

## **CHAPTER 1: THE SOCIO-MEDICAL CONTEXT OF VIABILITY AND PREMATURITY**

### **1.0 Introduction**

Understandings about the care of sick infants has changed dramatically in recent decades. The emergence of neonatal paediatrics as a profession, the establishment of neonatal intensive care units (NICU), and the specialised education of nurses to care for these vulnerable infants, has resulted in a substantial decline in morbidity and mortality, with subsequent improvement in outcomes for the extremely low birth weight (ELBW) infant. These improvements have led to a widespread public belief that all infants can be saved, and that technology has progressed to the stage where non-viable infants can be attached to life support devices for an extended period of time, go home and live normal lives. Such a picture is unrealistic for many infants of marginal viability, defined by this author as 24 weeks gestation and less. Many infants of marginal viability will endure physical and emotional damage from their stay in the NICU. Neonatal nurses have begun to question the value of aggressive neonatal intensive care for infants of marginal viability in the light of recent outcome studies that show that many will develop a major disability (Wood, Marlow, Costeloe & Wilkinson 2000, p. 378; Levene 2004, p. 150; Mikkola, Ritari, Tommiska, Salokorpi, Lehtonen, Tammela, Paakonen, Olsen, Korkman, Fellman 2005, p. 1392; Wilson-Costello, Friedman, Minich, Fanaroff & Hack 2005, p. 997; Wood, Costeloe, Gibson, Hennessy, Marlow, Wilkinson 2005, p. F134). The resuscitation and initiation of life support on infants of marginal viability can be questioned in the light of research that shows continued poor outcomes for these infants (Battin, Ling, Whitfield, Mackinnon & Effer 1998, p. 469; Vohr, Wright, Poole, McDonald 2005, p. 640; Watts & Saigal 2006, p. F222). Evidence-based clinical guidelines will encourage the questioning critique of such practices.

Premature birth is a worldwide phenomenon. It has been estimated that approximately 24 million low birth weight infants are born every year (World Health Organization 2007), or prior to the 37<sup>th</sup> week of pregnancy. The WHO (2005, p. 190) state that 28% of

neonatal deaths worldwide occurred because of prematurity. Statistics from the United States of America (USA) indicate the percentage of preterm births rose to 12.0% in 2002, from 10.6% in 1990 and 9.4% in 1981 (Arias, MacDorman, Strobino & Guyer 2003, p. 1215). More than a half million infants are born prematurely in the USA each year (March of Dimes 2007). Preterm birth is the most frequent cause of infant death in the USA accounting for two thirds of infant deaths (Callaghan, MacDorman, Rasmussen, Qin & Lackritz 2006, p. 1566). The vast majority of premature infants require little or no support other than warmth, supplemental oxygen and perhaps intravenous or nasogastric feeding. Those who are born extremely preterm will require months and perhaps years of intensive support. As the boundaries separating fetus and infant become increasingly blurred there is recognition that fetal viability is not a clear cut issue (Engelhardt 1973 p. 429E). The rapidly expanding technology of the NICU may in itself create a technological imperative where there is an obligation to use the technology because the capabilities exist to do so, regardless of the best available evidence (McHaffie & Fowlie 1996, p. 9). The purpose of this chapter is to examine the issues surrounding fetal viability and extreme preterm labour and delivery. This chapter will complement the research by providing the reader with an understanding of the many complexities of clinical management and ethical dilemmas associated with the life, death and survival of extremely premature infants. This understanding will explain why the process is fraught with anxiety and uncertainty for medical staff, nursing staff, and most importantly, parents.

### **1.1 Estimated date of delivery**

The accurate dating of a pregnancy can be difficult. Errors in the estimation of gestational age are likely to occur in one third of preterm deliveries (Tyson, Younes, Verter and Wright 1996, p. 1645). Unless the exact time of conception is known, gestational age is at best an educated guess. Ultrasound dating of pregnancy is considered to be accurate when coupled with menstrual history and laboratory data (Blanco, Suresh, Howard & Soll 2005, p. e478), however ultrasounds only provide better estimates of gestational age during early pregnancy (Berg & Bracken 1992, p. 280; Savitz, Terry,

Dole, Thorp, Siega-Riz & Herring 2002, p.1664; Kalish, Thaler, Chasen, Gupta, Berman, Rosenwaks & Chervenak 2004, p. 975). Inaccurate ultrasound estimates of fetal weight does not translate into information that will be useful in prenatal counselling of parents about their infant's possible survival (Allen, Donohoe & Dusman 1993, p. 1597).

### **1.2 Prediction of gestation**

The prediction of gestational age of extremely preterm infants is problematic. Differences exist between the obstetric estimate of gestational age and the currently used Ballard method of postnatal gestational estimation (Tyson et al. 1996, p. 1645). The most important reason for attempting to accurately assess the gestational age of an infant of marginal viability is related to whether or not intensive care should be instituted, and the preparedness of the neonatal staff for this infant's delivery.

### **1.3 Difficulties with predictions of survival**

Reports of survival of extremely premature infants have come from all over the world, but the ability to predict the survival of these infants is limited. Marked differences in survival rates of ELBW infants defined as less than 1000 grams have been noted across different centres in the same country and across different countries (Silver, MacGregor, Scott, Farrell, Ragin, Davis, & Socol 1993, p. 1724). Statistics are hard to interpret as very few studies deal specifically with the population under study (24 weeks and less gestation). Survival rates are hard to compare as statistics are reported from the delivery room, the NICU, discharge from hospital or at one year of age (Rijken, Stoelhurst, Martens, van Zwieten, Brand, Wit & Veen 2003, p. 355). These disparities make consensus on the ELBW infant's prognosis and outcome difficult. Outcome prediction is made more difficult because the data analysis is always retrospective, making it difficult to give an up to the minute prognosis for a group of tiny infants.

The gender of the premature infant may ultimately affect its survival and prognosis. Female premature infants were more likely than males to survive (Silver et al. 1993, p. 1724). This fact could be explained by the slower lung maturation of male fetuses (Yu,

Downe, Astbury & Bajuk 1986, p. 554). Female gender has proved an advantage for survival (Kilbride, Daily, Clafin, Hall, Maulik and Grundy 1990, p. 160; Silver et al. 1993, p. 1724; Blaymore-Bier, Pezzullo, Kim, Garcia-Coll and Vohr 1994, p. 1244; Tudehope, Burns, Grey, Mohay, O'Callaghan and Rogers 1995, p. 451; Tyson et al. 1996, p. 1645; Hack, Friedman, and Fanaroff 1996, p. 931; Elsmen Hansen Pupp & Wellstrom-Westas 2004, p. 529;), while male gender has proved a risk factor for adverse outcome (Wood et al. 2005, p. F134). Survival of female fetuses at 23 weeks gestation is equal to the survival of male fetuses at 24 weeks gestation (Holtrop, Ertzbischoff, Roberts, Batton & Lorenz, 1994, p. 1266). Preterm females are less likely to develop neurological and developmental disabilities than male preterm infants (Elsmen et al. 2004, p. 529).

#### **1.4 The law**

At this stage Australian law does not require that all fetuses be resuscitated and have treatment initiated. However, issues such as the legal and moral status of the fetus, and the changing status from fetus to newborn following birth need exploration. One difficulty is that obstetricians, neonatologists, midwives and neonatal nurses may disagree about the moral and legal status of the fetus and the ethical duties, which are owed to the woman and her fetus (Fleischman, Chevenak & McCullough 1998, p. 184). The legal status of the fetus is uncertain. Australian law acknowledges the existence of the fetus, but it is difficult to determine when the law would intervene to ensure fetal welfare (Seymour 2000, p. 135).

A fetus can be defined as the product of conception during its later development, but not before eight weeks gestation (English 1994, p. 116). The concept of fetus is more challenging than its mere definition. In Australia the states differ as to when a fetus is deemed viable, and this ranges from 14 to 22 weeks gestation (Cica, 1998-1999). At this stage the fetus would be unlikely to survive outside the maternal womb, even with neonatal intensive care. The age of viability has slowly slipped closer to conception than

it has to term, because of the advanced neonatal technologies, which are moving closer to providing a separate existence for the fetus.

#### **1.4.1 Viability**

It becomes important to determine when infants are deemed viable and when obligations exist for fetal infants to be resuscitated at birth? Confusion exists about the viability of extremely preterm infants. Viability has been defined as the point when a child can breathe on its own or with the assistance of a ventilator (Rennie 1996, p. F214). The WHO has defined a live birth as “the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered live born” (1977, p. 247). While fetuses at the end of the fourth month of pregnancy have a detectable heartbeat and may gasp at delivery, they are unable to sustain life because they do not have the prerequisite maturity of their organ systems (Rennie 1996, p. F214), particularly the lungs. Although the WHO’s definition is strictly applied to what constitutes a live birth for perinatal statistics, it does raise concerns. From this definition it follows that the live birth of fetal infants is not a valid indicator of viability. Viability has been defined by the Mosby’s Dictionary (1994 p. 1648) as “capable of living; born alive and with such form and development of organs as to be normally capable of living”. The important point here is the capability to grow and develop normally in extrauterine environments. Discussions on viability would be remiss if they did not include the longer-term outcome of these tiny infants from the physical, neurological and developmental viewpoints (Rennie 1996, p. F214).

It would be hoped that an extremely premature infant in being born alive should also have a reasonable chance of survival. Dunn and Stirrat (1984, p. 553) have suggested that viability would be less confusing if it were defined as the ability of the infant to live and grow normally. This revised and more practical definition would preclude previable fetuses of less than 22 weeks, and put those between 22-24 weeks in an extremely grey

area. This grey area has been described by Kraybill (1998, p. 207) as the “zone of uncertain viability”. Below this zone of viability where long term survival is currently possible but unlikely and above this zone of viability, with intensive care, survival is somewhat likely, though not assured. The “zone of uncertain viability” according to Kraybill (1998, p. 207) is 22 to 25 weeks, with a corresponding birth weight of 400 to 600 grams. Fost (1981) speaks of a grey zone of uncertainty in relation to sick rather than premature newborns. For Schollin (2005) there is a grey zone for infants of 22 to 25 weeks gestation.

The “born alive” rule suggests that a child is born alive if it exists as a live child, by “breathing and living by reason of its own breathing through its own lungs alone, without deriving any of its living or power of living by or through any connection with its mother” (Seymour 2000, p. 139). This is an acceptable rule for infants born at or near term, but for extremely premature infants presents difficulties. Firstly, although an infant may have a heart beat and may attempt to breathe, these rudimentary efforts do not equate with the ability to sustain life. Secondly, in order to be able to survive, extremely premature infants need to be resuscitated and attached to life support, therefore a mechanical ventilator provides breathing for the infant. Although the born alive definition exists, and viability is defined at 20 weeks gestation, there is no legal provision for treatment to be given when the effects of treatment can be said to outweigh benefits to the infant. Under Australian law, obstetricians and neonatologists have a degree of scope in situations involving extremely premature infants.

While viability in New South Wales (NSW) is defined as 20 weeks gestation (Family Planning Association 2004), there is debate surrounding this definition and its interpretation into clinical practice. Viability is not defined as 20 weeks gestation because the fetus can survive outside the womb. It may be associated with the ‘brain life theory’ that holds that the fetal human possesses an active and constantly developing central nervous system from at least the eighth week of development (Flower 1985, p. 237). Twenty weeks, however, is a critical time for neurological system development. Following this time further neural integration and maturation occur (Korein 1990, p.

982). Therefore, rather than an arbitrary figure, the 20 week definition bestows significant moral value on the developing fetus. At 20 weeks gestation brain development is given greater weight than physical development. The significance of brain development lies in its future potential to grow more complex, enabling the mental activities of human experience (Shea 1985, p. 205).

The WHO in 1977 defined viability as the state of a fetus having reached a birth weight of 500 grams or more. There is, however, no consensus for the cut off point for viability. Although increasingly infants with birth weights of 500 grams and less have been documented as surviving the NICU experience, (Monro 1939, p. 69; Pleasure, Dhand & Kaur 1984, p. 783; Moro & Minoli 1991, p. 270; Muraskas, Carlson, Halsy, Frederiksen, Sabbagha 1991, p. 1599; Amato 1992, p. 7; Coccia, Pezzani, Moro & Minoli 1992, p. 10; Sherer, Abramowicz, Bennett, Mercier & Woods 1992, p. 151; Ginsberg, Goldsmith & Stedman 1992a, p. 330; Ginsberg, Goldsmith & Stedman 1992b, p. 13; Opitz, Matsche, Borens & Madison 1993, p. 187; Muraskas, Bhola, Tomich, Thomasma 1998, p. 1095; D'Emilio 2002, p. 3; Taylor 2003; anonymous 2004; Lucey et al. 2004) the quality of their survival needs to be included in the discussion. There have been attempts by Muraskas, Myers, Lambert and Anderson (1992, p. 16) to define viability as a weight of 500 grams and a gestation of 24 weeks, because of the intact survival of a 280 gram infant. This definition remains confusing, because with a birth weight of 500 grams gestation is generally thought to be 22 weeks. Of greater significance is the fact that a fetus of 22 weeks menstrual age is only equivalent to a conception age of 20 weeks gestation (Dunn & Stirrat 1984, p. 553). More confusion arises when the Guinness World Records (2005) states the most premature baby ever born is James Elgin Gill who was born at 128 days or 18 weeks gestation, and weighed 624g. Using the standard of 22 weeks gestation and 500 grams, 18 weeks gestation and 624 grams seems unlikely. The difficulty in defining viability and assigning a universal point at which resuscitation should not be undertaken remains (Jakobi, Weissman & Paldi, 1993, p. 155). An individualised approach to these tiny infants is proposed (Ginsberg et al. 1992a, p. 330), Allen et al (1993, p. 1597) seek the middle ground and argue that factors other than gestation and birth weight should be taken into account, for example the previable

newborn's response to resuscitation. Frohock (1986, p.6) found that neonatologists thought that viability based on weight and gestational age was important, but that clinical signs like heart rate and respiratory rate and in marginal cases the attitude of the immediate family were important. Arbitrary cut-offs for the withholding of care based on birth weight or gestational age are not feasible (McCormick 1994, p. 801). Clinicians will continue to assess the vigour and viability of premature infants and make decisions about care regardless of birth weight or gestational age.

Although there are subjective criteria upon which decisions to save infants are based, there are no absolute standards for making decisions about infants of marginal viability. This situation could lead to preivable infants being resuscitated simply because it is possible without consideration for the ramifications of survival on the infant, the child, family and society. In reality the defining feature of whether or not an infant is actively resuscitated may depend on where birth takes place, as infants born at tertiary centres have a better prognosis (Lui, Abdel-Latif, Allgood, Bajuk, Oei, Berry & Henderson-Smart 2006b, p. 2076). Likewise the philosophies and optimism of obstetricians and neonatologists in relation to these tiny infants, their past experiences, including successes and failures, with infants of less than 24 weeks gestation.

“Doctors concede that viability is a tricky term... viability also varies across space as well as time. Babies born close to, or in, a hospital with a tertiary care nursery have a more generous threshold of viability.”

(Wade, in Frohock 1986, p. 39)

### **1.5 Classification of premature infants**

Premature infants can be classified by either gestation or birth weight, however birth weight has traditionally been used for statistical purposes because the recording of gestational ages world wide has been unreliable (Hack & Fanaroff 1988, p. 773). Birth



weight and gestational age are both problematic, but they are each strong predictors of outcome (Watts & Saigal 2006, p. F223). It is important to accurately ascertain gestational age as there are differences in the potential of fetuses, even of one week gestation, ie between 24 and 25 weeks. Silver et al (1993, p. 1724) found that in infants of 24 weeks gestation, the gestational age was the most valuable predictive indicator of survival. Nwaesei, Young, Byrne, Vincer, Sampson, Evans, Allen and Stinson (1987, p. 890) proposed gestational age better reflects fetal maturation, and is more likely to be a better predictor of outcome.

Birth weight is the determining factor in an infant's ability to survive, and the extent to which adverse sequelae, neurologic, physical and psychological will occur (Wheeler 1994, p. 66S). Birth weight is one of the most powerful indicators of perinatal morbidity and mortality (Roberts and Lancaster 1999, p. 114).

### **1.6 Potential survival**

Although small numbers of infants 24 weeks gestation and less are born, the financial impact of preterm delivery is substantial because of the intensive care days they require. Infants born at 22 weeks gestation rarely survive (Kaiser Permanente 1998, p. 1; Nuffield Council on Bioethics 2006). The current statistics suggest that those born at 23 weeks gestation have a 30% chance of survival, therefore of every 100 infants born, only 30 will survive. Infants born at 24 weeks gestation have a 50% chance of living, meaning that of 100 infants born, 50 will survive (NSW Pregnancy and Newborn Services 1996, p. 5; Nuffield Council on Bioethics 2006). Davis (1993, p. 447) found that infants born weighing 500 grams or less at birth, and who were actively resuscitated had a neonatal survival of 10%. The current figure of neonatal survival is 17% at discharge (Lucey et al. 2004, p. 1559).

### **1.7 Mortality and morbidity**

There have been major improvements in the morbidity and mortality of infants greater than 700 grams. Jakobi et al (1993, p. 155) lament that outcome data of this group has been inappropriately extrapolated to infants less than this birth weight. Stories of “miracle babies” lead the public to believe that infants around 500 gram birth weight mark will survive and do well (Ulrich 1998; Linnell 2001; Veitch 2002; D’Emilio 2002; Taylor 2003; anonymous 2004). This is one of the myths that surrounds perinatal care of infants of marginal viability. Rare cases are not an indication of the trend, and although the survival rate for infants under 26 weeks gestation has improved, the proportion of survivors with adverse outcomes has not decreased (Tyson & Saigal 2005, p. 372). Indeed, Mikkola et al (2005, p. 1391) found that one fourth of survivors were normally developed at five years of age. There has been only a marginal lowering of the limit of viability in recent years because very few infants born at less than 500g or 23 weeks gestation or less survive (Hack et al. 1996, p. 931; Lucey et al 2004, p. 1559). The highest mortality is likely to occur following complicated pregnancies. Both mortality and morbidity will improve as gestation increases. The survival of infants near the margin of viability has improved, although there is still a high mortality rate for these children (Holtrop et al. 1994, p. 1266; Lucey et al. 2004, p. 1559). Most outcome studies have little data pertaining to infants 23 – 25 weeks gestation. Survival in many studies is defined as being discharged from hospital, and not linked to the final outcome for these infants. Even in the era of routine surfactant use the limit of viability would appear to be 23 to 24 weeks gestation (Allen et al. 1993, p. 159; Levene 2004, p. 150; Genzel-Boroviczeny, MacWilliams, Von Poblitzki & Zoppelli 2006, p. 68).

Persistent differences exist between those who question the appropriateness of aggressive measures for ELBW infants, and those who initiate the treatment (Meadow, Reemshisel & Lantos 1996, p. 589; Nuffield Council on Bioethics 2006). These differences have been an ongoing source of tension, and Meadow et al (1996, p. 589) suggests this could result from how the issue is framed. Meadow et al (1996, p. 590) found that most deaths of ELBW infants occurred in the first three days of life (80%), and that from day four, illness severity was a more important indicator of survival than was birth weight. It is also suggested that because birth weight has been so powerfully correlated with outcome,

that decisions to start or stop treatment have focused on this easily obtainable prognostic measurement. They believe that although 600 gram (g) infants are less likely to survive than 1000g infants on day one, by day four the 600g infant who remains alive is as likely as the 1000g infant to survive. These results have implications for resource allocation. In this extremely premature population many will not survive past the fourth day (Meadow et al. 1996, p. 590). Current authors still report early deaths of many of these infants (Lucey et al. 2004, p.1559; Marlow, Wolke, Bracewell & Samara, 2005, p. 15; Markestad, Kaarensen, Ronnestad, Reigstad, Lossius, Medbo, Zanussi, Engelund, Skjaerven & Irgens, 2005, p. 1289)

### **1.8 Active resuscitation**

The development of useful criteria for determining which extremely premature infants would benefit from aggressive treatment, and which infants will not survive aggressive therapy has eluded neonatologists (Lantos, Miles, Silverstein & Stocking 1988, p. 91). Many neonatologists treat fetal infants at birth, and then withdraw support if, and only if, dire complications arise (Lantos et al. 1988, p.91). In extremely premature infants the resuscitation at delivery postpones death by only a few days (Doran, Veness-Meehan, Margolis, Holoman and Stiles 1998, p. 574). The issue of viability remains clouded, but it is clear that the need for cardiopulmonary resuscitation (CPR) in the extremely premature newborn, either at delivery or in their subsequent care, may be a more reliable indicator of prognosis. Infants less than 1500 grams who require CPR are more likely to have increased morbidity and mortality (Lantos et al. 1988, p. 91). Cardiac arrest in infants is usually caused by an underlying respiratory embarrassment, rather than being of cardiac origin (Landwirth 1993, p. 502).

Infants who require CPR for a correctable condition have a good prognosis, whereas those who require CPR for deterioration of their disease process are more likely to die. Lantos, Meadow, Miles, Ekwo, Paton, Hagemna and Siegler (1992, p. 286) found the constant predictors of poor outcome related to resuscitation were a low 5 minute apgar score, and the requirement for resuscitative therapy in the first 72 hours of life. Sood and

Giacoaia (1992, p. 130) found that none of the infants who underwent CPR after 72 hours survived. Interestingly, Lantos et al (1992, p. 286) found that outcome was not influenced by prenatal care, place of birth, type of delivery, hospital or birth weight. None of these parameters was associated with survival following resuscitation, although Jain, Ferro, Vidyasagar, Nath and Sheftel (1991, p. 781) disagree. Given the importance placed on these aspects as part of the care of a high-risk mother and fetus, Lantos et al's (1992) findings are surprising. Meadow, Katznelson, Rosen and Lantos (1995, p. 589) differentiated between acute and progressive situations. An acute problem was defined as one that could be traced directly to an acute rapidly reversible problem, while the progressive category described infants with multiple system organ failure and progressive haemodynamic deterioration, leading to CPR. Infants with acute problems necessitating the need for CPR survived. Infants whose CPR attempt followed a progressive decline in organ did not survive to discharge. All the infants in the progressive group were premature, mechanically ventilated, hypotensive and bradycardic and were dying despite maximum support. Willett and Nelson (1986, p. 773) found that the major variables associated with poor outcome were progressive, and included oliguria 24 hours before and after cardiac arrest, intraventricular haemorrhage, sepsis and prematurity.

The poor outcomes of CPR in the premature infant lead Lantos et al (1988, p. 91) to believe that CPR is a non-validated therapy in infants of ELBW, and that these infants should not be subject to a standing order for CPR in the first few days of life. They argue that aggressive support should still be given, but the need for CPR should be taken as a sign of impending death. Barr and Courtman (1998, p. 503) agree and suggest that CPR be withheld in infants who do not have a reversible cause for their cardiac arrest.

### **1.9 Infant mortality in Australia**

Infant mortality rates have changed in Australia in the last 100 years. In 1904, 82 infants per 1000 died prior to their first birthday compared to 5 per 1000 in 2004 (Child and Youth health 2007). There will probably never be zero infant mortality due partly to

prematurity, because efforts to prevent preterm delivery have been largely unsuccessful (Hack & Merkatz 1995, p. 1772).

### **1.10 Premature infants in Australia**

Preterm birth in Australia is less than seven percent of the total number of births (Roberts & Lancaster 1999, p. 116). The Australian figures mirror worldwide statistics, which are 5-9% of the number of live births (Keirse 1995, p. 618). Infants less than 28 weeks gestation account for only 10% of the total number of preterm deliveries (Keirse 1995, p. 618). Premature infants of 24 weeks and less constitute 0.09%, or slightly less than 0.1% of the total number of births in Australia (calculated using Roberts and Lancaster's 1999 data). The incidence of preterm deliveries is small in comparison to the total number of live births, however, extremely preterm births contribute substantially and disproportionately to perinatal morbidity and mortality, and extremely preterm births are even more disproportionately represented in the morbidity and mortality statistics (Keirse 1995, p. 618).

In the current NSW and Australian statistics, infants of 20 –27 weeks gestation and less than 1000 grams have been grouped together (Australian Institute of Health and Welfare, National Perinatal Statistics Unit, 2004, p. 56 & 60; Laws & Sullivan 2005; Laws, Grayson & Sullivan 2006). In 2004 there were 2152 infants born 20-27 weeks gestation, and 1212 infants born less than 1000 grams born in Australia, representing 0.8% of live births (Laws & Sullivan 2005, p. 22 & 47). In 2005 that figure increased to 2,284 infants born 20-27 weeks gestation, and 1,181 infants born less than 1000 grams representing 0.9% of live births (Laws, Grayson & Sullivan 2006, p. 56 & 60). The following table shows a breakdown of the NSW statistics showing the numbers are fairly stable.

#### **BIRTHS BY GESTATIONAL AGE AND BIRTH WEIGHT NSW 2000-2004**

	No infants 20-27 weeks gestation	No infants BW less than 500 grams
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2000	623	228
2001	628	243
2002	594	212
2003	585	223
2004	605	214

Source: Centre for Epidemiology and Research, NSW Health. NSW Midwives Data Collection (p. 25 & 26).

Roberts and Lancaster's (1999) data although now considered old, has been used because they give a full breakdown according to gestation and weight. Their birth weight percentiles provide a population norm for infants born in Australia, and their Australia wide data provides more valid data than individual states or hospitals. There has previously been no Australia-wide percentile birth weight data. The figures for the number of marginally viable infants in Australia have been collated according to gestational age, gender and birth weight and are listed below;

### **MALES**

Gestational age (in weeks)	Number of births	Mean birth weight (g)
20	27	385 +/- 76
21	43	447 +/- 66
22	74	495 +/- 80
23	95	607 +/- 92
24	135	690 +/- 129

Birth weight percentile values (g) for live singleton males born to non-indigenous Australian born women 1991-1994. (Roberts and Lancaster 1999, p. 116).

### **FEMALES**

Gestational age (in weeks)	Number of births	Mean birth weight (g)
20	12	418 +/- 184
21	25	414 +/- 55
22	71	485 +/- 85
23	79	591 +/-103
24	115	661 +/-95

Birth weight percentile values (g) for live singleton females born to non-indigenous Australian born women 1991-1994. (Roberts and Lancaster 1999, p. 117).

Roberts and Lancaster (1999) show that more infants less than 24 weeks gestation are male than female in all gestational age categories. This finding is interesting given that females have a higher survival rate. There were 374 males compared to 302 females. A total of 22,177 infants were born with more males born than females. The median birth weight for females was less than males in all weight categories.

### **1.11 Premature labour and delivery**

Despite advances in the treatment of sick newborns, preterm delivery remains a major contributor to perinatal morbidity and mortality. Preterm birth occurs prior to the 37th week of gestation, and morbidity and mortality increase as gestation and birth weight decrease. Obstetric management practices have evolved at the same pace as technological advances in the neonatal intensive care unit. This combination, has been largely responsible for the improved outlook for the premature infant.

Active obstetric interventions have proved beneficial for the premature infant. These include cervical cerclage for cervical incompetence, pharmacologic inhibition of labour, maternal steroid administration to accelerate fetal lung maturity, a conservative approach to ruptured fetal membranes, the monitoring of high risk pregnancies, and the increased use of caesarean section for delivery of these tiny infants (Cazan-London, Mozurkewich, Xu & Ranson 2005, p. 1187).). There are however, still significant risk factors for premature labour and delivery.

Preterm birth is a heterogeneous syndrome of complex aetiologies, which can be sub-classified as either pre-term birth associated with spontaneous rupture of membranes, or medically indicated preterm birth and spontaneous preterm delivery (Villar, Ezcurra, Gurtner de la Fuente & Campodonuci 1994, p. 9). The fetal membranes can rupture without the onset of clinically significant labour, therefore Keirse (cited in Villar et al 1994, p. 9) has suggested that it be defined as pre-labour rupture of membranes. Alternatively, a woman can enter premature labour without rupture of the fetal membranes. Preterm birth describes two specific issues. Firstly, there are cases where the related pathology of either the mother or fetus requires the delivery of the infant, therefore the obstetrician decides the pregnancy should come to an end. In many cases the woman does not go into labour, nor is labour induced. Secondly, if the woman is in preterm labour there may be medically indicated reasons why the infant needs to be delivered immediately, making it more desirable to end the pregnancy, rather than taking steps to prolong the pregnancy and endanger the life of the mother, fetus or both. Of all preterm births, 80% are the direct result of preterm labour, while 20% are related to the complications of pregnancy (Graf and Perez-Woods 1992, p. 51).

### **1.12 Risk factors for preterm labour and delivery**

There are significant risk factors for preterm labour and delivery, but identification of women likely to proceed to preterm delivery has proven difficult. Preterm labour and delivery can be grouped into categories of those that are potentially treatable, those with



a specific cause and those that are potentially preventable with socio-economic and environmental factors. A significant percentage of women who present in preterm labour will not have any risk factors for premature labour and delivery. Premature rupture of the membranes is one of the leading causes of perinatal morbidity and mortality (Hadi, Hodson & Strickland, 1994, p. 1139; Tanir, Sener, Tekin, Aksit & Ardic 2003, p. 167). When the membranes rupture prior to 25 weeks gestation the outlook for neonatal survival is poor (Hadi et al. 1994, p. 1139).

Risk factors include the age of the mother (Raju 1986, p. 233). Adolescents and women over 35 years of age have a greater risk of preterm labour and delivery. Smoking is associated with a two to five times increase in preterm delivery, however, the combination of smoking and alcohol intake increased the risk seven fold (Heffner, Sherman, Speizer & Weiss 1993, p. 750). Pre-eclampsia and hypertensive disease in pregnancy are associated with preterm birth, and the association is related to the severity of the hypertension (Jenkins, Head & Hauth 2002, p. 790). Multiple gestation is a significant risk factor for preterm delivery (Salat-Baroux & Antoine 1996, p. S17). Infertility treatments have been a major contributing factor to the increased numbers of multiple pregnancies observed in the industrialised world.

Studies consistently show that women who receive early and regular antenatal care are less likely to have a preterm infant (Berkowitz & Papiernik 1993, p. 414; Wheeler 1994, p. 66S). Gestational age may be unknown if the mother has not received prenatal care. Estimation of gestational age is likely to be inaccurate in 20% to 30% of cases when the mother has received no prenatal care (Hack & Fanaroff, 1993, p. 1649; Meadow et al. 1996, p. 636).

### **1.13 Treatment of preterm labour**

Tocolytic drugs act by stimulation of the beta-adrenergic receptors, which result in inhibition of uterine contractility (Joffe & Wright 2002, p. 19). The importance of tocolytics to suppress labour at 24 weeks gestation cannot be overstated. The fetus at 24

weeks gestation gains approximately 100 grams in a week or about 14 grams per day (Brenner, Edelman & Hendricks 1976, p. 555). There is a substantial difference in fetal potential in just one week, therefore extending the pregnancy for one week can significantly improve the outcome for the infant (Whyte et al. 1993, p. 1).

An effective tocolytic agent that successfully and indefinitely ceases uterine contractions has not been developed (Iannucci, Besinger, Fisher, Gianopoulos & Tomlich, 1996, p. 1043). Only 15-30% of preterm deliveries can be prevented with tocolytics (Zlatnick 1972, p. 704).

### **1.14 Enhancement of fetal lung development**

Glucocorticosteroids are used to enhance fetal lung development and decrease the risk of neonatal respiratory distress. Mothers in preterm labour at less than 34 weeks gestation are given intramuscular doses of betamethasone. This steroid enhances the development of fetal lungs by encouraging the production of surfactant a surface active agent, in the fetus which is important for lung stability. The advantage is greatest for infants whose mothers have received at least 24 hours of antenatal treatment with two doses 12 hours apart, and for whom the treatment was given one week prior to birth (Gjerdingen 1992, p. 601). Antenatal steroids are associated with a significant decrease in the incidence of neonatal and infant death (Amon, Anderson, Sibai & Mabie, 1987, p. 1143; Atkinson, Goldenberg, Gaudier, Cliver, Nelson, Merkatz & Hauth 1995, p. 300; Abbasi, Hirsch, Davis, Tolosa, Stouffer, Debbs & Gerdes 2000, p. 1243), a substantial reduction in the risk of intraventricular haemorrhage and neurological abnormality as well as necrotising enterocolitis (Crowley 1998).

### **1.15 Preterm delivery**

Debate surrounds the safest mode of delivery for the ELBW infant. A relationship exists between the obstetric management employed by obstetricians and the survival of the ELBW infant. Obstetricians choose whether or not to actively intervene (Garel, Seguret,

Kaminski & Cuttini 2004, p. 395), and therefore need an accurate picture of extreme prematurity. Obstetricians can underestimate the potential for neonatal survival in premature infants, therefore labour and delivery may not be managed aggressively. Obstetricians not practising in a tertiary centre are less likely to consider pregnancies viable, utilise fetal monitoring, transfer the pregnant woman to a tertiary centre, or perform a caesarean section for fetal indications (Goldenberg, Nelson, Dyer & Wayne 1982, p. 678). The critical factor in neonatal outcome is the obstetrician's perception of fetal viability (Amon, Shyken & Sibai, 1992, p. 17; Nwaesei et al. 1987, p. 890; Garel et al. 2004, p. 395).

The probability of infant survival and survival with major morbidity are higher with a willingness to perform a caesarean section (Cazan-London et al. 2005, p. 1187). Caesarean section before 22 weeks and 400 grams is not warranted because there are currently no survivors of this gestation or weight (Holtrop et al. 1994, p. 1266). Ferrara, Hoekstra, Couser, Gaziano, Calvin, Payne and Fangman (1994, p. 120) consider infants less than 23 weeks to be pre-viable. Tocolytics are warranted, but aggressive obstetric and neonatal management should be withheld. Australian obstetricians consider a birth weight of 500 grams and a gestation of 24 weeks to be the limits of viability (Gooi, Oei and Lui 2003, p. 454).

There are no clear guidelines about the initial delivery room care of infants of marginal viability. Hack and Fanaroff (1986, p.660) believe that decisions to resuscitate these infants are generally not made using the results of the outcome studies, they are made on the personal philosophies of the attending obstetrician, often with little or no input from the parents. Parental involvement in these decisions is now considered paramount (Zaner & Bliter 1991; Cook & Watchko 1996; van der Heide, van der Maas, van der Wal, Kollee, de Leeuw & Holl 1998; Partridge, Freeman, Weiss & Martinez 2001; Campbell & Fleischman 2001). Disagreement in management may occur because survival statistics may direct the neonatologist, but have less value for the obstetrician who makes the critical management decision before delivery (Nwaesei et al. 1987, p. 890). There may be disagreement between the obstetric and neonatal staff about the viability and expected outcome for the infant once delivered. Once delivery is completed the obstetrician's

obligations towards the infant are complete. The neonatal staff initiate the life support for this tiny infant. Statistics are important, because a fetus who is delivered alive and resuscitated is a neonatal statistic, rather than an obstetric statistic. Early death of ELBW infants might reflect an assessment of nonviability by obstetricians and neonatologists (Shankaran, Fanaroff, Wright, Stevenson, Donovan, Ehrenkranz, Langer, Korones, Stoll, Tyson, Bauer, Lemons, Oh & Papile 2002, p. 797). Later death could indicate a belief that an infant had a chance at life.

The improved survival of ELBW infants can be correlated to adequate prenatal care, birth at tertiary perinatal centres and transport of high risk women. Transportation of the high risk fetus in utero and birth at a specialised perinatal centre correlates with a significantly higher neonatal survival and a lower neonatal mortality rate (Lubchencho, Butterfield, Delaney-Black, Goldson, Koops & Lazotte, 1989, p. 539; The Victorian Infant Collaborative Study Group 1991, p. 765; Doyle and The; Blaymore-Bier et al. 1994, p. 1244; French, Parry and Evans 1995, p. 295; Victorian Infant Collaborative Study Group 1995, p. 11; Tudehope et al. 1995, p.p. 451; Shlossman, Manley, Sciscione & Colmorgen, 1997, p. 449). Maternal transports have been found to more cost effective, because sick infants have a shorter length of stay in the NICU, and require less ventilatory support and oxygen therapy. Infants transported in utero also have less long term disease states that includes bronchopulmonary dysplasia, retinopathy of prematurity, intraventricular haemorrhage and patent ductus arteriosus. Neurological outcome has also been found to be better in those infants born in a perinatal centre (Veelken, Stollhoff and Claussen 1991, p. 815; The Victorian Infant Collaborative Study Group 1991, p. 765; Whyte et al. 1993, p. 1).

### **1.16 Conclusion:**

Viability is problematic and managing ELBW infants presents numerous clinical challenges and ethical dilemmas. The ability to accurately determine gestational age is difficult at best, and highly inaccurate at worst. While 500 grams may be the WHO's definition for viability, it is unlikely that infants who are born at this weight will survive,

and if they do, the likelihood of severe handicaps is very real. It is still not clear how the decisions are made in relation to these infants and what criteria, if any is used. What is clear is that delivery outside a tertiary perinatal centre will have a significant impact on the morbidity and mortality of tiny infants (Shlossman et al. 1997, p. 449), that all infants under 24 weeks gestation are not the same, nor are they confronted with the same problems.

It is clear that there are multiple risk factors associated with preterm labour and delivery, but what remains unclear is why women who are not considered high risk, or even those without significant risk factors begin to labour prematurely. Preterm labour and delivery not only make a significant impact on the neonatal morbidity and mortality statistics, but infants of marginal viability will require an extended period of intensive care.

There is much uncertainty surrounding extremely preterm labour and delivery and which infants should be treated. The individual nature of each pregnancy and extremely premature infant makes it problematic and even hazardous to make rules and laws based on gestation. With arbitrary gestational rules and laws, outcomes cannot be predicted. This is where the dilemma begins.

The following chapter outlines the problems that are likely to be encountered by infants of 24 weeks and less when they are resuscitated and begin their stay in the intensive care nursery. For many infants their stay in the intensive care nursery is short because they do not survive, however, for others, there will be many months of intensive care, which may or may not result in survival.