Developing new neonatal strategies and improving survival rates
Kagoshima City Hospital has the largest NICU facility in Japan, and serves the 1.8 million population of the Kagoshima prefecture. With 17,000 births per year, the neonatal death rate of 1.3 per 1000 live births is one of the lowest in the nation. Critical Care News met Professor Satoshi Ibara MD, Chief of the hospital’s neonatal division, to discuss the therapeutic strategies that have contributed to saving the lives of its very premature patients.

Developing new neonatal strategies and improving survival rates

You have conducted extensive research in the field of surfactant therapy. What is your experience of surfactant replacement in neonatal patients?

We use surfactant produced in Japan from calves. Before birth, we check amniotic fluid to establish whether or not the baby has surfactant. If the baby’s surfactant is insufficient, we prepare the surfactant before birth. We intubate the baby immediately at birth, and administer surfactant supplement as quickly as possible. That is our Open Lung approach for the premature baby, to ensure there is no alveolar collapse. This way we prevent cyclic opening and closing, and low volume injury.

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How many neonatal cases does the unit treat each year?

Approximately 800 patients per year in Kagoshima, with about 70 patients weighing less than 1000 grams, and about 80 patients in the 1000-1500 gram range. We have around 250 invasive mechanical ventilation cases. Only 4-5 babies are treated with ECMO per year.

What are your special ventilatory treatment considerations for “micropreemies”, i.e. infants weighing 1000 grams or less?

For the past five years we have primarily been using SERVO ventilators, with SIMV and Pressure Support treatment. We have mostly SERVO 300 ventilators, but a few Babylog and Stephanie machines as well. We also have two SERVO-i ventilators from MAQUET Critical Care in this hospital, but these are shared between ICU departments.

Extremely low birth weight infants, less than 1000 grams, are mechanically ventilated long term, and need preventative measures for ventilator-induced lung injury (VILI), with respect to premature development of respiratory center and lungs, underdeveloped chest, respiratory muscles and circulatory system.

When did you establish this procedure, and what effect has it had on your survival rates?

We started following this procedure 13 years ago. It has had a very big impact on our survival rates. The average for the past three years looks like this: 57% at gestational age...
22 weeks; 85% at 23 weeks; 61% at 24 weeks. But there are many here that include TTTS – 82% at 25 weeks; 88% at 26 weeks; 89% at 27 weeks. Last year, all patients born at 22 weeks gestation survived.

**What method of suctioning does your NICU use?**

Open suctioning systems are currently predominant in other NICUs in Japan. We started using a closed system here about 10 years ago. Closed systems maintain the PEEP which is very good for the lungs. If you use an open system, there is no PEEP during suctioning, which means that alveolar compartments will collapse. This can induce volume-related injury. Hasty insertion of an aspiration catheter in the trachea of these patients may complicate conditions. The catheter tip may hit the trachea and bronchi, generating damage to the airway mucosa. If it is grave, an ulcer is generated with formation of granulation.

Insertion of the suctioning catheter is very important. If done incorrectly, it can cause stenosis and injury to the trachea or main bronchi. This can result in atrophy, emphysema or atelectasis. The closed suctioning catheter should be introduced very slowly while watching the pressure drop, in order to minimize risk of injury. We avoid inserting it past the tracheal tube, but where this is necessary we do not pass it by more than 5 mm so as not to injure the bronchi. The number of cases using dexamethasone has been rapidly and significantly reduced.

**How do you manage leakage in a clinical situation for neonatal patients?**

We use flow volume loops to monitor leakage. If the baby has a leak, we adjust the endotracheal tube. We have to reduce the leakage because we want to provide patient-triggered ventilation. We use slightly larger tracheal tubes for the tiny babies than other institutions, but we don’t have many tracheal problems.

Patient-triggered ventilation is part of our lung protective strategy. The weaning period is very short as a result of this strategy.

**What are the key components of your ventilation therapy for neonates?**

Our general lung protective strategy has many components: closed suctioning, humidification, early surfactant therapy, and reduction of oxygen toxicity. It also includes ventilator settings, especially PIP and inspiratory pressure.

**Are there any special clinical cases where you are developing new strategies?**

We are using a lung protective strategy for the diaphragmatic herniation baby. Almost all situations utilize hyperoxemia for the

### Survival rates at Kagoshima NICU, 2002-2004

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diaphragmatic herniation baby. We have just started using a low O2, so lung damage is reduced. We keep saturation by pulse oximetry between 85 and 91, and measure SVO₂ (saturation central venous O₂). We measure pulmonary vascular resistance using ultrasonography.

We keep mixed venous saturation (SVO₂) above 70%, in contrast to the normal 80% or 90%, so the baby has no pulmonary hypertension. We think that SVO₂ is a very important pulmonary vascular consideration. The pulse oximeter indicates saturation from the heart to the organ. SVO₂ presents the net value. Pulmonary artery blood saturation is dependent on the SVO₂, so we think pulmonary vascular resistance is affected by this as well. This is a very new approach to diaphragmatic herniation, and we have had very successful early results. I want to reduce pressure, inspiratory time and O₂ concentration as much as possible. This is our objective with every patient. We are also starting to measure a DNA marker (8 hydroxy – 2’deoxyguanosine) that is attacked by the oxygen radical; we measure this substance in urine. High concentration of O₂ results in a high marker. The baby’s blood has many scavengers, so now we are checking the origination of these substances.

**How are you weaning from invasive mechanical ventilation?**

Our first activity is to establish that FiO₂ is less than 30%, and respiratory rate less than 20. If the baby has good activity and a good triggering response, we extubate. We have a success rate of about 80%. In the remaining 20% we must re-intubate or start nasal CPAP. After extubation, nasal CPAP therapy usually lasts three to five days, depending on the baby.

**Can you tell us about the NICU facility and staff?**

We have six physicians and eight residents, with 117 nurses in the NICU including CCU. We have two nutritionists, one clinical engineer, and one psychologist on staff for parents.

The babies are on three separate ward facilities on two stories of the building. We also have our own neonatal surgical theatre, as well as a specially equipped NICU ambulance service.

We encourage the infant’s mother and father to be at the NICU between 2.00 pm and 8.00 am the next day. We have an average of 80 patients per day, and 32 mechanically ventilated babies.
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[Image 405x320 to 553x412]

Dr Hideki Maruyama and the NICU ambulance.

References:

Kagoshima NICU ambulance service

The Kagoshima City Hospital NICU provides a unique and dedicated NICU ambulance service to the city and outlying islands and areas of Kagoshima Prefecture. Dr Hideki Maruyama of the Perinatal Medical Center described the set-up.

How many patients does the NICU ambulance serve?

With 17,000 births per year in the prefecture, the NICU ambulance is used in about 150-200 emergency births per year.

How is the NICU ambulance equipped?

We have two incubators constantly on standby and warm, to meet any emergency situation. We have a specially designed shock-resistant bed for some of the mountain terrain in the prefecture. There is a ventilator, an oxygen blender to reduce risk of toxicity, and a generator for supplemental power in case of battery failure.

How long have you been providing this service, and what have been the results?

The special NICU ambulance has been in service for five years. Prior to introducing it, we usually had three to four deaths on arrival per year in our area. After implementation of this service, we are proud to say that we have had no deaths on arrival.

Biography:
Satoshi Ibara is Chief of the Neonatology Division and Perinatal Medical Center of Kagoshima City Hospital in Japan. He graduated from the Faculty of Medicine at Kagoshima University Hospital in 1981, and worked as a research fellow in 1984-5 at the Division of Maternal and Fetal Medicine at the University of California, Irvine. After several resident and staff positions at Kagoshima City hospital during 1986-9, he returned to the University of California, Irvine, from 1990-1, as visiting Assistant Professor at the Department of Obstetrics and Gynecology. He became Clinical Professor at the Faculty of Medicine at Kagoshima University in 2002.

[Image 416x794 to 553x1024]

Dr Hideki Maruyama and the NICU ambulance.

[Image 405x434 to 551x615]