NORDIC KNOW-HOW 2020

NCSH
Nordic Center for Sustainable Healthcare

BEST PRACTICES OF SUSTAINABLE HEALTHCARE IN THE NORDICS

REPORT SERIES BY
NORDIC CENTER FOR SUSTAINABLE HEALTHCARE

#1 NITROUS OXIDE DESTRUCTION

INTRODUCTION

Climate change is one of the greatest environmental challenges faced by societies today and action must be taken from a wide range of sectors – healthcare being no exception. A recent study estimates that the climate footprint of the healthcare sector is equivalent to 4.4% of global net emissions (HCWH, 2019).

Nordic sustainable healthcare is considered to be in the forefront in a global context (Eriksson et al, 2019). Sustainability within healthcare has a long tradition in the Nordics and there are many good examples of best practices.

The aim of this Nordic Know-How report series is to spread knowledge and examples of best practices to international actors in the field of sustainable healthcare.

The theme of this first report in the Nordic Know-How series is nitrous oxide destruction. **Nitrous oxide** substantially contributes to the climate footprint of the healthcare sector. This report provides good examples on how to reduce emissions of nitrous oxide in hospitals.

Examples are presented from Swedish municipal regions and hospitals. The examples illustrate what can be done to reduce emissions of nitrous oxide and thus the climate impact from healthcare facilities.

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NORDIC KNOW-HOW
#1 NITROUS OXIDE DESTRUCTION
NORDIC CENTER FOR SUSTAINABLE HEALTHCARE
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ABOUT NITROUS OXIDE

Nitrous oxide (N2O) is used in the healthcare sector as an anaesthetic gas, mainly during childbirth, surgery or dentistry due to its pain-relieving effects (WHO, 2019-a).

When used in a medical setting N2O is administered by the hospital staff who regulate the dose. It is consumed in gaseous form by the patient through a mouthpiece. It is when the patient exhales N2O that hospital staff and the surrounding environment can be exposed to the gas.

As the gas is only used in specific parts of health- and dentalcare, targeted efforts to reduce N2O emissions are facilitated.

ENVIRONMENTAL IMPACT

N2O is a powerful climate pollutant and one of the major long-lived greenhouse gases together with CO2 and CO4 (Andersen et al., 2010). It is estimated that 1 kg of N2O has the same greenhouse gas effect as 310 kg of CO2.

In addition to this, N2O remains in the atmosphere up until 150 years. Some scientists describe the gas as the dominant ozone-depleting substance of the 21st century. N2O is one of the six greenhouse gases targeted by the first UNFCCC Climate Change accord (Kyoto) (WHO, 2019-b).

It is estimated that an equivalent of 6% of global carbon dioxide emissions result from N2O, out of this 1% originates from medical use in the healthcare sector (Charlesworth and Swinton, 2017). This estimation shows that N2O emitted from medical use have an impact on a global level.

In Sweden total N2O emissions accounts for 10% of all greenhouse gas emissions. As N2O is emitted from a limited number of point sources, targeted efforts are easier and cheaper.

One of these point sources is the healthcare sector. Measures such as nitrous oxide purification installations in maternity wards and dental clinics can significantly reduce the emissions of N2O from the sector. Measurements made in Swedish municipalities have shown that as much as 60% of the exhaled N2O is released to the environment, and only 40% is exhaled back in the mouthpiece (Leuchovius, 2014).

Therefore, there is a lot of potential in reducing the climate impact from hospitals and other healthcare facilities by targeting the emissions of N2O.

TECHNIQUE
FOR NITROUS OXIDE DESTRUCTION

Various techniques and equipment can be used in the process of N2O purification. Below are examples of the most common techniques used in healthcare facilities presented in more detail. The type of equipment and method of N2O purification affects the climate impact the process will have.

FLOW OF ANAESTHETIC GASES

The flow rate of anaesthetic gases inhaled by the patient can be low or high in volume, this is also known as low-flow anaesthesia and high-flow anaesthesia. Below these two flow rates are presented more in detail, as they have different environmental impacts.

LOW-FLOW ANAESTHESIA

Low-flow anaesthesia is when the anaesthetic gas is re-circulated and re-used during the medical procedure. This method decreases the flow of fresh gas from 1 litre per minute to about 0,2-0,5 litres per minutes (Sveriges Kommuner och Regioner, 2019).

Low-Flow Anaesthesia requires a circle breathing system, along with some essential equipment such as a carbon dioxide absorber. The circle breathing system needs to be closed and leak-free. The low-flow technique can be easily implemented with modern anaesthetic machines and equipment (Brattwall et al., 2012).

Using low-flow anaesthesia has significant environmental benefits, as it reduces the amount of fresh anaesthetic agents used and emitted to the environment. Compared to higher flows of anaesthesia, there are also several benefits beyond environmental. As a lower amount of fresh anaesthetic gas is used, there are economic gains from using this technique. It is safer and more comfortable to use for the patient, as well as creating a better working environment for healthcare staff (Brattwall et al., 2012).

HIGH-FLOW ANAESTHESIA

High-flow anaesthesia is a method where the anaesthetic gas is not re-circulated in the breathing system. The flow of fresh gas is therefore more than 1 litre per minute, which is higher than with low-flow anaesthesia (Sveriges Kommuner och Regioner, 2019).

High-flow anaesthesia brings higher costs and environmental impact, however this method also has its advantages. For example, higher flows facilitate reaching and adjusting the depth of anaesthesia (Brattwall et al., 2012).

TECHNIQUE
FOR NITROUS OXIDE DESTRUCTION

DOUBLE MASK

The double mask is a technique designed to ensure that N2O or other anaesthetic gases do not leak out to the surrounding environment when inhaled and exhaled by the patient. With this, the environmental impact from leakage of N2O can be reduced.

The double mask consists of a hard outer mask, and a softer inner mask. Between the two masks is a suction system which evacuates leaking N2O gas, transporting it through a coupling house and evacuation hose to the evacuation tube system. The masks are kept in place through a neck band, and/or a chin mask (Kurrek et al., 2013).

The double mask has proven more effective than other masks regarding collecting the exhaled N2O gas. Studies have shown that the double mask collects 75-85% of exhaled gas. The study also showed that the amount of collected exhaled gas is affected by how old the equipment is, working methods, and the engagement of staff in the process. In healthcare facilities where the staff has good knowledge of the process and instructs their patients on how to use the equipment correctly, the leakage of N2O gas is reduced (Sveriges Kommuner och Regioner, 2019).

NITROUS OXIDE DESTRUCTOR

When the N2O gas is exhaled by the patient, it is captured by a mask and transported to the nitrous oxide destructor through a central fan system. The destructor purifies the N2O by breaking it down into oxygen and nitrogen. According to a study made in 2019 by the Swedish Association of Local Authorities and Regions, the nitrous oxide destructors in use in Swedish regions purifies between 89-100% of the collected N2O gas (Sveriges Kommuner och Regioner, 2019).

The energy use of the whole destruction system varies with airflow, the concentration of N2O, and whether the destructor is older or more modern.

EXAMPLES FROM SWEDEN

FOR MORE INFORMATION ABOUT INSTALLED N2O DESTRUCTORS AND SUPPLIERS PLEASE CONTACT NCSH:

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In Sweden hospitals and other healthcare clinics have extensively installed N2O purification systems, and thus many examples of measures to reduce emissions of N2O from the healthcare sector can be found.

Sweden is divided into 21 regions, which are municipal areas with responsibility for the healthcare. 14 of Sweden's 21 regions have now installed a total of 35 active nitrous oxide destruction systems. The destruction installations are prioritized for maternity clinics, but some regions have also installed smaller, mobile systems for paediatric and dentalcare. 7 regions in Sweden still lack N2O destruction installations. If these regions were to install purification systems, the climate impact of Swedish regions could decrease an additional 13%, which is equivalent to 3 000 tonnes of CO2 (Sveriges Kommuner och Regioner, 2019).

N2O stands for 84% of the climate impact from medical gases in Swedish regions. Other emissions include sevoflurane, isoflurane and desflurane. There is no specific national goal to reduce the climate impact from medical gases. Still, the climate impact from medical gases has decreased with 52% since 2009, thanks to installations of nitrous oxide destruction and other efforts (Sveriges Kommuner och Regioner, 2019).

In the following sections we present three examples of N2O destruction installations in Swedish regions.

REGION JÖNKÖPING

In September 2014, the first nitrous oxide purification in Region Jönköping was installed at Ryhov maternity ward. The region has now installed N2O destruction systems in all emergency hospitals in the region: Ryhov, Eksjö and Värnamo. In addition to this, Region Jönköping has a couple of mobile destruction systems that are used in smaller healthcare operations.

N2O EMISSIONS

Measurements made in 2019 show that the total amount of N2O emissions in the region has reduced from 3901 kg of N2O to 876 kg per year. This means that the CO2 emissions has lowered from 1162 tCO2 equivalents to 262 tCO2 equivalents per year, a reduction of around 77%. The use of N2O in healthcare in the region has meanwhile remained relatively constant.

The purification systems break down and purifies 99% of the N2O passing through the installation, eliminating the climate impact from leakage of N2O.

EMISSIONS FROM MEDICAL GASES PER INHABITANT:

2009: 4.4 kg CO2 equivalents

2018: 1.6 kg CO2 equivalents

EXAMPLES FROM SWEDEN

REGION ÖSTERGÖTLAND

In 2017, region Östergötland installed a nitrous oxide destruction system at Linköping University hospital with an estimated reduction of N2O emissions by 810 tCO2 equivalents. In 2018, they also installed a destruction system at Vrinnevi hospital in Norrköping, the other maternity hospital in the region. Region Östergötland has applied low flow anaesthesia in order to recirculate the anaesthesia agent during surgery. This way, the fresh gas flow can be reduced to 0.2-0.5 litres per minute, compared to the average flow of over 1 litre per minute (Region Östergötland, 2019).

N2O EMISSIONS

In 2016, Region Östergötland had the highest emissions in the country of medical gases per inhabitant. But since they installed the destruction systems, they reduced the release of N2O by 1200 tCO2 equivalents. The installations have reduced their total emissions of medical gases by 50% since the installations (Region Östergötland, 2019).

EMISSIONS FROM MEDICAL GASES PER INHABITANT:

2009: 7.3 kg CO2 equivalents

2018: 2.3 kg CO2 equivalents

REGION STOCKHOLM

Karolinska University Hospital in Stockholm was the first hospital in Sweden to install a nitrous oxide destruction system. The installation at Karolinska Huddinge was commissioned in 2005, and Karolinska Solna received their destruction system in December 2010. In 2011, both nitrous oxide destruction systems were in full operation and were able to demonstrate a degree of destruction of 90-98% of the amount N2O collected from the maternity wards. In terms of all nitrous oxide distributed and used by Karolinska, the destruction rate was 55% in 2011.

Today, Region Stockholm has nitrous oxide destruction systems in all maternity hospitals (Karolinska Solna, Karolinska Huddinge, Södersjukhuset, Danderyd, Södertälje). A couple of installations have also been made at smaller healthcare facilities, such as dentalcare (Karolinska Universitetssjukhuset, 2011).

N2O EMISSIONS

When the region started the work with reducing emissions from N2O in 2002, the emissions were 31 961 kg. In 2016, the emissions from N2O were 8643 kg. The total emissions from medical gases were in 2018 4254 kg (Region Stockholm, 2018). Through systematic work, increased awareness and installations of destruction systems in the maternity hospitals, the region managed to greatly reduce the N2O emissions (Region Stockholm, 2016).

EMISSIONS FROM MEDICAL GASES PER INHABITANT:

2009: 2.9 kg CO2 equivalents

2018: 1.3 kg CO2 equivalents

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ABOUT NORDIC KNOW-HOW

Nordic Know-How is a report series created by Nordic Center for Sustainable Healthcare (NCSH), within the project *Platform for Internationalisation: Energy and Climate Smart Healthcare*. The project is financed by the Swedish Energy Agency.

This series consists several reports which provide an overview of good examples and best practices of sustainable healthcare in the Nordics.

Each report has a certain theme relating to a sustainability challenge in the healthcare sector. The purpose of this series is to bring Nordic practices and knowledge to international actors, spreading Nordic expertise in this field to the world.

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