THE KNOWLEDGE OF INOvent®-DELIVERY SYSTEM AMONG NURSES AT SOME NEONATALS' AND CHILDREN'S INTENSIVE CARE UNITS IN FINLAND

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Title
The knowledge of INOvent®- delivery system among nurses at seven neonatal and children intensive care units in Finland

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Abstract

Intensive care units contain numerous amounts of different devices for many purposes of use. A nurse has to operate a lot of medical equipment not forgetting the clinical treatment as well. The purpose of the Bachelor's Thesis was to chart the gather knowledge of INOvent® -nitric oxide delivery system among registered nurses at seven children and neonatal intensive care units in Finland. Nitric oxide is used for instance to treat babies who struggle with pulmonary insufficiency. The device is basically used rarely, at some wards, only one to two times a year.

The study was designed in a co-operation with the gas company Oy AGA Ab. The company can develop and specify their device education and the wards can improve their expertise and competitiveness with personnel training.

The study method was quantitative and it was implemented with a questionnaire using an Internet program, Digium Enterprise. The study was completed anonymously and the responding was voluntary. The Internet links for the questionnaire were sent by e-mail to the head nurses of each seven wards and the head nurses then distributed the links forward to the nurses of their ward. The questionnaire was completed in February 2010 and it was available for three weeks. The amount of respondents was 67. The results were able to analyse with the Digium Enterprise program which precipitated the analysing process notably.

The results indicated that registered nurses' knowledge of INOvent® is very good; anyhow supplemental training is wanted and needed on behalf of the manufacturer yearly. As a conclusion of the results it is seen that the nurses want to develop their professional skills regularly as well as educate themselves and update their knowledge base.

Keywords
Personnel training, Internet questionnaire study, nitric oxide, medical device, registered nurse, AGA

Miscellaneous

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Työn nimi
Sairaanhoitajien tietotaito osaaminen INOvent®- jakelulaitteesta seitsemässä Suomen vastasyntyneiden ja lasten teho-osastoilla

Koulutusohjelma

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Tiivistelmä

Teho-osastoilla on lukuisia määriä erilaisia laitteita moniin eri käyttötarkoituksiin. Sairaanhoitajan kuuluu hallita niin monimutkaisten laitteiden käyttöä kuin kliinistä hoitoakin. Opinnäytetyön tarkoituksena oli kartoittaa sairaanhoitajien tieto-taito osaamista INOvent®- typpihoito jakelulaitteesta seitsemässä Suomen vastasyntyneiden ja lasten teho-osastoilla. Typpihoitoa käytetään mm. vastasyntyneiden hengitysvajauksessa, ja joillakin osastoilla vain 1-2 kertaa vuodessa sen harvinaisuuden vuoksi.

Tutkimus toteutettiin yhteistyössä kaasuyhtiö Oy AGA Ab:n kanssa ja se on tarkoitettu hyödynnettäväksi yrityksen laitekouluttajien työhön. Halutessaan sitä voivat myös hyödyntää vastasyntyneiden- sekä lasten teho-osastot ja muut teho-osastot, jossa kyseistä laitetta käytetään.

Tutkimus muoto oli kvantitatiivinen ja se toteutettiin käyttäen Internet -kyselyohjelma Digium Enterpriseä. Tutkimus toteutettiin anonyymisti ja vastaaminen kyselyyn oli vapaaehtoista. Kyselylomake linkit lähetettiin sähköpostitse osastonhoitajille ja he välittivät linkin kyselyyn eteenpäin osastonsa sairaanhoitajille. Kysely oli avoinna helmikuun 2010 alusta kolme viikkoa. Vastaajia tutkimus keräsi yhteensä 67. Tulokset oli mahdollista analysoida Digium Enterprisen avulla joka nopeutti huomattavasti analysointi vaihetta.

Tutkimuksessa selvisi, että sairaanhoitajien tieto-taito INOvent®- jakelulaitteesta on hyvä, mutta lisäperehdytystä tarvitaan sekä halutaan toteutettavan laitevalmistajan puolesta vuosittain. Johtopäätöksenä tutkimuksesta voidaan todeta, että sairaanhoitajat haluavat kehittää ammattitaitoansa säännöllisesti ja kouluttautua sekä päivittää omaa osaamistaan.

Avainsanat (asiasanat)

Perehdyttäminen, sairaanhoitaja, Internet- kyselytutkimus, typpihoito, sairaalalaite, AGA

Muut tiedot

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1 INTRODUCTION

The need for intensive care units (ICU) in Finland emerged from the field of surgery in the 1950's. There was a need to continue intensive care with patients after surgery and, furthermore, unfortunate pandemics and difficult infection diseases in the 1950's further increased the need of ICUs. The first intensive care units were built in Helsinki and in Kuopio University Hospitals in the 1960's. Hence, the definition of an ICU in Finland is rather new. (Kaarlola 2008; Kari 2008.) The first children's hospital in Finland founded in 1893 and at the same time, the education of pediatrics started to develop. Infection diseases and child mortality were an ordinary issue at that time. The most significant person to influence to the development of pediatrics was a pediatrician, Arvo Ylppö. (Muurinen & Surakka 2001, 12.)

ICU includes highly developed expertise and new, updated medical knowledge. All this does not come automatically by itself. Consequently, there is a constant need for good, functioning training programs and ongoing training possibilities on various topics, for instance, device orientation for registered nurses. (Lundgren-Laine & Suominen 2009.) Personnel's training is part of the development of working life, as well as that of an organization. An employee is a key factor in clinical orientation and the initiation of the employees is a considerable tool in the organizational development and expertise. (Pohjonen 2005, 79.)

An ICU contains countless numbers of different devices, machines and medical units for a great variety of uses. Medical devices which enable a continuous follow-up of a patient's vital functions are extremely important tools for the ICU environment. Moreover, some of the medical units can be used to, first of all, keep a patient alive. However, the truth is that nurses and doctors are the ones who conduct the treatment, and the devices can only work in their hands. In addition, not one of the devices can improve the treatment unless the nursing team using it is qualified enough. Nurses need practical and theoretical skills to work with different medical machines everyday at clinical practice. (Blomster, Mäkelä, Ritmala-Castren, Säämänen & Varjus 2001, 10; Hankonen 2009.)

AGA Ltd wanted a study on registered nurses' knowledge and skills related to the use of the INOvent® -delivery system and also to collect information if there was a need for supplemental training or device orientation. The INOvent® -delivery system enables the delivery of inhaled nitric oxide to a patient as required. This study introduces the device used with newborn babies and the results of a questionnaire for registered nurses at five neonatal and children's ICUs in Finland. Babies struggling with hypoxic respiratory failure (HRF) have blood vessels in the lungs constricting and preventing the heart from pumping blood through the lungs for oxygenation. This reduces oxygen delivery to body tissues. INOmax®, inhaled nitric oxide, relaxes pulmonary blood vessels in newborns with HRF, alleviating hypoxemia and reducing the need for high-risk rescue procedures. In addition, the nitric oxide therapy is necessary for babies with a persistent pulmonary hypertension of the newborn (PPHN). (Aikio 2002, 15-16.)

AGA (2009) is a part of The Linde Group, which is the world's largest gas company. They produce different types of gases for different uses, e.g. industrial and medical gases. They also sell different machines and medical devices for the delivery of gases. For instance, nitric oxide gas (INOmax®) is used for medical purposes and can be delivered with the INOvent® delivery system. Furthermore, Linde Healthcare is a part of AGA and Linde Gas therapeutics is available worldwide. Linde Healthcare develops and produces medical gases, medical devices and services, thereby having a major role in the health care system in hospitals and in home care. Linde Gas therapeutics trains nurses for the safety and proper usage of gases and medical machines. (Linde Healthcare Finland 2007.)

Literature review

To review the relevant literature studies about nurses' knowledge and skills related to hospital devices the Cinahl, E-Journal Portal, Ebrary, CINAHL/EBSCO and Terveysportti databases were searched through. The keywords used were, ´nurses' skills´, 'device', 'education', ´technology´, ´device orientation´, ´training´ and ´hospital technology or ICU technology´. In addition, Finnish and English printed books and papers, internet publications and articles as well as expert material from the last

decade were used. An important amount of data came from AGA's own material, meaning INOvent® literature, brochures, guidebooks, instruction manuals, INOvent®- and INOmax®- DVDs, studies on nitric oxide, instructions for the use of INOmax® and guidelines for device orientation by AGA.

Plenty of information and studies about inhaled nitric oxide therapy in neonates and children were found mostly in articles. Licentiate in Medicine, Outi Aikio from Oulu University Hospital is one of the leading researchers in Finland on the use of nitric oxide therapy in premature infants. Many articles and books by Aikio can be found, for instance in Duodecim. There are also a great number of studies about personnel training, education and learning at clinical settings related to other contexts. Books were used to collect theoretical background and formal concepts about training in general, nitric oxide and technology in general. Articles and journals were the best way of collecting updated data of the latest research and they also complemented the information collected from the theoretical viewpoint.

It was soon found out that previous studies on registered nurses' skills with medical devices were fractional. Nevertheless, Tuomi (2008) studied broadly children's nurses' skills and found out for instance that nurses self-rated their knowledge and practical skills as 'very good'. There were few qualitative opinion studies about ICU nurses' co-operation with children and families. There were few qualitative surveys about ICU nurses' co-operation with children and families. Unfortunately, only quantitative studies were found about studying the skills of registered nurses. For instance, Grandell-Niemi, Hupli, Leino-Kilpi and Puukka (2004) made a quantitative study about registered nurses' and nursing students' pharmacological skills. The study revealed that nurses and students had some deficiencies in their pharmacological skills. Nurses had better pharmacological skills than students according to both self-ratings and actual performance in the test. The idea to use both self-rating and test questions (Grandell-Niemi et al. 2004) as the data collection method was deemed suitable for this study as well. In addition Luotola, Koivula, Munnukka and Åstedt-Kurki (2003) studied intensive care units' nurses self-rated skills of their professional skills.

2 NITRIC OXIDE

About half a billion years ago nitric oxide (NO) was one of the common gases in the atmosphere, and toxic for most of the organisms. Still, in 1980 NO was known as pollution, which came out from cars and chimneys, causing acid rains and failures in the ozone layer. (Malo-Ranta 2002.)

NO is one of the smallest molecules found consisting of one atom of nitrogen and one atom of oxygen. Today it is known that NO takes part in many biological functions, in both healthy- and sick bodies and in nature. Since it was found being a free radical, one of the discoverers received the Nobel Prize for it in 1998. (Aikio & Hallmann 2002.) As being a free radical, NO is oxidized, reduced and/or completed with other bio-molecules. NO regulates, for instance, blood pressure, bowel movement, memory, sleep, learning difficulties, depression, sexual potency, anorexia, diabetes, cancer, heart infarction, and drug dependency, blood poisoning caused by shock and tuberculoses as well as other inflammatory diseases. (Malo-Ranta 2002; Aikio 2002, 19-31.)

NO is made of the eNOS-enzyme in almost every tissue, but it is especially delivered in blood vessels, lungs, breathing airways, heart and liver (Malo-Ranta 2002). Blood's hemoglobin carries NO as well as oxygen and carbon dioxide, but hemoglobin binds NO five times faster than an oxygen molecule, thus, NO's half-life is only a few seconds in the blood circulation. NO also works as an antioxidant reacting with other free radicals. (Aikio 2002, 19-31; Aikio & Hallman 2002.)

Nowadays, there are many different types of treatments using NO. When breathing NO by an inhalator, it is mainly used for helping newborns with breathing disorders. It also cures adult patients with anemia or ARDS (Acute Respiratory Distress Syndrome) and prevents blockages of veins after a bypass operation. (Malo-Ranta 2002.)

INOmax® is the product name of nitric oxide registered by AGA and the delivery of it is provided with the system called INOvent®. INOvent® is also a registered name for AGA's own nitric oxide delivery system. (Linde Healthcare Finland 2007.)

2.1 The use of Nitric Oxide in a premature infant

In 1992, two study groups published results of infants treated with NO. A small amount of inhaled nitric oxide was given to six critically ill infants for 30 minutes. The result was that all of them showed quick and significant improvement of oxygen saturation. Nevertheless, the first official and controlled trial was published in 1995 and it had the same result as the previous studies: inhaled NO does improve the oxygenation of an infant. (Aikio 2002, 29.)

When a child is born during the 22nd week of the gestation period or the newborn weighs under 2 500 grams, the birth is premature. Normal gestation lasts 40 weeks counted from the starting date of the last menstruation. The prematurity increases the risk of having illnesses and invalidity, but it is difficult to predict the risks or to prevent a premature birth. In Finland, the proportion of premature babies is from 5 to 6 percent (%) (THL 2009) and the majority of the premature births cannot be prevented but attempts can be made to delay them with medication. (Lääkärikirja Duodecim 2009.)

A premature infant needs to be supervised on the ward for possible complications. Newborns weighing under 1 000 grams are treated in University hospitals, since the treatment is very demanding and it includes many specialities and examinations. Newborns weighing from 1 000 to 1 500 gram are treated in Central hospitals and their follow-up visits are continued until the baby is 1-2 years old. Over 1 500 gram newborns can be followed-up in maternity clinics assuming naturally that the clinic is prepared to treat premature babies. (Hoitoketjut 2010; Muurinen & Surakka 2001, 26.)

Inhaled nitric oxide (INO) has been accepted to be used as a treatment in a premature infant's pulmonary hypertension (PPHN). It is commonly related to congenital or the more familiar term, inherent, heart-failures with babies and children. The biggest threat it poses for premature babies. Acute pulmonary hypertension leads to an increased after load of the heart's right ventricle. This then leads to decreased blood flow in the coronary arteries causing malfunction in the heart. There are also some provocative facts relating to the worsening of the pulmonary hypertension, such as Hypoxia (breathing deficiency), Acidosis (excessive acidity in the body), Hypothermia (low body temperature), Polycythemia (excessive amount of red blood cells in the body), Agitation (agitated in a medical sense which often needs medical attention), Hypovolemia (low blood pressure) or abnormal lung capacity. (Duodecim Lääkärin tietokannat 2010; Räsänen, Leijala, Meretoja, Peltola & Rautiainen 1994, 70-73.)

Short-term care of INO has proved to be very effective in acute pulmonary perfusion deficiency as an intensive treatment. It is actually very laborious to give and use INO as a treatment, because it is a gas which is very effective and fast. Specific care and follow-up equipments are needed as well as knowledge to use them and readiness for fast vital changes of patient care. In the future there may already be an intravenous medication of NO. (Aikio & Hallmann 2002.)

Hurford and Bigatello (2002), two doctors of medicine, explain that, when a baby is to be born, NO increases in the blood vessels of the lungs, causing vasodilatation which decreases the resistance of pulmonary circulation and causes the opening of the embryo's ducts and starting of independent breathing. INO improves selective blood flow in ventilated alveoli. It dilates pulmonary veins and the bronchial tube, improving ventilation and perfusion relations and elevating the arterial oxygen pressure. Since hemoglobin binds oxygen and NO in seconds in the blood, INO improves oxygenation without a systemic decrease of blood pressure.

A small infant's INO-care is still in the research stage because it is such an interesting and difficult gas. Nevertheless, preliminary results indicate that it is very effective in the prevention of a premature infant's chronic pulmonary disease and early bacterial

infection which causes oxygenation problems (Malo-Ranta 2002). According to research, the INO-care has increased the survival of infants. Oxygenation has improved in over 50 % of the treated babies. The side-effects of INO-treatment have been very few, but it may also have some unknown causes. (Aikio & Hallmann 2002.) Some side-effects have been found by the researchers. The high level of NO may cause pulmonary edema. Small infants are known to have low levels of methaemoglobin (which is the form of red blood cell not carrying oxygen), and it should be measured within one hour after the initiation of INO-therapy, using an analyzer which reliably differentiates between hemoglobin and methaemoglobin. NO may also debilitate pulmonary infection. NO_2 forms in gas mixtures containing NO, oxygen and NO_2 and may cause airway inflammation and thus damage the patient. (INOmax® Therapy 2006.)

2.2 Patient safety with Nitric Oxide

In Finland, *Lääkelaitos* (National Agency for Medicines) promotes the health and safety of the citizens by controlling medical and blood products. A medicinal product must have a valid marketing authorisation before it can be introduced to the market and submitted for distribution. Application for medical products can be made either via mutual recognition, a decentralised, centralised or national procedure. The mutual recognition may be used when the product already has marketing authorisation granted by one of the EU Member States. The decentralised procedure may be used in the products which do not have a marketing authorisation in any Member State. The centralised procedure is used when marketing authorisation is applied within the EU area for new biotechnological or medical products. The national procedure can be used when application is made for the first time in EU for a product. (Lääkelaitos 2009.)

INOmax® received the marketing authorisation on the 1st Aug 2001 and is the only inhaled nitric oxide which is licensed to be used in humans. The owner of the selling permit is INO Therapeutics AB. The disposal terms for INOmax® by Lääkelaitos (2009) are; the treatment has to take place in premature infants' intensive care units and

the prescription of INOmax® should be supervised by a physician experienced in neonatal intensive care. (Op. cit.) INOmax® should be delivered according to a neonatologist's prescription and should be used in ventilated infants expected to require support over 24 hours. (INOmax® Therapy 2006.)

Certain fundamental issues related to patient safety are important when using any medicinal products with children. The medicinal effectiveness needs to be carefully proven since the pharmacokinetics and pharmacodynamics are essentially different compared to adults. It is salient to consider the growth- and developmental stage of a child when planning a medical treatment. The medical treatment can then be designed by the proportion size, medical form and medical route. It is a fact that children and adolescents belong to a group in which the least attention has been paid to medical safety. However, it is easy to imagine that the topic is very difficult to study in the first place. Many of the medicines with children are therefore used and modified based on the experience of adults' medical treatment. (Lääkelaitos 2009.)

3 TECHNOLOGY AT INTENSIVE CARE UNIT

A patient has once described the ICU environment: “Sophisticated monitors surround the bed, the electronic screens spewing out a torrent of data…hurried nurses and physicians: how to make sense of all that data.” (Rotman 1999).

Boud and Garrick (1999, 18) state that the effects of technological change can be seen as the division of labour and specialization, the patterning of skill and the role of human labour in production. The effects on skill demands affect a worker’s experience and sense of value at the workplace drastically. Nowadays, skills are acquired and respected at the workplace, thus not forgetting the development which provides constant learning at work. “The worker is able both to perform a wider range of tasks and take responsibility for the overall operation…”

Highly developed automation and new technologies have integrated fragmented tasks so as to almost force the employers for `multiactivity´. “Workers must be willing and able to learn and perform new tasks, take different roles and be easily redeployed in the flexible new workplace.” (Op. cit. 16-18). This can be easily connected to the work in the hospital environment since the lack of employers is great and the patient material varies a lot. The nursing personnel need to be qualified to treat the patient and use the machines with the treatment, not forgetting reporting and clinical observation. (Kaarlola 2008, 23.) Wikström & Sätterlund-Larsson (2003) state that the nursing personnel must be equally trained to handle technological tools. `Good´ hospital technology provides information, offers parameters and saves human lives (Almerud, Alapack, Fridlund & Ekebergh 2008).

By the side of caring of critically ill patients, technology is a part of intensive care units’ daily life and both caring and highly developed technology live harmonically in a symbiosis (Almerud et al 2008). A patient at ICU is extremely dependent on the nursing personnel and the equipment that are connected to him to monitor the vital functions, e.g. heart rate, blood pressure, breathing, temperature and not forgetting

the special devices. Depending on the character of the ward, there should be already fabricated or fast buildable devices for rapidly changing situations. (Blomster et al 2001, 9-11.)

At ICU, the human body becomes measurable and, to some extent, predictable and controllable via electronic devices. The health care professionals, who have adequate medical training, do realize, however, that the machines are not panacea. This is where education has a vital role. Technology dominates the ICU milieu but at the same time, the nurses monitor the technology and benefit from it. In a life threatening situation, a nurse needs technology in order to receive objective information about physiological processes. “It is lifesaving.” (Almerud et al. 2008.)

3.1 INOvent®- delivery system

The INOvent® -delivery system enables delivery of inhaled nitric oxide to a patient as required (See Appendix 1). It coheres with every kind of ventilator support mode and offers a diversity of installations to ensure the delivery of the exact amount of nitric oxide as required by the patient. It also enables a constant monitoring of NO, NO_2 and FiO_2, (fraction of inspired oxygen). The delivery system is connected to the respirator and the respirator is connected to the patient. Nitric oxide (in this case INOmax®) is delivered to the patient via mechanical ventilation after dilution with an oxygen or/and air mixture using the INOvent® delivery system. (INOmax® Therapy 2006.)

3.2 Personnel training

Since the amount of devices is large at intensive care units, the employees are required to have good skills and knowledge in technology and physics. Generally, the hospitals use their own personnel to educate their employees in a variety of matters, initiating the employees to their work places, as well as familiarizing them with the equipment. When it comes to more special equipment, the education and service is

provided by the manufacturer itself or by the equipment importer. (Blomster et al 2001, 72.)

People are different and thus the methods of personnel training must differ – especially with regard to guidance and teaching. The teacher needs to have the ability to adapt to changing situations. However, it needs to be considered that when building up new strategies for clinical learning, it is almost impossible to pay attention to the different ways of learning by many individuals. (Ruohotie 2000.) Gerber (1998, 168-170) sees important that in the process of clinical learning, the whole individual and his personality, his feelings, thoughts and know-how are considered.

Pohjonen (2005, 47-48) explains professional skills as something that can be viewed from the perspectives of the employees, the employers or education. The concept of skills is related to professional activity but also to constant readiness for changing situations and to the results of the work. Professional skill is a character of an individual which is not permanent but dynamic. It changes due to the environment, assessments, and the demands of the working place but also through the balance of the mind of the individual. The professional skills are not the sum or the collection of different skills; on the contrary, it is an ability to connect the knowledge and mastery of the profession to a meaningful entity.

Pohjonen (2005) refers to Helakorpi (1992) when stating that professional skills can be divided in to six categories: core skills, border skills, silent skills, hidden skills, invisible skills and key skills.

- *Core skills* are the common skills that the employee uses in his work. Generally they are related to the technical ability, interaction relationships, co-operation and different combinations of professional skills. The core skills require the management and practice of knowledge and the basics of skills. Moreover, the right attitude and commitment are included in core skills.

- *Border skills* are the skills that support the basic skills and the core skills. They widen the core skills and give them perspective. In other words, the border skills require deeper knowledge of the profession.
- *Silent skills* are an important part of the professional skills. They appear in practical and functional knowledge which is part of the overall management. The silent skills are generally used in complicated- and problem solving situations. The skills are improved via long working history and experience.
-*Hidden skills* are, as the term implies, skills, which generally are kept as a secret from one's employer and colleagues. The purpose of hidden skills is mainly to maintain the person's own professional status and the appreciation of one's work.
- *Key skills* are commonly the skills that are used to gain new skills or solutions to the problems at work. Typical key skills are, for instance, communication skills, co-operational skills, leading skills and learning skills. They are usually related to situations that require new and unusual working methods. (Op. cit. 48-49.)

The professional education, working environment and the whole surrounding society changes and new requirements arise all the time. Tough schedules of the working life demand flexibility and rapidity, which means that formal education, has to respond to the demands as well as possible. The demands for working life are becoming polarized: on the other hand, we are required to have wide knowledge and mastery of subjects and process that is to say a universal education. At the same time we are also expected to master some top skills in a specific small-scale area. (Pohjonen 1997, 288.)

Pohjonen (2005, 78) refers to Järvinen (1998) when saying that entrepreneurship life has criticised traditional course education outside the working environment as being too narrow and inadequate. Since that, education and personnel training have been seen in slightly different perspectives. The significance of know-how as a success factor of an organisation has grown in this society and training needs to be a

seamless part of a company's development and of the development of individuals' own work.

3.3 Device orientation

The use of the INOvent® -delivery system requires not only the manual skills of the employer but also the knowledge of and interest in the device and conscious reflection. People's abilities to learn certain issues are different. The time and practices used in learning differ as much as the people. The determinations of professional skills, clinical- and situational learning are needed since this study will concentrate on employers' skills and capability to manage the INOvent®-delivery system.

The INOvent® delivery system presumes a constant inhaled nitric oxide concentration irrespective of the ventilator. It achieves a continuous flow of neonatal ventilator by infusing a low flow of INOmax® into the inspiratory limb of the ventilation circuit. Occasional flow ventilation can be associated with spikes in INOmax® concentration. The delivery system for occasional flow ventilation should be suitable to avoid spikes in INOmax® concentration. (INOmax® Therapy 2006.)

The inhaled INOmax® concentration should be measured continuously in the inspiratory limb of the circuit near by the patient. Also the nitrogen dioxide (NO_2) and the fraction of inhaled oxygen ($FiO_{2)}$ concentrations should be measured by using calibrated and approved monitoring equipment. For patient safety, it is extremely important to have appropriate alarms set for INOmax®, NO_2 and $FiO_{2.}$ Nitric oxide gas cylinder pressure should also be displayed in order to allow timely gas cylinder replacement without the loss of treatment. INOmax® therapy should be also available for manual ventilation such as suctioning, patient transport and resuscitation, because anything can go wrong with the lack of education or a system failure. (INOmax® Therapy 2006.)

When training hospital personnel some of the key elements are very important, since the need to use nitric oxide therapy may occur rapidly and it does not look at the

time or place or personnel on the ward. These procedures are the main features when AGA is orientating personnel to use the device correctly.

1. Correct set-ups and connections to the gas cylinder – INOvent® delivery system – ventilator - patient breathing circuit. The correct set-up instructions can be written near the delivery system. It is important that the connections to the gas cylinder and to the ventilator's patient breathing circuit are made correctly. During the training it should be done many times, so that no failures will occur.
2. The correct settings of the INOmax®, NO_2 and O_2 monitors for high and low alarms limits. The physician prescribes the correct limits, but the nurse needs to set up and control them by using the device correctly.
3. The correct procedures for switching the gas cylinder and purging system on and off. It is important to handle the gas cylinder correctly and to know how to purge NO_2 out of the tubes. (INOmax® Therapy 2006.)
4. The calibrating of the medical device has to be done at designated intervals in order for values to be reliable and accurate. (Linde Gas 2007). The device is calibrated for nitrogen and oxygen. (Pöysti, AGA.)
5. Every personnel member using the delivery system should also be trained for the manual backup delivery system so as to have the skills of suctioning and manual ventilation. Resuscitation should be updated with every member of hospital personnel. This is important when working as a nurse.
6. Before every use of the delivery system, it is important to pre-use the system and have a check list nearby. In this way all the problems during the use can be avoided. Monthly system performance check-up procedures must be also done and are usually done by a person who is trained to do so. (INOmax® Therapy 2006; Pöysti, AGA.)

3.4 Device safety

Valvira, National Supervisory Authority for Welfare and Health, improves the control of environmental health risks through guidance and supervision as well as ensures the quality of services and implementation of people's legal protection. It also controls and supervises the operations of health care organizations and professionals. Since the 1st Nov. 2009, all medical devices used in health care have been under Valvira's supervision as well. Before that they had been under the supervision of the Finnish Lääkelaitos (Lääkelaitos 2009). Now, the responsibility is to improve the safe usage of medical devices and ensure their quality demands. (Valvira 2009.)

Medical devices that are in accordance with the existing regulations can only be placed on the market or into service in Finland. When a new product is placed on the market, the manufacturer must be able to establish its safety, suitability for use and its performance. The device must also bear the CE marking which proves its licence. Professional users, e.g. hospital personnel, have a duty to ensure a safe use of the devices, the availability of instructions and training for operating. The proper use of a medical device must not harm the safety or health of the patient, user or other persons. The INOvent® -delivery system has the CE marking and the development and safe use of the device is regulated by AGA and Valvira. (Op. cit.)

Some instructions are important when handling gas cylinders of nitrogen (See Appendix 2). The handling of cylinders is immediate when changing the gas cylinder. In order to avoid all incidents, the following instructions should be respected:

- The good condition of the material (in this case the cylinder) should be checked before use by seeing that the cylinder is not damaged.
- The gas cylinder should be fixed and stowed away in order to avoid falling. Nevertheless, the cylinder should be close by but in a secure area.
- The valve of the cylinder should not be opened by using too much force. If, however, it is opened in that way, the valve should not be repaired.

- A gas cylinder whose valve is not protected by a cap or a shell should not be used, because of personnel and patient safety.
- The pressure of the nitrogen (N) -nitric oxide (NO) mixture should be purged before each new use, in order to prevent nitrogen dioxide (NO_2) inhalation. Inhalation of NO_2 may cause airway inflammation and damage. (INOmax® Therapy 2006.)

4 AIM AND PURPOSE OF THE STUDY

The aim of the study was to determine the need for device orientation and to measure the knowledge of the nurses of the INOvent®-delivery system. The purpose was to improve the care and safety when using the INOvent®- delivery system. The study was also aimed to be a benefit to the co-operation wards as well as to the co-operation company, AGA. Based on the aim and purpose of the research, the problems were formed as follows:

1. Is there a need for supplemental education on the INOvent® -delivery system from the nurses' perspective?
2. How do the nurses self-rate their practical skills with the INOvent® -delivery system?
3. What is the nurses' actual knowledge base with the INOvent®-delivery system?

The need for supplemental education was studied since the INOvent®-delivery system is rather new at some wards as well rarely operated. Toxic gases, causing possible damage to the patient when misused, are delivered through the device, making safety issues extremely important. Correct use and concrete device orientation are important to ascertain that the personnel, mostly nurses, are qualified.

5 PROCEDURE OF THE STUDY

The study method was quantitative which stands for a studying method where there are commonly used specific, countable, statistical methods. The term is mostly used among anthropology such as sociology and pedagogies. In a quantitative study the researcher is attempting to collect empiric data. The term, empiric data, means a kind of data which is collected by observation and is dependent on evidence. The data collection method can be, for instance, interview or a letter questionnaire. The quantitative research method is convenient for large masses of people and it is common to use statistical models and numerical values to explain and clarify the data. (Hirsjärvi, Remes & Sajavaara 2007, 135-139.)

Permissions

Research permission forms were needed from the co-operation wards. In the permission sheet, the aim and purpose was determined and the permission to question the nurses was asked. The permission forms and the copy of the plan were sent to the ICU head nurses of the hospitals via AGA and as soon as the permission sheets were returned, the questionnaire was distributed by the head-nurses to the nurses via e-mail.

Sample

There are five hospitals in Finland, four University Hospitals and one Central Hospital, which have more than one ward with the INOvent® -delivery system. Thus, the overall amount of children's and neonatal ICU ward units is seven. Each ward has about fifty registered nurses. The sample was formed mostly by the action of the head nurses, since they were distributing the e-mail links forward to the ICU nurses. The sample was formed on the basis of the size of a certain ward and the character of the e-mail list kept by the head nurse. Most head nurses had lists which included all the registered nurses of their wards. There were no selections of who the mail would be sent to. Thus, the overall amount of sent questionnaire links became 207.

The respondents divided in two groups based on the ground factors; 74 % (N=49) of the nurses had worked at the ICU for over 5 years.

5.1 Methods

Nowadays, the questionnaires can be answered online in the Internet environment, contrary to the more traditional paper questionnaires and phone interviews. One benefit of it is its economic efficiency, not forgetting that the answers already are in the form of an electronic file, thus making it easier to attach them in to the written part of the study. Unfortunately there are downsides as well, for example, respondents' high age can lead to lower amounts of answers since the Internet can to some of them be an unapproachable environment. Moreover, even though the e-mail is well known nowadays, not everyone visits their Internet-mailboxes every week. Mostly young people tend to answer to Internet questionnaires more easily. (Aaltola & Valli 2007, 111.)

The questionnaire was designed for the purposes of this study by the researchers in co-operation with AGA. It took place in the Internet environment using the Digium – program to compile the questions. The main reason for using an Internet program was that it was easier to reach the study group which was located geographically scattered in Finland. A secondary intention was to simplify the data collection as well as the data analysis. The Digium - program includes all the features that are needed to collect and analyze data. There are possibilities to make all kinds of graphic summaries and models of the results and modify them to benefit different study designs. (Digium Enterprise 2008.)

Primarily the instrument was constructed of closed questions but it also included three open questions. Thus it can be said that the questionnaire was a combination of the two. In a primarily closed questionnaire it is correct to have at least one open question for expressing an opinion or a thought. Some of the advantages according to Neutens and Rubinson (2001, 117) of a closed questionnaire are:

- Easy for the respondent to complete.

- Coding and analysis are simple since the questions can be precoded.
- A minimum amount of irrelevant responses. (Op. cit.)

On the other hand, there are some disadvantages of the closed questionnaire as well:

- There is a list of potential answers already, the respondent may guess or randomly select an answer.
- The respondent may become frustrated since he or she cannot find an answer that suites one's opinion,
- Thus the respondent may circle a ´wrong´ answer. Or, alternatively circle a 3 instead of a 4. (Op. cit.)

5.2 Data collection

The questionnaire was used to collect data of how the nurses self-rated their practical skills with the INOvent® -delivery system and what the nurses' actual knowledge base was toward their self-rated answers. One purpose was also to collect information if supplemental education was wanted and needed. The Internet questioning was completed at the beginning of February 2010 and it was available for three weeks. The questions were answered individually and the researchers were not at the scene supervising the situation (Neutens & Rubinson 2001, 78). The questionnaire sheet was available in Finnish since it was easier for the nurses to answer it by using their mother language. The time that it took people to answer the questions was approximately from ten to fifteen minutes, and the nurses could do that at their computers in the Internet environment e.g. at their workplace.

The Internet link to the questions was sent by e-mail to the head nurses of each ward, and the head nurses distributed the link forward to the nurses. At the beginning of the questionnaire there was a covering letter (See appendix 3.) to introduce the researches and to clarify the aim and purposes of the study. The respondent was given an opportunity contact the researchers if needed and the appropriate contact information was available at the end of the covering letter. It

was explained there that the time that it took for a person to answer was approximately going to be ten minutes. It was also defined that the responding was totally voluntary and anonymous. Neutens and Rubinson (2001, 128) refer to Scott's (1961) study on which sort of issues in the cover letter affect the attitudes of the respondents. One aspect stated that a "permissive" letter obtains a greater number of responses than a "firm" letter does. In addition, a short and compact letter is better than a long, logical appealing letter. However, they also refer to Wiersma (2000) who recommends an official letter with the researcher's signature to be the one that can be used most widely.

Question 1 was an open question determining the education of the respondent. Questions 2 and 7 determined the length of employment and the general usage of the device; they were closed questions (See appendix 4). A short, one word answer was expected for question 1 and the answers for question 2 could be selected from two choices. Questions 3, 4, 5 and 6 were multiple questions to determine the nurses' actual knowledge of the device and the use of device. The test questions had four statements with one right answer. The nurses did not know about the test questions beforehand, so it was proper to make the test questions comprehensible and not too demanding. Nevertheless, the respondents could still have the opportunity to ask from their colleagues or look for the right answer on the Internet. Question 8 was a self-rating question, where four subjects were listed in which the respondent could indicate a particular view from the opinions that best described the feeling on that matter. Question 9 was an open question to tell more what the respondent wanted to learn about the INOvent®- delivery system. Questions from 10 to 14 were opinion poll questions to determine the need for device orientation. These were closed questions with multiple choices available. The last question, 15, was an open question giving an opportunity to free comments.

5.3 Data analysis

By analyzing the data, the researcher is able to make generalizations about the results and is able to understand some societal generalizations. The instrument was

able to work together with the Internet-program in a way that the respondent had to pick a choice out of the multiple answer choices; otherwise he/she was not able to proceed. Therefore, the number of excluded answer sheets could be minimized. The necessity to answer was only at the closed questions. The open questions were voluntary. As the instrument was a combination of closed and open questions, it was not deemed necessary to analyze the open questions qualitatively. Some of the open questions were brought out to the answers as they were written; only translated in English. The answers were included in the text with the other answers. (Neutens & Rubinson 2001, 253-270.)

The questionnaire was compiled with the Digium- program which also enables the researcher to conduct the data analysis. There are several analysing methods and models available as required by the case. Since the results already were in the electronic form, it was easy to add the results and the data summaries to the written study. This way, the possible errors and mistakes with the data input diminished. (Digium Enterprise 2008.)

6 RESULTS OF THE STUDY

The average time that it took for the respondents to answer the questionnaire was 10 minutes (624s.), and they had mostly answered at night (n=23) or in the morning (n=23). The times were determined by the schedule of most wards' three-shift work, morning: 07.00 – 15.00, evening: 15.00 – 21.00 and night: 21.00 – 07.00. The total number of responses was 67 (N) forming the response percentage of 32 %. Nevertheless, the number of failed response sheets was 47. The percentage quantities were rounded up to even numbers to simplify reading. (See Appendix 4. where all the answers are in a graphic form.)

6.1 A need for supplemental device orientation

The nurses' responses to the training questions implied that there is a need for supplemental training. The question about the origin of the training was a type of a question where more than one choice was selectable. The total responses to this particular question were 96 (N), meaning that 29 people had answered more than once.

84 % (N=56) told that they had received the training for INOvent® at their workplaces, given by a colleague or by a mentor. 46 % (N=31) received the training by the manufacturer, in this case by AGA. The rest of the respondents chose the third option: by someone else. The answers where for instance: "have not had training", "from research", "from a guidebook". However, among the open ended questions, there where answers like: "Linde gas therapeutic", "manufacturer agent". These answers could be included in the second choice of answers, 'had received the training by the manufacturer', and in that event, the answering percentage becomes 52 % (N=35).

The questions of 'who should be giving the device orientation' were answered: 49 % (N=33) would like to receive orientation from the manufacturer agent and 45 % (N=30) responded that the orientation would be provided by the employer.

The question about ´how many training times have you had´ was responded: no training (0) 18 % (N=12), training times (<2<) 51 % (N=34) and training times (<4<) 31 % (N=21).

The question about 'how many training times would you like to have' was responded: 2-3 times per year 54 % (N=36), yearly 42 % (N=28) and every second year 4 % (N=3). This refers to the fact that even though over 50 % have had one to three device orientation times, however 54 % would like to have two to three training times per year. It was clear that the nurses saw themselves in need of more training. (See Figure 1. the results of 'if one needs more training'. 'Yes'/blue 64 % (N=43), `No´/purple 27 % (N=18) and ´Do not know´/beige 9 % (N=6))

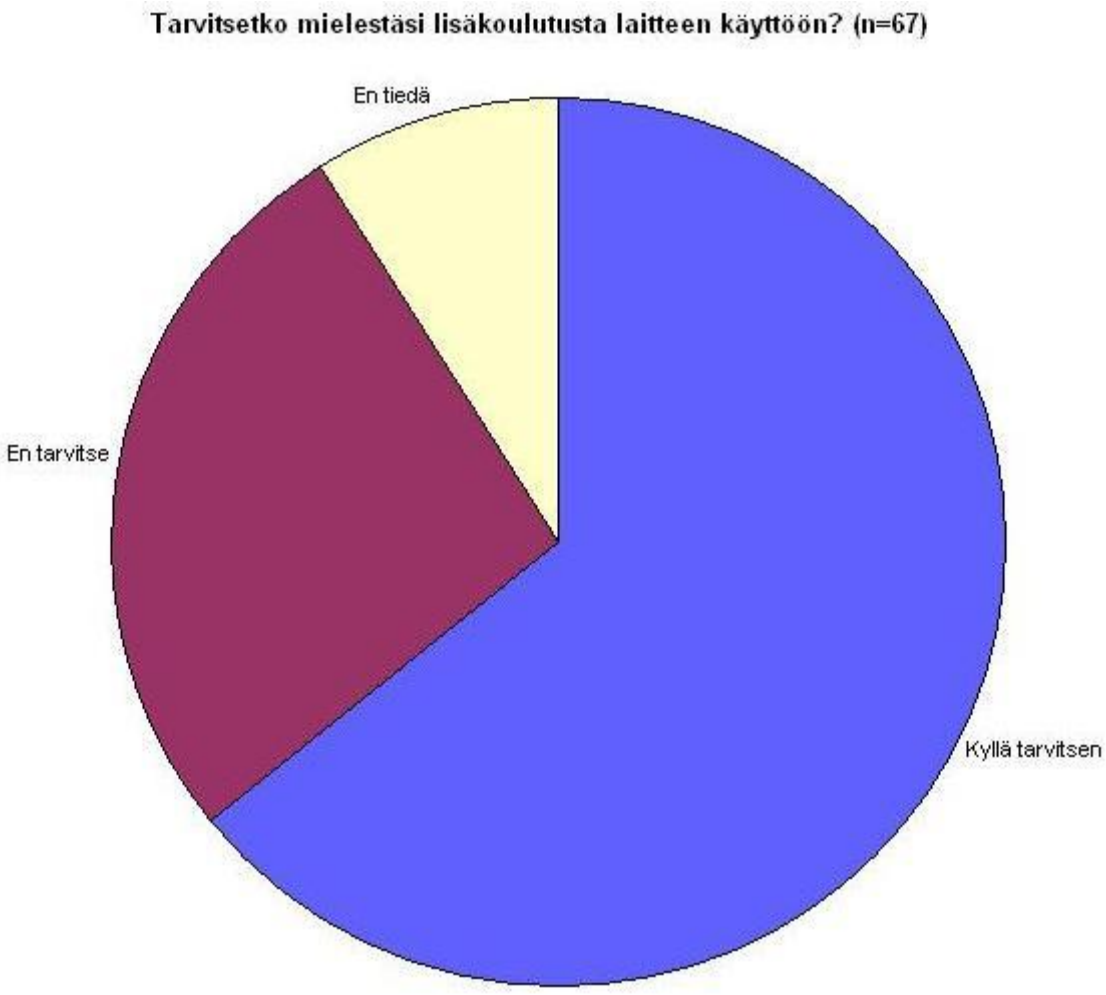

Figure 1. Do you need more device training with INOvent®?

6.2 Nurses' self-rated skills with the INOvent®

The chart to evaluate own skills with the INOvent®- delivery system was scaled from 1 to 5. The average value of ´how well the nurses feel they could activate the device and what sort of matters the start up situation included´, was 3,34 out from 5 meaning good knowledge of the situation. The start-up situation at scene includes the manual instructions of the device, which naturally facilitates the start-up situation even if the person activating the device has not done it many times.

´To calibrate the device´ was valued as 3,31 out from 5. The calibration is meant to set up the oxygen and nitrogen levels correctly. ´To change the INOmax® cylinder´: 3,38 out from 5 gathered most know-how and this procedure is important to manage that the NO_2 is purged out of the tubes to avoid the toxic gas going in to the patient, in this case the baby.

The most difficult to manage with the device was seen to be the problem situations including alarms, 2,97 points out from 5. This can be considered from multiple perspectives, for instance, nurses can be unsure with the problem situations if they appear rarely, which then actually is a positive issue. Another perspective is that which sort of matter is seen as a problem situation, for instance, is it a real problem situation, if an alarm is turned on. Furthermore, people's experiences of problematic situations differ, in a way that the same situation can be experienced totally differently by different persons. (See Figure 2. the values of self-rated knowledge.)

Overall, the self-rated knowledge of INOvent® is rather good. Consequently the nurses' self-rated knowledge base on a scale from 1 to 5, meaning one is poor knowledge and 5 is expert, was 3,25, thus very good. (For more detailed figures of each area, see appendixes 5, 6, 7 and 8.)

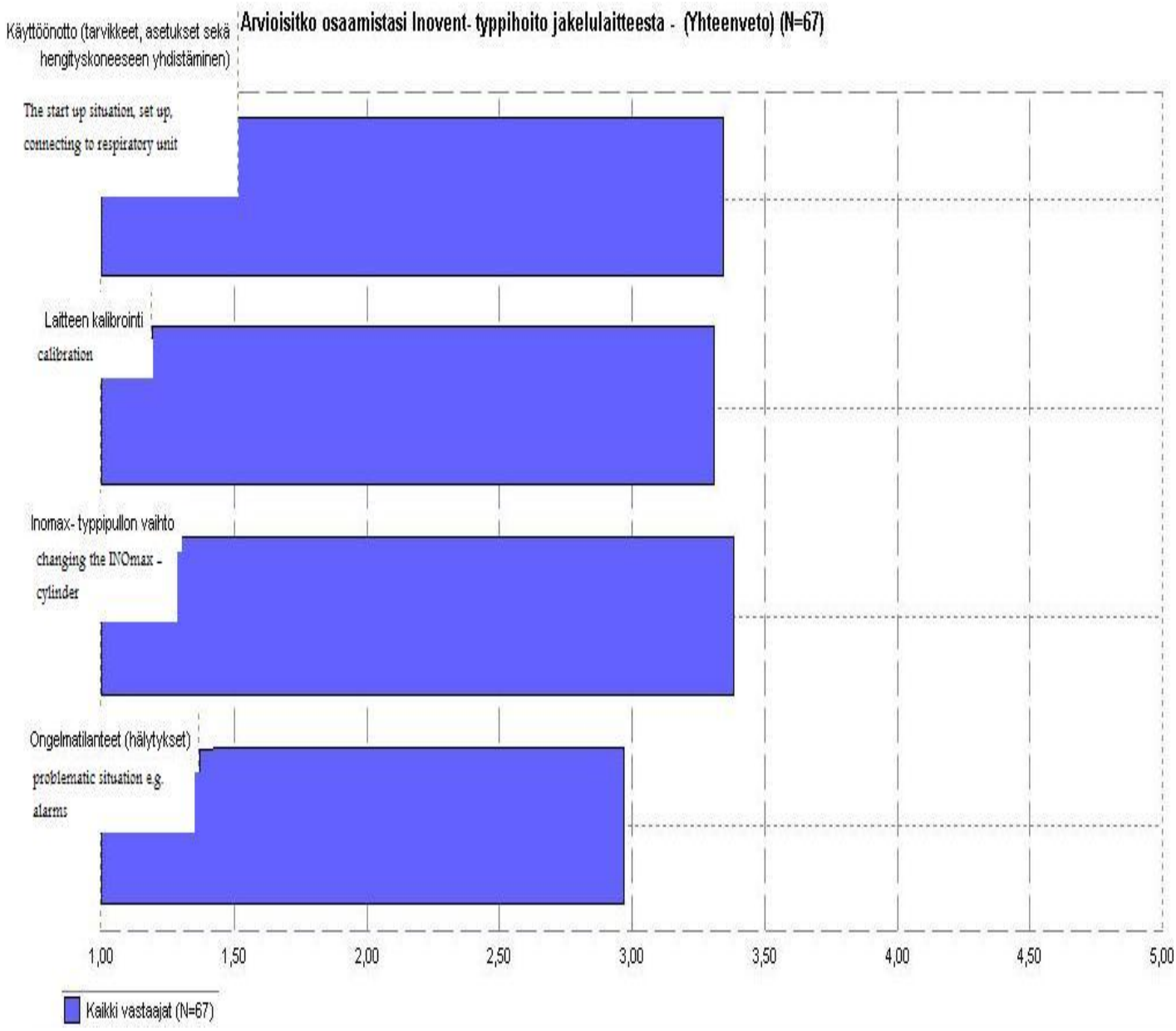

Figure 2. Nurses self-rated skills with INOvent®

6.3 Nurses' actual knowledge base of the INOvent®

There were three questions about the actual knowledge base with one correct answer. 87 % (N=58) answered correctly that INOvent®- delivery system is used to treat newborns with breathing disorders. Nevertheless 97 % (N=65) answered that they would know on what occasion the device is used, the question was answered by

´yes´ or ´no´. The question about ´which medical gases are used with the device´ had 63 % (N=42) correct answers, anyhow at this question all the options were correct in a way that the right answer was that all of the concentration of these gases should be monitored. 73 % (N=49) answered correctly on ´important facts to monitor with INOvent®´.

The average knowledge base is then calculated as 74 % which is a great actual knowledge base of the device. The actual knowledge base questions were designed rather easy and simple to answer since the nurses had no background information about the questionnaire. Meaning that they would have has an opportunity to memorize the facts about INOvent®. Nevertheless it was seen important to have the actual knowledge base test questions included in the questionnaire.

All the knowledge base questions could easily be compared with the question ´how often do you use the devise at your work at ICU´, since, the more one uses the device, the wider the knowledge base and skill level is. Mostly people use the devise yearly 40 % (N=27) but weekly users are significantly much, 15 % (N=10). (See Figure 3. explanation of 'how often the nurses use the device'. Yearly/beige, monthly/purple, weekly/dark blue and less than yearly/light blue.)

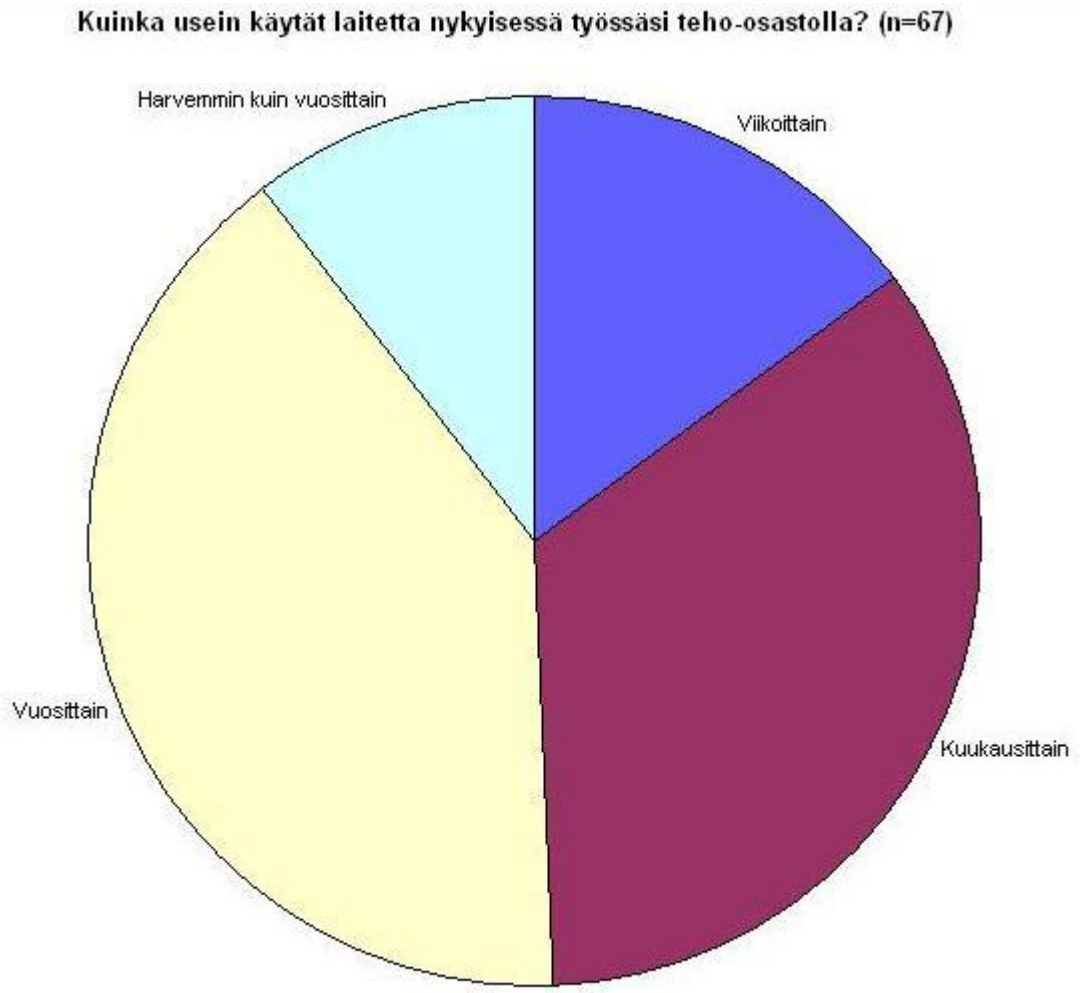

Figure 3. How often do you use the device at your current work in ICU?

7 DISCUSSION

7.1 Conclusion of the results

As a conclusion of the device training questions it is found out that the orientation is mostly provided inside the work place, nevertheless over fifty percent of the trainings are provided by the manufacturer as well. This again tells, that on top of the orientations by the manufacturer, the employee is providing orientation by themselves as well, which is a good matter, not leaving the manufacturer's orientation as the single training for the employers. The more the training times, naturally the more experiment and assurance with the device. Anyhow, some of the responders pointed out, that it can be a disadvantage if there are many initiatives, all orientating differently.

It is naturally a good matter that the device is used rarely; thereby the amount of dangerously sick babies is lower. On the other hand the skills can only be improved via training and usage. Therefore, the amount of device orientation times, for instance training with dolls, need to be regular and sufficient. Quickly changing situations at neonatal and children treatments are appearing fast and sudden, thus the device orientation needs to be fresh in mind and the skills well trained. Nurses need to be aware at all times therefore having good practical skills as well as knowledge of using variable devices at ICU.

When a newborn needs an inhaled nitric oxide treatment the situation is critical. The nurses have to be able to connect and set INOvent® -delivery system correctly into respirator, calibrate the system and clear the tubes out of toxic NO_2 gas, set correct lower and upper limits of gases as required, check and handle the gas cylinders and device itself correctly, and at the same time take the orders from a physician and observe the newborn. In some neonatal wards the device is use so rarely that some important procedures could be difficult to remember. (INOmax® Therapy 2006.)

Even though the nurses actual knowledge base was very good (74 %), clearly over half (64 %) still wanted to have supplemental and repetitive training periods. This refers to big thirst of learning and wanting to do a one's best at work, saving human lives, as well as wanting to take a great responsibility when treating babies. This naturally is a very good result since ICU nurses are required wide knowledge of several of matters for instance of clinical treatment, different kinds of machines, reporting and diseases (Boud & Garrick 1999, 16-18; Kaarlola 2008, 23). The professional skills thus play a big part of how well a person is able to adjust to different situations (Pohjonen 2005, 47-48). To maintain the professional skills as well as development at personal level requires capability to recognise own necessities to improve. Moreover it demands person's own activity and planning. The responsibility of improving one's professional skills is within oneself. (Haatainen 2007).

The results of nurses' self-rated practical skills refer to capability to consider own skills and be able to see on which developmental level a person is with the device. The result 3,25 on a scale from 1 to 5 seems to be at a good level. Nevertheless it needs to take under consideration that there is a difference on how people tend to criticize or value themselves. Some of us could be very self critical where other have a high trust on their skills or are more self confidence than others. At the study of Grandell-Niemi et al. (2004) it was noticed that people tend to self-rate their skills higher than they actually are. The same kind of result came out from this study as well. The nurses responded that they would know on which occasion the machine is used 97 % (N=65) where on the other hand only 87 % (N=58) knew correctly why the machine is used. However, this is a small evidence of the self-evaluation since the actual practical skills were not tested for instance on the scene.

A conclusion of open-ended questions, meaning the free-word section, clearly showed that the device orientation and the machine itself were criticised. The nurses would like to have the device orientation more repeatedly and represented in a more clear way, using 'common sense language'. The device was criticised of its' complex use and settings compared to its' rare use.

"The device orientation should be given so many times that every experienced nurse can do it "

"The primary training should naturally happen inside the ward; nevertheless every now and then it is good when the manufacturer agent comes to have the training so that the equipment person in charge could update their knowledge."

"It's easy to forget the skills after the orientation when one's own turn to use the device comes up."

Nurses' comments about the orientation showed that the orientation should be even clearer and appear frequently. Most of the responders would like to have the orientation from the manufacturer, but is this really the best way to get the orientation of the devices. In this study there is no evidence about who is the best instructor, the manufacturer or the ward itself, since there was no clinical test of handling or extensive test of the actual knowledge base of the device. At this study there was asked, from where the nurses would like to have the training from. Interestingly, no-one answered 'school' as their source of orientation. This leads to the fact that school does not take any responsibility to educate special technology or the hospital devices. The reason is probably simply explained that there are numerous amounts of different devices.

Mostly, small amount of device orientation is included to practical training periods. An idea from a manufacturer is that device agents of different companies would have lectures and lab skill sessions in schools. Therefore, the primary orientation would come from the school and when starting to work at the specific ward, no primary orientation would be needed from the ward, meaning that people would have some knowledge base of the devices already. Anyhow, there are still some disadvantages about this phenomenon, that after graduation from schools, nurses have the opportunity to go anywhere to work; it may not be the place that a person had studied for. Possibly the wanted work place is topical until after few years. By that

time, the trainings of different devices has most likely forgotten and the initiation at the new work place is a necessity.

Year by year, medicine and technology are developing, thereby even more human lives can be saved by new medication and treatments. Furthermore new devices are developed into market constantly and in hospital surroundings, this may cause that technology is overshadowing the patient care. When technology is introducing new devices into market and therefore to the hospitals, the nurses are supposed to be able to use the devices safely considering patient's safety as well. In fact, it is one of the nurses' responsibilities to be educated and willing to learn to use new devices.

It is said that the responsibilities and requirements are increasing at nurses' profession but is the time and personal resources supporting the development. The hospital technology is developing at fast rate which challenges the nursing personnel to be updated all the time, therefore creating more pressure and stress to perform the professional skills.

7.2 Discussion of the procedure

The amount of responses was fallen short of the target (100 responses) and the reasons may possible be explained with the facts that the responding time was only three weeks and the lack of personal contact with the responders may have had a bad impact as well. Nevertheless, the amount of responses with paper questionnaires would probably been even smaller, since the Internet was quick and it caught people from a wide area. The primary idea at the plan was to raffle an Aqvia – sparkling water maker to reach more responders. Anyhow, one University Hospital did not approve the raffle thus it could not be carried through.

The loss of responders could also be seen as the fact that the internet questionnaire may not be pleasant for all people, for instance older people may not find the answering at the internet comfortable. A reason for 47 failed questionnaire sheets could be reviewed from the aspect that most questions were designed to be 'must to answer', otherwise not getting further. This may have affected some responders to stop answering since they have not found a likable answer option. On the other hand, there might have become an unexpected situation and people are forced to go to work. There have been persons as well who have only wanted to take a look at the questionnaire sheet and thereby the program has counted these as failed answers.

In addition, the success of the questionnaire was greatly liable of the head nurses' activity to distribute the e-mails. Some hospitals wanted to have their own research permission sheets, which made the permission sending difficult and drawn-out. Interestingly Neutens and Rubinson (2001, 108) claim that the months of February and April prefers the lowest rate of responses of surveys. The time that the questionnaire was available in the Internet environment, three weeks, can now be seen as rather short time, even though reminder messages were sent three times.

At the planning stage of the study got a great amount of positive feedback from head nurses and they were excited about the questionnaires and results. During the study, few head nurses gave feedback about the questionnaires: they would have wanted to have specific data of each ward and as many responses as possible.

7.3 Reliability of the results

The errors in the study are naturally tried to be avoided, however reliability and quality of the study can be variable. Thus the reliability of the study need to evaluated. The reliability of the study means that the results of the study can be repeatable. For instance, if the study is done a second time by different researcher and the results appear the same; the study can be seen reliable. The purpose of the study would be that the results are not random but evidence based. (Hirsjärvi et al 2007, 226-228.) This particular study was the first of its' kind and if it is done twice, the reliability is improved. One issue is also that the researches were not on the scene testifying the answering situation, thus the trustworthy of the responders cannot be proved.

Another important concept of study evaluation is its' validity, meaning that the instrument has been able to measure exactly the fact that it was meant to measure. For instance, the responder may understand a question differently than the researches has meant, thus the result is unreliable or at least open to interpretations. (Op. cit.) For instance at this study, the question about 'how many trainings have you participated' was meant to mean the training times of INOvent®. The instrument of this study was pre-tested briefly by the co-company, which thereby improved the validity of this study.

Ethical appraisal

At the covering letter it was explained that the answering is anonymous and voluntary. Sample was gathered in a way that no individuals were exposed thus there were no characters involved. The instrument in the internet environment is designed to be used safely (Digium Enterprise 2008). The researchers were able to access the results for five weeks with safety passwords, and it was not available for third parties for misuse.

Further study proposals

At this study the main purpose was to gather information about registered nurses' knowledge of INOvent®- delivery system. It would be interesting to study families' experiences, how they experience the treatment with INOvent®. At the open questions of the questionnaire, the nurses pointed out that they have proved "miracle healings" with the machine and there could be statistical information that what exactly has been done with the INOvent®. The actual practical skills and the actual knowledge base at the form of an exam could be tested of the nurses. There were not many studies found in general about knowledge and know-how of ICU equipment. A wish from the head nurses in general came that they would want to know accurate information of nurses' knowledge with INOvent® at each ward.

ICUs are full of different devices and there is always a possibility to study and research about other medical devices, for instance to find out the knowledge of respirator. AGA is a global company and the Northern countries are co-operating together, therefore there could be a research of the knowledge of INOvent® -delivery system among nurses in all Nordic countries. A research of different methods of education and the use of device in several countries could lead to the fact that one country may have better orientation or more functioning usage of the device than others. This kind of study would give more opinions for educating nurses to be better users of the INOvent®-delivery system.

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APPENDIXES

APPENDIX 1. INOvent® delivery system

APPENDIX 2. Nitrogen cylinder

APPENDIX 3. Covering letter

Hei, arvoisa sairaanhoitaja!

Olemme kaksi englanninkielisen linjan sairaanhoitajaopiskelijaa Jyväskylän ammattikorkeakoulusta. Teemme opinnäytetyön, jossa keräämme tietoa tehohoitajien osaamisesta käyttää Inovent®- typpihoito jakelulaitetta. Tarkoituksenamme on hyödyntää tietoa tulevaisuudessa laitekoulutuksen kehittämiseen ja samalla kartoittaa sairaanhoitajien osaamista kyseisestä laitteesta. Opinnäyteyön tulokset tulevat Jyväskylän ammattikorkeakoulun ja kaasuyhtiö Oy Aga Ab:n käyttöön sekä sitä voivat halutessaan hyödyntää vastasyntyneiden ja lasten teho-osastot: Helsinki, Kuopio, Oulu, Seinäjoki ja Turku. Tämän kyselyn vastaamiseen sinulla menee n.10 minuuttia ja toivomme, että sinulta löytyisi se aika. Kyselylomakkeeseen vastaaminen on täysin vapaaehtoista ja kysely tehdään anonyymisti.

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APPENDIX 4. Question sheet in Finnish

Inovent- typpihoito jakelujärjestelmä: kysely vastasyntyneiden sekä lasten teho-osastojen sairaanhoitajille

Yhteenvetoraportti

N=67

Vertailuryhmä: Kaikki vastaajat

Olen koulutukseltani:

Kuinka kauan olet työskennellyt teho-osastolla?

	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	Alle 5 vuotta	18	26,87%					
2.	Yli 5 vuotta	49	73,13%					
	Yhteensä	67	100%					

Tiedätkö mihin Inovent -typpihoito jakelujärjestelmää käytetään?

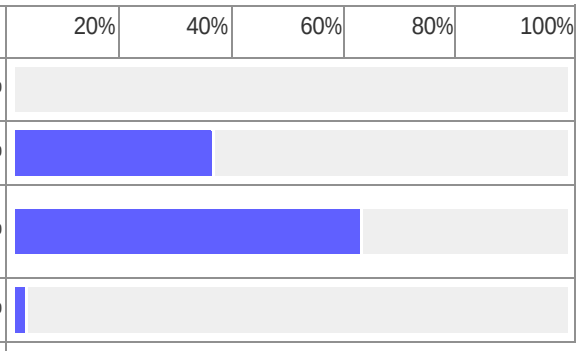
	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	Kyllä	65	97,01%					
2.	Ei	2	2,99%					
	Yhteensä	67	100%					

Sitä käytetään:

	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	Vastasyntyneiden epilepsiaan	0	0,00%					
2.	Vastasyntyneiden hengitysvajaukseen	58	86,57%					
3.	Vastasyntyneiden sydänsairauksiin	9	13,43%					
4.	Vastasyntyneiden munuaissairauksiin	0	0,00%					
	Yhteensä	67	100%					

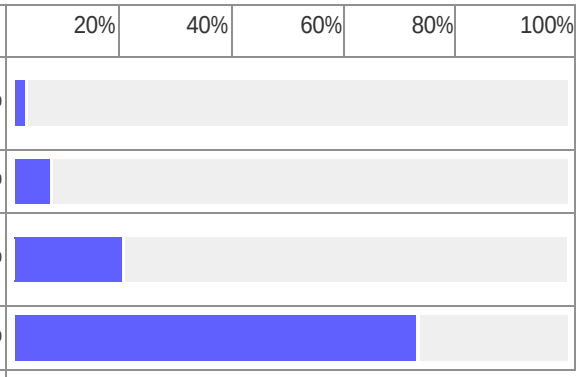
Mitä lääkkeellisiä kaasuja käytetään INOvent- jakelulaitteessa?

	Vastaus	Lukumäärä	Prosentti
1.	Happi (O2)	0	0,00%
2.	Typpioksidi (NO)	24	35,82%
3.	Happi ja typpioksidi (O2 ja NO)	42	62,69%
4.	En tiedä	1	1,49%
	Yhteensä	67	100%



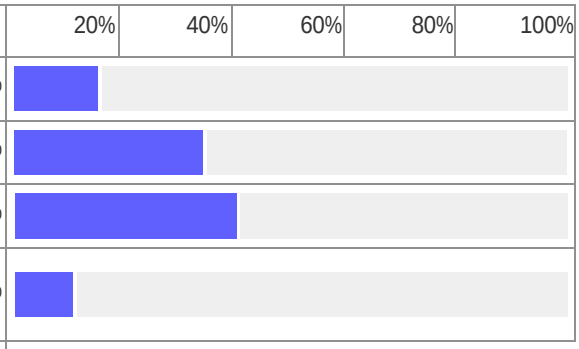
Mitä näistä on tärkeää tarkkailla käyttäessä INOvent- jakelulaitetta?

	Vastaus	Lukumäärä	Prosentti
1.	Sisäänhengitetyn ilman happipitoisuutta (FiO2)	1	1,49%
2.	Typpioksidipitoisuutta (NO)	4	5,97%
3.	Typpidioksidipitoisuutta (NO2)	13	19,40%
4.	Kaikkia näitä	49	73,13%
	Yhteensä	67	100%



Kuinka usein käytät laitetta nykyisessä työssäsi teho-osastolla?

	Vastaus	Lukumäärä	Prosentti
1.	Viikoittain	10	14,93%
2.	Kuukausittain	23	34,33%
3.	Vuosittain	27	40,30%
4.	Harvemmin kuin vuosittain	7	10,45%
	Yhteensä	67	100%



Arvioisitko osaamistasi Inovent- typpihoito jakelulaitteesta

	Edistynyt käyttäjä, pystyn neuvomaan muita (Arvo: 5)	Osaava käyttäjä, pystyn käyttämään itsenäisesti (Arvo: 4)	Perustason käyttäjä, osaan käyttää pääsääntöisesti itsenäisesti (Arvo: 3)	Alkeistason käyttäjä, tarvitsen apua toisinaan (Arvo: 2)	Aloitteleva käyttäjä, tarvitsen apua (Arvo: 1)	Yhteensä
Käyttöönotto (tarvikkeet, asetukset sekä hengityskoneeseen yhdistäminen) (avg: 3,34)						100 %
Laitteen kalibrointi (avg: 3,31)						100 %
Inomax- typpipullon vaihto (avg: 3,38)						100 %
Ongelmatilanteet (hälytykset) (avg: 2,97)						100 %
Yhteensä	27 %	19 %	22 %	20 %	13 %	

Kertoisitko omin sanoin mitä haluaisit vielä oppia laitteen käytöstä?

Mistä olet saanut koulutuksen laitteen käyttöön?

	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	Työpaikalta (kollega tai ohjaaja)	56	83,58%					
2.	Laitevalmistajalta	31	46,27%					
3.	Jokin muu, mikä	9	13,43%					
	Yhteensä							

Kuinka monessa koulutuksessa olet ollut?

	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	0	12	17,91%					
2.	<2<	34	50,75%					
3.	<4<	21	31,34%					
	Yhteensä	67	100%					

Tarvitsetko mielestäsi lisäkoulutusta laitteen käyttöön?

	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	Kyllä tarvitsen	43	64,18%					
2.	En tarvitse	18	26,87%					
3.	En tiedä	6	8,96%					
	Yhteensä	67	100%					

Kenen mielestäsi kuuluu antaa laitekoulutus?

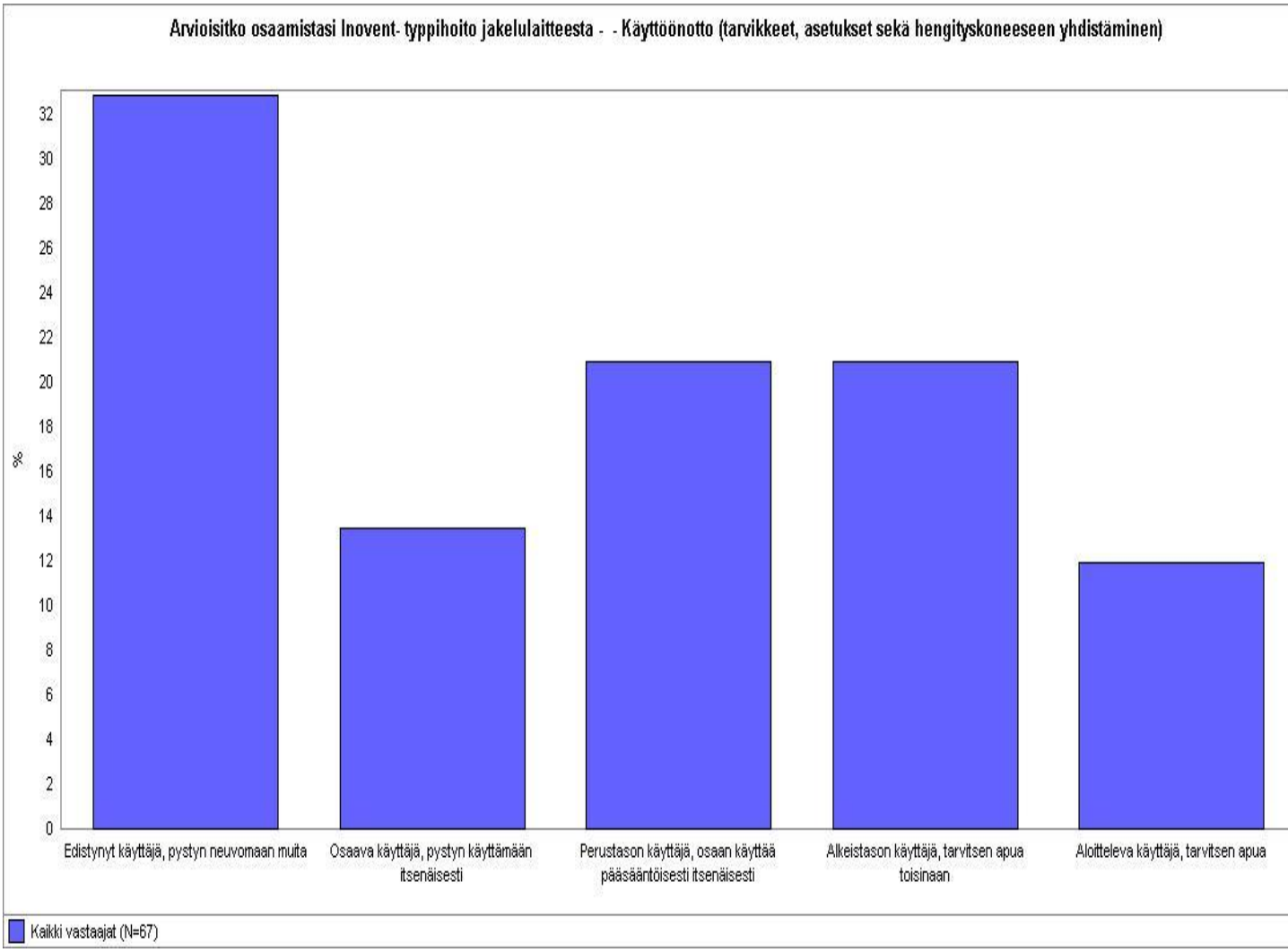
	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	Työpaikka (osaston sisäisesti)	30	44,78%					
2.	Laitteenvalmistaja	33	49,25%					
3.	Oppilaitos	0	0,00%					
4.	Jokin muu, mikä	4	5,97%					
	Yhteensä	67	100%					

Kuinka useasti mielestäsi laitekoulutus pitäisi järjestää?

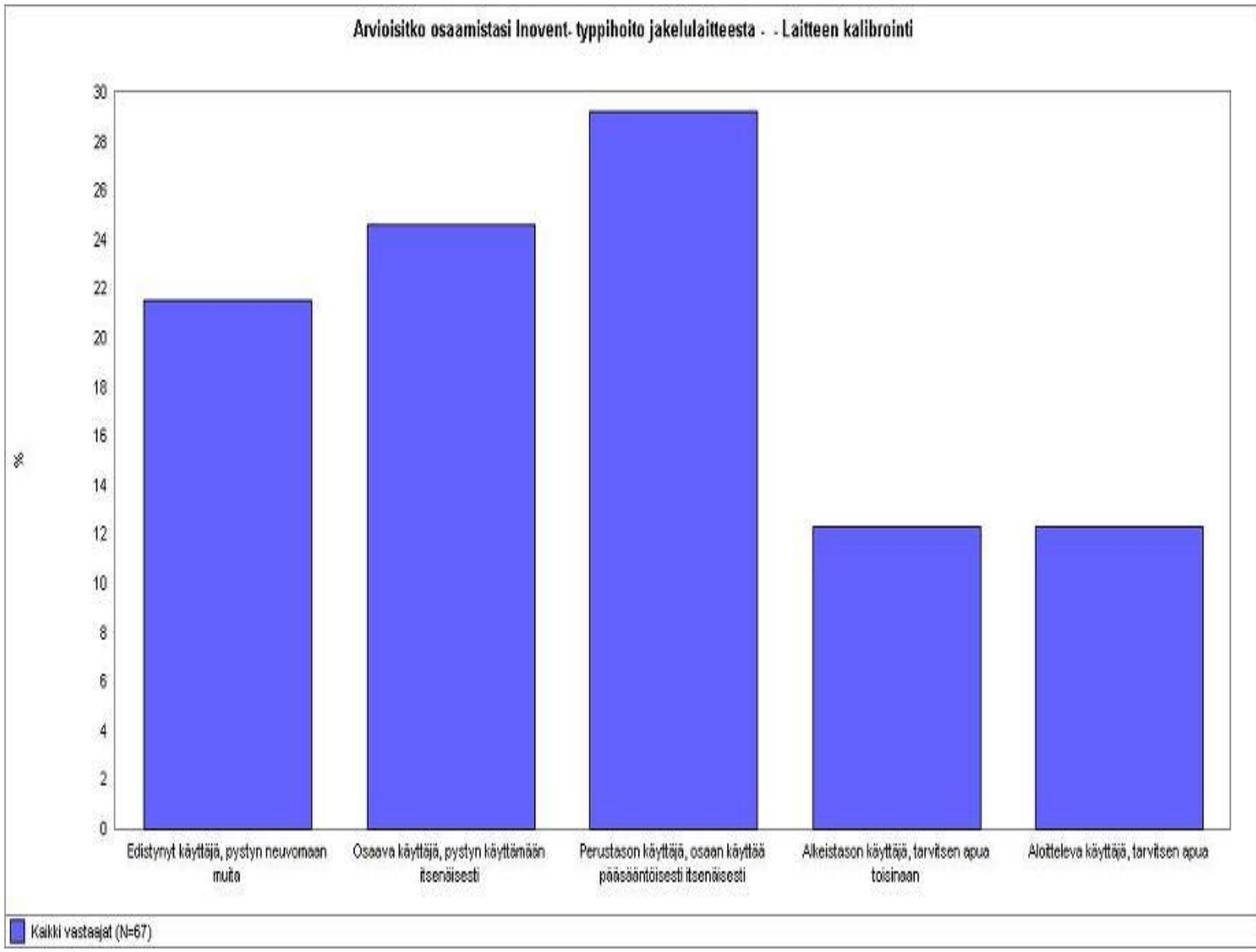
	Vastaus	Lukumäärä	Prosentti	20%	40%	60%	80%	100%
1.	2-3-kertaa vuodessa	36	53,73%					
2.	vuosittain	28	41,79%					
3.	yli kahden vuoden välein	3	4,48%					
	Yhteensä	67	100%					

Vapaa sana, jotain muuta mitä haluaisit lisätä.

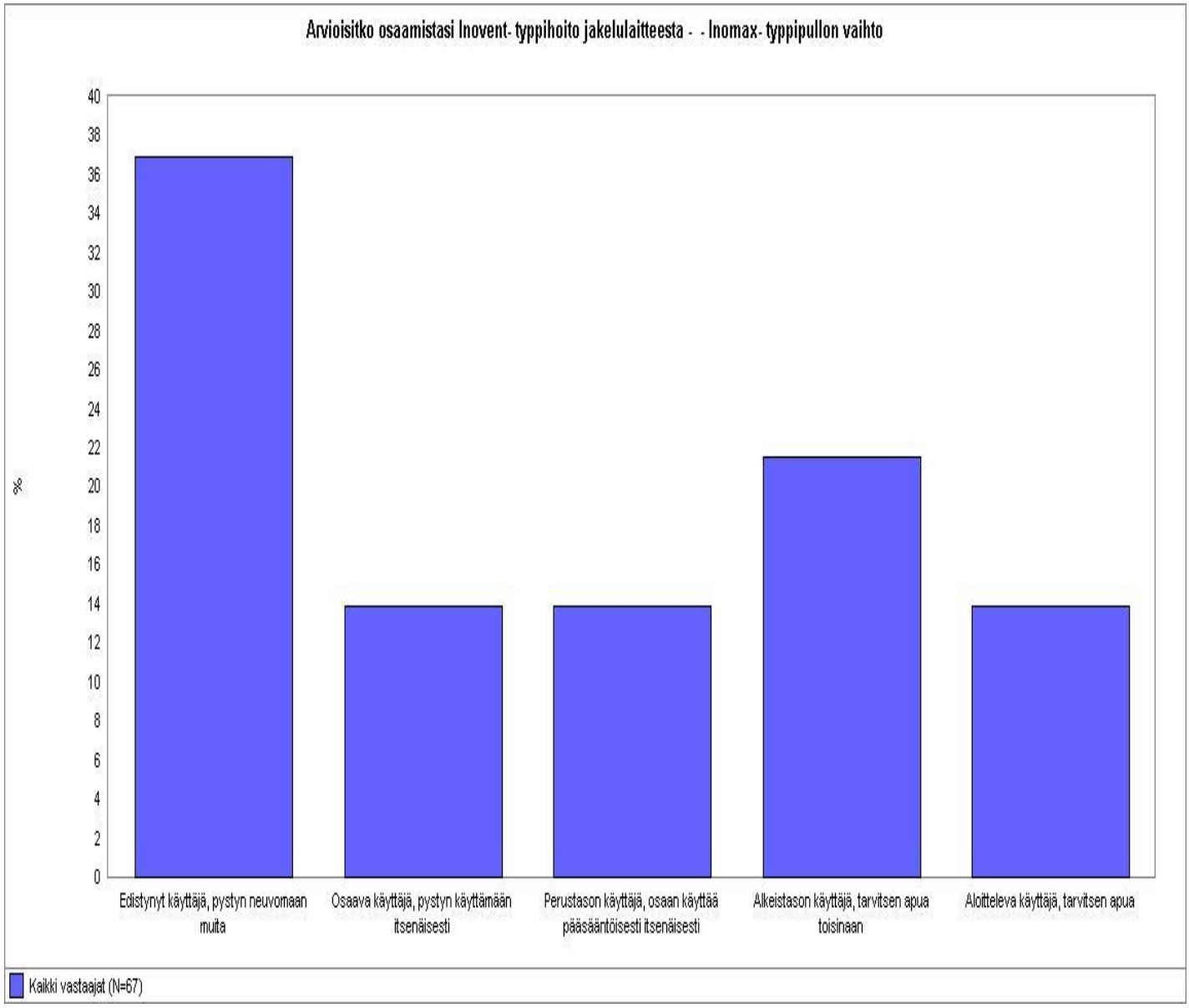
APPENDIX 5. The start-up situation



APPENDIX 6. Calibration



APPENDIX 7. Chainging the INOmax® cylinder



APPENDIX 8. Problematic situations