Low flow Anaesthesia: Revolutionising Patient Care

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ASPA 2024

IN & Out Hospital Anaesthesia:

6400 anaesthesia in ENT,
Gynaecology & Obstetrics,
General surgery, Emergency Surgery,
Dermatology

Oncologic surgery

1100 anaesthesia in
Breast Cancer Center
Pancreas Cancer Center
Colon Cancer Center
Ovarial Cancer Center

Paediatric anaesthesia

2800 in ENT, newborn and neonatal paediatric anaesthesia, difficult airway Management, patients with syndroms, Anaesthesia for MRI scan

Critical Care Medicine & Pain Service

Conflict of interest:

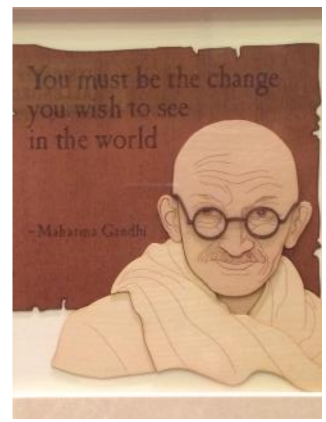
Prof. Hönemann was paid in the last 3 years salary for scientific and congress presentation from following companies:

Draeger, GmbH&CoKG, Lübeck, Germany
Vifor Pharma GmbH, München, Germany
Sedana medical GmbH, Geretsried-Gelting, Germany
Ärztekammer Niedersachsen, Hannover, Germany
WIVIM e.V. , Bremen, Germany
DGAI e.V. Nürnberg, Germany
Sysmex Deutschland GmbH, Germany

New ENT Clinic + pediatric department, Central OR





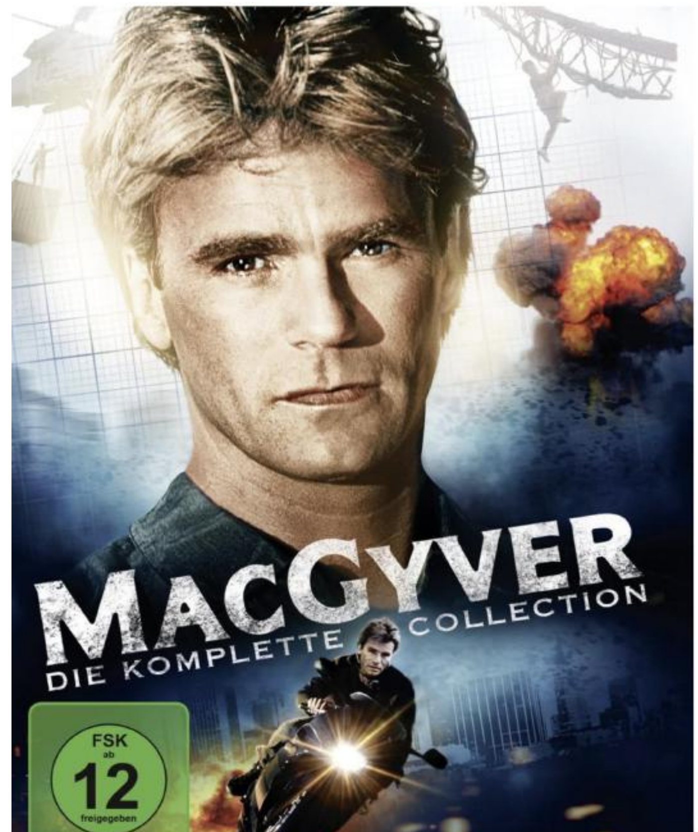
UKM
Universitätsklinikum
Münster

Influenced by family, humans,
professors, teachers,
medical schools education

Malteser
...weil Nähe zählt.

Low Flow, Minimal and Metabolic Flow Anaesthesia

is not a rocket science or Mac Gyver tale



"I could learn it", so you can do it!

One fundamental part of green hospital or green anaesthesia is low flow anaesthesia

Many countries and their professional societies demand environmentally friendly implementation in the context of clinical anaesthesia.

- Great Britain

  https://anaesthetists.org/Home/Resources-publications/Environment/Guide-to-green-anaesthesia

- United States of America

  https://www.asahq.org/education-and-career/asa-medical-student-component/green-anesthesia-initiative

- Germany

  https://www.dgai.de/wissenschaft-expertengruppen/expertengruppen/foren/forum-nachhaltigkeit-in-der-anaesthesiologie.html

- France

  https://sfar.org/comites/developpement-durable/

- Canada, Austria, …………

Agenda

Green Anaesthesia and reduced fresh gas flow (minimal and metabolic flow)

I. Basics

II. Advantage for the patient

- Reduced fluid loss
- Increased Body temperature

  due to better gas climatization

III. Ecological advantages

- Ozone depleting anaesthetic gases
- Greenhouse effect

IV. Economical Advantages

- Money
- Money
- money

V. Preoxygenation 6 L/min O2

VI. Wash in period

  O_2 Flow 0,7 L/min (until MAC 1.0)

VII. Steady State Period

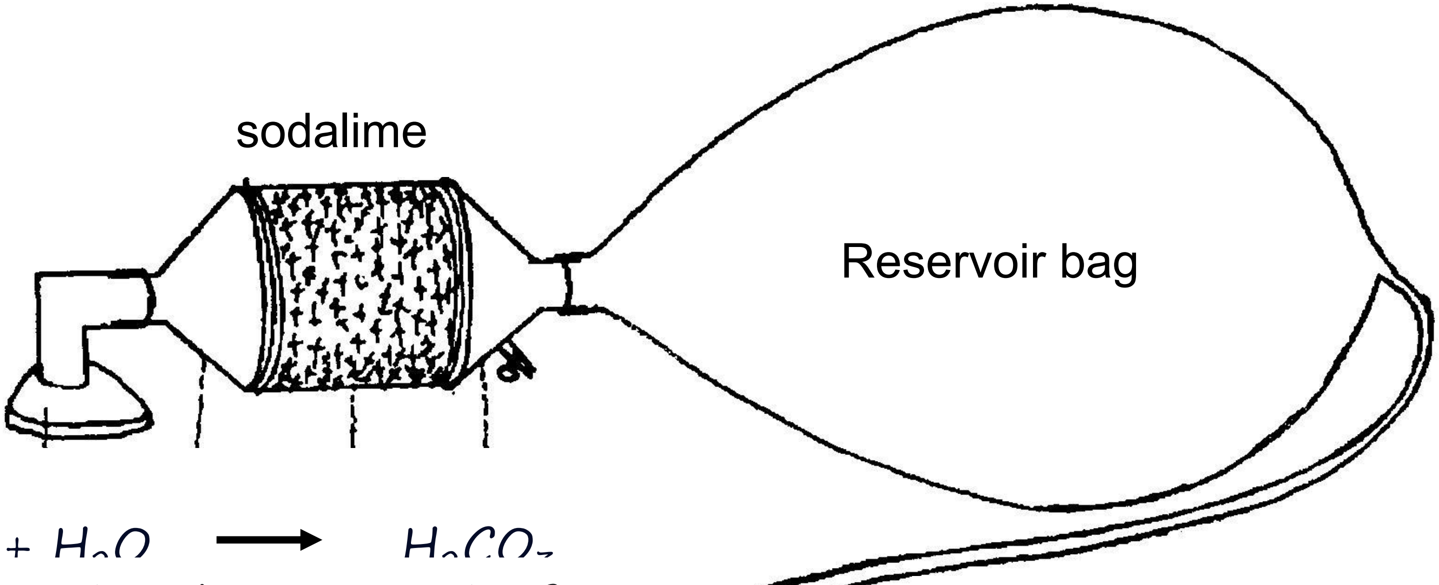
  Metabolic Flow (0,35 L/min)

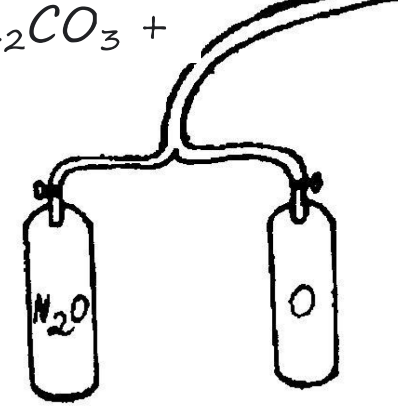
  Closed Circuit Anesthesia

VIII. Wash out period (until extubation and transfer to the recovery)

IX. Professional technical helpers….

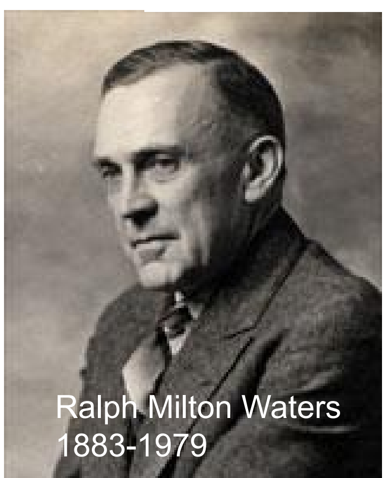
The beginning: Easy rebreathing system, presented ASA 1924

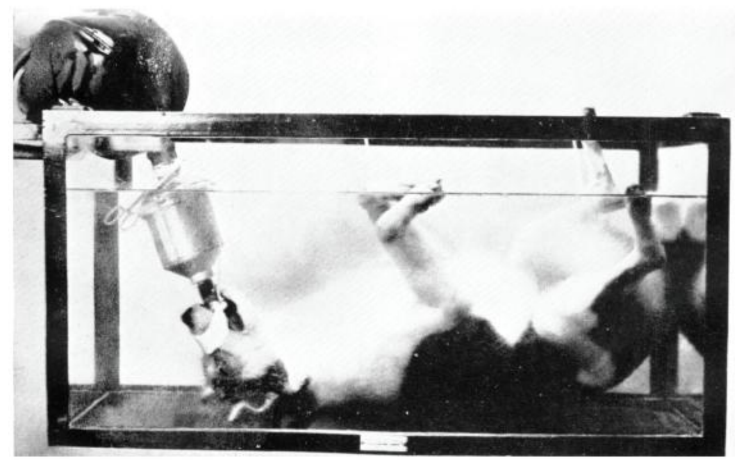




$$CO_2 + H_2O \rightarrow H_2CO_3$$

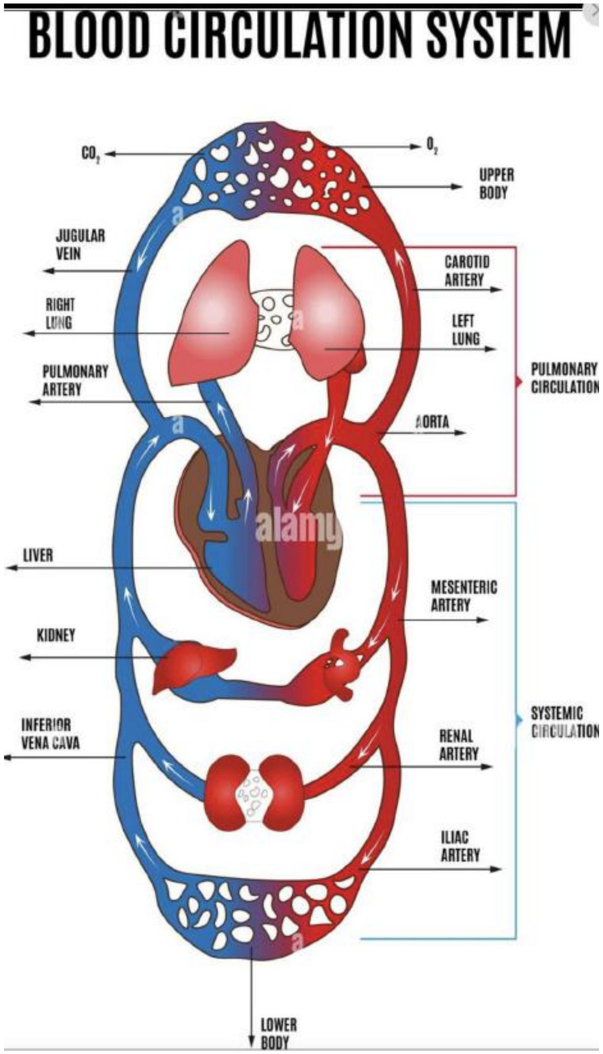
$$H_2CO_3 + 2\ NaOH \rightarrow Na_2CO_3 + 2\ H_2O + heat.$$





Ralph Waters´To-and-Fro Systm 1924

Where does CO_2 comes from? How many oxygen we need?



Chemical Equation

C=Carbon, H=Hydrogen, O=Oxygen

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + ATP$$

Sugar | Oxygen | Carbon Dioxide | Water | Usable Energy

Reactants → Products

Oxygen consumption estimated by formulation by brody

Adults	children	
3-4 ml / min	5-7 ml /min	per kg (bodyweight)

CO_2 production

Adults	children	
2-4 ml / min	4-7 ml /min	per kg (bodyweight)

Brody S.
Bioenergetics and Growth with Special Reference to the Efficiency Complex in Domestic Animals.
Reinhold, USA 1945

Before rebreathing the anesthetic gas, CO_2 must first be eliminated and O_2 added.

Chemical Equation

C=Carbon, H=Hydrogen, O=Oxygen

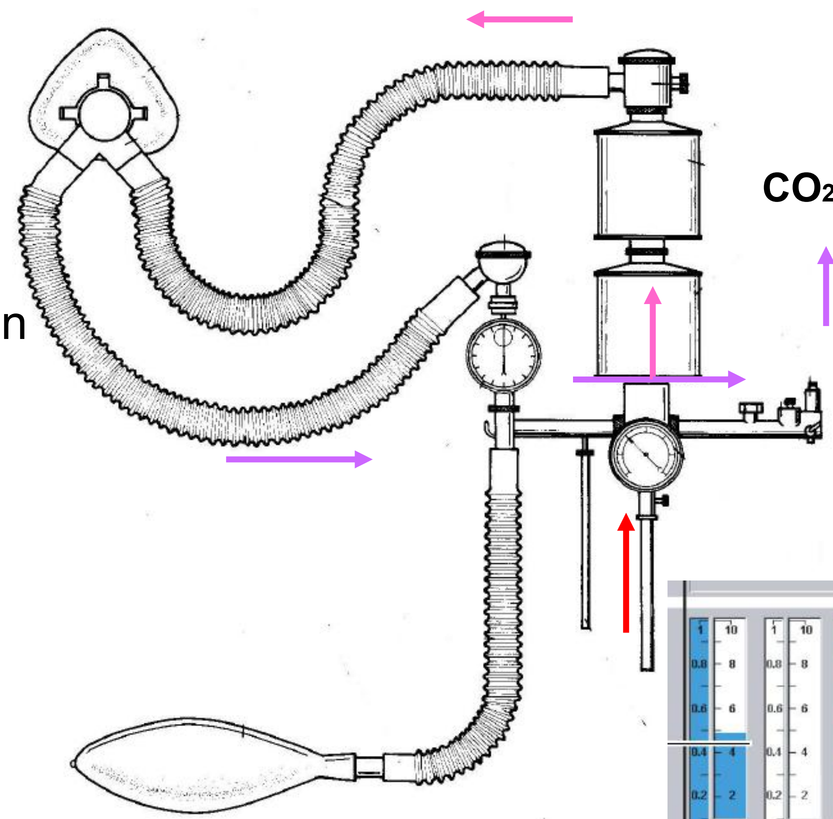
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

Sugar, Oxygen, Carbon Dioxide, Water, Usable Energy

Reactants → Products

160 ml O_2 Consumption

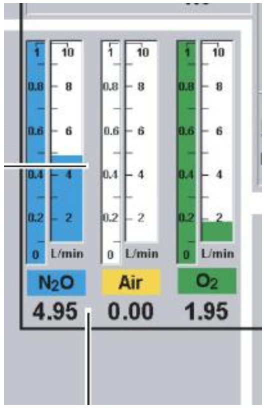
(e.g. 40 kg body weight)



CO2 absorber

carbon dioxide + calcium hydroxide (limewater) → calcium carbonate + water

$CO_2\,(g) + Ca(OH)_2\,(aq) \Rightarrow CaCO_3\,(s) + H_2O\,(l)$



Fresh gas flow

1000 ml FLOW

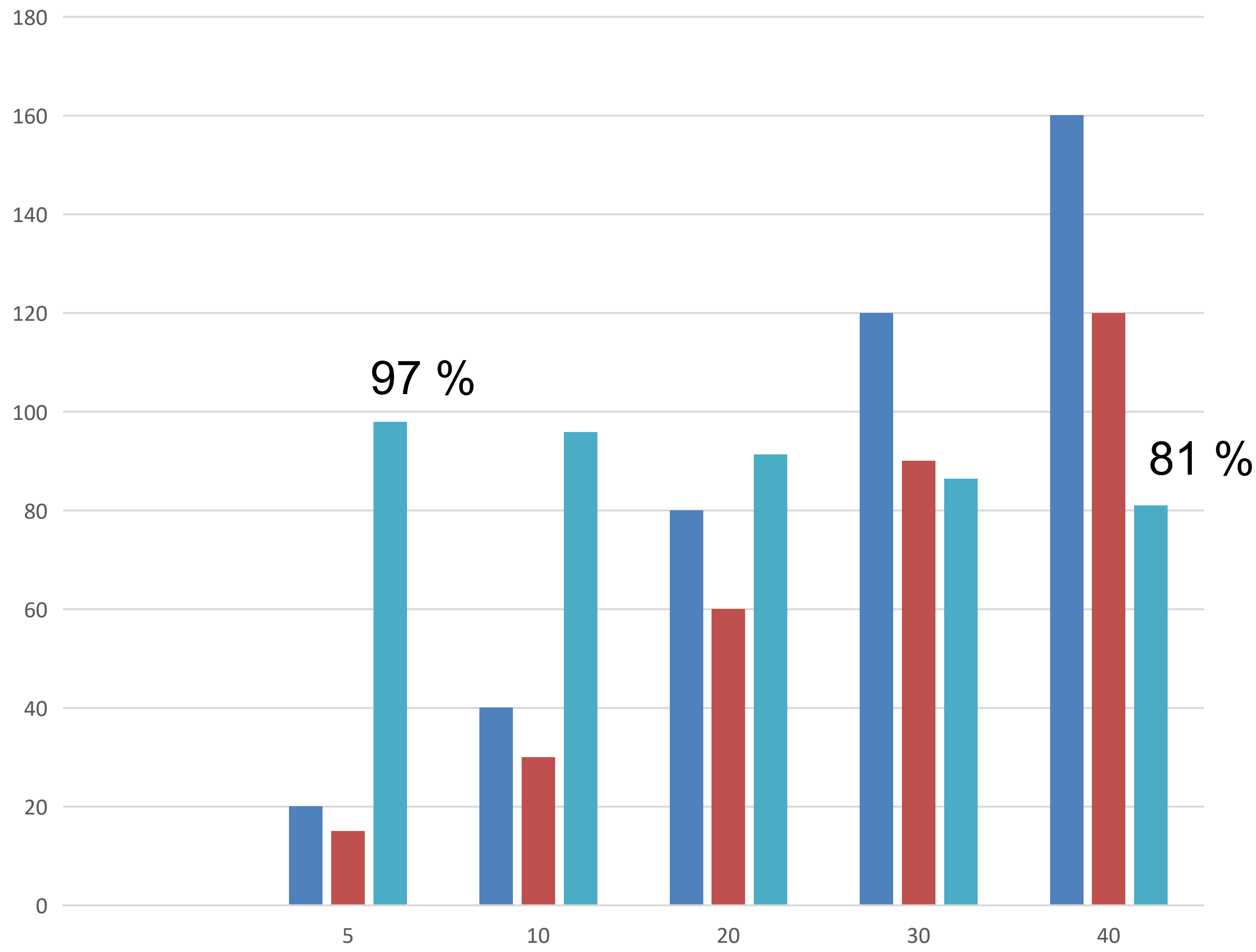
(500 ml O_2, 500 ml N_2)

Circle System,

a valve controlled rebreathing system

Gauss und Wieland 1925
Narcylennarkoseapparat

Efficacy of low flow anaesthesia (1 L/min)



O_2 = consumption in ml/min

CO_2 = production in ml/min

e.g. children 5 - 40 kg Bodyweight (kg)

Chemical Equation

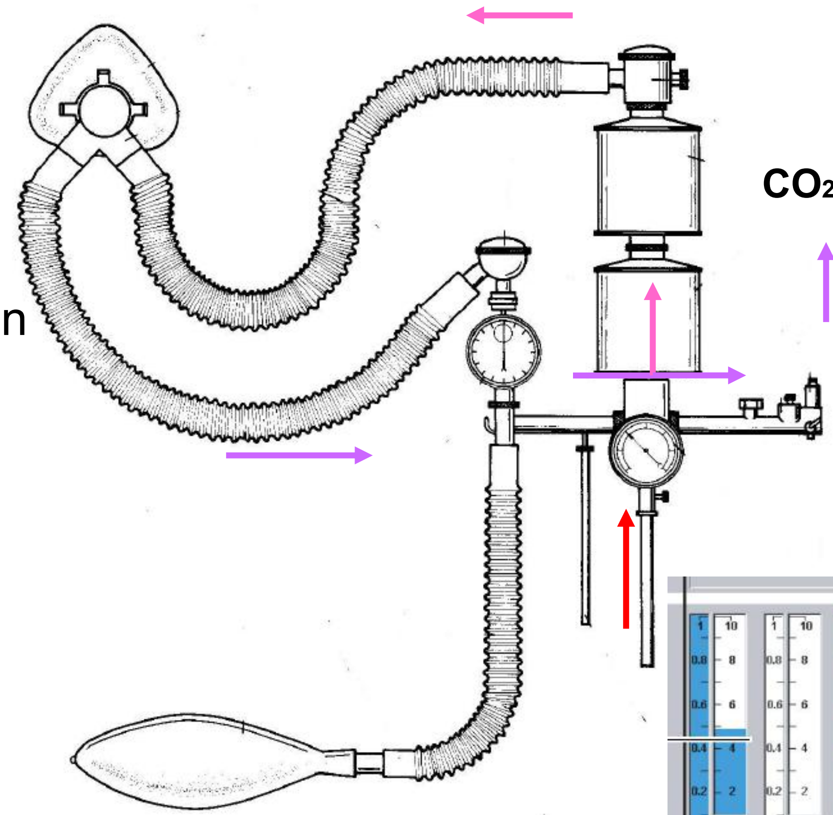
C=Carbon, H=Hydrogen, O=Oxygen

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

Sugar, Oxygen → Carbon Dioxide, Water, Usable Energy

Reactants → Products

160 ml O_2 Consumption



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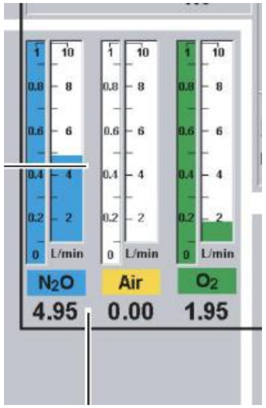


Fresh gas inlet,
Fresh gas flow

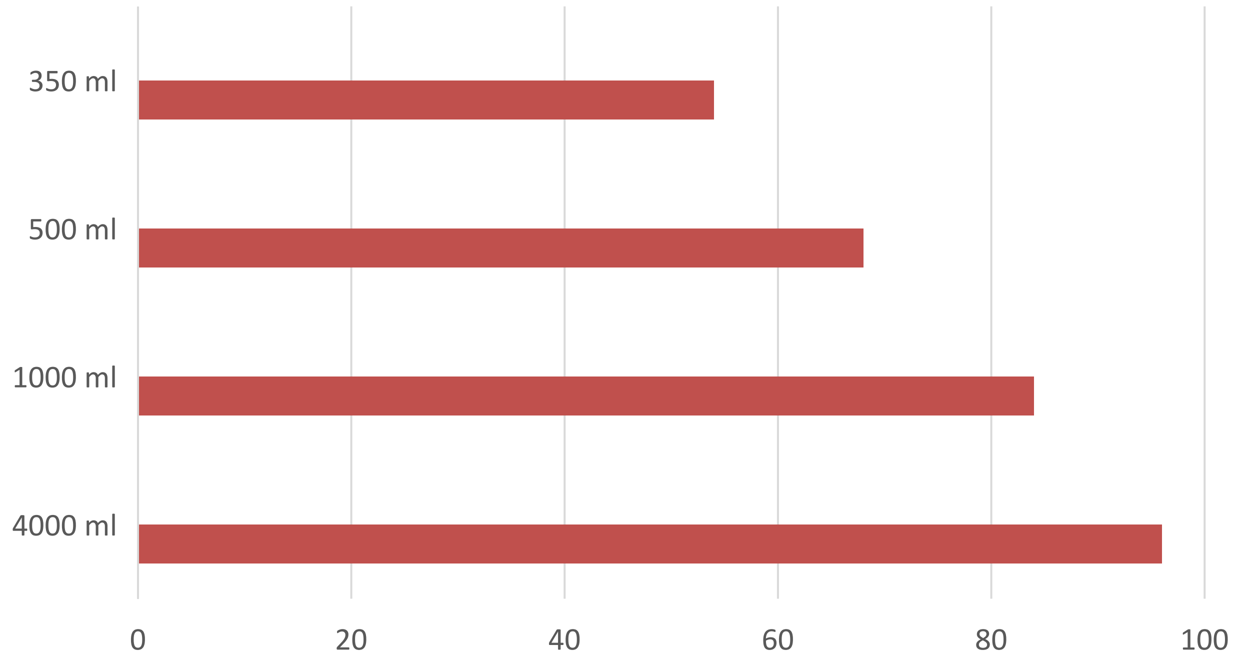
350 ml O_2 FLOW

Circle System,

a valve controlled rebreathing system

Efficacy of high flow, low flow, minimal and metabolic flow anaesthesia

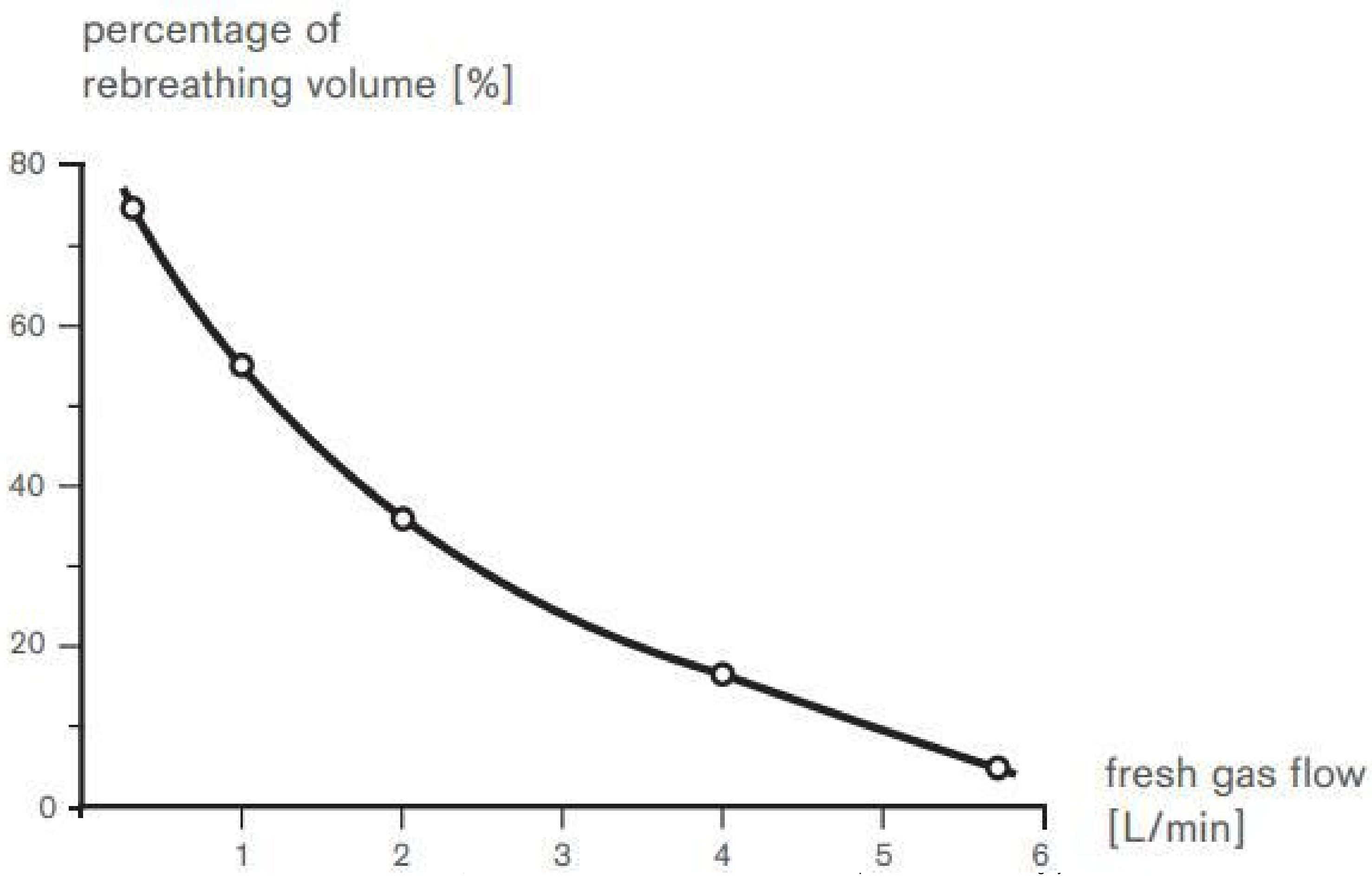
Fresh gas flow



O_2 = mL/min
CO_2 = mL/min

40 kg bodyweight (kg)

Efficacy of reduced fresh gas flow anaesthesia,
as lower the fresh gas flow, as higher the rebreathing and more efficacy



Definition:

Low flow anesthesia

Semiclosed
re-breathing system

- Low Flow Anaesthesia
  Fresh gas flow: 1.0 L/min
- Minimal Flow Anaesthesia
  Fresh gas flow: 0.5 L/min
- Metabolic Flow Anaesthesia
  fresh gas flow according to consumption

Closed
re- breathing system

- Closed Circuit
  Constant gas volume
- Quantitative anaesthesia with Closed Circuit
  Constant gas volume and gas composition

https://www.draeger.com/Content/Documents/Content/low-minimal-flow-anaesthesie-bk-9067990.pdf

II. Advantage for the patient

- **clinical:**

- Better breathing gas climate (warm and humid gases)
- Keeps body temperature constant
- By this reduced postoperative respiratory complications

Some data from our group

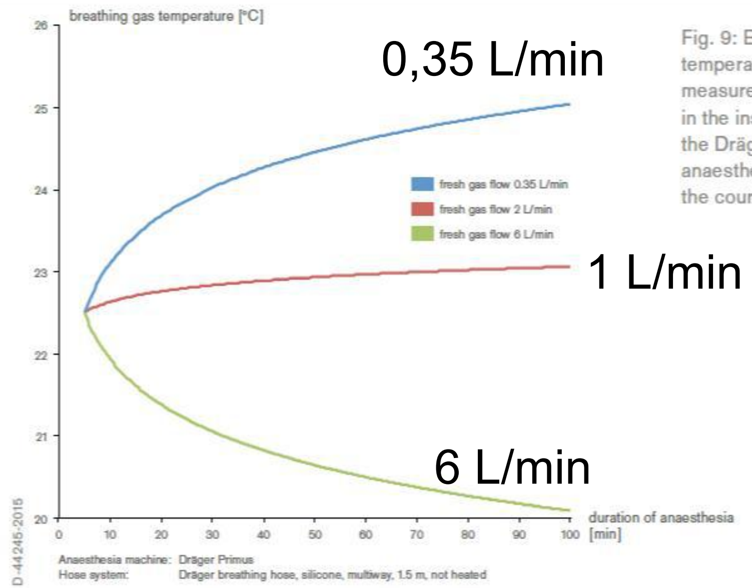


Fig. 9: Breathing gas temperature in °C measured at the Y-piece in the inspiratory arm of the Dräger Primus anaesthesia machine over the course of anaesthesia

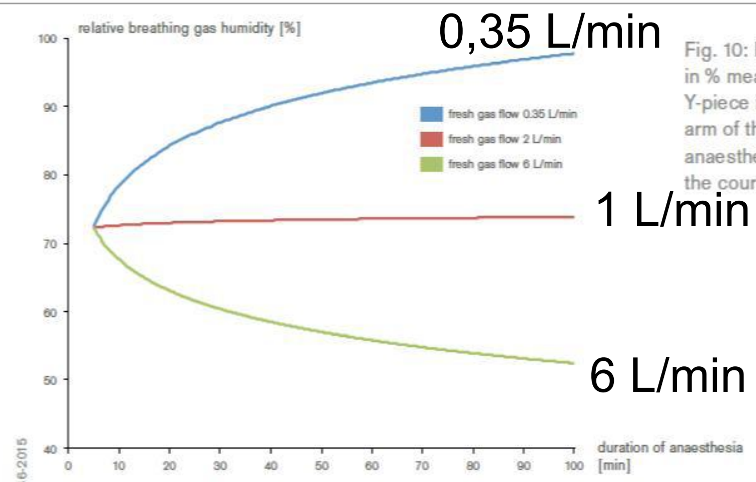


Fig. 10: Relative humidity in % measured at the Y-piece in the inspiratory arm of the Dräger Primus anaesthesia machine over the course of anaesthesia

Anesthesia

Fresh Gas Flow 0,35 L/min:

Increased circle gas temperature up to 35 °C

Increased circle gas humidity up to 100 % humidity

III. Ecological advantages

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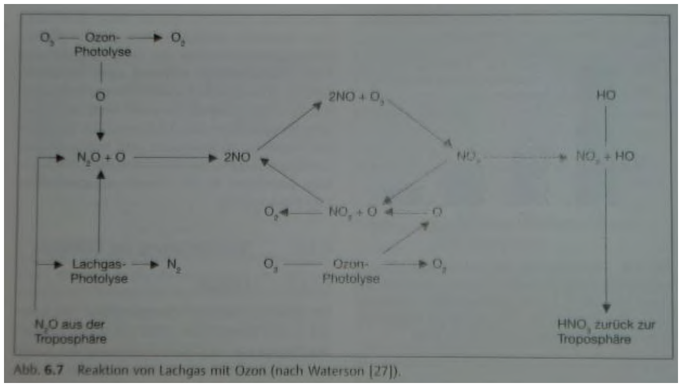
St. Marienhospital Vechta

- avoid unneccessary pollution with greenhous gases
- avoid nitrous oxide
- avoid desflurane

III. Ecological reasons

Reaction of Nitrous oxide with ozone (Waterson)



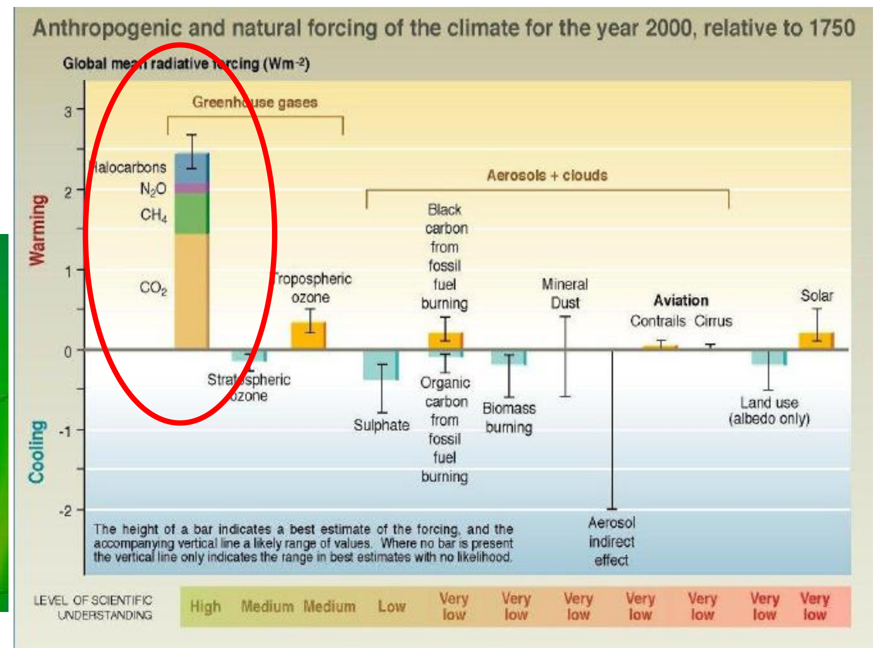
Nitrous oxide is

the most important ozone-depleting

and heat-trapping greenhouse gas.

Hole in the ozone layer

Hole in the ozone layer over the Antarktis (July 2005): nitrous oxide, the new danger for the ozone layer? (Spiegel online)



http://theresilientearth.com/files/images/Anthro+Natural_Forcings-ipcc.jpg

Volatile Anethetics are ozone depleting and green house gases

Table. One Hour of Anesthetic Is Like Driving a Car (How Many) Miles?

1-MAC-h	Sevoflurane 2.2%; Global Warming Potential = 130	Isoflurane 1.2%; Global Warming Potential = 510	Desflurane 6.7%; Global Warming Potential = 2540	N_2O[a] (0.6 MAC h); Global Warming Potential = 298
0.5 L/min	...	4	93	29
1.0 L/min	4	7	189	57
2.0 L/min	8	15	378	112
5.0 L/min	19	38	939	282
10.0 L/min	38	74	1876	564

Adapted from Ryan SM, Nielsen CJ. Global warming potential of inhaled anesthetics: application to clinical use. *Anesth Analg*. 2010;111:92–98.[2]
Results assume Environmental Protection Agency 2012 fuel efficiency average of 23.9 miles per gallon.
Abbreviations: MAC, minimum alveolar concentration; N_2O, nitrous oxide.
[a]Because N_2O cannot be delivered at 100%, the more typical percentage of 60% is used. In combination, 0.6 MAC hour of N_2O would be added to 0.4 MAC hour of volatile.

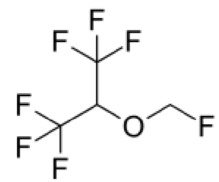
A&A, June 2019 – Sherman et al

Volatile Anethetics ecological aspects

- Volatile anesthetics are halogenated carbons or ether.

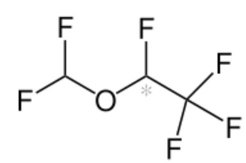
GWP$_{100}$
130

- Sevoflurane $C_4H_3F_7O$



GWP$_{100}$
2.540

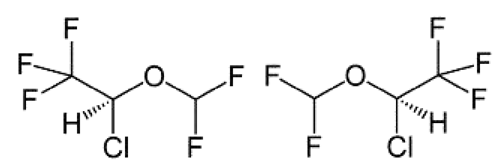
- Desflurane $C_3H_2F_6O$



GWP$_{100}$
510

A&A, June 2019 – Sherman et al

- Isoflurane $C_3H_2ClF_5O$



IV. Economical reasons

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St. Marienhospital Vechta

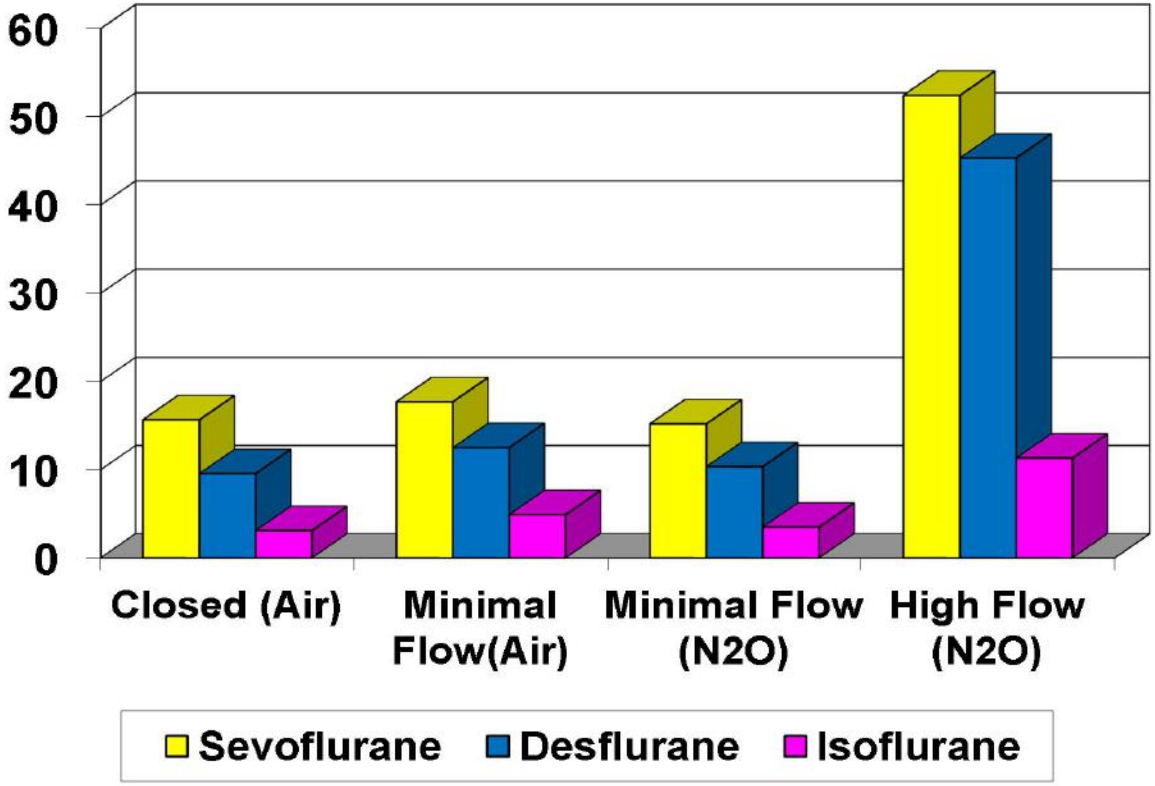
Saving volatile anesthetics

- Increase in efficacy of the volatile anesthetic
- Decrease cost, saves up to 90%

Economical reasons

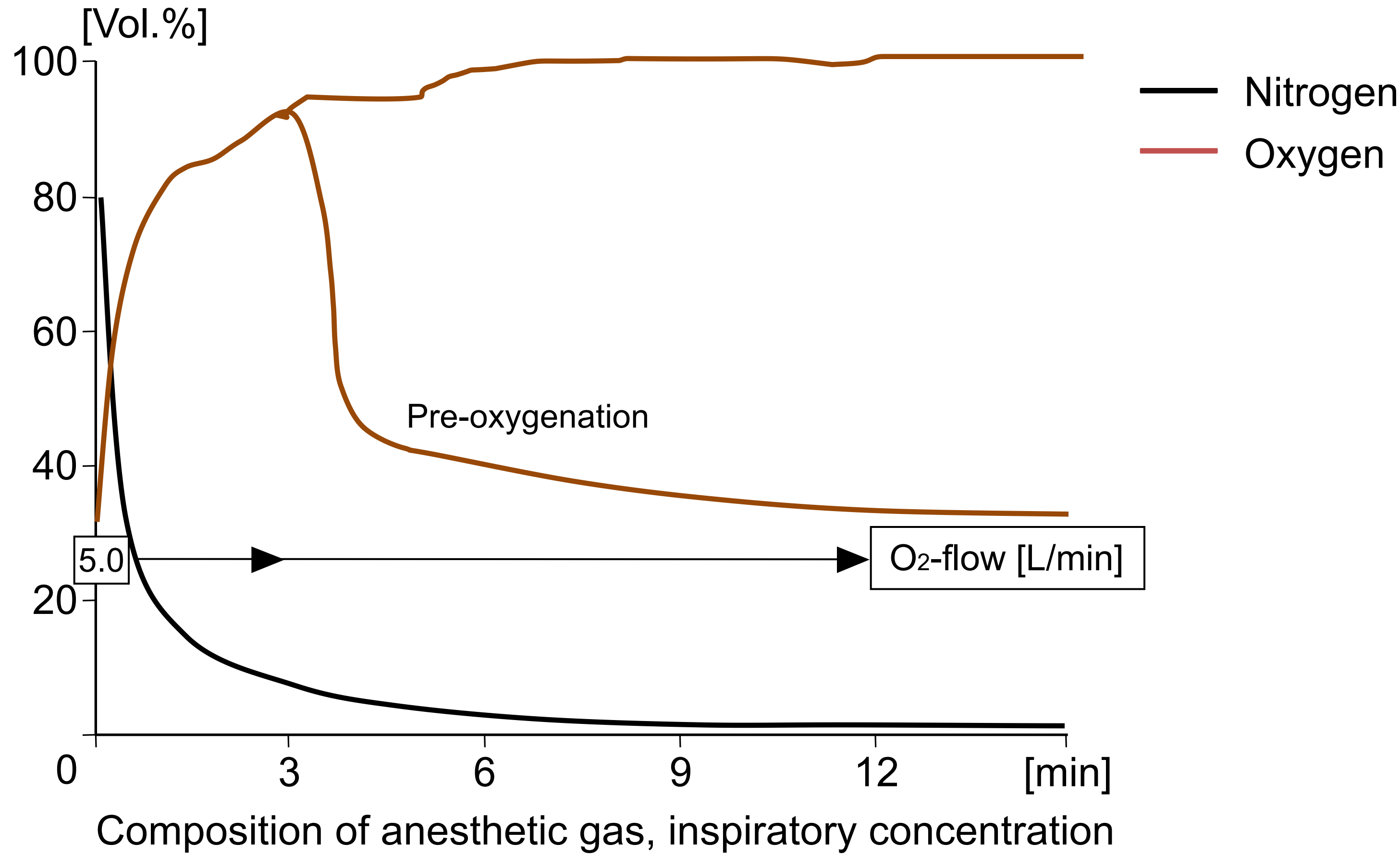
Katholische Kliniken Oldenburger Münsterland — St. Marienhospital Vechta —

Costs for inhalational anaesthetics in €



0,35 L/min closed vs. 0,5 L/min minimal flow vs. 4.4 L/min fresh gas flow high flow

V. The induction Period - Preoxygenation



2 – 3 min preoxygenation with 6 L / min, FiO_2 0.8 – 1.0

VI. Wash in period - our practice

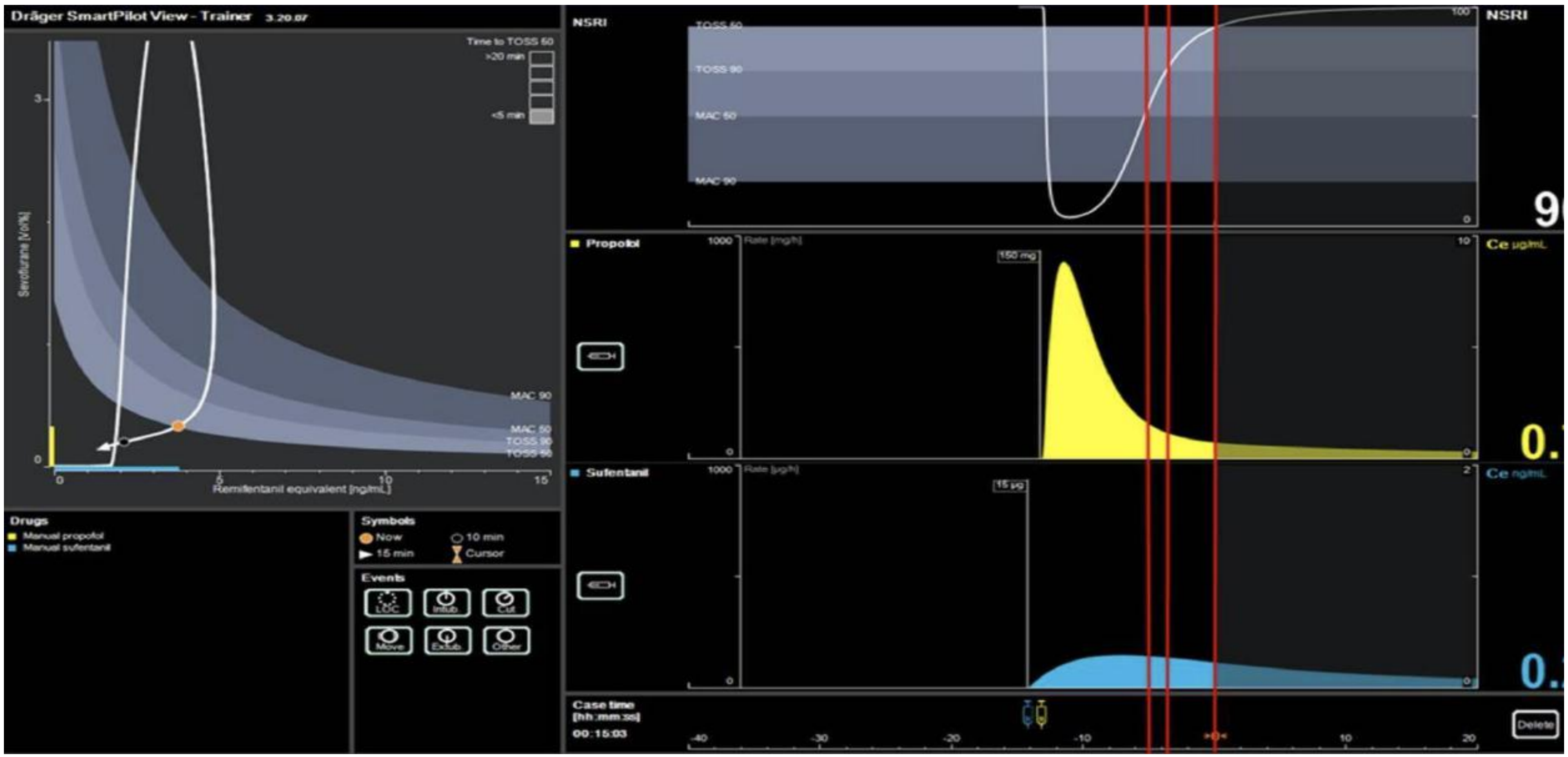
- EMLA topical creme for local anaesthesia of the skin (45 min – 1 h)
- i.v. propofol 1,5 – 2 – (4) mg/kg or inhalational induction – sevoflurane
  (Fresh gas flow 2 L/min)
- analgesic 0.1 – 0,25- (0,5) µg/kg KG sufentanile
- Rocuroniumbromide 0,4-0,6 mg/kg KG

- dial in sevoflurane vapor to 8 Vol/% and reduce FGF 0.7L/min with FiO_2 1,0 until you reach 0.7 – 1.3 MAC

After 2-4 min concentration of sevoflurane increases

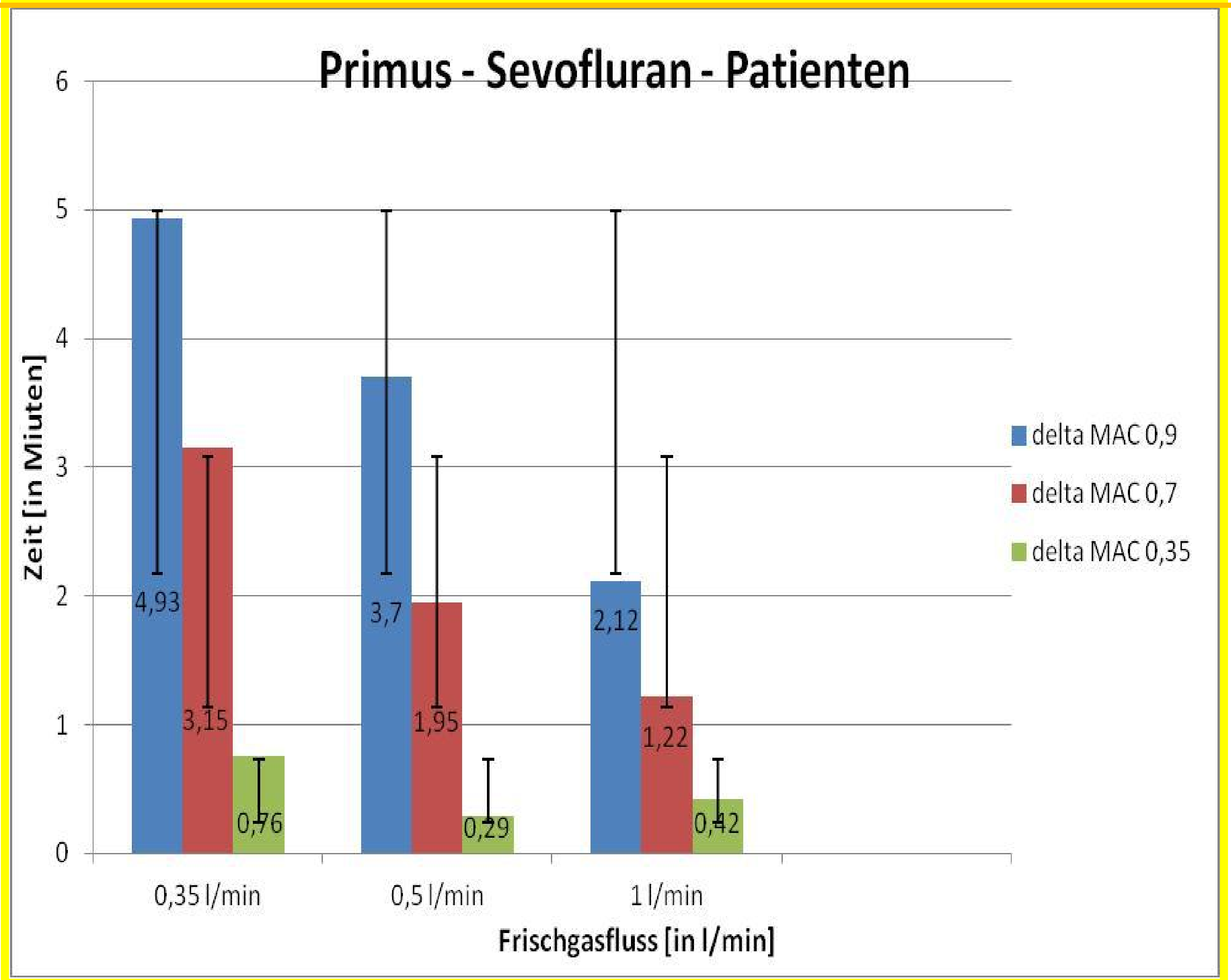
To 0.9 – 1.2 MAC

Duration of effective anaesthesia is 7-8 min after single bolus administration of Propofol 2 mg/kg and sufentanil 0,1µg/kg



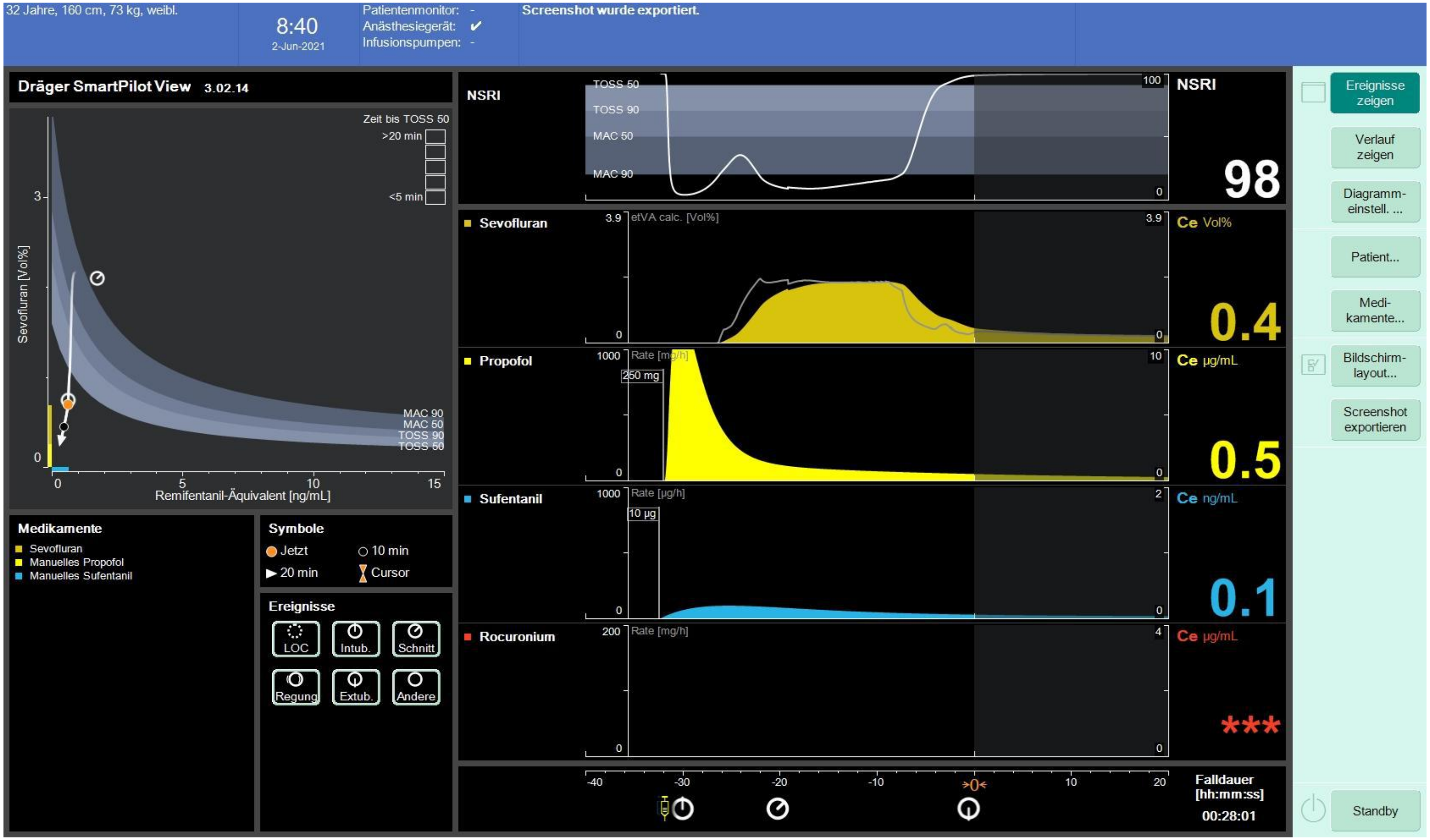
Smart Pilot View® Draeger

Wash in volatile anesthetics with low fresh gas flows, Primus, Dräger®



Cand.med. Y. Dietzler
Marienhospital Vechta
Dissertationsarbeit
Data, not published

Wash in period, 0,7 L Fresh gasflow sevofluran vapor dialed in to 8 Vol%



Smart Pilot View® Draeger

VII. Steady state period - our practice

- dial in sevoflurane vapor to 3 - 5 Vol% and reduce FGF 0.35 L/min with FiO_2 between 1.0 and 0.5 (0.4). Measure exspired sevoflurane and inspired FiO_2. Use alarm monitoring for low inspired oxygen and high concentration of sevoflurane.

Sevoflurane concentration will be stable at 0.9 - 1.3 MAC.

Inspired FiO_2 Depending of FiO_2 in steady state Period

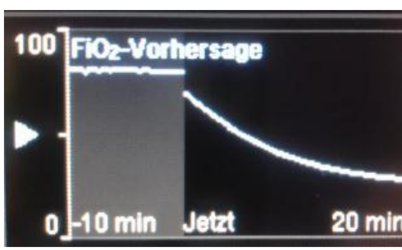
FGF 0,35 L/min, FiO_2 1.0
350 ml O_2

FGF 0,35 L/min, FiO_2 0,9
315 ml O_2

FGF 0,35 L/min, FiO_2 0.8
280 ml O_2

FGF 0,35 L/min, FiO_2 0.7
245 ml O_2

FGF 0,35 L/min, FiO_2 0.6
210 ml O_2



FGF 0,35 L/min, FiO_2 0.5
175 ml O_2

FGF 0,35 L/min, FiO_2 0.4
140 ml O_2

FGF 0,35 L/min, FiO_2 0.3
105 ml O_2

80 kg, 40 years (221 ml O_2)

In paediatrics this will be no problem

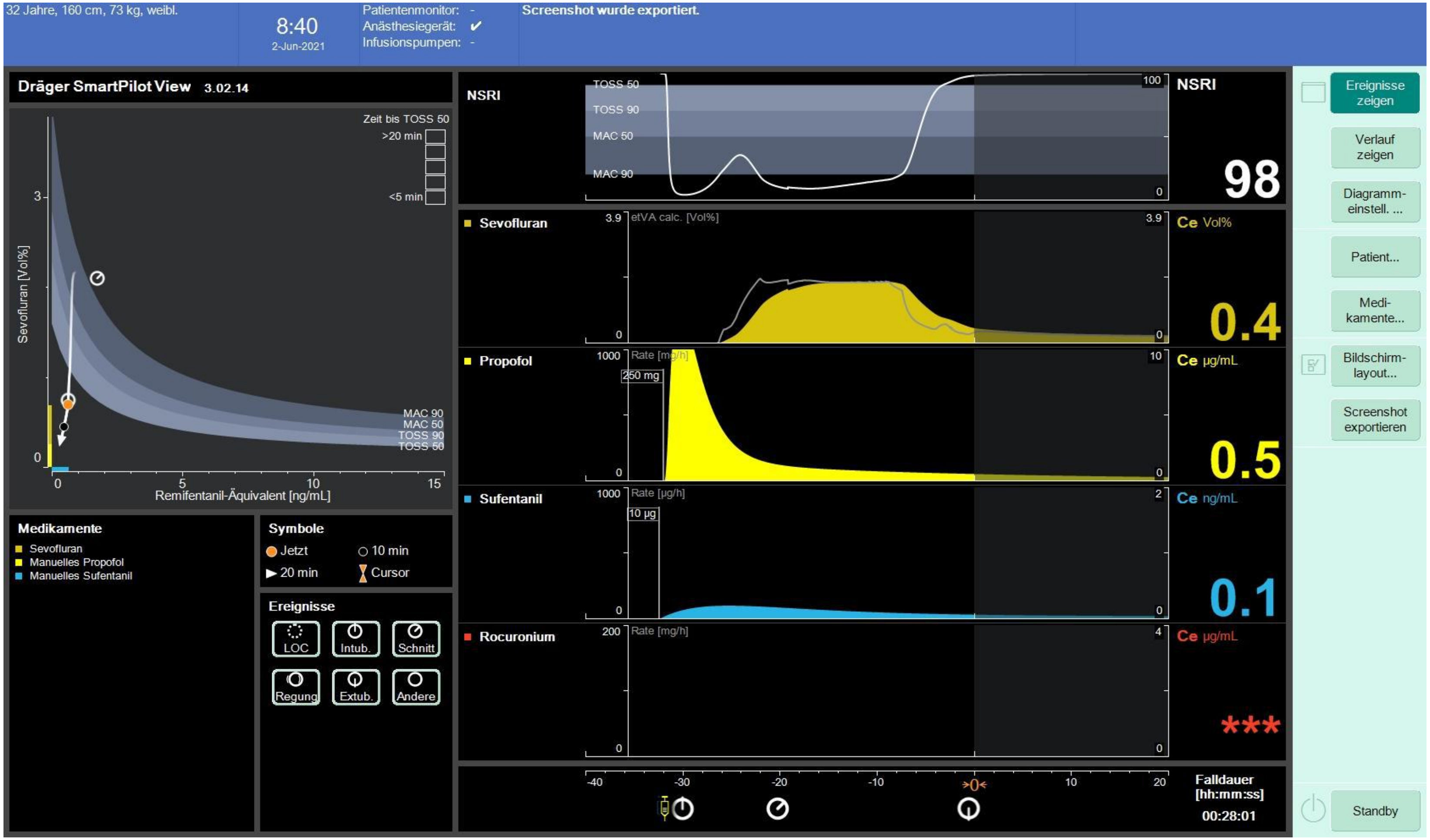
Metabolic flow (withdrawal)

Anesthesia withdrawal

-Vaporizer can be closed 10 min before end of surgery.

- In the recovery room what ever is needed.

Wash out 6 L/min FIO_2



Smart Pilot View® Draeger

But:
Green anaesthesia is more
than just anesthetic gas.

Circular economy thanks to device returns and the recycling of consumables (e.g. soda lime)

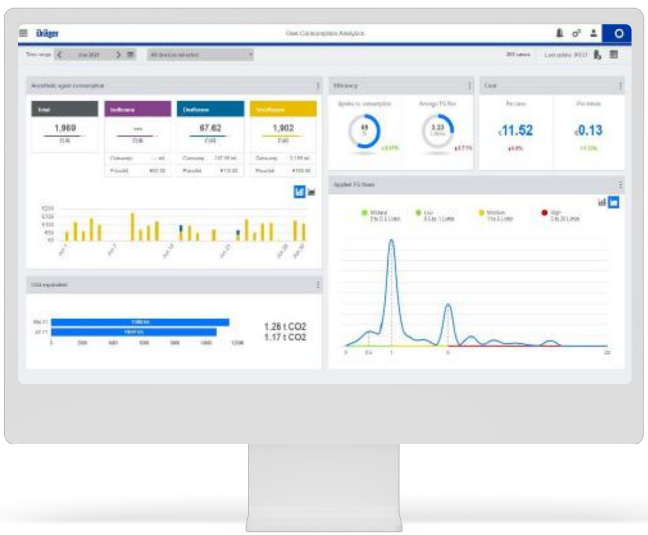
Reduction of anesthetic gas consumption through low-flow anesthesia with the help of technologically leading anesthesia machines, assistance systems, training and data analytics applications

Agent capturing and energy consumption of anesthetic gas scavenging systems

Around 2 % of a hospital's greenhouse gas emissions are attributable to anesthetic gases.

Reduction of anesthetic gas consumption

The efficient use of anesthetic gases is crucial.



Economical low flow anesthesia

- Reduction of anesthetic gas consumption
- Ecological and economic advantages
- More lung-protective ventilation

Pioneering technology

- Advanced anesthesia equipment and assistance systems
- Further education, webinars, training and information material

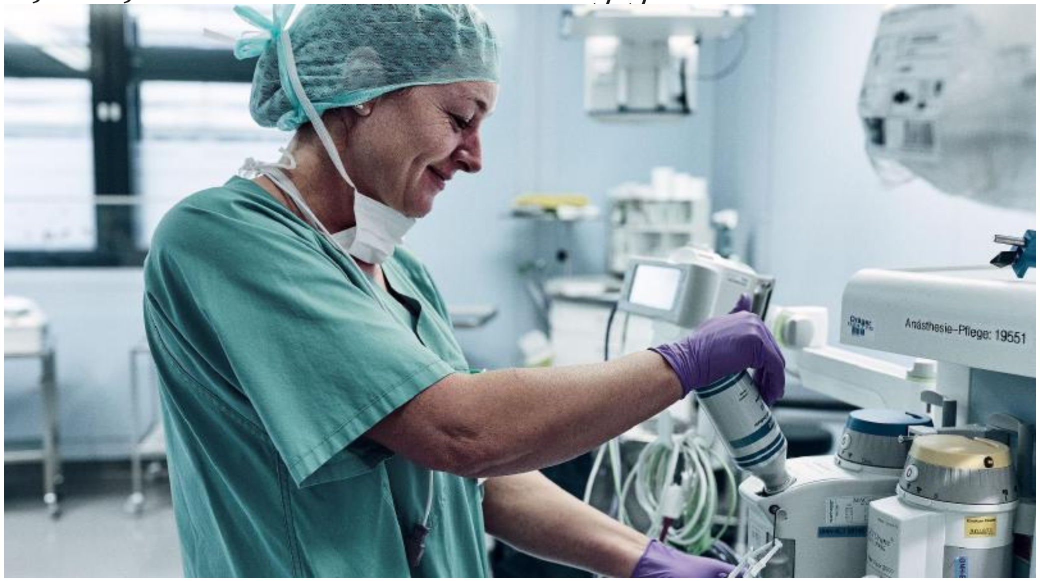
Innovative analysis dashboard

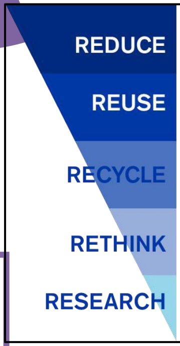
- Transparency regarding consumption and efficiency of volatile agent use
- Hospital-wide optimization of anaesthetic gas consumption

Drugs and anesthetic gases can cause significant climate-damaging effects

Reduction in anesthetic gas consumption

It is estimated that the climate-damaging effect of anesthetic gases is equivalent to the CO_2 emissions of 1,000,000 cars worldwide every year.



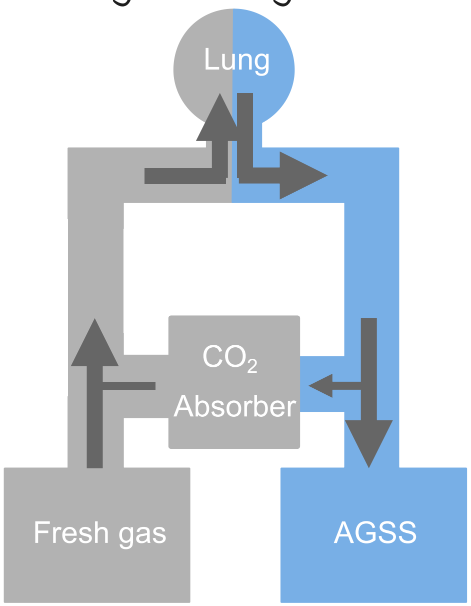


Anesthesia with volatile anesthetics and/or nitrous oxide should be administered in such a way that as few anesthetics as possible are released into the environment. This means the consistent use of minimal flow anesthesia.

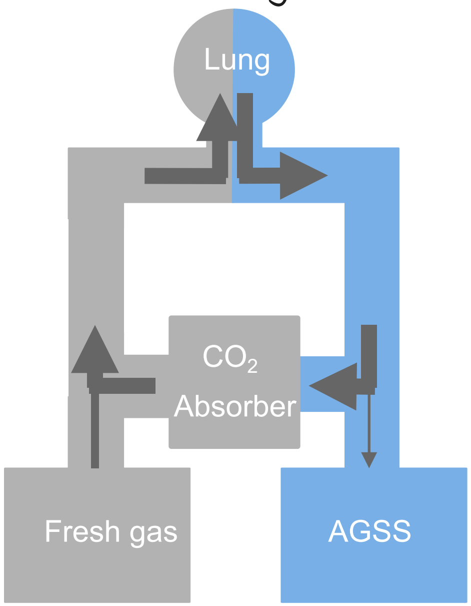
Source: A&A, April 2012 - Nielsen et al.; DGAI/BDA position paper.

Rebreathing and fresh gas flow

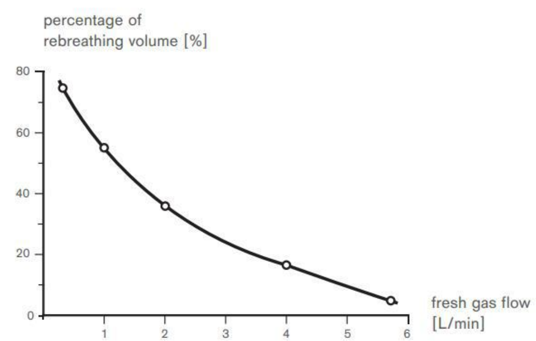
High fresh gas flow



Low fresh gas flow

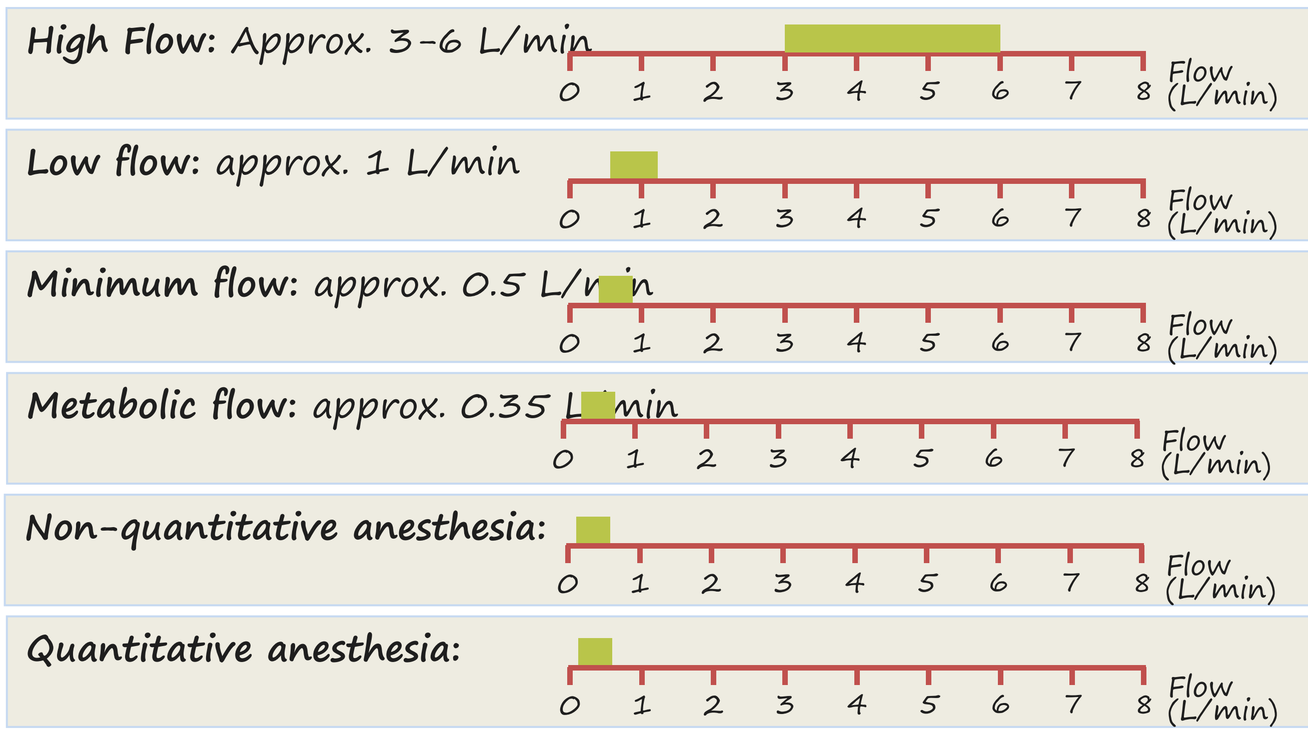


Reduction in anesthetic gas consumption

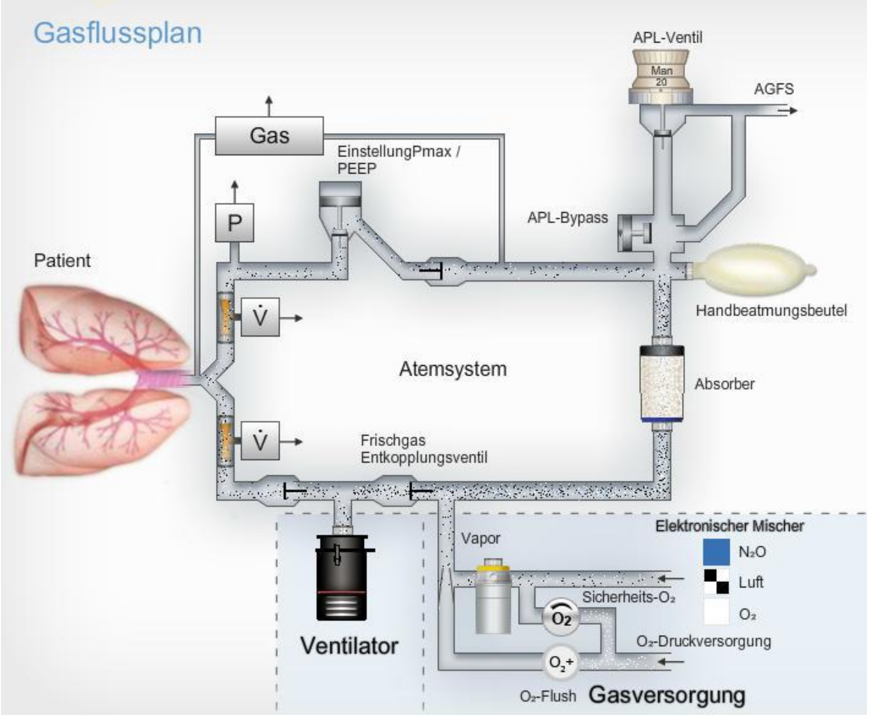


Source: Hönemann & Mierke;
Low-flow, minimal-flow and metabolic-flow anesthesia Clinical techniques for use with rebreathing systems

Classification of low flow anesthesia



Low flow anesthesia
Technical requirements



- Precise fresh gas dosing
- Precise anesthetic gas dosing
- Modern compact re-breathing system
  - High permanent tightness of the breathing system
  - Integrated breathing system heater
  - Air conditioning of the breathing gas right from the start
  - Adequate moisture management
  - Quick and easy hygienic preparation
- CO_2 -absorption by soda lime
- Precise gas measurement (inp. /exp.)
- Sample gas return
- Patient-specific alarm limits

Save twice and protect patients - advantages of low flow anesthesia

Reduction in anesthetic gas consumption

Clinical advantages
- Breathing gas conditioning (warm and humid breathing gas)
  - Maintaining the core body temperature
  - Prevention of damage to the airway epithelium
- Estimation of the O_2 patient uptake

Economic advantages
- Saving on volatile anesthetics
- Saving of fresh gas (oxygen, compressed air, nitrous oxide)

Monetary advantages of low flow anesthesia

Assumption
120 min. operation, sevoflurane price 81 € per 250 ml, 10 operating theaters, 250 operating days with 3 cases and 10 years of use

Scenario
Fresh gas flow 0.5 instead of 2 l/min in steady state

Savings
approx. 7.31 € per anesthesia*
over 10 years approx. € 528,525

Source: The calculations were carried out using the Gas Man® 4.3 simulation software.

Reduction of volatile anesthetics through technologically advanced anesthesia machines

Reduction in anesthetic gas consumption

- *Support in the efficient control of anesthesia and in particular the fresh gas flow with various assistance systems*
- *High permanent tightness of the breathing systems, humidity management, adequate gas and ventilation monitoring and sample gas return*
- *Clinic-wide optimization of consumption through intelligent dashboards*

Preoxygenation: 6 L Oxygen (FiO_2 0.8 – 1.0)
i.v. Induction or inhalational induction

Wash in period: FGF 0.7 L sevoflurane volatile vaporizer open completely
(2-4 min MAC 0.9-1.3)

Steady state, surgery period: FGF 0.35 L/min + Vaporizer 3-5 Vol%
(MAC 0.9 – 1.3)

End of surgery / Wash out: 6L O2, close vaporizer

Low Flow Booklet – published June 2014 (German)

Low flow poket card – published Nov. 13 2014 (German)

English version – November 2015

New booklet is comming this year

Dräger

Low-flow, minimal-flow and metabolic-flow anaesthesia
Clinical techniques for use with rebreathing systems

Christian Hönemann
Bert Mierke

Dräger. Technology for Life®

Dräger

Minimal-Flow-Anästhesie mit Sauerstoff-Luft-Gemisch als Trägergas
Schematische Vorgehensweise

Prämedikation

Prämedikation nach gewohntem Schema

Einleitung

- Präoxygenierung mit 100 % Sauerstoff mit 6 l/min für 1 bis 3 Minuten unter Vorhalten einer Gesichtsmaske
- Intravenöse Gabe des Hypnotikums oder Inhalationseinleitung
- Analgesie und Relaxation (Achtung: Einleitungsopioid eventuell bis 20 % höher dosieren)
- Endotracheale Intubation oder Einlegen einer Larynxmaske
- Anschluss des Patienten an das Kreissystem

Initialphase

- Dauer 6 bis 10 Minuten – Einstellungen Frischgasflow
  Sauerstoff 1 l/min, Air 3 l/min
  Vapor-Einstellungen

Isofluran	2,5 Vol.-%
Sevofluran	3,5 Vol.-%
Desfluran	6 Vol.-%

Die inspiratorische Sauerstoffkonzentration wird sich zwischen 35 und 40 Vol.-% einpendeln.

ach 10 bis 15 Minuten

Verminderung Frischgasflow für Sauerstoff auf 0,3 l/min, für Air auf 0,2 l/min
Erhöhung der Vapor-Einstellung für

Isofluran auf	5 Vol.-%
Sevofluran auf	5 Vol.-%
Desfluran auf	8 Vol.-%

onitoring

Inspiratorische Sauerstoffkonzentration mit einer unteren Alarmgrenze von mindestens 28 Vol.-%
Atemminutenvolumen: untere Alarmgrenze auf 0,5 l/min unter dem angestrebten Sollwert einstellen.
Überwachung der Narkosemittelkonzentration im Atemsystem: Obergrenzen für Isofluran auf 2 bis 2,5 Vol.-% setzen, für Sevofluran auf 3 bis 3,5 Vol.-% und für Desfluran auf 8 bis 10 Vol.-%.
Der Einsatz des Dräger SmartPilot View kann Minimal-Flow-Techniken sinnvoll unterstützen.

usleitung

Reduzierung der Vapor-Einstellung auf 0 % etwa 10 Minuten vor OP-Ende.
Beibehalten des niedrigen Flusses von 0,5 l/min.
Überführen des Patienten zur Spontanatmung.
Nach Ende der Naht, vor Extubation: Spülen des Systems mit 100 % Sauerstoff mit 6 l/min.
Postoperative Betreuung des Patienten entsprechend den üblichen abteilungsinternen Verfahrensweisen.

Dräger

Minimal-Flow-Anästhesie mit Sauerstoff als Trägergas
Schematische Vorgehensweise (ab einem Patientenalter > 6 Monate)

Prämedikation

Prämedikation nach gewohntem Schema

Einleitung

- Präoxygenierung mit 100 % Sauerstoff mit 6 l/min für 1 bis 3 Minuten unter Vorhalten einer Gesichtsmaske
- Intravenöse Gabe des Hypnotikums oder Inhalationseinleitung
- Analgesie und Relaxation (Achtung: Einleitungsopioid eventuell bis 20 % höher dosieren)
- Endotracheale Intubation oder Einlegen einer Larynxmaske
- Anschluss des Patienten an das Kreissystem

Initialphase

- Dauer 1 bis 8 Minuten – Einstellungen Frischgasflow
  100 % Sauerstoff 1 l/min
- Vapor-Einstellungen

Isofluran	5 bis 6 Vol.-%
Sevofluran	5 bis 6 Vol.-%
Desfluran	12 Vol.-%

- Die inspiratorische Sauerstoffkonzentration wird sich in Abhängigkeit von Alter und Gewicht zwischen 60 und 80 Vol.-% einpendeln.

Nach Erreichen des Ziel-MAC-Wertes von 0,8 bis 1

- Verminderung Frischgasflow für 100 % Sauerstoff auf 0,25 bis 0,35 l/min
- Keine Änderung der Vapor-Einstellungen

Monitoring

- Inspiratorische Sauerstoffkonzentration mit einer unteren Alarmgrenze von mindestens 28 Vol.-%
- Atemminutenvolumen: untere Alarmgrenze auf 0,5 l/min unter dem angestrebten Sollwert einstellen.
- Überwachung der Narkosemittelkonzentration im Atemsystem: Obergrenzen für Isofluran auf 2 bis 2,5 Vol.-% setzen, für Sevofluran auf 3 bis 3,5 Vol.-% und für Desfluran auf 8 bis 10 Vol.-%.
- Der Einsatz des Dräger SmartPilot View kann Minimal-Flow-Techniken sinnvoll unterstützen.

Ausleitung

- Reduzierung der Vapor-Einstellung auf 0 % etwa 10 bis 15 Minuten vor OP-Ende.
- Beibehalten des niedrigen Flusses von 0,35 l/min.
- Überführen des Patienten zur Spontanatmung.
- Nach Ende der Naht, vor Extubation: Spülen des Systems mit 100 % Sauerstoff mit 6 l/min.
- Postoperative Betreuung des Patienten entsprechend den üblichen abteilungsinternen Verfahrensweisen.

Erhöhung der Narkosemittelkonzentration unter Ausnutzung der langen Zeitkonstante

- Der Frischgasflow bleibt unverändert auf 0,35 l/min.
- Die Vapor-Einstellungen auf maximale Abgabeleistung erhöhen. Besonderheit Isofluran: Eine Vertiefung der Narkose allein mit Isofluran ist nur mit maximaler Abgabeleistung des Isofluran-Vapors bei gleichzeitiger Erhöhung des Frischgasflows zu etablieren.

Dräger

Minimal-Flow-Anästhesie mit Sauerstoff-Lachgas-Gemisch als Trägergas
Schematische Vorgehensweise

Prämedikation

Prämedikation nach gewohntem Schema

Einleitung

- Präoxygenierung mit 100 % Sauerstoff mit 6 l/min für 1 bis 3 Minuten unter Vorhalten einer Gesichtsmaske
- Intravenöse Gabe des Hypnotikums oder Inhalationseinleitung
- Analgesie und Relaxation
- Endotracheale Intubation oder Einlegen einer Larynxmaske
- Anschluss des Patienten an das Kreissystem

Initialphase

- Dauer 15 bis 20 Minuten – Einstellungen Frischgasflow
  Sauerstoff 1,4 l/min, Lachgas 3 l/min
- Vapor-Einstellungen

Isofluran	1 bis 1,5 Vol.-%
Sevofluran	2 bis 2,5 Vol.-%
Desfluran	4 bis 6 Vol.-%

- Die inspiratorische Sauerstoffkonzentration wird sich zwischen 30 und 40 Vol.-% einpendeln

Nach 15 Minuten

- Verminderung Frischgasflow auf insgesamt 0,5 l/min (Sauerstoff 0,3 l/min, Lachgas 0,2 l/min)
- Erhöhung der Vapor-Einstellung

Isofluran auf	2,5 Vol.-%
Sevofluran auf	3 bis 3,5 Vol.-%
Desfluran auf	5 bis 7,5 Vol.-%

Monitoring

- Inspiratorische Sauerstoffkonzentration mit einer unteren Alarmgrenze von mindestens 28 Vol.-%
- Atemminutenvolumen: untere Alarmgrenze auf 0,5 l/min unter dem angestrebten Sollwert einstellen.
- Überwachung der Narkosemittelkonzentration im Atemsystem: Obergrenzen für Isofluran auf 2 bis 2,5 Vol.-%, für Sevofluran auf 3 bis 3,5 Vol.-% und für Desfluran auf 8 bis 10 Vol.-% setzen.
- Der Einsatz des Dräger SmartPilot View kann Minimal-Flow-Techniken sinnvoll unterstützen.

Ausleitung

- Reduzierung der Vapor-Einstellung auf 0 % etwa 10 bis 15 Minuten vor OP-Ende.
- Beibehalten des niedrigen Flusses von 0,5 l/min.
- Überführen des Patienten zur Spontanatmung.
- Nach Ende der Naht, vor Extubation: Spülen des Systems mit 100 % Sauerstoff mit 6 l/min.
- Postoperative Betreuung des Patienten entsprechend den üblichen abteilungsinternen Verfahrensweisen.

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https://www.draeger.com/Library/Content/low-minimal-flow-anaesthesie-bk-9067990.pdf

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A call for immediate climate action in anesthesiology: routine use of minimal or metabolic fresh gas flow reduces our ecological footprint

Appel à une action climatique immédiate en anesthésiologie : le recours systématique à un débit minimal ou métabolique de gaz frais réduit notre empreinte écologique

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SPECIAL ARTICLE

A call for immediate climate action in anesthesiology: routine use of minimal or metabolic fresh gas flow reduces our ecological footprint

Appel à une action climatique immédiate en anesthésiologie : le recours systématique à un débit minimal ou métabolique de gaz frais réduit notre empreinte écologique

Marie-Luise Rübsam, MD · Philippe Kruse, MD · Yvonne Dietzler, MD · Miriam Kropf, MD · Birgit Bette, MD · Alexander Zarbock, MD, PhD · Se-Chan Kim, MD, PhD · Christian Hönemann, MD, PhD

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Abstract

Purpose *Climate change is a global threat, and inhalational anesthetics contribute to global warming by altering the photophysical properties of the atmosphere. On a global perspective, there is a fundamental need to reduce perioperative morbidity and mortality and to provide safe anesthesia. Thus, inhalational anesthetics will remain a significant source of emissions in the foreseeable future. It is, therefore, necessary to develop and implement strategies to minimize the consumption of inhalational anesthetics to reduce the ecological footprint of inhalational anesthesia.*

Source *We have integrated recent findings concerning climate change, characteristics of established inhalational anesthetics, complex simulative calculations, and clinical expertise to propose a practical and safe strategy to practice ecologically responsible anesthesia using inhalational anesthetics.*

Principal findings *Comparing the global warming potential of inhalational anesthetics, desflurane is about 20 times more potent than sevoflurane and five times more potent than isoflurane. Balanced anesthesia using low or minimal fresh gas flow (≤ 1 L·min^{-1}) during the wash-in period and metabolic fresh gas flow (0.35 L·min^{-1}) during steady-state maintenance reduces CO_2 emissions and costs by approximately 50%. Total intravenous anesthesia and locoregional anesthesia represent further options for lowering greenhouse gas emissions.*

Conclusion *Responsible anesthetic management choices should prioritize patient safety and consider all available options. If inhalational anesthesia is chosen, the use of minimal or metabolic fresh gas flow reduces the consumption of inhalational anesthetics significantly. Nitrous oxide should be avoided entirely as it contributes to depletion of the ozone layer, and desflurane should only be used in justified exceptional cases.*

Résumé

Objectif *Les changements climatiques constituent une menace mondiale et les anesthésiques volatils contribuent*

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Conclusion: Responsible anesthetic management choices should prioritize patient safety and consider all available options. If inhalational anesthesia is chosen, the use of minimal or metabolic fresh gas flow reduces the consumption of inhalational anesthetics significantly. Nitrous oxide should be avoided entirely as it contributes to depletion of the ozone layer, and desflurane should only be used in justified exceptional cases.

My wife and I feel beyond honored and proud to be members of the ASPA Faculty.

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