Dear TNI audience,

For ten years, TNI® medical AG has had one goal: to develop nasal high flow therapy in order to provide highly efficient and comfortable respiratory support to patients suffering from respiratory insufficiency.

We are committed to keeping you up to date with any information on Therapy with Nasal Insufflation (TNI) – the evolution of nasal high flow therapy – and the company behind this therapy: TNI® medical AG. In the following pages, we would like to give you an overview of TNI and the current technological and clinical knowledge. We would also like to invite you to regularly check our website www.tni-medical.com for current information on new TNI products, application recommendations as well as scientific publications and events.

Convince yourself of the efficiency, safety and comfort of TNI and get a genuine alternative to NIV for hospital and outpatient treatment of patients suffering from respiratory insufficiency. Set new standards – we will support you as a steadfast partner. Your patients will be grateful.

Best wishes,

Ewald Anger, CEO
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A huge step in nasal high flow therapy.
TNI softFlow 50 is the flagship of the TNI product family. It has been developed through intensive research and focussed development in Therapy with Nasal Insufflation (TNI).

The three pillars of TNI.
Due to the unique technology of the internal high flow generator, TNI softFlow 50 generates a precisely regulated, stable high flow (TNI Flow) from room air or a mix of room air and oxygen. Controlled oxygen supply ensures oxygenation while, at the same time, the respiratory airways are humidified.

Convincing. The quality of life.
In practice, this therapy is more effective than conventional oxygen therapy and just as successful but much more comfortable than NIV (non-invasive ventilation). The use of a soft, comfortable and noise-optimized patient interface ensures recovering patients’ quality of life. Being able to eat, drink and talk during therapy contributes significantly to higher patient compliance.

We can Flow.
A stable air flow is essential for treating hypoxemic and hypercapnic respiratory failure. Together with the TNI applicator (comprising respiratory circuit and patient interface), the TNI Flow generator guarantees a constant TNI Flow and in doing so, it is completely independent of external pneumatic systems. Due to this, the TNI softFlow 50 is able to treat respiratory insufficiency and allows therapy at home as reliable and efficient as in the hospital.

Only TNI can be as effective as NIV in hospital and homecare treatment!
Nasal High Flow

The Flow makes the difference

TNI Flow:
Stable high flow
Air / Mixture of air and O₂, humidified and warmed

- Consistent CO₂ washout:
  - from the anatomical dead space
  - from the small respiratory tracts

- Steady O₂ supply:
  - stable FiO₂

PEEP*:
- Preventing end-expiratory collapse of alveoli
- Recruiting further areas in the lungs

- Higher breathing efficiency:
  - pO₂ increases and pCO₂ decreases

- Increase of tidal volume
- Decrease of respiratory rate
- Facilitated work of breathing
- Relief of breathing muscles

Reduction of risk

Comfortable patient interface
TNI softFlow 50
Unique technology: the internal high flow generator

Respiratory insufficiency
- Reduced gas exchange: hypoxemia, hypercapnia
- Compensatory increase of the respiratory drive
- Respiratory muscles fatigue by the increased work of breathing

Hypercapnic respiratory failure
Mechanical ventilation
Therapy with Nasal Insufflation

**Improved respiratory efficiency**

### Reduction of hypercapnia

Studies with chronic hypercapnic COPD and IPF patients show that applying TNI for a short time reduces arterial pCO₂. At higher flow rates, pCO₂ decreases even further. A significant decrease in pCO₂ was noticed in stable hypercapnic COPD patients who were treated with TNI at home for several weeks. The normocapnic value remained stable during the following NIV treatment (Bräunlich et al., 2013a, 2015a, 2016; Fig. 1).

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**Mechanism: Washout effect**

The washout effect is viewed as the central mechanism of pCO₂ reduction. Supplying a flow rate exceeding the inspiratory demand results in a constant washout of breathed air (rich in CO₂) out of the nasopharynx and the small airways. Of essential value is a stable air flow during inspiration and expiration. This is guaranteed by the technology of the TNI Flow generator in combination with the TNI applicator. CO₂ elimination increases with higher flow rates (Bräunlich et al., 2017, Fig. 2).

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**Efficient oxygenation**

TNI efficiently treats chronic hypoxic respiratory insufficiency without causing any side effects. This was confirmed during a clinical comparison with conventional O₂ therapy in stable O₂-dependent COPD patients. The application of TNI Flow alone (without adding O₂) already resulted in an improved oxygenation. A comparatively lower volume of O₂ had to be added to the therapy air to reach the same level of oxygenation as with pure O₂ therapy (Vogelsinger et al., 2013).

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**Mechanism: constant FiO₂ + PEEP**

The stable high TNI Flow guarantees continuous supply of therapy air with an FiO₂ value that is individually adjusted to the patient’s deficit. It remains stable even during high breathing frequency. As the flow rate increases, a PEEP builds up: an expiratory alveolar collapse is avoided and otherwise insufficiently ventilated areas of the lung are recruited. As a consequence, the gas exchange improves (Bräunlich et al., 2016, 2017; Fig. 3; McGinley et al., 2007).
Facilitated work of breathing

In patients suffering from chronic respiratory insufficiency, the respiratory muscles are constantly overloaded. During TNI, the desired effect of a respiratory therapy can be noticed: COPD patients were breathing slower and deeper; the respiratory minute ventilation decreased (Bräunlich et al., 2013a). The respiratory muscles were thus relieved, rested and were able to resume their ventilating function again.

In comparison to breathing room air or O₂, TNI facilitated work of breathing during sleep in COPD patients (Biselli et al., 2016; Fig. 4). Reaction due to an improved exchange of gas and a reduced sympathetic tone is discussed as mode of action. Sympathetic activity decreased in REM and Non-REM phases in COPD patients during TNI, but not during an O₂ therapy as shown in clinical studies (Schneider, DGP congress 2017, Symposium „Symposium „NHF: The better alternative?“).

TNI ensures

- $pCO_2 \downarrow$
- $pO_2 \uparrow$
- work of breathing $\downarrow$

Comments from the DGP congress 2017 // Symposium “NHF: The better alternative?”

Prof. H. Wirtz, Pneumology dept., Uniklinikum Leipzig

“NIV is seen as standard therapy for hypercapnic respiratory insufficiency which, however, is not always tolerated by the patients. TNI is an alternative for these patients in particular: TNI supports ventilation - the task of the breathing pump - which counteracts parenchyma failure and improves the gas exchange. In addition, patients being treated with TNI save energy they would have to spend on conditioning the respiratory gas.”

Prof. Kähler, Lungenzentr. Süd-West, Wangen im Allgäu

“NHF is not NHF - each system applies a different way of generating high flow. Thus, not all systems are equally suitable for hospital and homecare use.

Using NHF in weaning is promising with regard to the duration of stay in intensive care and the reintubation rate.”
Therapy with Nasal Insufflation

Lung protection

Improved mucociliary clearance

It has been verified that an optimized breathing gas conditioning leads to an improved self-cleaning function of the ciliated epithelium, the mucociliary clearance. Mucus in the lung becomes more fluid facilitating removal and expectoration (Hasani et al., 2008, Fig. 5). The TNI humidification technology reliably provides warming and humidification of the therapy air, which is balanced with the physiological demand of the lungs. The TNI applicator is heated for its entire length to the nostrils, which guarantees that humidity remains stable without condensing in the patient circuit. Humidity reaches the patient’s respiratory tract.

Fig. 5 Tracheobronchial deposition at baseline and following breathing gas humidification. Source: Hasani et al., 2008

TNI ensures

> no drying-out of the mucosa
> improvement of mucociliary clearance
  · mucus dissolution and removal
  · lower risk of respiratory infections

From practice

Prof. H. Schneider, Johns Hopkins University, Baltimore, USA
DGP congress 2017, Symposium "NHF: The better alternative?"

"Application fields of NHF include any conditions benefitting from an improved respiratory efficiency. This mainly relates to patients suffering from stable COPD, restrictive lung diseases such as ILD or pulmonary hypertension as well as neuromuscular disorders. Patients suffering from pneumonia, cystic fibrosis, bronchiectasis and asthma benefit from an improved mucociliary clearance and an increase in PEEP."
Better quality of life

Comfort

The TNI applicator’s small, soft and noise-optimized nasal cannula was developed guaranteeing a comfortable feel without causing any pressure marks and skin irritation. It is suitable for use during sleep. A key advantage of TNI is the fact that the patient can almost unrestrictedly eat, drink and talk during therapy. Humidification of therapy air prevents side effects such as dry nasal and oral mucosa, which in turn significantly contributes to the therapy tolerance. The patient can regulate the therapy air temperature according to comfort.

Efficiency of therapy + comfort = better quality of life

Patient letter

We are very grateful for receiving such a feedback from our patients.

"... I was able to do so many things I could not even think to do in the past. That is why I can say:

This device saved my life!

Now, I am very happy with my new lung and I think I wouldn’t have made it this far without this device. I would like to once again express my gratitude - also on behalf of my wife ..."
Therapy with Nasal Insufflation

Application: easy, secure, effective

In which patients can TNI softFlow 50 be used?

For treating respiratory insufficiency type I and II in patients suffering from

- COPD (chronic obstructive pulmonary disease)
- ILD (interstitial lung disease)

The three pillars of efficient TNI

**TNI Flow**

The flow rate can be accurately determined, according to the patient’s individual ventilation demand.

In combination with the TNI applicator, the TNI Flow generator guarantees a stable air flow during inspiration and expiration independent of the environment and pneumatic systems.

- flow volume: 10–50 l/min
- increments of 0.5 l/min

**Oxygen**

O₂ addition can be titrated according to the patient’s O₂ deficit.

- supply from any external O₂ source
- up to 20 l/min

**Humidification**

The level of humidification and the temperature of therapy air can be adjusted by the patient according to comfort.

- dew point: 30–37°C DP
- increments of 1°C DP

The flow rate should be significantly higher than the inspiratory demand. CO₂ elimination increases by raising the flow rate.

Applicator sizes cover different flow rates. The higher CO₂ washout required, the larger the applicator size needed.

Oxygenation remains efficient if the oxygen supply is simultaneously increased with the flow rates.

34–37°C DP is recommended for optimal humidification of the respiratory tract.
Humidification of therapy air in hospital / homecare environment

Hospital humidifier

- quick transfer between patients due to use of disposable components
- respiratory infection control guaranteed by bacterial filter

Homecare humidifier

- easy handling when filling with drinking water
- stable construction

Therapy air supply

- comfortable, soft silicone patient interface
- noise-optimized
- different sizes for customised therapy
- heating up to the prongs prevents condensation
- automatic applicator type recognition

Monitoring

The display provides information on

- current humidification and nominal value
- current flow rate and nominal value
- O₂ flow rate
- therapy air FiO₂
2017
“TNI causes an effective CO₂ washout in the small respiratory tracts.”

2016
“As compared to O₂ therapy, TNI results in a significant reduction of work of breathing and respiratory minute ventilation as well as in a reduction of CO₂ levels, if applied during sleep in patients suffering from chronic COPD.”
Biselli, P.J.C. et al. Nasal High Flow therapy reduces work of breathing compared to oxygen during sleep in COPD and smoking controls – prospective observational study. J. Appl. Physiol. jap.00279

“TNI increases the breathing efficiency in COPD patients facilitating the work of breathing and decreases pCO₂ proportionally to the flow rate.”

“Constant FiO₂ of TNI guarantees an effective oxygenation.”

2015
“In patients suffering from stable hypercapnic COPD, TNI reduces the pCO₂-value.”

“The CO₂ washout effect increases proportionally to the increase of flow rate.”
Bräunlich, J., Goldner, F. & Wirtz, H. Nasaler Highflow (NHF) – Quantifizierung des CO₂–Auswascheffektes in einem Lungenmodell. Pneumologie 69

“In combination of NHF and O₂ in TNI improves oxygenation (SpO₂), reduces the breathing rate and alleviates signs of dyspnoea in patients with chronic lung diseases.”
Bräunlich, J., Goldner, F. & Wirtz, H. Nasaler Highflow (NHF) – Konkurrenz für die Sauerstofftherapie? Pneumologie 69

Please find more information on the studies at www.tni-medical.com
2013

"In COPD patients, tidal volumes increase due to TNI. Work of breathing is facilitated in patients suffering from obstructive or restrictive lung diseases."

Bräunlich, J. et al. Effects of nasal high flow on ventilation in volunteers, COPD and idiopathic pulmonary fibrosis patients. Respiration 85

"TNI lowers minute ventilation and breathing frequency while simultaneously increasing the tidal volume. The washout effect seems to be the key mechanism for the decrease in pCO₂."


"TNI is a secure and efficient therapy procedure allowing oxygenation and reducing hypercapnia in COPD patients. TNI is superior to the classic O₂ therapy and improves oxygenation merely through nasal high flow."


"As compared to O₂ therapy, TNI alleviates nocturnal hypoventilation in COPD patients suffering from severe hypercapnic respiratory insufficiency."

Nilius, G. Nasal High Flow Oxygen Therapy Attenuates Nocturnal Hypoventilation In COPD Patients With Hypercapnic Respiratory Failure: BSS. NON-INVASIVE VENTILATION. ATS 2013

2012

"Indices of sleep-related respiratory disorders improve during TNI."


"TNI does not negatively effect the cardiac performance and frequency, the stroke volume neither the mean arterial pressure and is thus a suitable alternative to CPAP for patients suffering from heart diseases."

Tiffin and Connelly. Differences in Hemodynamic Effects between CPAP and High Flow Therapy. RTSO Airwaves Fall

"Compared to CPAP, TNI does not raise the sympathetic tone."

Tiffin and Connelly. Differences in Neurophysiologic Effects between CPAP and High Flow Therapy. RTSO Airwaves Fall

2011

"In hypoxic patients, TNI is as effective as O₂ therapy during physical exertion. With regard to performance, energy and ventilation efficiency, TNI is superior."

Juhász. Comparison of two different O₂-delivery systems during exercise in patients with chronic hypoxia. The European respiratory journal

2010

"Obstructive hypopnea can efficiently be treated with TNI."

Nilius, G. et al. Predictors for Treating Obstructive Sleep Apnea With an Open Nasal Cannula System (Transnasal Insufflation). Chest 137

2009

"Moderate to serious sleep apnea in children can efficiently be treated with TNI."

Therapy with Nasal Insufflation

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Nilius, G. Nasal High Flow Oxygen Therapy Attenuates Nocturnal Hypoventilation In COPD Patients With Hypercapnic Respiratory Failure : B55. NON-INVASIVE VENTILATION.


Tiffin, N.H., and Connelly, S.F. Tiffin and Connelly, RTSO Airwaves 2012_ Hemodynamics

Tiffin, N.H., and Connelly, S.F. Tiffin and Connelly, RTSO Airwaves 2012_ Neurophysiology

TNIFlow Makes The Difference