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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Updated second version

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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 CH4 (Andersen et al., 2010). N2O has the global warming potential of 289 times that of CO2 within a time frame of 20 years (WHO, 2019-b).

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.

N2O is emitted from a limited number of point sources, which facilitates targeted efforts to reduce emissions. One of these point sources is the healthcare sector. Measures such as nitrous oxide destruction installations in maternity wards and dental clinics can significantly reduce the emissions of N2O from the sector (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 destruction. Below are examples of the most common techniques used in healthcare facilities presented in more detail. The type of equipment and method of N2O destruction affects the climate impact the process will have.

SINGLE MASK

The single mask consists of one mask, as opposed to a double mask which consists of two masks to collect the exhaled gas. The mask is an important aspect of nitrous oxide destruction, as it is the first step to collect the exhaled nitrous oxide for destruction. Nitrous oxide that is not collected through the mask, is leaked into the surrounding environment. Studies in Swedish regions have shown that between 43-93% of exhaled nitrous oxide is collected by the mask and transported to destruction (Sveriges Kommuner och Regioner, 2019).

To a single mask, an additional device can be attached to optimize the collection of exhaled gas. This additional device can be used where a low flow technique of nitrous oxide is applied.

Using a low flow technique for nitrous oxide can have several benefits. For example, the technique lowers the volume of fresh gas in use, lowers the volume in the working environment, and the energy use of the process. This overall contributes to a lower climate impact and a lower cost (Sveriges Kommuner och Regioner, 2019; Leuchovius, 2014).

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. High flow of nitrous oxide is used in the double mask (Leuchovius, 2014).

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

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 facilities. The destruction facilities are prioritized for maternity clinics, but some regions have also installed smaller, mobile facilities for pediatric wards and dental care. Seven regions in Sweden still lack nitrous oxide destruction installations. If these regions were to install destruction systems, the climate impact of Swedish regions could potentially decrease an additional 13%, which is equivalent to 3 000 tonnes of CO2 (Sveriges kommuner och landsting 2019).

N2O stands for 84% of the climate impact from medical gases in Swedish regions. Other emissions include the anaesthetic gases sevoflurane, isoflurane and desflurane. There is no specific national goal to reduce the climate impact from medical gases in Sweden. 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 landsting, 2019).

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

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

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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 (Region Jönköpings Län, 2020).

The purification systems break down and purifies 99% of the N2O passing through the installation, eliminating the climate impact from leakage of N2O (Region Jönköpings Län, 2020).

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, 2017). Region Östergötland has applied a low flow technique 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 (Linköping, n.d). 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 facility. The installation at Karolinska University Hospital in Huddinge was commissioned in 2005, and Karolinska University Hospital in Solna received their destruction facility in December 2010. In 2011, both nitrous oxide destruction facilities 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 University Hospital, the destruction rate was estimated to be 55% in 2011.

Today, Region Stockholm has nitrous oxide destruction facilities in all maternity hospitals (Karolinska University Hospital in Solna and Huddinge, Södersjukhuset, Danderyd hospital, Södertälje hospital) (Karolinska Universitetssjukhuset 2011). A couple of installations have also been made at smaller healthcare facilities, such as dental care. At the Eastman Institute in Stockholm, the first central destruction facility in the world for nitrous oxide in dentalcare was installed in 2017 (Folktandvården Stockholm, 2017).

N2O EMISSIONS

Since the region installed destruction for nitrous oxide in all maternity hospitals, the emissions from N2O were in 2016 more than 75% lower than in 2002, calculated with the increased number of deliveries considered. Through systematic work, increased awareness and installations of destruction facilities, the region managed to greatly reduce the N2O emissions (Region Stockholm, 2016). In 2018, the total emissions from nitrous oxide and anaesthetic gases (sevoflurane, isoflurane and desflurane) in region Stockholm were 4 254 tCO2 equivalents (Region Stockholm, 2018).

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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