Outcomes after automated oxygen control for preterm infants

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OUTCOMES after AUTOMATED **OXYGEN CONTROL** for PRETERM **INFANTS**

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Financial support for the printing of this thesis was kindly provided by:
Universitaire Bibliotheken Leiden
Department of Paediatrics of the Leiden University Medical Center
SLE Limited

Cover by: Ridderprint, www.ridderprint.nl
Printed by: Ridderprint, www.ridderprint.nl
Layout by: Hylke Salverda

ISBN: 978-94-6458-500-1
E-ISBN: 978-94-6458-501-8

The studies in this thesis were financially supported by an unrestricted research grant from SLE Limited; they had no role in study design nor in the collection, analysis, and interpretation of data, writing of the reports and decision to submit this manuscript or the papers for publication.

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Proefschrift

ter verkrijging van

de graad van doctor aan de Universiteit Leiden,

op gezag van rector magnificus prof.dr.ir. H. Bijl,

volgens besluit van het college voor promoties

te verdedigen op donderdag 3 november 2022

klokke 10:00 uur

door

Hylke Hendrik Salverda

geboren te Alkmaar

in 1988

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Voor mijn broer

What is now proved was once only imagined.
– William Blake

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Preface

Oxygen is crucial for the survival of all organisms. Without it, there would be no life. This much humankind has known since the first scientists discovered oxygen, one may have been as early as 1604. However, it was not until 1790 that oxygen was first mentioned for medical purposes and it would take another 110 years before it was first used in neonatal care.

To get oxygen in our blood to enable the essential metabolic processes in our body, we use our lungs. The lungs of a preterm infant are not fully developed and they are thus not always capable of taking in enough oxygen. This prompts clinicians to give extra oxygen – a key treatment which has helped save many lives. Exactly how much oxygen clinicians can safely give is still unknown and can change within seconds for preterm infants. As with so many things in life, too little or too much can be harmful. A fine balance needs to be kept.

In the first half of the 20th century, neonatal care saw little involvement from physicians. Few medical procedures were done to neonates. It was believed that handling during care led to cyanosis and apnoea and as a result, care was mostly limited to warming, feeding and isolation. Giving extra oxygen to preterm infants was also rare. The first mention of administering oxygen to preterm infants was by Budin in 1900, when he reported a beneficial effect of administering oxygen during cyanotic bouts. In the following years physicians noted that administering oxygen could also reduce irregular, also known as periodic, breathing. As a result, extended periods of oxygen administration were recommended and oxygen use for preterm infants became common practice. Oxygen hoods, funnels and even incubators were designed to administer oxygen, all with the aim of mixing in as little ambient air as possible.

The first sign of the drawbacks of administering such a high fraction of oxygen in the air infants breathed appeared in 1940, when paediatrician Clifford noticed a new eye condition, later called retrolental fibroplasia. This new condition was meticulously studied by ophthalmologist Terry in the following years and another eleven years of research were needed to link this blindness-causing disease to administering oxygen. From then on, physicians began to realize that too much oxygen was harmful, and a more restrictive approach followed in the mid-1950s.

Physicians lowered the oxygen content in supplied breathing air to 40%, and as a result the rate of retinopathy of prematurity - the contemporary name for retrolental fibroplasia - decreased. This change in practice was not based on evidence from research, but on clinical findings from individual paediatricians. Lowering the oxygen content also had a problem: both the rate of hyaline membrane disease, now known as respiratory distress syndrome, and the rate of cerebral palsy went up for preterm infants - keeping the balance between too much and too little was, and still is, difficult.

Although a form of a pulse oximeter - a device to measure the oxygen saturation of the blood – was developed in 1935, titrating oxygen on the basis of the oxygen content in the blood only started in the 1960s, when blood gas monitoring became readily available. It would not be pulse oximetry as used today, as this was only developed by researcher Takuo Aoyagi in 1974. These early pulse oximeters were highly inaccurate when patients moved. This poses a particular problem for preterm infants, who cannot be instructed to lie still. Eventually, in 1995, Masimo developed Signal Extraction Technology, which is more resistant to motion, and this is now the basis for guiding how much oxygen to give preterm infants.

Technology has become more and more sophisticated. In our unit, infants in need of respiratory support can receive breath volumes as low as 2 millilitres. The breath is given at the exact moment the baby attempts to breathe, and the amount of oxygen is automatically adapted to the infants' need by measuring the oxygen saturation of the blood. By continuous automatic adjustment of the oxygen content we give, we are better than ever at keeping the fine balance between too much and too little.

Despite these improvements many infants still suffer from the complications of prematurity every year. With this thesis, I hope to contribute to a better life for these infants by researching how the devices for automated oxygen control work, how well they work to balance the oxygen saturation in the blood and, most importantly, what the health outcomes are of the preterm infants treated with these devices.