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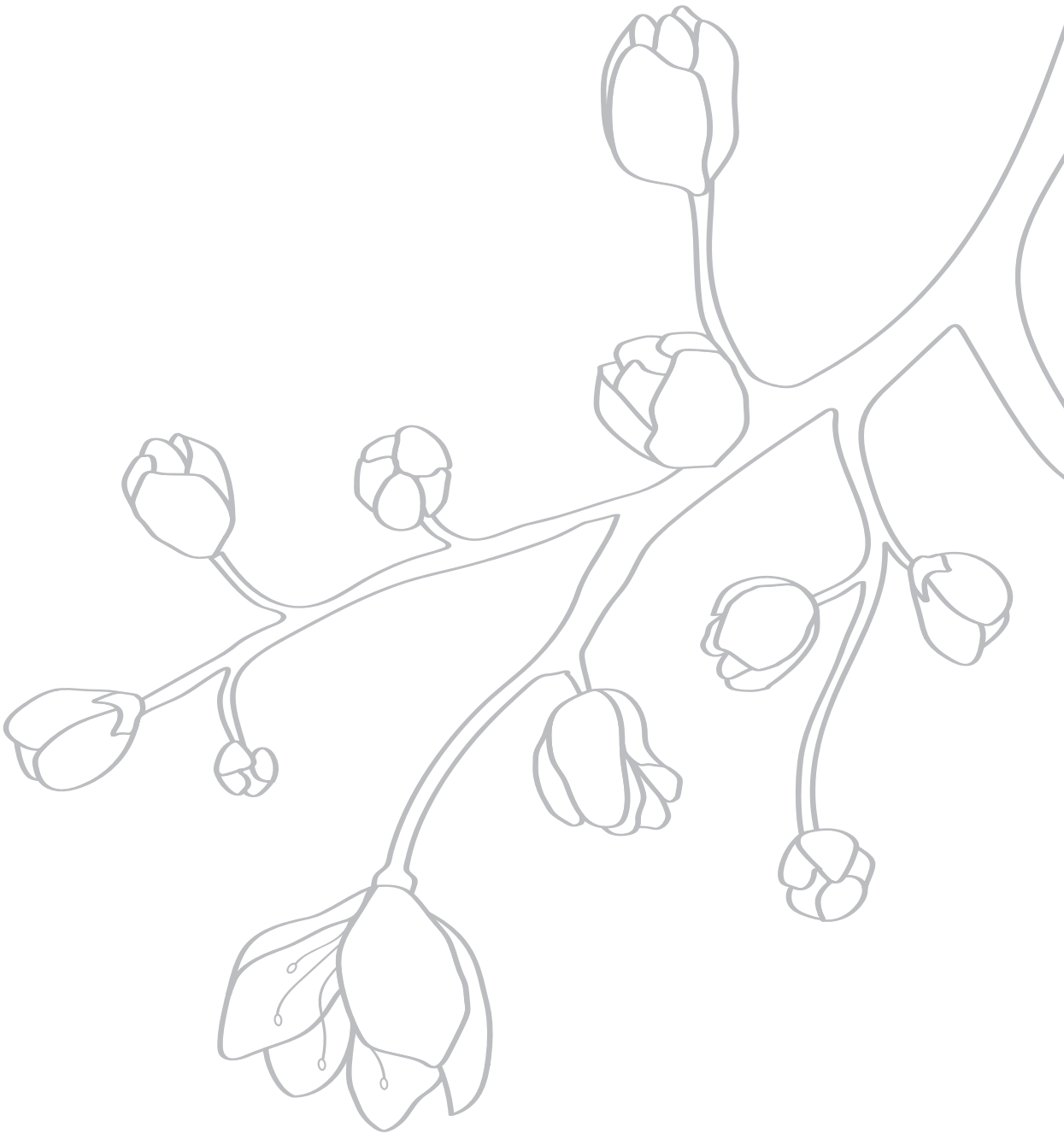

Preface

It is 9.20 AM and the handover for neonatal clinical staff, as well as a joint Inter-Departmental meeting, had just finished when the neonatal resident received an incoming call. Overnight, a woman was admitted into hospital at 26 weeks gestation with preterm rupture of membranes and contractions. Labour continued despite tocolytic treatment and the cervix was 8 centimetres dilated, making it likely that her baby would be born that day. With twenty-six weeks into the pregnancy and an estimated fetal weight of 920 grams, her child was going to be born too soon and would need medical assistance to transition from a fetus into a newborn infant.

The neonatal resident called her supervising neonatologist and asked a nurse for assistance. Next to the delivery suite where the woman was to give birth, the neonatologist, resident and nurse prepared the resuscitation table. They switched on the radiant heater above the resuscitation table to prewarm the table and turned on the pulse oximetry monitor and oxygen analyser to measure heart rate, oxygen saturation and the amount of supplemental oxygen that is given when providing respiratory support. Furthermore, they calibrated the resuscitation monitor, which displayed and recorded all physiological parameters, including respiratory function. The resident set the T-Piece resuscitator to deliver positive end-expiratory pressures of 5 cmH_2O and peak inspiratory pressures of 20 cmH_2O, using a flow of 12 L/min. The air/oxygen blender was set on a concentration of 30% oxygen and a syringe full of caffeine was prepared in case respiratory effort was insufficient.

Only minutes later, the neonatologist entered the resuscitation room and gently placed the newborn infant on the table. Her breathing was spontaneous, but irregular. The neonatologist positioned the infant in a plastic wrap and supported her breathing with 5 cmH_2O continuous positive airway pressure (CPAP) and an inspired oxygen content of 30% by placing a mask over her nose and mouth. Despite intermittent tactile stimulation, her irregular breathing rapidly diminished, eventually resulting in apnea. The neonatologist started artificial ventilation, starting with 5 inflations, each with a duration of 3 seconds. The pulse oximetry device displayed a reliable plethysmograph signal, a heart rate of 65 beats per minute and an oxygen saturation of 54%. Therefore, a second group of inflations were given while increasing the peak inspiratory pressure to 25 cmH_2O, which increased heart rate to 120 beats per minute. As there was still no sign of breathing and the oxygen saturation had not improved, they continued with positive pressure ventilation and the nurse increased the inspired oxygen concentration to 50%. After a minute of ventilation, they observed spontaneous breathing on the respiratory function monitor and stopped ventilation to evaluate her breathing efforts. While the infant breathed spontaneously, she made grunting noises, indicating that she was struggling to preserve lung volume. Her breathing remained irregular and was merely enough to maintain peripheral oxygen saturations at 82%, while still receiving an inspired oxygen content of 50%. To further support her breathing effort, the neonatologist increased the CPAP pressure to 8 cmH_2O, and to stimulate breathing, they administered caffeine via a butterfly needle inserted into the umbilical vein. Meanwhile, the obstetrician entered accompanied with the father and the team first congratulates the father before explaining to him how she

was doing. The father was encouraged to touch her and he was asked to gently rub the sole of her feet. The increase in CPAP level, caffeine and tactile stimulation had a positive effect and the respiratory effort increased and became more regular, yet the oxygen saturation remained around 85%. To improve the oxygen saturation, the nurse increased the supplemental oxygen concentration to 100%. The oxygen saturation rose and once it was above 95%, they titrated down the inspired oxygen concentration. Eventually, the little baby girl was spontaneously breathing on 8 cmH_2O CPAP with an inspired oxygen content of 40% before she was transferred to the Neonatal Intensive Care Unit. However, before being placed in the transport incubator she was first given to her mother so she can meet and touch her daughter.

In recent years, the focus of respiratory support for extremely preterm infants in the delivery room has shifted from intubation and mechanical ventilation towards stimulating and supporting spontaneous breathing. Although it has been shown that applying CPAP is beneficial for supporting the breathing effort at birth, little research has investigated the optimal level of CPAP. In fact, the choice of CPAP level given to this baby was largely based on “eminence-based” medicine, where expert opinion dictates “this is how we do this”. There is no CPAP titration recommended and the current recommendation in how much CPAP (level) should be given is merely based on a mix of the current practice in the neonatal unit, expert opinion and extrapolations from preclinical studies in animals that have already transitioned. In recent years, it has become clear that the transition to newborn life at birth is a vulnerable moment for preterm infants with prompt changes in pulmonary characteristics. It is likely that the CPAP strategy required in the delivery room is completely different to the CPAP protocols used in the neonatal unit. This thesis therefore focusses on optimising CPAP used at birth to support spontaneous breathing of preterm infants.