28/?? T 4	??/?? 4	31/?? T 4	30/11 T 0	29/10 T 0	30/?? T 0	28/09 T 0	30/08 T 0	28/06 T 0	??/?? 4	30/?? T 4 M
7	29/08 T 0	29/08 T 0	29/08 T 0	29/09 T 0	29/08 T 0	28/07 T 0	29/?? T 4	27/06 T 0	26/08 0	27/07 T 0	28/08 T 0	27/08 T 0	26/06 0	28/?? T 4	25/07 0	27/04 T 0
8	28/07 T 0	27/07 T 0	27/07 T 0	27/07 T 0	27/08 T 0	29/07 T 0	30/?? T 4	27/08 T 0	26/?? 4	29/?? T 4	30/06 T 0	??/?? 4 M	29/?? T 4	29/?? T 4	??/?? 4	31/?? T 4 M
9	31/?? T 4	30/?? T 4	30/?? T 4	30/10 T 0	29/08 T 0	29/06 T 0	28/08 T 0	26/07 0	25/09 0	25/?? 4	28/?? T 4	27/10 T 0	29/06 T 0	29/06 T 0	29/09 T 0	28/10 T 0
10	29/06 T 0	29/09 T 0	29/12 T 0	29/12 T 0	30/?? T 4	29/10 T 0	29/09 T 0	29/07 T 0	30/12 T 0	29/11 T 0	29/15 T 0	29/14 T 1	29/10 T 0	28/08 T 0	28/06 T 0	29/?? T 4 M

Directory:34_weeks\Normals NAME: Ant Date:26-03-92 Time: 16h12->17h18 Comments:Frames 1->8 display 20 seconds each.
Frames 9->16 display 10 seconds each.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	42/20 2	43/17 2	43/15 2	44/22 2	43/19 2	43/?? 4	45/19 2	46/17 2	23/08 0	24/11 0	24/13 0	24/11 0	24/09 0	24/09 0	23/09 0	24/09 0
2	??/?? 4 M	??/?? 4 M	??/15 4 M	??/?? 4 M	??/18 4 M	??/?? 4 M	??/18 4 M	??/16 4 M	24/08 0	24/09 0	24/?? 4	24/09 0	24/11 0	25/12 0	25/09 0	25/09 0



Directory:34_weeks\Normals NAME: Ant Date:26-03-92 Time: 16h12->17h18

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
3	??/18 (4)	??/20 (4)	??/17 (4)	??/16 (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/23 (4)	24/10 (1)	24/09 (1)	24/10 (1)	24/09 (0)	24/?? (0)	23/?? (0)	23/10 (0)	23/09 (0)
4	??/21 (4)	??/21 (4)	??/19 (4)	??/23 (4)	??/19 (4)	??/17 (4)	??/19 (4)	??/21 (4)	24/11 (1)	25/09 (1)	24/12 (1)	24/12 (0)	23/11 (0)	23/11 (0)	24/10 (0)	23/09 (0)
5	??/24 (4)	??/24 (4)	??/?? (4)	??/18 (4)	??/19 (4)	??/20 (4)	??/26 (4)	??/26 (4)	23/09 (0)	24/15 (1)	23/14 (1)	24/08 (0)	22/09 (0)	23/13 (0)	23/14 (1)	23/10 (0)
6	??/15 (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/20 (4)	??/?? (4)	??/16 (4)	22/08 (1)	22/10 (0)	22/12 (0)	B 21/09 (0)	B 21/16 (0)	22/12 (0)	B 21/10 (1)	20/10 (3)

Directory:34_weeks\P_Breath NAME: Wil Date:26-03-92 Time: 09h38 Comments:High frequency noise in ecg channel.

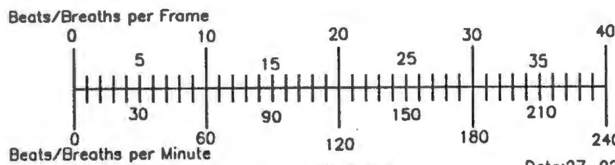
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/23 (4) M	??/22 (4) M	??/20 (4) M	??/20 (4) M	??/20 (4) M	??/12 (4) M	??/11 (4) M	??/?? (4) M	??/?? (4) M	25/13 (4)	26/?? (2)	PB T 27/02 (4)	PB 25/00 (0)	PB B 21/01 (0)	Ap B 19/00 (0)	??/?? (4)

Directory:34_weeks\Tachy NAME: And Date:20-02-92->21-02-92 Time:Data capture discontinuous Comments:All files defective:Impossible to read signals.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? (4)	??/16 (4)	??/21 (4)	??/23 (4)	??/16 (4)	??/18 (4)	??/?? (4)	??/15 (4)	??/?? (4)	??/16 (4)	??/20 (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/14 (4)
2	??/18 (4)	??/14 (4)	??/21 (4)	??/15 (4)	??/?? (4)	??/20 (4)	??/?? (4)	??/?? (4)	??/16 (4)	??/13 (4)	??/16 (4)	??/15 (4)	??/?? (4)	??/19 (4)	??/?? (4)	??/?? (4)
3	??/?? (4)	??/?? (4)	??/16 (4)	??/18 (4)	??/18 (4)	??/16 (4)	??/20 (4)	??/?? (4)	??/09 (4)	??/20 (4)	??/17 (4)	??/17 (4)	??/16 (4)	??/15 (4)	??/19 (4)	??/?? (4)
4	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)
5	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)
6	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/?? (4)
7	??/18 (4)	??/20 (4)	??/21 (4)	??/20 (4)	??/17 (4)	??/?? (4)	??/?? (4)	??/23 (4)	??/18 (4)	??/19 (4)	??/22 (4)	??/21 (4)	??/?? (4)	??/?? (4)	??/?? (4)	??/20 (4)

Directory:34_weeks\Tachy NAME: Are Date:10-03-92 Time: 08h58->10h00 Comments:Heart rate stable around 170 beats/min. Low HRV. Respiration stable around 75 breaths/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	T 27/?? (4)	T 27/13 (1)	T 27/13 (1)	T 27/13 (1)	T 27/13 (1)	T 27/14 (1)	T 27/15 (1)	T 27/12 (1)	T 28/12 (1)	T 27/13 (1)	T 27/14 (1)	T 28/15 (1)	T 28/12 (1)	T 28/14 (1)	T 27/14 (1)	T 28/15 (1)
2	T 28/12 (1)	T 28/14 (1)	T 28/14 (1)	T 28/13 (1)	T 28/11 (1)	T 28/?? (4)	T 28/14 (1)	T 28/13 (1)	T 28/14 (1)	T 28/13 (1)	T 28/13 (1)	T 27/13 (1)	T 28/13 (1)	T 28/13 (1)	T 28/14 (1)	T 28/16 (1)
3	T 28/16 (0)	T 27/10 (0)	T 28/12 (0)	T 27/13 (0)	T 28/15 (0)	T 28/13 (0)	T 28/14 (0)	T 29/12 (0)	T 28/12 (0)	T 28/13 (0)	T 28/12 (0)	T 28/14 (0)	T 28/13 (0)	T 28/12 (0)	T 28/13 (0)	T 28/13 (0)
4	T 28/11 (3)	T 28/14 (0)	T 28/13 (0)	T 29/14 (0)	T 28/13 (0)	T 28/13 (0)	T 28/11 (0)	T 28/14 (0)	T 28/14 (0)	T 28/14 (0)	T 28/13 (0)	T 28/13 (0)	T 27/13 (0)	T 28/14 (0)	T 28/13 (0)	T 28/13 (1)
5	T 28/12 (0)	T 28/12 (0)	T 27/11 (0)	T 27/13 (0)	T 27/13 (0)	T 28/13 (0)	T 28/12 (0)	T 29/12 (0)	T 28/13 (0)	T 28/14 (0)	T 28/14 (0)	T 28/12 (1)	T 28/12 (0)	T 28/12 (0)	T 28/12 (0)	T 27/12 (0)
6	T 29/11 (0)	T 29/13 (3)	T 29/16 (0)	T 28/13 (0)	T 27/13 (0)	T 28/13 (0)	T 28/14 (0)	T 29/14 (0)	T 28/13 (0)	T 27/13 (0)	T 27/13 (0)	T 28/10 (0)	T 27/?? (4)	T 28/11 (3)	T 28/12 (3)	T 28/12 (3)
7	T 29/14 (0)	T 27/11 (0)	T 29/14 (0)	T 29/13 (3)	T 28/13 (0)	T 29/14 (0)	T 29/14 (0)	T 29/13 (0)	T 29/14 (0)	T 29/13 (0)	T 29/13 (0)	T 29/13 (0)	T 29/13 (0)	T 29/13 (0)	T ??/14 (4)	T 29/14 (2)
8	T 29/14 (0)	T 29/13 (0)	T 29/15 (0)	T 28/13 (0)	T 29/13 (0)	T 28/12 (0)	T 29/13 (0)	T 29/14 (0)	T 28/10 (1)	T 28/11 (1)	T 28/13 (0)	T 28/12 (0)	T 29/13 (0)	T 28/12 (0)	T 27/11 (0)	T 28/13 (1)
9	T 28/11 (0)	T 28/12 (1)	T 28/12 (0)	T 28/09 (1)	T 29/11 (1)	T 28/?? (4)	T 28/10 (0)	T 28/13 (0)	T 28/14 (0)	T 29/11 (0)	T 29/?? (4)	T 28/09 (1)	T 29/11 (0)	T 29/14 (0)	T 28/12 (0)	T 29/12 (0)
10	T 29/11 (3)	T 29/11 (1)	T 29/14 (3)	T 30/13 (2)	T 29/?? (4)	T 29/05 (3)	T 30/13 (0)	T ??/12 (4)	T 29/10 (3)	T 29/09 (3)	T ??/07 (4)	T ??/05 (4)	T ??/06 (4)	T ??/06 (4)	T 29/08 (2)	T 28/09 (2)



Directory:34_weeks/Tachy

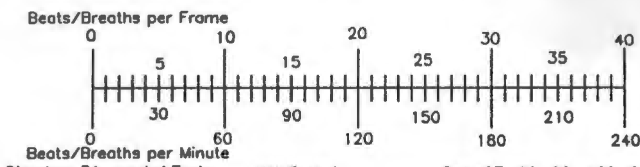
NAME: Hof

Date:27-02-92->09-03-92

Time:Data capture discontinuous

Comments:Patient being ventilated.
Tachycardia (expected due to septacaemia)
Patient administered nebulized adrenaline.
Noisy respiration channel.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/08 T (2)	32/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)	32/?? T (4)	31/10 T (3)	31/?? T (4)	32/?? T (4)	32/?? T (4)	32/10 T (2)	32/?? T (4)	32/?? T (4)
2	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/10 T (2)	32/?? T (4)	32/?? T (4)	33/?? T (4)	33/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/09 T (2)
3	31/10 T (2)	31/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)	31/10 T (2)	31/10 T (2)	32/?? T (4)	32/?? T (4)	31/?? T (4)
4	32/?? T (4)	31/?? T (4)	32/?? T (4)	31/?? T (4)	32/11 T (2)	31/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	32/?? T (4)	31/?? T (4)	31/10 T (2)	31/?? T (4)	31/?? T (4)
5	31/?? T (4)	32/?? T (4)	31/?? T (4)	31/?? T (4)	32/10 T (2)	31/10 T (2)	32/?? T (4)	31/?? T (4)	31/?? T (4)	231/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)
6	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/11 T (2)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)
7	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	31/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)	31/?? T (4)	32/?? T (4)
8	31/?? T (4)	32/?? T (4)	31/10 T (2)	32/10 T (2)	32/?? T (4)	31/?? T (4)	31/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	31/11 T (2)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)
9	32/?? T (4)	32/?? T (4)	33/?? T (4)	33/10 T (2)	33/10 T (2)	32/10 T (2)	32/10 T (2)	33/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)	32/10 T (2)	32/11 T (2)	31/10 T (2)
10	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	32/?? T (4)	32/?? T (4)	31/?? T (4)	30/?? T (4)	31/?? T (4)	30/?? T (4)	32/?? T (4)	33/?? T (4)	31/11 T (2)	31/?? T (4)
11	31/?? T (4)	31/?? T (4)	31/?? T (4)	32/08 T (2)	32/09 T (2)	32/09 T (2)	32/09 T (2)	32/09 T (2)	32/09 T (2)	32/09 T (2)	32/08 T (2)	32/09 T (2)	32/09 T (2)	33/?? T (4)	32/08 T (3)	33/08 T (2)
12	32/08 T (2)	33/09 T (2)	32/?? T (4)	32/09 T (2)	32/08 T (2)	32/08 T (2)	32/09 T (3)	32/09 T (2)	31/08 T (2)	32/09 T (2)	31/09 T (2)	33/09 T (3)	32/?? T (4)	34/?? T (4)	33/?? T (4)	31/?? T (4)
13	32/?? T (4)	31/?? T (4)	31/?? T (4)	30/00 T (2)	30/09 T (2)	31/?? T (4)	31/?? T (4)	31/?? T (4)	30/?? T (4)	29/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	32/?? T (4)	32/?? T (4)	32/?? T (4)
14	31/?? T (4)	32/09 T (2)	32/?? T (4)	31/08 T (3)	32/?? T (4)	??/08 T (4)	33/?? T (4)	32/?? T (4)	33/08 T (3)	32/?? T (4)	32/?? T (4)	31/?? T (4)	31/?? T (4)	31/?? T (4)	32/09 T (3)	32/?? T (4)
15	32/?? T (4)	32/?? T (4)	32/08 T (3)	32/09 T (3)	33/10 T (3)	33/09 T (3)	??/?? (4)	34/09 T (3)	33/09 T (3)	32/09 T (3)	31/?? T (4)	33/?? T (4)	32/?? T (4)	32/08 T (3)	31/09 T (3)	32/?? T (4)
16	??/?? (4)	36/?? T (4)	35/?? T (4)	35/?? T (4)	34/08 T (3)	35/08 T (3)	34/?? T (4)	35/09 T (3)	35/09 T (3)	35/?? T (4)	??/?? (4)	??/?? (4)	??/?? (4)	37/?? T (4)	35/?? T (4)	??/?? (4)
17	35/?? T (4)	??/?? (4)	36/?? T (4)	36/?? T (4)	35/09 T (4)	35/11 T (3)	35/?? T (3)	36/?? T (4)	35/?? T (4)	??/?? (4)	37/08 T (4)	34/?? T (4)	35/?? T (4)	35/09 T (4)	35/?? T (4)	35/?? T (4)
18	35/?? T (4)	??/?? (4)	34/?? T (4)	34/?? T (4)	??/?? (4)	??/09 (4)	35/?? T (4)	33/11 T (3)	35/10 T (3)	33/09 T (2)	33/09 T (2)	33/08 T (2)	34/09 T (2)	34/08 T (3)	34/10 T (3)	34/08 T (3)
19	33/08 T (2)	34/09 T (2)	33/12 T (3)	34/09 T (2)	34/10 T (2)	34/10 T (3)	??/?? (4)	36/?? T (4)	35/10 T (3)	??/?? (4)	36/09 T (3)	35/?? T (4)	??/?? (4)	??/?? (4)	??/?? (4)	36/?? T (4)
20	??/?? (4)	36/09 T (3)	34/11 T (2)	36/09 T (2)	36/08 T (2)	36/13 T (2)	??/?? (3)	36/?? T (4)	??/?? (4)	??/?? (4)	??/?? (4)	35/?? T (4)	34/?? T (4)	34/?? T (4)	35/09 T (3)	35/?? T (4)
21	35/?? T (4)	35/?? T (4)	34/?? T (4)	35/?? T (4)	35/?? T (4)	35/11 T (2)	36/?? T (4)	36/?? T (4)	35/?? T (4)	35/?? T (4)	35/?? T (4)	35/?? T (4)	36/?? T (4)	35/?? T (4)	34/?? T (4)	34/?? T (4)
23	35/10 T (3)	35/08 T (3)	36/09 T (3)	35/09 T (3)	35/11 T (3)	34/?? T (4)	35/12 T (3)	35/10 T (3)	35/10 T (3)	34/08 T (3)	34/06 T (3)	34/?? T (3)	35/08 T (3)	36/?? T (4)	35/?? T (4)	34/09 T (3)
24	36/?? T (4)	35/09 T (3)	35/10 T (3)	??/?? (4)	34/?? T (4)	??/08 (4)	??/?? (4)	34/?? T (4)	34/09 T (3)	35/09 T (3)	34/09 T (3)	??/?? (4)	34/?? T (4)	35/?? T (4)	34/07 T (3)	34/09 T (3)
25	34/?? T (4)	35/?? T (4)	34/08 T (2)	33/07 T (2)	34/?? T (4)	33/?? T (4)	32/09 T (2)	34/?? T (4)	33/08 T (2)	34/10 T (2)	33/?? T (4)	35/?? T (4)	??/?? (4)	??/?? (4)	36/?? T (4)	??/?? (4)
26	37/09 T (3)	36/?? T (4)	??/?? (4)	36/08 T (3)	35/08 T (3)	35/09 T (3)	34/?? T (4)	34/?? T (4)	34/10 T (3)	34/08 T (3)	33/08 T (3)	34/07 T (3)	??/?? (4)	34/?? T (4)	35/?? T (4)	33/?? T (4)



Directory:34_weeks\Tachy NAME: Hof·· Date:27-02-92->09-03-92 Time:Data capture discontinuous

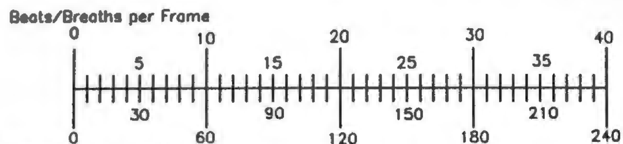
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
27	65/06 T 0	64/07 T 0	60/?? T 4	64/07 T 0	64/09 T 0	62/10 T 1	62/15 T 0	62/13 T 0	32/07 T 0	32/05 T 0	32/06 T 0	32/05 T 0	32/08 T 0	32/07 T 0	32/08 T 0	32/07 T 0
28	64/14 T 0 M	64/15 T 0 M	64/14 T 0 M	64/12 T 0 M	64/13 T 0 M	64/10 T 0 M	64/12 T 0 M	64/11 T 0 M	32/01 T 0 M	32/06 T 0 M	32/06 T 0 M	32/06 T 0 M	32/06 T 0 M	32/05 T 0 M	32/?? T 0 M	32/05 T 0 M
29	64/10 T 0	64/11 T 0	64/11 T 0	64/09 T 0	64/09 T 0	64/11 T 0	64/08 T 0	64/09 T 0	32/04 T 0	32/05 T 0	32/05 T 0	32/05 T 0	32/05 T 0	32/04 T 0	32/04 T 4	32/03 T 0
30	62/08 T 0	62/08 T 0	62/08 T 0	62/09 T 1	62/07 T 0	62/09 T 0	62/11 T 0	62/11 T 0	30/04 T 1	31/07 T 0	31/05 T 0	??/?? 0	31/?? T 0	31/05 T 0	31/?? T 0	31/07 T 1
31	62/12 T 0	62/16 T 0 M	62/14 T 0	62/15 T 0	62/13 T 0	62/15 T 0	61/16 T 0	62/13 T 0	31/08 T 0	31/08 T 0	31/06 T 0	31/07 T 4	31/06 T 4	31/07 T 0	31/06 T 4	31/?? T 0
32	62/13 T 0	62/?? T 0	62/12 T 0	??/?? 0	??/?? 0	62/12 T 0	62/09 T 0	62/11 T 0	32/07 T 0	30/06 T 0	??/?? 0	??/?? 0	??/?? 0	30/08 T 0	??/?? 0	30/?? T 4
33	??/?? 0	??/?? 4	??/?? 0	??/12 4	62/12 T 4	??/?? 0	62/10 T 0	??/?? 0	31/?? T 0	??/?? 0	31/07 T 4	31/06 T 4	31/04 T 4	31/06 T 0	??/?? 4	??/?? 4
34	62/14 T 4	62/12 T 4	??/?? 4	62/16 T 4	62/12 T 0	??/?? 4	??/?? 0	62/15 T 4	31/07 T 4	31/08 T 4	31/08 T 0	31/10 T 0	31/06 T 0	??/?? 0	??/?? 4	31/07 T 4

Directory:34_weeks\Tachy NAME: Jik Date:03-03-92 Time: 08h23 Comments:Frames 1->8 display 20 seconds. Frames 9->16 display 10 seconds. High frequency noise on ecg channel.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/23 4	??/24 4	??/24 4	??/23 4	??/20 4	??/05 4	26/25 4	26/26 4	27/12 T 2	27/10 T 2	26/11 2	27/11 T 2	27/10 T 2	27/11 T 2	27/08 T 2	27/?? T 4

Directory:34_weeks\Tachy NAME: Kom Date: 04-05-92 Time:09h23->10h39 Comments:Tachycardia after medical examination. Heart rate:180->200 beats/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	31/12 T 1	31/11 T 1	31/11 T 1	31/11 T 1	31/10 T 1	31/09 T 1	31/09 T 1	31/10 T 1	30/09 T 1	31/08 T 1	31/07 T 1	31/?? T 4	31/?? T 4	31/?? T 4	31/09 T 1	31/11 T 1
2	??/?? 4	??/?? 4	32/?? T 4	33/05 T 0	??/?? 4	??/?? 4	??/?? 4	35/?? T 4	34/?? T 4	34/?? T 4	34/?? T 4	34/?? T 4	34/?? T 4	34/?? T 4	34/?? T 4	34/?? T 4
3	31/?? T 4	31/?? T 4	31/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4
4	30/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4	31/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4	30/?? T 4	31/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4
5	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4	31/?? T 4
6	32/?? T 4	33/?? T 4	30/?? T 4	??/?? T 4	32/?? T 4	32/?? T 4	32/?? T 4	33/?? T 4	33/?? T 4	33/?? T 4	32/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	32/?? T 4
7	32/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4	32/?? T 4	32/?? T 4	??/?? T 4	31/?? T 4
8	31/?? T 4	31/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4	30/?? T 4	??/?? T 4	??/?? T 4	27/?? T 4	30/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4
9	32/?? T 4	32/?? T 4	32/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	30/?? T 4	30/?? T 4	31/?? T 4
10	30/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	32/?? T 4	??/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	32/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	31/?? T 4	32/?? T 4



Directory:34_weeks\Brady NAME: Ant Date:26-03-92 Time: 16h01->17h12

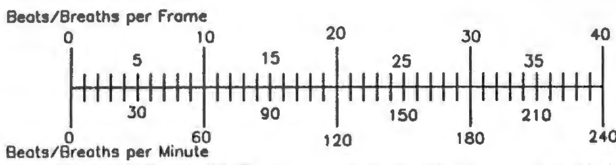
Comments:First 8 frames of these files are defective. QRS complexes poorly defined. Frames 8->16 show threshold bradycardia.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4	??/19 4	??/17 4	??/?? 4	??/?? 4	??/17 4	??/21 4	??/22 4	21/10 B 0	20/07 B 0	20/10 B 0	21/06 B 0	22/?? 4	21/08 B 0	22/10 0	22/07 0
2	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	21/11 B 0	21/13 B 0	22/11 0	20/?? B 0	21/12 B 4	21/14 B 0	21/?? B 0	22/08 0
3	??/?? 4	??/18 4	??/?? 4	??/19 4	??/17 4	??/18 4	??/18 4	??/?? 4	21/08 B 0	20/08 B 1	21/12 B 0	21/07 B 0	21/10 B 1	21/16 B 1	22/10 0	20/?? B 4
4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	20/?? B 4	21/?? B 4	21/09 B 0	22/12 0	22/10 0	21/?? B 4	22/12 1	22/09 0

Directory:34_weeks\Brady Date:10-04-92->12-04-92
NAME: Hof Time:Data capture discontinuous

Comments:Patient being ventilated.High HRV. Tachycardia expected due to septacoemia. Recordings contain periods of bradycardia->tachycardia. First 8 frames display 20 seconds/frame. Patient had been administered nebulized adrenaline. Frames 9->16 display 10 seconds/frame

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	65/?? T 4	66/?? T 4	67/?? T 4	67/?? T 4	66/?? T 4	62/?? T 4	60/?? T 4	63/?? T 4	28/?? T 4	30/?? T 4	18/?? B 4	??/?? 4	33/?? T 4	35/?? T 4	35/?? T 4	34/?? T 4
2	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	25/?? 4	23/?? 4	35/?? T 4	34/?? T 4	34/?? T 4	33/?? T 4
3	58/?? T 4	58/?? T 4	58/?? T 4	58/?? T 4	55/?? T 4	56/?? T 4	57/?? T 4	54/?? T 4	30/?? T 4	29/?? T 4	21/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
4	56/?? T 4	56/?? T 4	44/?? 4	55/?? T 4	56/?? T 4	52/?? 4	47/?? 4	??/?? 4	22/?? 4	20/?? B 4	??/?? 4	??/?? 4	27/07 4	??/?? 4	??/?? 4	28/?? T 4
5	58/?? T 4	57/14 T 4	58/?? T 4	57/?? T 4	51/?? T 4	38/?? B 4	??/?? 4	54/?? T 4	27/04 4	??/?? 4	21/?? B 4	18/?? B 4	15/?? B 4	12/?? B 4	11/?? B 4	??/?? 4
6	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	24/?? 4	??/?? 4	23/?? 4	27/?? T 4	25/?? 4	27/?? 4	25/?? 4	25/?? 4
7	??/?? 4	??/?? 4	??/?? 4	??/?? 4	50/?? 4	52/?? 4	55/?? 4	52/?? 4	18/?? B 4	20/?? B 4	??/?? 4	??/?? 4	??/?? 4	27/?? 4	28/?? T 4	28/?? T 4
8	56/?? T 4	47/?? 4	56/?? T 4	57/?? T 4	57/?? T 4	46/?? 4	??/?? 4	??/?? 4	??/?? 4	26/?? 4	28/?? T 4	29/?? T 4	28/?? T 4	29/?? T 4	29/?? T 4	29/?? T 4
9	57/?? B 4	38/?? B 4	34/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	14/?? B 4	11/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
10	53/?? T 4	44/?? 4	34/?? B 4	57/?? T 4	58/?? T 4	59/?? T 4	59/?? T 4	54/?? T 4	20/?? B 4	21/?? B 4	??/?? 4	??/?? 4	??/?? 4	30/?? T 4	29/?? T 4	??/?? 4
11	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	23/?? 4	28/?? T 4	??/?? 4	27/?? T 4	26/?? 4	22/?? 4	??/?? 4	24/?? 4
12	??/?? 4	56/?? T 4	??/?? 4	59/?? T 4	54/?? T 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	25/?? 4
13	39/?? B 4	33/?? B 4	32/?? B 4	33/?? B 4	33/?? B 4	45/?? 4	??/?? 4	??/?? 4	??/?? 4	33/?? T 4	34/?? T 4	33/?? T 4	32/?? T 4	33/?? T 4	33/?? T 4	32/?? T 4
14	52/?? 4	54/?? T 4	??/?? 4	46/?? 4	38/?? B 4	??/?? 4	??/?? 4	??/?? 4	30/?? T 4	29/?? T 4	29/?? T 4	28/?? T 4	??/?? 4	26/?? 4	23/?? 4	23/?? 4
15	51/?? B 4	60/?? T 4	59/?? T 4	51/?? B 4	48/?? B 4	45/?? B 4	41/?? B 4	34/?? B 4	14/?? B 4	14/?? B 4	15/?? B 4	15/?? B 4	16/?? B 4	??/?? 4	??/?? 4	??/?? 4
16	??/?? 4	48/?? 4	??/?? 4	??/?? 4	61/?? T 4	58/?? T 4	51/?? B 4	49/?? B 4	25/?? 4	??/?? 4	18/?? B 4	18/?? B 4	17/?? B 4	16/?? B 4	15/?? B 4	23/?? 4
17	??/?? 4	??/?? 4	58/?? T 4	51/?? 4	??/?? 4	??/?? 4	??/?? 4	55/?? T 4	27/?? T 4	25/?? 4	25/?? 4	25/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
18	64/?? T 4	57/?? T 4	54/?? T 4	??/?? 4	??/?? 4	??/?? 4	56/?? T 4	56/?? T 4	32/?? T 4	33/?? T 4	??/?? 4	??/?? 4	??/?? 4	31/?? T 4	32/?? T 4	32/?? T 4
19	58/?? T 4	51/?? 4	??/?? 4	??/?? 4	??/?? 4	55/?? T 4	??/?? 4	54/?? T 4	28/?? T 4	28/?? T 4	27/?? T 4	27/?? T 4	27/?? T 4	27/?? T 4	28/?? T 4	28/?? T 4
20	56/?? T 4	54/?? T 4	53/?? 4	57/?? T 4	??/?? 4	??/?? 4	54/?? T 4	??/?? 4	27/?? T 4	27/?? T 4	29/?? T 4	27/?? T 4	27/?? T 4	28/?? T 4	27/?? T 4	27/?? T 4
21	55/?? T 4	52/?? T 4	55/?? T 4	54/?? T 4	53/?? T 4	53/?? T 4	??/?? 4	??/?? 4	27/?? T 4	27/?? T 4	26/?? T 4	27/?? T 4	27/?? T 4	27/?? T 4	25/?? 4	27/?? T 4



Directory:36_weeks\Brady NAME: Alk Date:20-02-92 Time:23h01->23h07 Comments:Heart rate stable around 129 beats/min. Low HRV. Patient breathing oxygen in a headbox.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	21/10 B 0	22/11 0	22/10 0	21/11 B 0	21/11 B 0	22/11 0	22/11 0	21/10 B 0	21/10 B 0	22/11 0	22/10 0	21/11 B 0	21/11 B 0	22/11 0	22/10 0	21/10 B 0
2	21/10 B 0	22/10 0	22/10 0	21/11 B 0	21/11 B 0	22/09 0	22/09 0	21/10 B 0	21/10 B 0	22/10 0	22/10 0	21/11 B 0	21/11 B 0	22/09 0	22/09 0	21/10 B 0

Directory:36_weeks\Brady NAME: Ben Date:19-05-92 Time:14h12->14h59 Comments:Consistently low heart rate around 116 beats/min.Low HRV. Traces exhibit a high degree of noise due to movement.

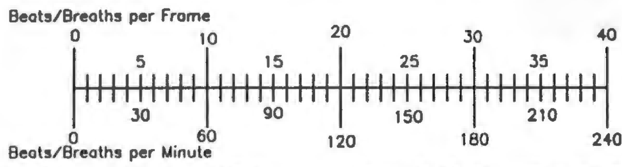
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	21/?? B 4	??/?? 4 M	21/10 B 0	21/07 B 0	??/?? 4 M	??/?? 4	21/07 B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
2	??/?? 4	??/?? 4 M	20/00 Ap B 0	19/00 Ap B 0	??/?? 4 M	20/00 Ap B 3	??/?? 4	??/?? 4	21/?? B 4	19/00 Ap B 0	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
3	??/?? 4	??/?? 4 M	??/?? 3 M	??/?? 3 M	16/08 B 4	18/09 B 4	??/?? 4	??/?? 4	18/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/05 4	??/?? 4	??/11 4	??/?? 4
4	17/12 B 3	??/?? 4 M	20/10 B 3	21/09 B 3	18/?? B 4 M	??/09 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	00/00 0 LC	??/?? 4	??/?? 4	??/?? 4	??/?? 4
5	19/00 Ap B 0	18/00 Ap B 0	19/00 Ap B 0	19/00 Ap B 0	20/18 Ap B 0	??/?? 0	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	19/?? B 4	19/08 B 1	19/11 B 1	20/11 B 0	18/14 B 1
6	19/16 B 1	20/12 B 0	19/11 B 1	19/11 B 0	20/?? B 4	19/12 B 0	20/15 B 1	18/15 B 1	19/13 B 1	19/16 B 1	20/15 B 1	19/13 B 1	18/16 B 1	19/13 B 1	19/16 B 1	18/15 B 1
7	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	19/?? B 4	21/?? B 4	??/?? 4	19/?? B 4 M	19/07 B 0	19/10 B 0	18/10 B 1	18/10 B 1	19/10 B 0	18/07 B 0	19/08 B 0
8	19/09 B 0	18/09 B 0	19/09 B 0	20/09 B 0	18/10 B 3	20/07 B 0	19/08 B 0	20/11 B 0	19/09 B 0	20/12 B 0	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M
9	20/?? B 4	19/06 B 0	20/07 B 0	19/07 B 0	19/08 B 0	20/09 B 1	19/09 B 0	20/07 B 0	19/08 B 0	19/08 B 0	19/07 B 0	20/08 B 0	19/07 B 1	20/09 B 0	20/08 B 0	20/09 B 0
10	21/?? B 4	19/08 B 1	20/09 B 1	20/?? B 4	21/09 B 0	20/07 B 0	20/08 B 0	20/10 B 0	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	20/?? B 4	19/?? B 4 M	20/?? B 4 M	20/?? B 4 M
11	21/10 B 0	21/10 B 0	21/10 B 0	21/10 B 0	21/09 B 0	21/10 B 0	21/10 B 0	22/09 B 0	21/09 B 0	20/09 B 0	21/08 B 0	21/08 B 0	21/10 B 0	21/11 B 0	20/10 B 1	21/11 B 0
12	21/10 B 0	21/09 B 0	22/10 0	21/08 B 0	21/09 B 0	21/?? B 4 M	??/?? 4 M	21/11 B 1	20/?? B 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M
13	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M

Directory:36_weeks\Brady NAME: Jo Date:19-05-92 Time:17h33->17h56 Comments:Tracings stable - baby sleeping. Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	20/07 B 0	20/06 B 0	20/09 B 0	21/07 B 0	21/14 B 0	20/10 B 0	20/?? B 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/08 1
2	21/?? B 4	19/07 B 3	??/?? 4	??/?? 4	??/?? 4	21/?? B 4	20/?? B 4	20/07 B 1	21/08 B 1	20/11 B 1	21/12 B 1	22/07 1	21/10 B 1	22/?? 4	??/?? 4	??/?? 4
3	21/08 B 0	21/08 B 0	21/08 B 0	22/?? 0	??/?? 4	??/?? 4	??/?? 4	??/?? 4	20/08 B 3	21/07 B 3	21/11 B 1	20/07 B 1	20/?? B 4	21/08 B 1	21/08 B 1	21/07 B 1
4	21/?? B 0	??/?? 0	21/?? B 4	21/08 B 4	21/08 B 4	21/08 B 4	22/08 0	21/05 B 0	21/12 B 0	21/08 B 0	??/11 0	??/?? 0	21/?? B 4	20/07 B 4	21/07 B 4	20/07 B 40
5	22/07 0 M	21/08 B 0 M	21/?? B 0 M	22/?? 0 M	??/?? 0 M	??/?? 0 M	21/07 B 0 M	21/08 B 0 M	21/07 B 0 M	22/08 0 M	22/09 0 M	21/06 B 0 M	??/?? 4 M	??/?? 4 M	21/?? B 4 M	21/08 B 0 M
6	23/08 0	21/07 B 0	22/08 1	22/13 1	20/?? B 4	20/?? B 4	22/06 0	21/09 B 0	22/10 0	21/?? B 4	22/05 0	21/06 B 0	??/?? 4	??/?? 4	21/?? B 4	21/04 B 1
7	22/05 0	22/05 0	22/06 3	22/06 0	22/05 1	22/07 0	23/06 0	22/06 0	22/07 0	23/08 0	22/09 0	23/09 0	23/07 0	22/05 0	22/07 0	23/07 3

Directory:36_weeks\Brady NAME: Mo Date:18-05-92 Time:09h57->10h31 Comments:Bradycardia stable between 66 & 74 beats/min. Low HRV. ECG crosstalk on respiratory channel.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	13/10 B 0	12/10 B 0	12/11 B 0	12/12 B 0	12/11 B 0	12/?? B 4	12/12 B 0	12/?? B 4	11/?? B 4	12/11 B 1	12/11 B 0	12/11 B 1	13/?? B 4	12/?? B 4	12/13 B 0	11/?? B 4
2	12/?? B 4	12/?? B 4	13/?? B 4	12/10 B 0	13/?? B 4	12/?? B 4	12/?? B 4	13/?? B 4	12/?? B 4	13/?? B 4	13/10 B 0	12/?? B 4	12/?? B 4	13/?? B 4	12/?? B 4	13/?? B 4
3	13/?? B 4	12/?? B 4	13/10 B 0	12/09 B 0	13/11 B 0	12/?? B 4	12/?? B 4	13/?? B 4	12/12 B 0	12/07 B 0	12/?? B 4	12/?? B 4	12/?? B 4	13/?? B 4	12/11 B 0	13/?? B 4



Directory:36_weeks\Brady NAME: Mo Date:18-05-92 Time: 09h57->10h31

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	13/07 B 0	12/10 B 0	12/09 B 0	12/10 B 0	13/11 B 0	12/09 B 0	12/08 B 0	12/10 B 0	13/12 B 0	12/12 B 0	12/?? B 4	12/?? B 4	Ap 12/00 B 0	12/?? B 4	12/06 B 1	11/?? B 4
5	13/?? B 4	12/12 B 0	13/15 B 1	11/10 B 1	13/11 B 1	13/?? B 4	13/08 B 0	13/07 B 0	12/07 B 0	12/09 B 0	11/12 B 0	12/11 B 0	12/09 B 0	12/09 B 0	12/06 B 0	12/10 B 0
6	12/10 B 0	12/11 B 0	12/12 B 0	12/10 B 0	12/11 B 0	12/12 B 0	12/12 B 0	12/12 B 0	12/12 B 0	12/12 B 0	12/13 B 0	12/12 B 0	13/11 B 0	12/10 B 0	13/10 B 0	12/12 B 0
7	13/09 B 0	12/09 B 0	12/07 B 0	12/06 B 0	13/08 B 0	12/10 B 0	13/12 B 0	12/08 B 0	12/11 B 0	12/09 B 0	12/09 B 0	12/10 B 0	12/12 B 1	12/06 B 0	12/08 B 0	12/08 B 1
8	12/10 B 0	12/06 B 1	12/09 B 0	12/11 B 1	13/10 B 0	12/09 B 0	13/11 B 0	12/11 B 0	12/07 B 0	13/08 B 1	12/12 B 0	12/11 B 0	12/11 B 0	12/10 B 1	12/11 B 0	13/12 B 0
9	13/11 B 0	12/08 B 0	12/10 B 0	13/12 B 0	13/11 B 1	13/?? B 0	12/10 B 4	13/09 B 0	13/?? B 1	12/?? B 4	12/11 B 4	13/12 B 1	13/09 B 1	12/13 B 0	12/13 B 0	13/13 B 0
10	12/10 B 0	13/10 B 0	12/13 B 0	13/12 B 0	13/13 B 0	13/13 B 0	13/13 B 0	13/10 B 0	12/11 B 1	13/11 B 0	13/13 B 0	12/12 B 0	13/13 B 0	12/12 B 0	13/09 B 0	12/12 B 0

Directory:36_weeks\Brady NAME: Tol Date:19-05-92 Time: 09h22->09h30 Comments:Patient on a ventilator. Breathing rate set at 20/min. Heart rate low:120->130 beats/min. Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	21/04 B 0	21/05 B 0	21/05 B 0	21/05 B 0	22/05 0	21/05 B 0	22/05 0	21/06 B 0	22/05 1	20/03 B 0	21/04 B 0	20/05 B 0	21/05 B 0	21/05 B 0	21/05 B 0	20/06 B 0
2	21/05 B 0	21/06 B 0	21/05 B 0	22/05 0	21/05 B 0	21/06 B 0	22/05 0	22/05 0	23/05 0	22/?? 4	22/04 0	21/04 B 0	21/04 B 0	22/04 0	22/04 0	21/04 B 1

Directory:36_weeks\Brady NAME: Wil Date:25-03-92->28-03-92 Time:Data capture discontinuous Comments:Record 1:Frames 1->8 display 20 seconds. Frames 9->16 display 10 seconds Crosstalk from respiratory channel.

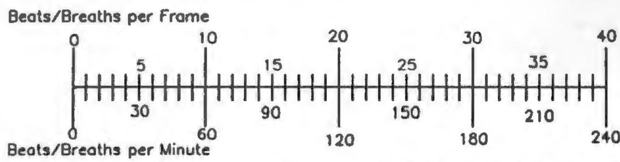
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	51/22 4	??/24 4	??/24 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	21/14 B 4	23/13 0	27/?? T 0	??/?? 0	22/?? 0	18/17 B 0	12/12 B 0	??/?? 1
2	26/?? 0	27/?? T 4	22/?? 4	22/?? 4	21/?? B 4	16/07 B 4	14/10 B 4	23/?? 4	23/?? 0	24/13 1	24/10 4	23/11 4	24/12 4	24/14 0	25/14 0	25/10 4

Directory:36_weeks\Normals NAME: Af Date:19-05-92 Time: 16h09->16h53 Comments:Tracings unstable: Movement artifact -> hiccups

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/15 4 M	24/12 0	23/07 0	22/10 0	22/10 0	??/08 4 M	23/12 3	23/12 0	??/11 4 M	??/08 4 M	24/10 0	??/?? 4 M	23/12 0	21/09 B 0	23/?? 4	20/13 B 0
2	??/?? 4 M	??/?? 4 M	??/08 4 M	??/?? 4 M	??/?? 4 M	??/12 4 M	??/11 4 M	??/13 4 M	??/14 4 M	??/13 4 M	??/13 4 M	??/15 4 M	??/10 4 M	??/13 4 M	??/13 4 M	??/?? 4 M
3	??/?? 4 M	25/?? 4 M	25/?? 4 M	23/14 3	24/14 3	??/14 4 M	23/13 3	??/12 4 M	??/13 4 M	??/13 4 M	??/14 4 M	??/15 4 M	??/11 4 M	??/?? 4 M	??/?? 4 M	??/08 4 M
4	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/13 4 M	??/?? 4 M	??/?? 4 M	??/12 4 M	??/?? 4 M	??/15 4 M	23/12 4 M	??/11 3 M	??/14 4 M	??/14 4 M	??/12 4 M	??/14 4 M
5	??/13 4 M	??/12 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/12 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/15 4 M	??/12 4 M	??/12 4 M	??/13 4 M	??/15 4 M	??/09 4 M
6	??/11 4 M	??/11 4 M	??/12 4 M	24/15 0	24/10 0	??/?? 4 M	??/10 4 M	??/12 4 M	23/12 0	23/12 0	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	23/13 0	23/12 0
7	??/16 4 M	??/16 4 M	??/?? 4 M	??/14 4 M	??/?? 4 M	??/?? 4 M	23/11 1	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/13 4 M	??/13 4 M	??/13 4 M	??/?? 4 M
8	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M
9	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M
10	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M

Directory:36_weeks\Normals NAME: Alk Date:20-02-92 Time: 21h38->22h54 Comments:Patient breathing oxygen in a headbox. Heart rate within normal limits.Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	23/11 0	22/06 0	23/09 0	23/10 0	23/09 0	22/09 0	22/10 0	23/06 1 M	23/11 0	22/06 0	23/10 0	23/11 0	23/09 0	22/09 0	22/10 0	23/06 0
2	23/14 0	23/12 0	23/15 0	24/12 0	25/?? 4	24/?? 4	24/?? 4	25/13 1	23/14 0	23/12 0	23/15 0	24/12 0	25/?? 4	24/?? 4	24/?? 4	25/13 0
3	24/?? 4	24/10 0	24/08 0	24/06 1	24/09 0	24/09 0	23/09 0	24/10 0	24/?? 4	24/10 0	24/08 0	24/06 1	24/09 0	24/09 0	23/09 0	24/10 0



Directory:36_weeks\Normals NAME: Alk Date:20-02-92 Time:21h38->22h54 Comments:All records defective:Frames9->16 duplicate 1->8.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	25/11 0	24/10 0	25/12 0	24/10 0	25/08 0	24/10 0	25/?? 4	25/?? 4	25/11 0	24/10 0	25/12 0	24/10 0	25/08 0	24/10 0	25/?? 4	25/?? 4
5	22/11 0	22/11 0	23/11 0	22/12 0	23/10 0	22/11 0	22/07 0	22/13 0	22/11 0	22/11 0	23/11 0	22/12 0	23/10 0	22/11 0	22/07 0	22/13 0

Directory:36_weeks\Normals NAME: Ben Date:19-05-92 Time: 15h03 Comments:Noisy signals:Motion artifact

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	21/?? 4 b M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M

Directory:36_weeks\Normals NAME: Go Date:30-04-92 Time:13h49->14h20 Comments:Breathing rate:20->50 breaths/min. Heart rate within normal limits. Low HRV.

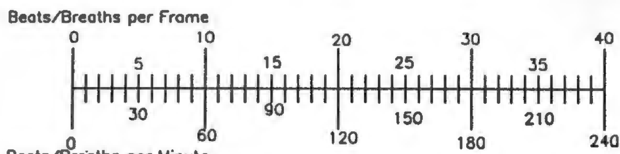
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	24/09 0	24/?? 4	24/?? 4	24/?? 4	27/?? 4 T	25/?? 4	26/?? 4	26/?? 1	23/14 4	24/?? 4	24/?? 4	27/?? 4 T	??/?? 4	??/?? 4	28/?? 4 T	27/?? 4 T
2	29/?? 4 T	27/?? 4 T	23/08 0	24/04 1	25/?? 4	24/?? 4	27/?? 4 T	21/?? 4 B	24/?? 4	25/?? 4	25/?? 4	26/?? 4	24/?? 4	26/?? 4	23/?? 4	25/?? 4
3	26/12 0	24/09 0	29/?? 4 T	26/10 0	27/?? 4 T	26/?? 4	28/?? 4 T	26/?? 4	25/11 1	26/06 1	24/07 1	25/?? 4	25/?? 4	24/07 0	25/02 1	24/?? 4
4	24/04 0	25/08 0	28/?? 4 T M	23/?? 4	24/08 1	24/?? 4	25/?? 4	26/?? 4	24/?? 4	25/?? 4	24/?? 0	23/06 0	24/06 40	25/?? 4	26/07 0	24/?? 4
5	25/05 1	24/?? 4	25/05 1	25/06 1	26/08 1	25/09 1	25/?? 4	28/?? 4 T	25/05 0	25/10 0	25/11 0	25/14 0	25/10 0	25/10 0	25/09 0	25/08 0
6	26/09 0	25/07 0	26/09 1	26/08 1	26/08 1	26/08 1	26/08 1	26/05 1	25/03 1	26/07 1	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	27/06 1 T
7	27/07 0 T	25/08 0	26/08 0	26/08 0	26/07 0	27/?? 4 T	27/09 0 T	26/05 0	27/04 0 T	27/?? 4 T	24/?? 4	25/05 0	26/09 0	26/05 0	27/08 0 T	27/09 1 T
8	26/04 0	25/04 0	26/06 1	25/06 1	26/08 0	25/08 0	26/08 0	26/08 0	26/08 0	27/07 0 T	26/07 2	25/04 1	25/08 0	25/08 0	25/03 1	26/?? 4

Directory:36_weeks\Normals NAME: Jo Date:19-05-92 Time:17h27->18h05 Comments:Records 1&2 noisy.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4	??/?? 4	??/?? 4	20/?? 4 B	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4	??/?? 4
2	??/?? 4	??/?? 4	??/?? 4	23/08 3	23/09 3	??/?? 4	??/05 4	??/?? 4	??/?? 4	??/?? 4	20/?? 4 B	21/?? 4 B	??/?? 4	22/?? 4	??/?? 4	??/?? 4
3	23/06 0	23/?? 4	23/?? 4	22/04 0	22/06 0	23/06 0	22/07 1	23/08 0	23/07 0	23/04 1	22/06 0	22/?? 4	22/04 1	23/05 1	23/05 1	??/?? 4

Directory:36_weeks\Normals NAME: Lu Date:23-03-92 Time:08h23->09h15 Comments:Heart rate within normal limits. Low HRV. Breathing rate stable:40->50breaths/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	25/06 0	25/07 0	25/05 0	24/09 0	26/03 0	24/08 0	25/05 0	25/08 0	25/08 2	27/09 3 T	25/?? 4	25/07 3	27/?? 4 T	??/?? 4	27/?? 4 T	??/05 4
2	24/07 0	25/08 0	25/10 0	25/09 0	26/10 0	26/10 1	25/08 0	25/04 0	26/07 3	25/09 3	??/?? 4	25/03 1	27/06 0 T	26/08 1	26/11 1	??/05 4
3	25/06 0	25/08 0	27/07 0 T	27/10 0 T	25/09 0	27/08 0 T	25/08 0	26/09 0	26/09 0 M	25/05 0	25/08 0	25/10 0	24/09 0	25/07 0	24/07 0	24/08 0
4	25/07 0	24/07 0	24/?? 4	24/06 0	23/05 0	23/06 0	23/07 0	23/07 0	23/07 1	23/07 0	??/05 4	25/09 3	??/?? 4	26/04 3	??/06 4	??/06 4
5	25/10 1	25/06 3	23/12 0	25/12 0	24/11 0	24/10 0	23/09 0	24/09 0	24/11 0	24/10 0	24/10 0	24/08 0	23/07 0	22/06 0	23/08 0	23/09 0
6	23/09 0	22/08 0	23/04 0	24/09 0	23/13 0	24/11 0	22/08 0	23/09 0	22/08 0	23/09 0	22/10 0	22/07 0	22/09 2	22/09 0	22/10 0	22/10 0
7	23/10 0	22/09 0	23/07 0	23/10 0	23/05 0	24/11 0	23/06 1	23/07 1	22/10 0	23/06 0	23/07 1	24/04 1	21/?? 4 B	22/01 1	22/07 0	23/08 0
8	25/05 3	24/04 1	24/11 0	25/09 0	24/11 0	24/04 0	23/07 0	24/11 0	24/09 0	23/07 0	23/08 0	23/08 0	22/07 0	23/07 0	23/07 0	22/06 0
9	22/08 0	23/07 0	23/07 0	23/08 0	23/07 1	23/07 0	23/07 0	23/07 0	23/08 0	23/08 2	22/03 1	23/02 1	22/07 0	23/06 0	22/05 0	23/07 0
10	23/07 0	23/08 0	23/07 0	24/07 0	24/08 0	24/07 2	23/06 0	24/06 0	23/08 0	24/06 0	24/05 3	24/06 0	24/06 0	23/07 0	23/07 0	??/07 4



Directory:36_weeks\Normals NAME: Tol Date:19-03-92 Time:08h27->09h52 Comments:Patient on a ventilator. Breathing rate around 20 breaths/min. Low HRV

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	24/10 0	23/04 1	25/04 1	25/05 1	26/?? 4	T 27/?? 4	T 27/07 1	T 27/?? 4	T 27/05 1	26/03 1	24/08 0	23/06 1	24/03 1	23/06 1	24/05 1	24/06 1
2	25/?? 4	Ap B 21/00 0	22/01 0	25/06 1	23/01 0	23/02 0	25/05 1	T 27/05 1	26/07 0	25/07 1	26/04 3	26/07 1	26/04 1	T 27/?? 4	23/07 3	Ap B 21/00 0
3	22/04 0	B 21/04 0	22/05 0	B 21/05 1	B 21/07 0	B 21/05 1	B 21/04 0	B 21/04 0	22/04 0	23/04 0	22/05 0	22/05 0	22/05 0	B 21/04 0	22/06 0	B 21/04 0
4	22/04 0	B 21/04 0	22/05 0	B 21/05 1	B 21/07 0	B 21/05 1	B 21/04 0	B 21/04 0	22/04 0	23/04 0	22/05 0	22/05 0	22/05 0	B 21/04 0	22/06 0	B 21/04 0
5	22/05 1	B 21/04 0	22/04 0	B 21/04 0	22/05 0	B 21/04 0	22/03 0	22/05 0	22/03 0	23/08 0	24/04 0	23/04 1	B 21/04 0	23/04 0	23/05 0	22/06 0
6	23/06 0	22/05 0	24/06 0	25/?? 4	25/?? 4	23/07 0	22/02 1	23/04 0	23/02 0	24/08 0	23/02 0	24/06 0	22/09 0	22/09 0	22/05 0	23/05 0
7	24/03 0	24/05 0	24/07 0	22/02 0	22/09 0	B 21/04 0	B 21/05 0	23/06 0	22/04 0	B 21/05 0	22/04 1	25/07 3	25/06 3	23/06 0	B 21/05 0	22/04 0
8	22/06 0	22/06 0	B 21/06 0	23/05 0	22/06 0	23/06 0	25/?? 4	23/07 0	B 21/04 0	23/06 0	22/05 0	23/04 0	22/05 0	23/04 0	23/05 0	23/05 0

Directory:36_weeks\Normals NAME: Wil Date:02-04-92 Time:09h40->09h50 Comments:Heart rate stable on tachycardia threshold. Low HRV.

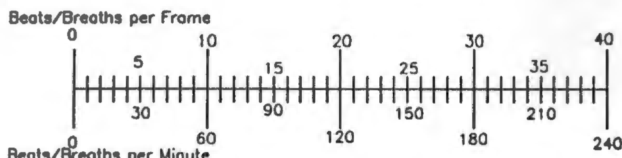
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	T 27/09 1	26/14 1	T 27/11 1	T 27/?? 4	26/13 0	T 27/08 0	26/07 0	26/10 0	26/08 0	26/08 0	T 27/07 0	26/07 0	T 27/08 0	26/13 0	26/?? 4	T 27/05 0
2	T 27/09 0	T 27/11 0	26/07 0	T 27/09 0	26/09 0	T 27/08 0	26/09 0	T 27/1`1 0	T 27/08 0	26/10 0	T 27/09 0	T 27/07 0	26/10 0	T 27/06 0	25/10 0	26/10 0
3	26/11 0	26/07 0	T 27/08 0	26/08 0	T 27/08 0	26/10 0	T 27/08 0	T 27/07 0	T 27/08 0	26/10 0	T 27/08 0	26/08 1	T 27/09 0	T 27/07 0	28/10 0	26/07 1
4	26/09 0	T 27/08 0	26/05 3	T 28/08 1	26/09 0	T 27/10 0	T 27/08 0	T 27/07 0	T 27/07 0	??/08 4	T 28/09 1	T 27/10 0	T 27/11 0	26/09 0	??/12 4	??/?? 4

Directory:36_weeks\P_Breath NAME: Hen Date:30-04-92 Time:11h43 Comments:Possibly Periodic breathing. Record should be viewed from a display routine that allows scale modification.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4 M	T 30/10 1	PB T 30/00 0	PB T 30/01 0	PB T 30/00 0	T 29/01 1	T 27/01 1	T 28/02 1	T 27/01 1	PB T 27/00 0	PB T 28/00 0	??/?? 4	??/?? 4	T 29/?? 4	??/?? 4	T 27/08 3

Directory:36_weeks\P_Breath NAME: Nto Date:22-04-92 Time:17h02->17h43 Comments:Heart rate within normal limits. Low HRV. Breathing rate generally stable around 30 breaths/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	25/06 0	PB 25/03 0	PB 24/04 0	25/06 0	PB 24/02 0	PB 23/06 0	PB 24/03 0	24/05 0	23/04 0	23/04 0	PB 24/00 0	25/05 0	PB 24/00 0	22/05 0	23/08 0	24/06 0
2	26/07 1	28/04 0	28/?? 4	PB 25/03 1	25/03 0	PB 24/00 0	24/04 0	25/03 0	24/04 0	23/04 0	PB 24/05 0	PB 24/02 0	PB 23/04 0	PB 24/03 0	PB 24/01 0	24/04 0
3	PB 24/01 0	PB 24/06 0	24/03 0	23/03 0	24/06 0	24/06 0	25/06 0	PB 24/00 0	PB 24/03 0	PB 23/00 0	PB 23/00 0	PB 24/03 0	PB 24/00 0	PB 22/03 0	26/02 0	25/03 0
4	24/05 0	25/06 2	T 28/08 1	T 29/09 1	T 30/08 3	T 31/11 0	T 32/07 0	T 31/08 3	T 32/06 3	T 32/13 2	T 31/08 3	PB T 27/07 0	T 27/02 0	T 27/13 0	25/11 0	PB 26/04 0
5	PB 26/06 0	PB 24/06 0	PB 25/02 0	PB 24/04 0	PB 24/03 0	25/07 0	24/08 0	25/06 0	24/05 0	24/03 0	24/04 0	23/06 0	24/04 0	24/07 0	24/05 0	PB 24/05 0
6	PB 23/04 0	23/08 1	24/08 1	25/05 0	24/07 1	23/07 1	24/07 1	23/08 1	23/05 1	23/06 1	23/07 1	24/05 1	23/05 1	24/06 1	24/06 1	23/05 1
7	24/05 1	24/06 1	23/05 1	23/07 1	24/07 1	24/06 1	25/04 1	PB 25/04 0	24/05 1	24/06 0	24/06 0	24/05 1	24/06 0	24/05 0	24/05 1	24/07 1
8	PB 24/04 0	PB 24/05 0	23/05 0	26/04 1	22/03 1	23/07 0	23/07 0	PB 23/05 0	PB 24/03 0	24/03 0	24/04 0	23/04 0	23/05 0	PB 24/02 0	24/07 0	PB 25/03 0
9	PB 24/02 0	PB 25/06 0	PB 24/05 0	PB 25/02 0	PB 25/05 0	PB 25/03 0	25/03 0	24/04 0	24/04 0	23/06 0	25/06 0	24/04 0	24/05 0	25/04 0	24/04 0	PB 24/03 0
10	24/04 0	25/04 0	24/04 0	24/04 0	24/05 0	25/03 0	24/04 0	25/05 0	24/05 0	24/04 0	25/05 0	24/03 0	24/03 0	24/05 0	24/03 0	24/04 0



Directory:36_weeks\P_Breath NAME: Tol Date:19-03-92 Time:08h35->08h50 Comments:Heart rate stable on tachycardia threshold. Low HRV. Breathing rate eratic.

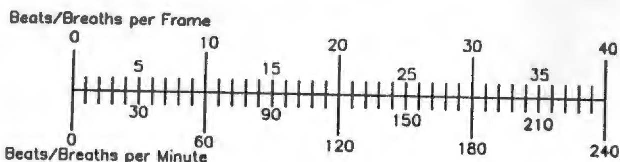
FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	23/05 0	23/05 0	23/06 0	22/02 0	22/03 0	22/04 0	24/07 1	27/05 1 T	27/?? 4 T	25/06 1	27/?? 4 T	26/?? 4	26/?? 4	27/05 1 T	26/?? 4	24/07 1
2	21/10 2 B	23/02 0 PB	23/03 0 PB	23/00 0 PB	24/00 0 PB	23/03 0 PB	26/04 0	27/03 0 T	27/00 0 PB T	22/07 0	??/?? 4	??/?? 4	??/?? 4	27/07 1 T	27/?? 4 T	28/?? 4 T
3	28/?? 4 T	28/00 1 PB T	24/00 1 PB	27/00 1 PB T	27/00 0 PB T	25/01 1 PB	27/00 1 PB T	25/00 1 PB	24/00 1 PB	25/00 0 PB	27/06 0 T	27/09 1 T	26/00 1 PB	27/00 1 PB T	28/00 0 PB	27/00 1 PB T
4	25/06 0	25/05 0	25/10 0	25/00 0 PB	27/11 1 T	27/10 1 T	25/10 0	25/11 0	26/06 0	26/?? 4	25/?? 4	26/?? 4	25/00 0 PB	25/00 0 PB	26/?? 4	26/?? 4
5	24/06 0	25/08 0	27/05 0 T	25/10 0	26/10 1	27/08 1 T	25/?? 0	26/10 0	27/?? 0 T	26/09 4	27/08 4 T	26/04 4	24/07 0	25/10 0	26/06 4	26/07 4
6	27/07 3 T	26/07 3	25/04 3	26/?? 4	26/06 3	26/?? 4	25/01 3 PB	25/01 0 PB	25/10 1	23/05 1	26/?? 4	25/00 1 PB	26/05 0 PB	24/04 0 PB	26/00 0 PB	25/05 0

Directory:36_weeks\Tachy NAME: Af Date:19-05-92 Time:16h29->16h39 Comments:Tracings unstable:Movement artifact due to hiccups.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M
2	26/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/12 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M	??/?? 4 M

Directory:36_weeks\Tachy NAME: Fre Date:31-03-92 Time:Data capture discontinuous Comments:Heart rate stable around 194 beats/min. Low HRV. Patient breathing rate high around 96/min.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	32/18 0 T	32/19 0 T	31/21 0 T	33/16 0 T	33/17 0 T	32/16 0 T	31/16 1 T	34/12 1 T	33/17 0 T	33/19 0 T	33/20 0 T	33/20 0 T	34/15 0 T	33/12 0 T	34/20 0 T	33/20 0 T
2	33/18 2 T	33/19 0 T	33/19 0 T	33/18 0 T	33/18 0 T	33/19 0 T	32/19 0 T	33/21 0 T	33/21 0 T	33/20 0 T	33/18 0 T	32/20 0 T	32/18 0 T	33/16 0 T	33/16 0 T	33/19 0 T
3	32/19 0 T	33/17 0 T	33/17 0 T	33/18 0 T	33/15 0 T	33/12 0 T	32/19 0 T	33/17 0 T	32/15 0 T	33/14 0 T	33/15 0 T	32/15 0 T	32/15 0 T	32/16 0 T	32/17 0 T	32/15 0 T
4	32/21 0 T	32/19 0 T	33/15 0 T	32/15 0 T	32/14 0 T	33/18 0 T	33/14 0 T	32/10 1 T	33/18 0 T	33/21 0 T	33/22 0 T	33/20 0 T	33/18 0 T	33/18 0 T	33/17 0 T	32/17 0 T
5	32/16 0 T	32/16 0 T	33/17 0 T	32/16 0 T	32/16 0 T	32/14 0 T	32/14 0 T	32/14 0 T	32/17 0 T	32/15 0 T	32/17 0 T	32/17 0 T	32/17 0 T	32/16 0 T	32/15 0 T	32/15 0 T
6	32/15 0 T	31/16 0 T	31/16 0 T	32/15 0 T	32/16 0 T	32/15 0 T	30/?? 4 M T	29/16 3 M T	??/?? 4 T	??/?? 4 T	33/18 3 M T	33/17 1 M T	33/17 1 M T	32/?? 4 T	33/09 0 T	33/13 1 T
7	32/17 0 T	33/15 0 T	33/16 0 T	32/16 0 T	32/15 0 T	32/14 0 T	32/15 0 T	32/12 0 T	32/15 0 T	32/14 0 T	31/16 0 T	32/14 0 T	31/15 0 T	32/15 0 T	32/14 0 T	32/16 0 T
8	31/18 0 T	32/13 0 T	31/17 0 T	31/18 0 T	31/16 0 T	32/20 0 T	31/10 0 T	32/19 0 T	32/15 0 T	31/19 0 T	32/13 0 T	31/17 0 T	32/20 0 T	31/19 0 T	31/18 0 T	31/15 1 T
9	31/19 0 T	32/18 1 T	32/17 2 T	31/22 0 T	31/20 0 T	32/18 0 T	32/22 0 T	32/18 0 B	32/20 0 T	32/17 0 T	31/19 0 T	32/17 0 T	31/14 0 T	33/14 0 T	32/23 0 T	31/20 0 T
10	29/18 0 T	29/12 0 T	29/09 0 T	??/14 4 T	29/17 0 T	30/19 0 T	30/13 1 T	27/00 0 T	20/00 0 Ap B	19/00 0 Ap B	29/05 3 T	28/?? 4 T	??/15 4 T	29/16 3 T	29/18 0 T	30/20 1 T
11	30/15 0 T	29/17 0 T	29/16 0 T	29/15 0 T	29/11 0 T	30/17 0 T	30/14 0 T	29/13 0 T	29/16 0 T	29/18 0 T	29/17 0 T	29/12 0 T	29/21 0 T	29/18 0 T	29/20 0 T	29/21 0 T
12	29/15 0 T	29/15 0 T	29/13 0 T	29/16 0 T	29/13 0 T	30/14 0 T	29/12 0 T	29/18 0 T	29/19 0 T	29/16 0 T	30/14 0 T	29/14 0 T	29/15 0 T	29/15 0 T	29/13 0 T	29/18 0 T
13	30/16 0 T	29/15 0 T	29/15 0 T	28/14 0 T	29/13 0 T	29/18 0 T	28/16 0 T	29/18 0 T	29/19 0 T	29/15 0 T	29/13 0 T	29/13 0 T	29/14 0 T	29/18 0 T	29/15 0 T	29/14 0 T
14	24/06 0	25/12 0	30/11 0 T	30/14 0 T	30/16 0 T	30/19 0 T	31/14 1 T	30/20 0 T	30/19 0 T	30/20 0 T	31/21 0 T	30/19 0 T	31/19 0 T	30/13 0 T	30/17 0 T	31/13 1 T
15	31/19 0 T	31/?? 4 T	31/19 0 T	32/12 1 T	??/?? 4	32/11 2 T	32/20 0 T	32/20 0 T	33/20 0 T	32/19 0 T	32/22 0 T	32/21 0 T	34/18 0 T	32/21 0 T	33/14 0 T	32/21 0 T
16	29/18 0 T	29/16 0 T	29/?? 4 T	30/?? 4 T	30/13 3 T	31/13 3 T	31/15 3 T	31/18 3 T	??/?? 4	??/?? 4	??/?? 4	32/?? 4 T	32/?? 4 T	31/15 3 T	??/?? 4	30/17 3 T
17	30/17 0 T	30/20 0 T	31/18 3 T	30/16 2 T	30/15 2 T	31/19 2 T	31/?? 4 T	31/19 3 T	31/19 3 T	30/20 2 T	31/21 2 T	30/16 3 T	30/17 0 T	31/16 0 T	30/18 0 T	31/15 3 T



Directory:36_weeks\Tachy NAME: Fre Date:31-03-92 Time:Data capture discontinuous

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
18	32/15	30/15	31/18	31/14	30/18	31/19	30/18	30/18	30/21	31/18	30/17	31/19	30/19	31/16	30/19	31/20
19	30/18	30/13	29/16	30/16	30/16	30/13	30/16	29/20	30/18	29/18	30/17	30/16	29/17	30/19	30/16	29/16

Directory:36_weeks\Tachy NAME: Go Date:30-04-92 Time:13h43->13h59

Comments:Noisy signals due to movement artifact. Low HRV.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	29/13	29/12	29/14	29/??	27/??	24/??	??/??	28/??	28/??	26/??	23/08	28/??	??/??	??/??	??/??	??/??
2	28/??	28/??	29/10	29/??	29/11	27/??	29/14	29/11	28/??	??/??	27/08	29/15	30/??	27/??	??/??	??/??

Directory:36_weeks\Tachy NAME: Hen Date:30-04-92 Time:10h04->11h57

Comments:Heart rate stable. Low HRV. Rapid & shallow breathing particularly in records 7->13.

FRAME:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	33/09	34/10	??/??	34/??	??/??	??/??	??/??	??/??	33/21	33/14	34/10	33/09	34/14	34/??	34/11	34/09
2	32/??	34/??	??/??	??/??	??/??	??/??	??/??	34/09	??/??	36/??	??/??	??/??	??/??	34/09	??/??	??/11
3	31/11	31/09	32/13	30/??	31/10	30/09	31/??	30/07	30/11	30/10	31/10	31/10	30/09	29/09	31/10	31/09
4	33/09	31/12	31/08	33/??	32/07	32/09	32/??	33/??	??/??	33/??	32/07	34/07	33/12	??/08	33/??	32/06
5	28/14	28/14	28/14	28/15	29/06	??/??	26/??	27/11	28/14	28/13	27/10	29/10	28/??	27/07	28/07	27/09
6	28/??	28/??	28/??	29/??	28/??	28/??	28/12	29/12	28/14	28/13	28/??	28/??	29/??	28/??	28/??	29/??
7	28/??	29/??	28/??	28/??	28/??	28/??	28/??	29/??	27/??	28/??	28/??	28/??	28/??	28/??	29/??	28/??
8	29/??	28/17	28/15	28/19	28/18	28/10	28/16	28/19	28/19	28/19	28/17	28/11	28/19	28/19	28/19	28/18
9	28/18	28/17	28/17	29/16	28/16	29/15	27/15	26/17	27/15	28/18	28/17	28/17	28/13	28/16	28/17	28/16
10	27/15	28/15	28/15	28/16	28/12	27/14	28/11	27/11	27/10	28/11	27/11	29/16	28/17	28/17	27/18	27/18
11	27/15	27/18	28/18	28/18	28/17	28/16	28/??	28/??	27/??	27/17	27/18	28/16	28/14	28/??	28/12	29/15
12	28/19	27/20	27/??	28/??	28/16	27/??	28/16	28/??	28/17	27/15	27/11	26/10	26/15	27/??	28/??	27/16
13	28/14	28/16	28/??	29/14	28/16	29/16	28/11	29/11	28/??	28/14	28/18	27/18	28/13	27/16	28/13	28/14
14	28/16	28/12	28/??	25/??	28/??	26/09	27/08	28/12	28/13	27/11	28/12	28/12	28/11	27/11	28/??	26/08