

Current Recommendations for Lung Protective Ventilation during Anesthesia in the OR



St. Marienhospital
Vechta

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Priv.-Doz. Dr. med. Christian Höinemann

Chefarzt im Kollegialsystem (CA Dr. Olaf Hagemann)
Abteilung für Anästhesie und operative Intensivmedizin
Marienhospital Vechta gGmbH
Marienstraße 6-8, 49377 Vechta





Marienhospital Vechta
new hospital building, old hospital building,
Kardiology, Nephrology



Ambulatory building I+II, Rehaclinic, Management
Physiotherapy, Pharmacy

Dr. Hönenmann received in the last 3 years lecturer fees from the following Companies:
Draeger, GmbH & CoKG, Lübeck
Vifor Pharma GmbH, Munich
Sedana medical GmbH, Geretsried-Gelting



New ENT + Pediatric Department
Central OR



Katholische Kliniken
Oldenburger Münsterland





From: Protective Ventilation during Anesthesia: Is It Meaningful?

Anesthes. 2016;125(6):1079-1082. doi:10.1097/ALN.0000000000001382



Figure Legend:

Image: J. P. Rathmell.

Date of download: 4/16/2019

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Christian Höinemann. 11-й Британо-Український Симпозіум. Київ, 2019



From: Apply Protective Mechanical Ventilation in the Operating Room in an Individualized Approach to Perioperative Respiratory Care

Anesthes. 2015;123(1):12-14. doi:10.1097/ALN.0000000000000707



Figure Legend:

Image: J. P. Rathmell.

Outline, Protektive Ventilation – Influencing Factors

Freshgasflow

- Breathing Gas humidity
- Breathing Gas temperature
- Breathing System Filter HME, electrostatic, mechanical

Ventilation pressures

- PEAK / PLAT / Driving Pressure
- PEEP
- inspiratory flow
- mode of ventilation (Pressure/volumen controlled, spontaneus)

Breathing gas composition

- FiO_2
- $\text{O}_2/\text{N}_2\text{O}$
- O_2/AIR





Physiological background of the upper airway

- In the upper airway inspired air is warmed and humidified
- trachea: 36 – 40 mg H₂O/l
carina: 44 mg H₂O/l (= 100% humidity at 37°C)
→ Optimal conditions for gas exchange on alveocapillary membrane.
- Ciliary strike for mobilization and cough of secretions and inhaled particles

Wolf M, Naftali S, Schroter RC, Elad D. Air-conditioning characteristics of the human nose. The Journal of laryngology and otology 2004;118:87–92.





- **Ventilation via endotracheal tube or laryngeal mask**

Elimination of physiological Humidification in the upper respiratory airway

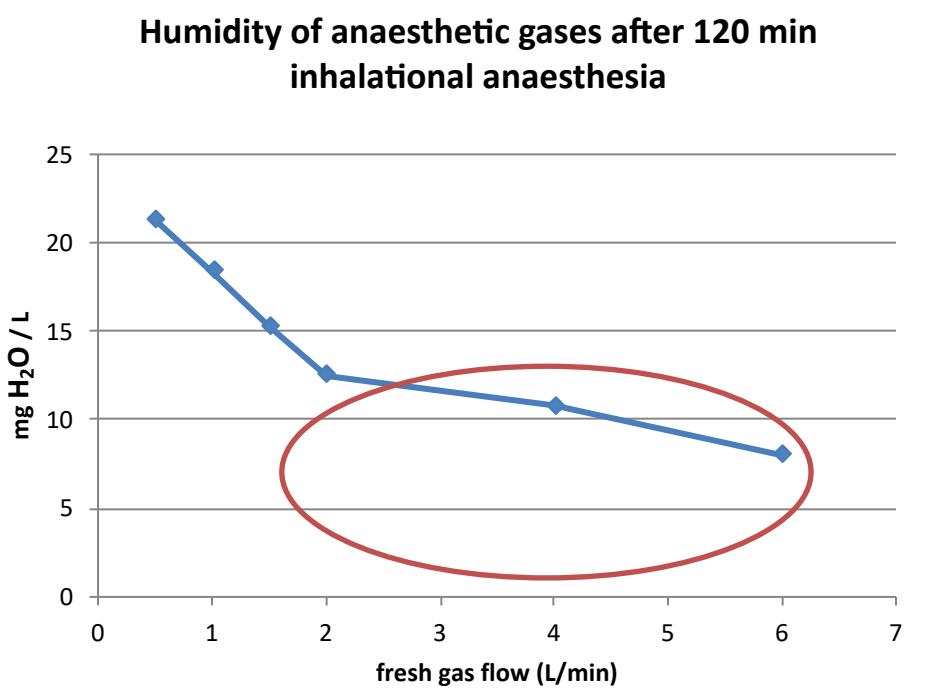
By using decompressed and therefore dry and cold gases from central Gas supply

negative effects for the lungs

Irlbeck D. Normal mechanisms of heat and moisture exchange in the respiratory tract. Respiratory care clinics of North America 1998;4:189–198.



Breathing Gas Humidity



Modified by

Humidity of anaesthetic gases with respect to low flow anaesthesia

Kleemann PP

Anaesth Intensive Care 1994; 22 (4): 396-408



Dr. med. Eva Blömer, resident

„When I started my education in anaesthesia, I got trained in Metabolic flow anaesthesia (0,35 L/min). I didn't know that it is possible to use 1 L/min fresh gas flow for more than 5-10 min . It dries out the mucosa.“

Breathing gas temperature and humidity

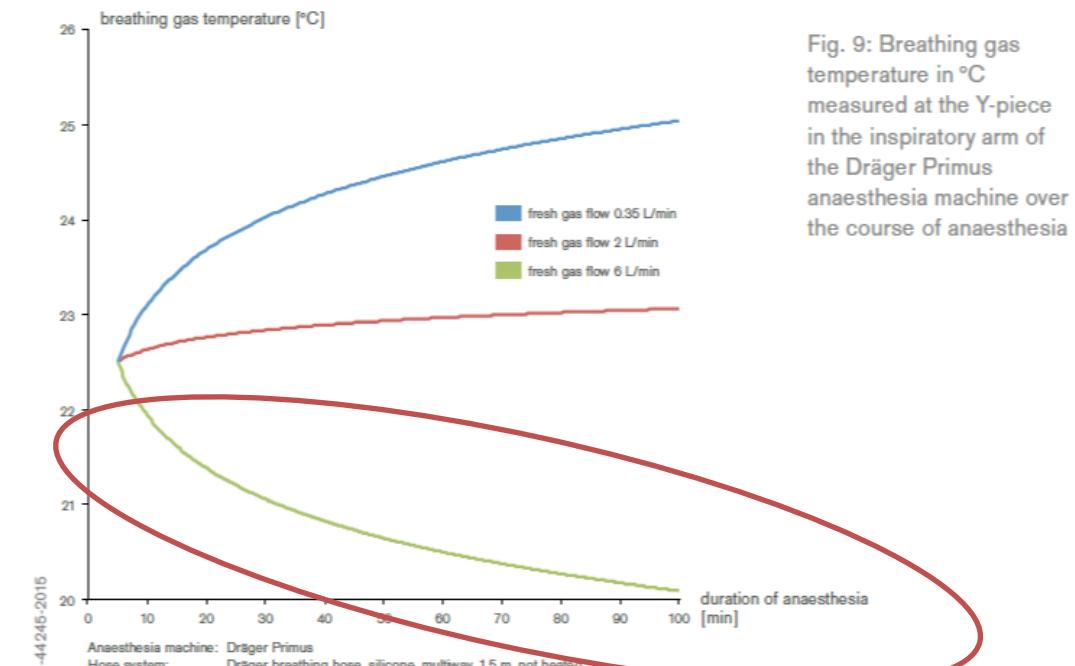


Fig. 9: Breathing gas temperature in °C measured at the Y-piece in the inspiratory arm of the Dräger Primus anaesthesia machine over the course of anaesthesia

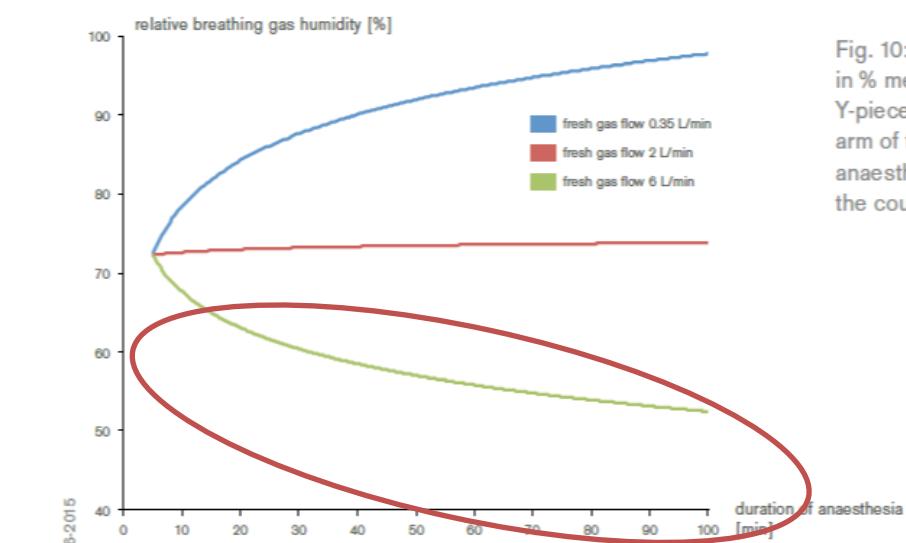
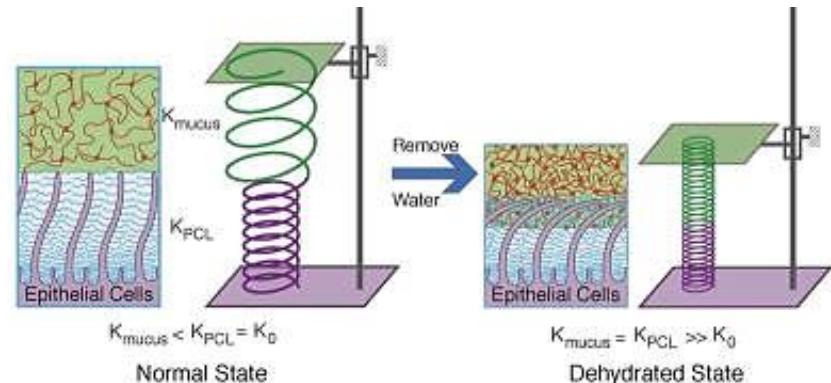


Fig. 10: Relative humidity in % measured at the Y-piece in the inspiratory arm of the Dräger Primus anaesthesia machine over the course of anaesthesia

Consequences of cold and dry inspired gases

- Changes in the tracheobronchial epithelium
- Reduced Mucus Viscosity
- Secreting with atelectasis
- ↓ pulmonale compliance
- ↑ Breathing Work postoperative
- Heat and Fluid Loss



Branson RD, Campbell RS, Davis K, Porembka DT. Anaesthesia circuits, humidity output, and mucociliary structure and function. *Anaesthesia and intensive care* 1998;26:178–183.
Button B, Cai LH, Ehre C, Kesimer M, Hill DB, Sheehan JK, et al. Periciliary Brush Promotes the Lung Health by Separating the Mucus Layer from Airway Epithelia. *Science (New York, N.Y.)* 2012;337:937–941.

Kleemann PP. The climatisation of anaesthetic gases under conditions of high flow to low flow. *Acta anaesthesiologica Belgica* 1990;41:189–200
Williams R, Rankin N, Smith T, Galler D, Seakins P. Relationship between the humidity and temperature of inspired gas and the function of the airway mucosa. *Crit Care Med* 1996;24(11):1920-1929.

Gross JL, Park GR. Humidification of inspired gases during mechanical ventilation. *Minerva anestesiologica* 2012;78:496–502.
Kilgour E, Rankin N, Ryan S, Pack R. Mucociliary function deteriorates in the clinical range of inspired air temperature and humidity. *Intensive Care Med* 2004;30(7):1491-1494.
Zuchner K. Humidification: measurement and requirements. *Respir Care Clin N Am* 2006;12(2):149-163.



Sources of heat and Humidity within the anesthesia circuit

Internal Sources

- CO₂ - absorber

$$\Delta T = 14 \text{ kcal/molCO}_2$$

$$T = 44,1 \pm 1,1^\circ\text{C}$$



+ Ethylenviolett

- Valve Plates flat is heated (Primus, Fabius, etc.)
- Ventilator Waste Heat (Turbine/Blower)

External Sources

- Heating and Moisturising the Inspiration air
- Warming blankets and – bair hugger systems
- Room temperature

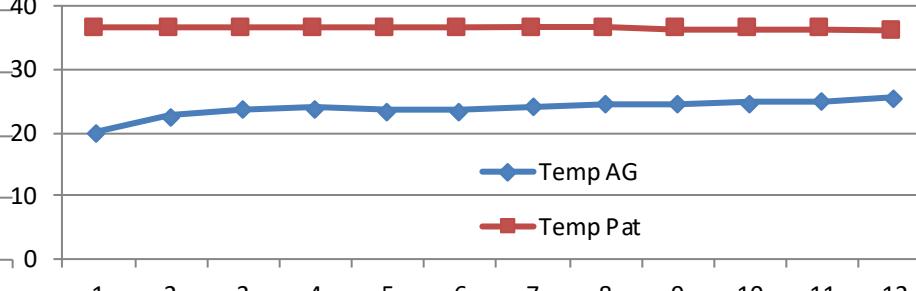
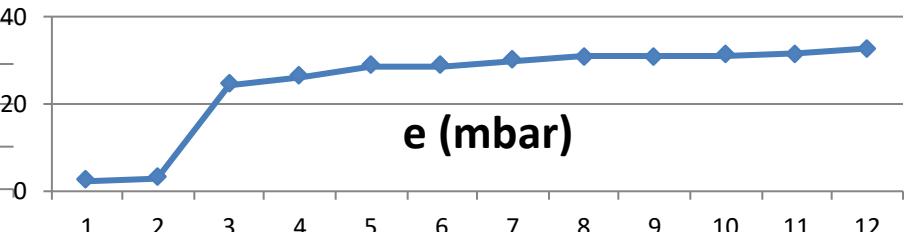
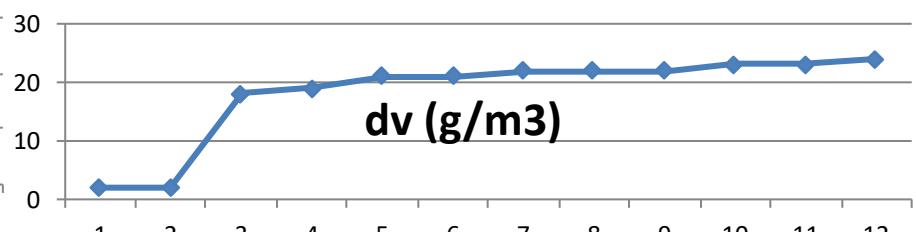
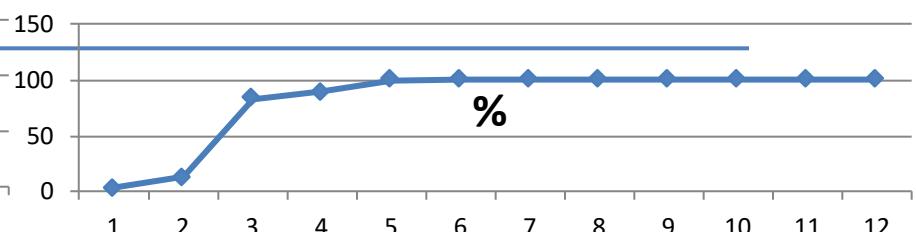
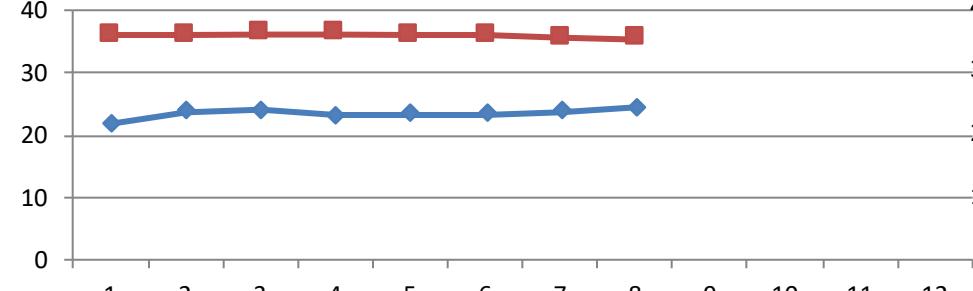
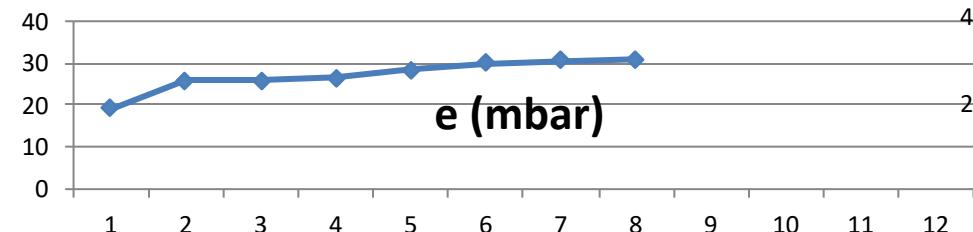
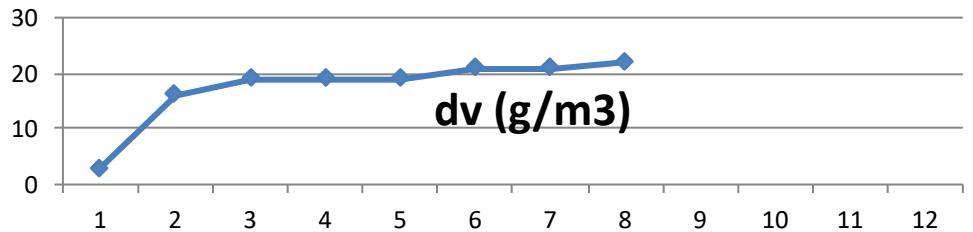
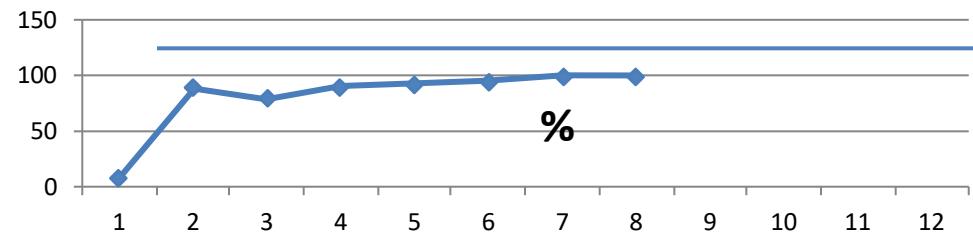
Lutropp HH, Johansson A. Soda lime temperatures during low-flow sevoflurane anaesthesia and differences in dead-space. Acta Anaesthesiologica Scandinavica 2002;46:500–505.



Experimental OR – Brachytherapy - Radiologydepartment, room temperature 22,15°C, 2-3 h procedures, no surgery



Our data in Primus[©]



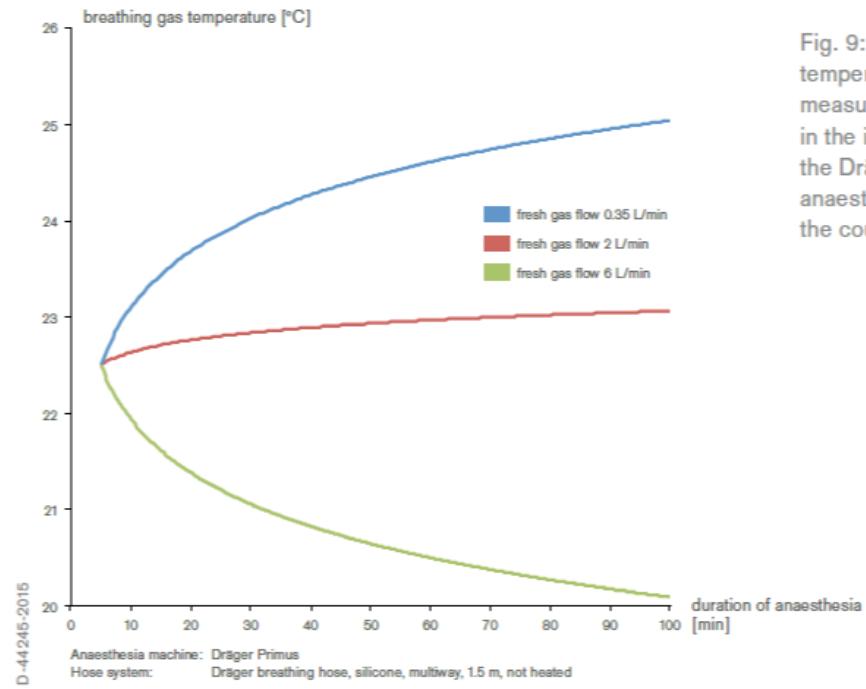


Fig. 9: Breathing gas temperature in °C measured at the Y-piece in the inspiratory arm of the Dräger Primus anaesthesia machine over the course of anaesthesia

Valve flat heating

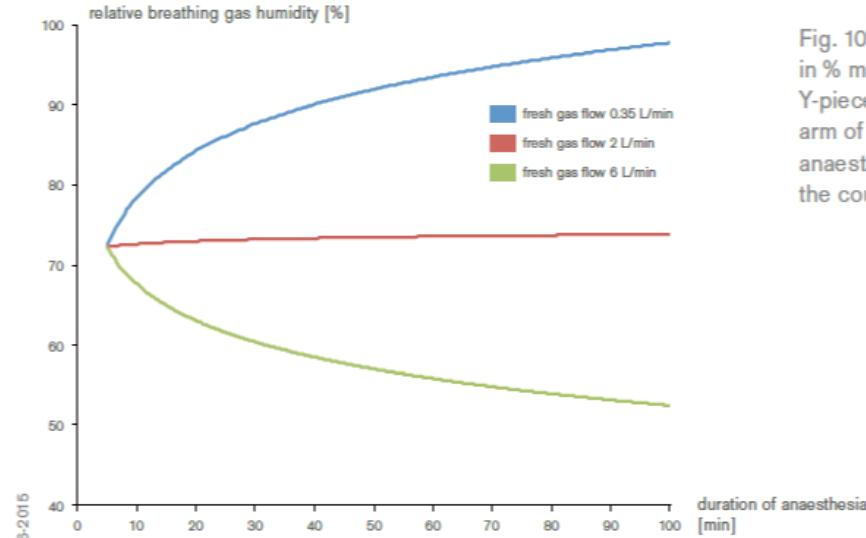
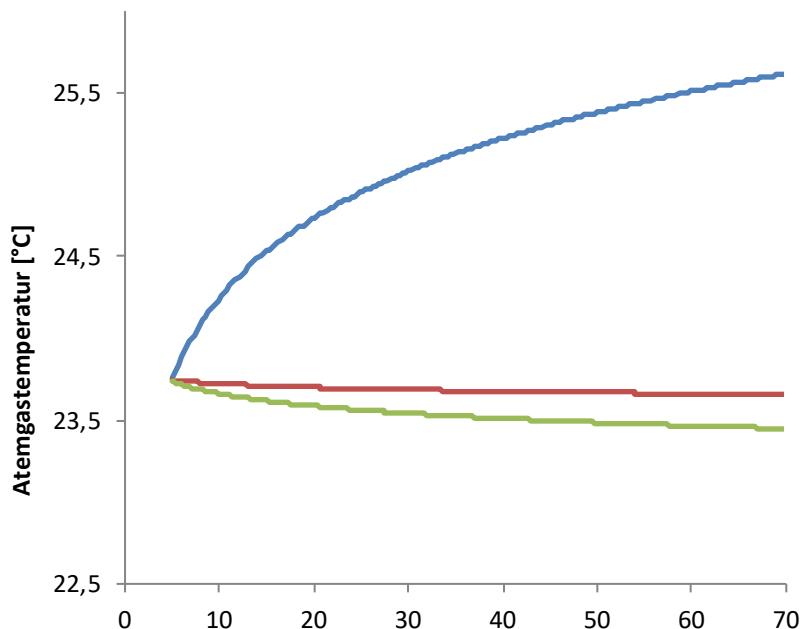


Fig. 10: Relative humidity in % measured at the Y-piece in the inspiratory arm of the Dräger Primus anaesthesia machine over the course of anaesthesia

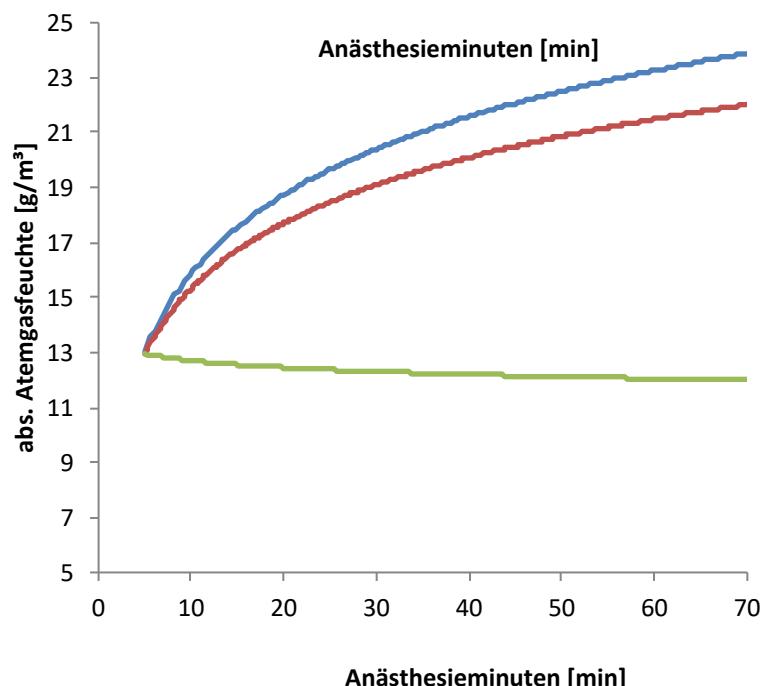


Perseus®

Waste heat from
the blower



Breathing gas temperature measured in °C at the Y-piece at the inspiratory arm of Draeger Perseus anesthesia machine over the course of anesthesia



Absolute humidity measured in g/m³ at the Y-piece at the inspiratory arm of Draeger Perseus anesthesia machine over the course of anesthesia

- Frischgasflow 0,35 l/min
- Frischgasflow 1 l/min
- Frischgasflow 6 l/min

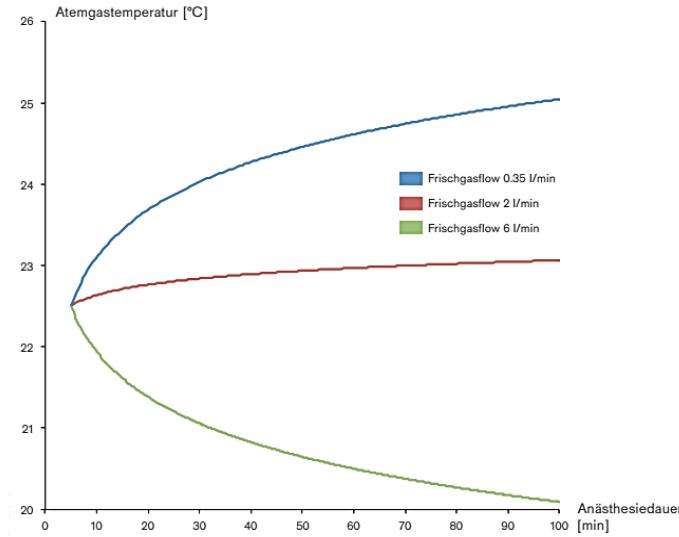
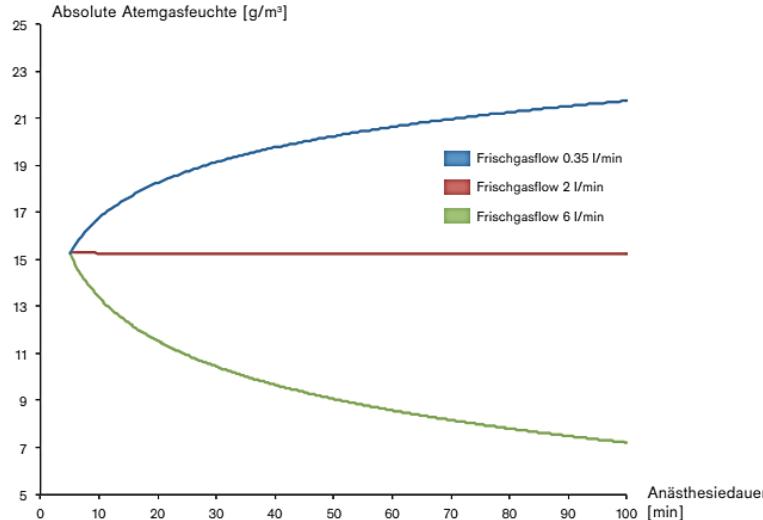


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Oldenburger Münsterland

Fresh Gas Flow as low as possible



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Primus ®, Drägerwerk AG & Co. KGaA, Lübeck

- High Fresh Gas Flow (FGF) leads to Dehydration and Cooling
- Minimal flow technique can increase respiratory gas moisture and – temperature during anaesthesia
- Recommendation DGAI: FGF to choose AS low as possible

Hoenemann C, Mierke B. Low-Flow-, Minimal-Flow- und Metabolic-Flow-Anästhesien, Lübeck: Drägerwerk AG & Co. KGaA; 2015, S. 22ff.

Kramer A, Kranabetter R, Rathgeber J, Züchner K et al. Infektionsprävention bei der Narkosebeatmung durch Einsatz von Atemsystemfiltern (ASF): Gemeinsame Empfehlung der Deutschen Gesellschaft für Krankenhaushygiene e.V. (DGKH) und der Deutschen Gesellschaft für Anästhesiologie und Intensivmedizin e.V. GMS Krankenhaushygiene interdisziplinär 2010;5.



Breathing hose systems



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Double hose breathing systems

- Unheated
- Heated



- One-hose breathing systems
 - Hose in hose (coaxial tube)
 - With internal membrane
(Double D hose)

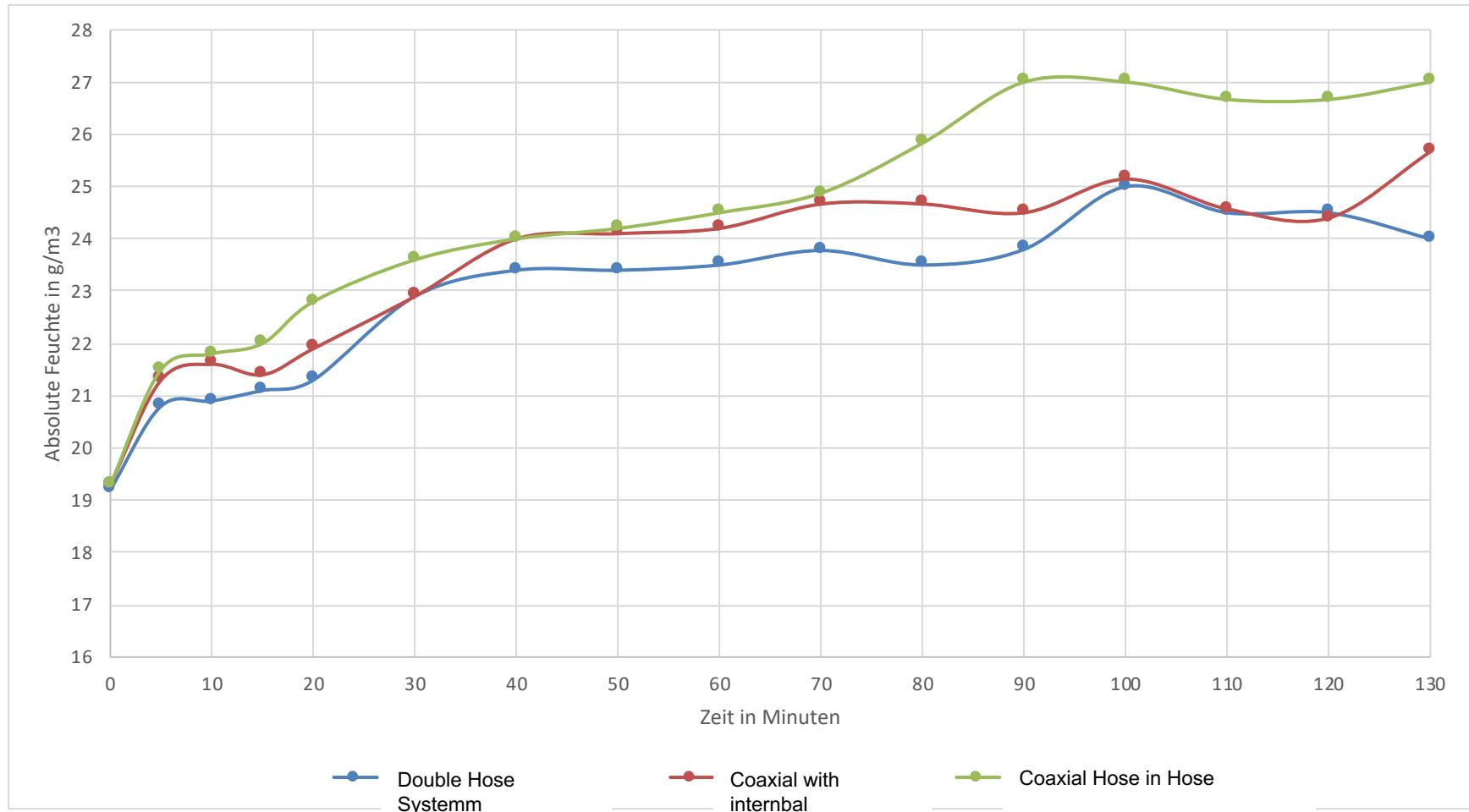
Doppelschlauch-System, Koaxiales Schlauchsystem® und
Double D®

Rüsch, Teleflex Medical, Ireland





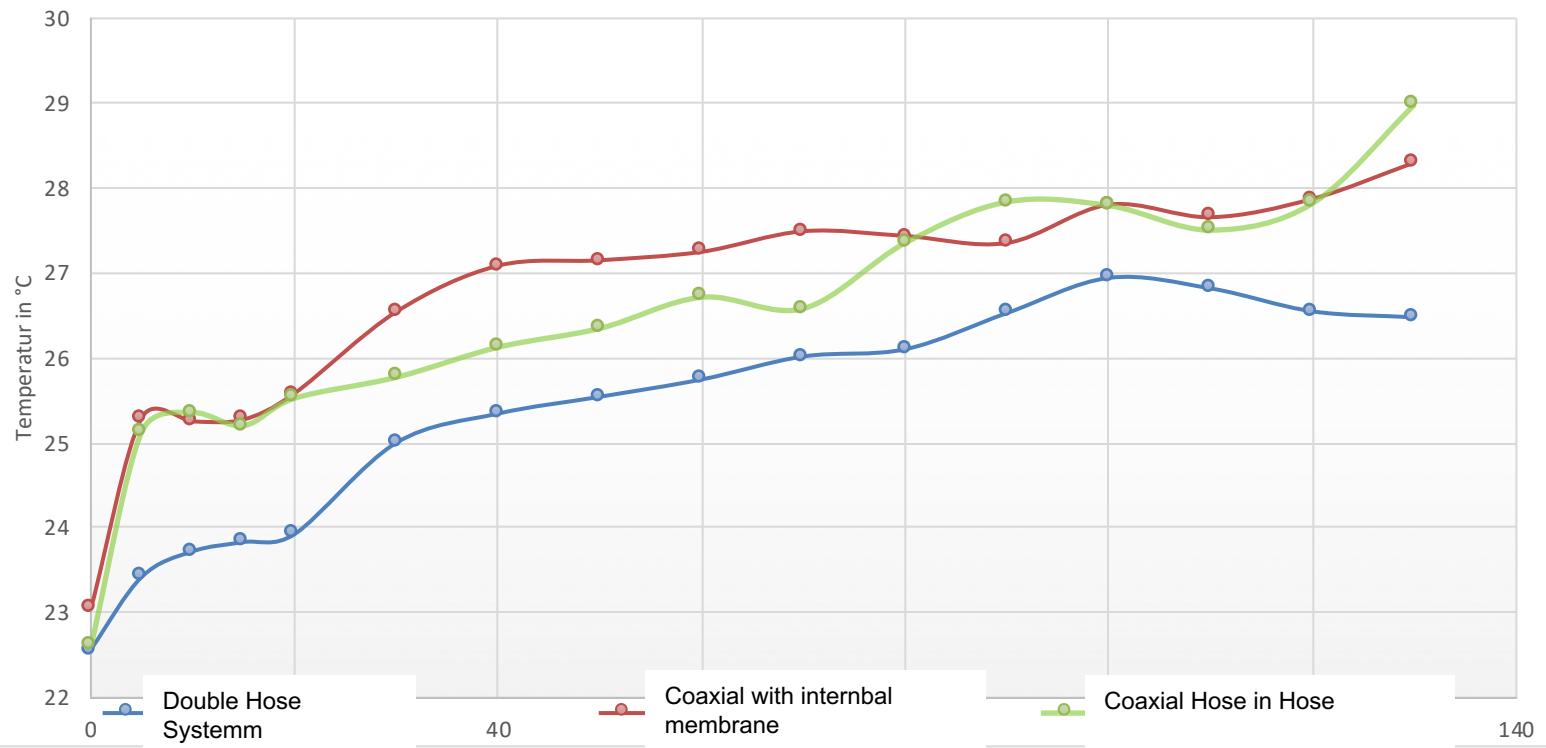
Absolute moisture / humidity



Breathing Gas Temperature



St. Marienhospital
Vechta



Working Group

“Ventilation Technology”



St. Marienhospital
Vechta

Leitung: PD Dr. Christian Hönemann (St. Marienhospital, Vechta)

Dr. Bert Mierke (St. Elisabeth-Krankenhaus, Damme)

Dr. Marie-Luise Rübsam (Universitätsmedizin Greifswald)



Julia Woehlk
(Doktorandin, Uni Münster)

Thi Nguyen-Minh
(Dokotrand, Uni Münster)

Benedikt Groß
(Dokotrand, Uni Münster)



Heike Havermann
(Doktorandin, Uni Münster)





Summary

- Elimination of physiological mechanisms in the upper respiratory airway by artificial airways (ETT/LM)
- No recommendations for temperature / humidity limits:
 - 30 and 37°C and 30-35 mg H₂O/l Air
- Circle component with different effects
 - Choice of fresh gas flow: Metabolic flow Anaesthesia (0.35l/min)
 - Ventilation tubes: Coaxial Tube-in hose systems, If possible, place it under external heat source (bair hugger)
 - Guess: Room Temperature / ΔT with decisive Influence



Outline, Protektive Ventilation – Influencing Factors

Freshgasflow

- Breathing Gas humidity
- Breathing Gas temperature
- Breathing System Filter HME, electrostatic, mechanical

Ventilation pressures

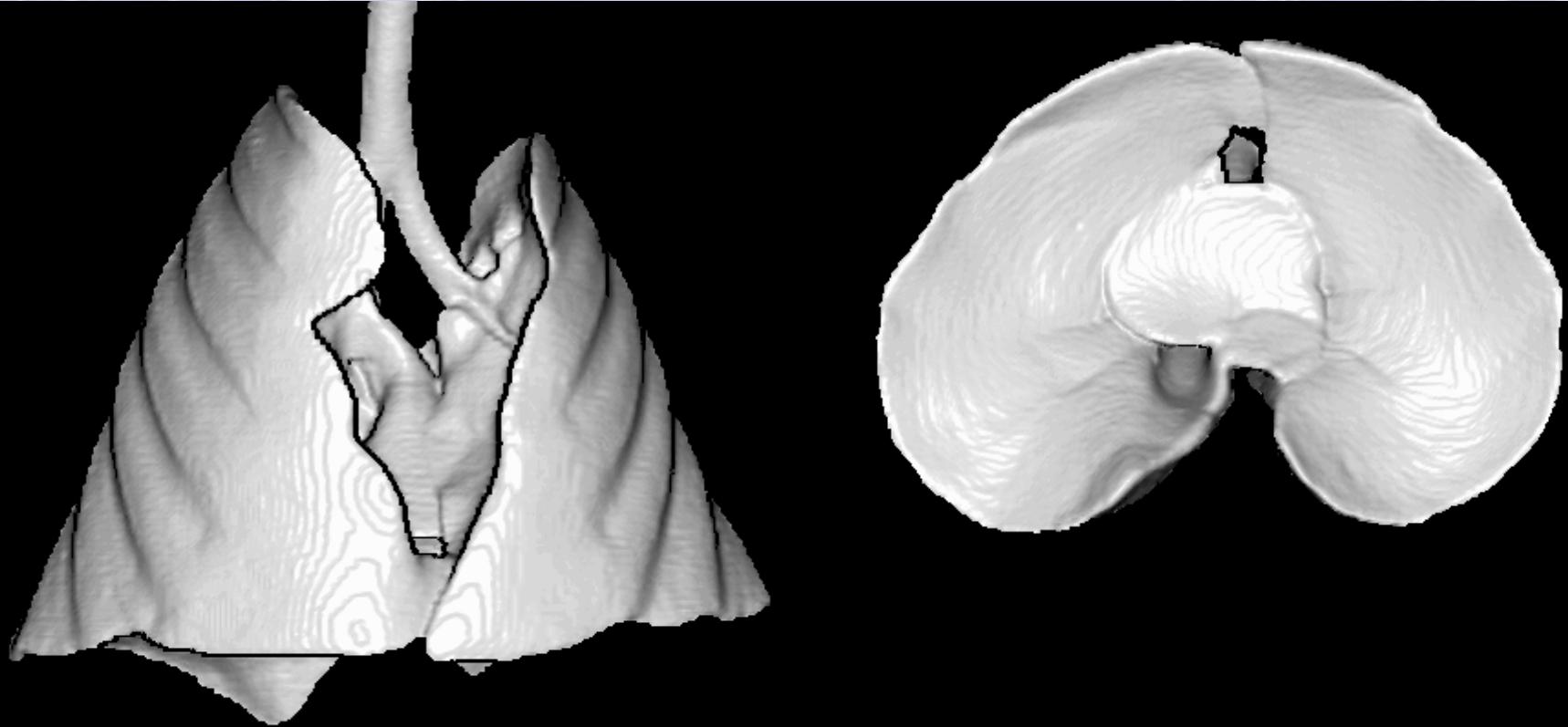
- recruitment manouvers
- PEAK / PLAT / Driving Pressure
- PEEP
- inspiratory flow
- mode of ventilation (Pressure/volume controlled, spontaneous)

Breathing gas composition

- FiO_2
- $\text{O}_2/\text{N}_2\text{O}$
- O_2/AIR



CT-3D: 3 kg KG rabbits, for anesthesia induction

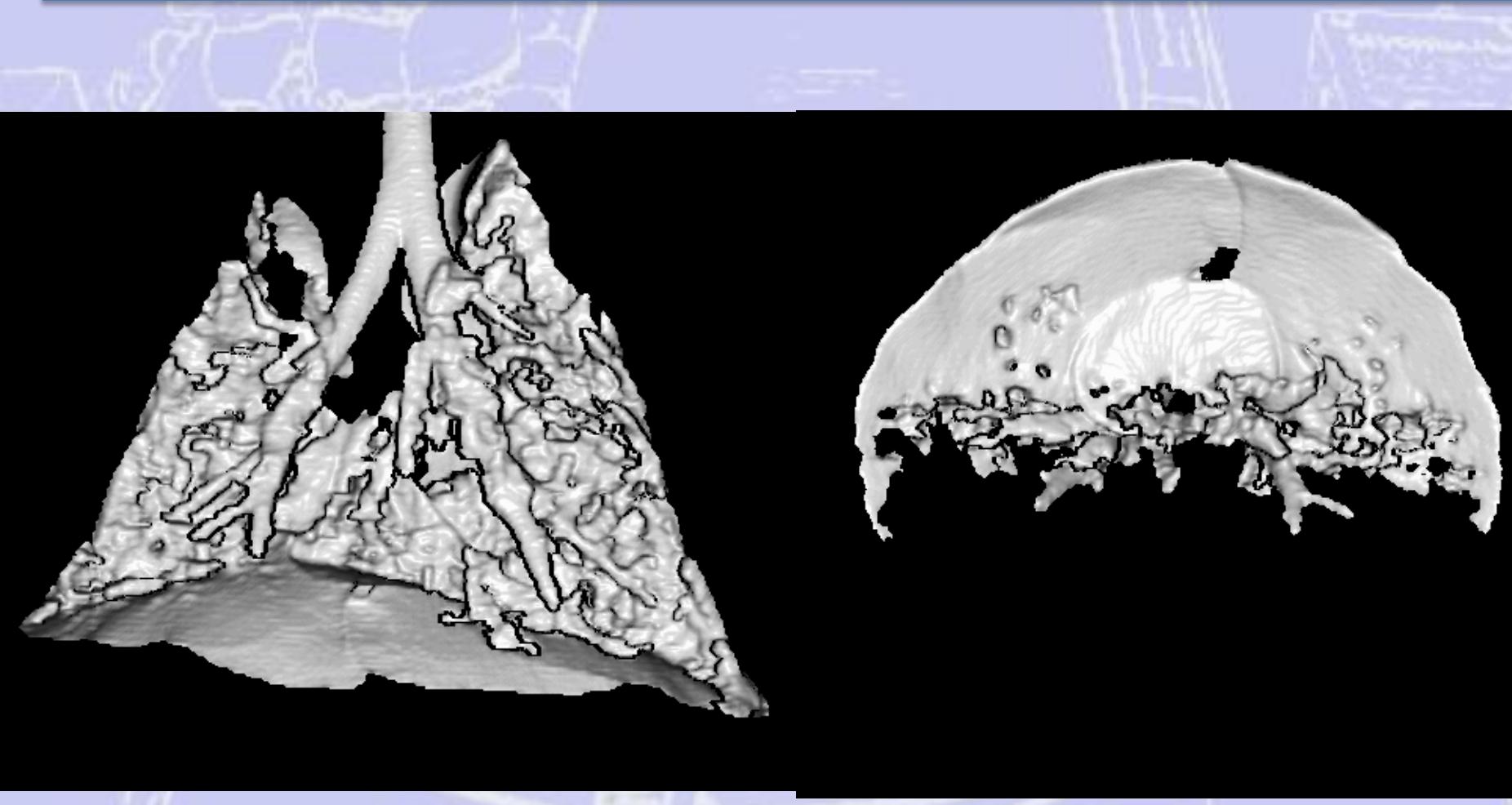


J.B. Borges. Curso de Ventilación Pediátrica. Madrid 2010.



Christian Höinemann. 11-й Британо-Український Симпозіум. Київ, 2019

CT-3D: 3 kg KG rabbits after anesthesia induction

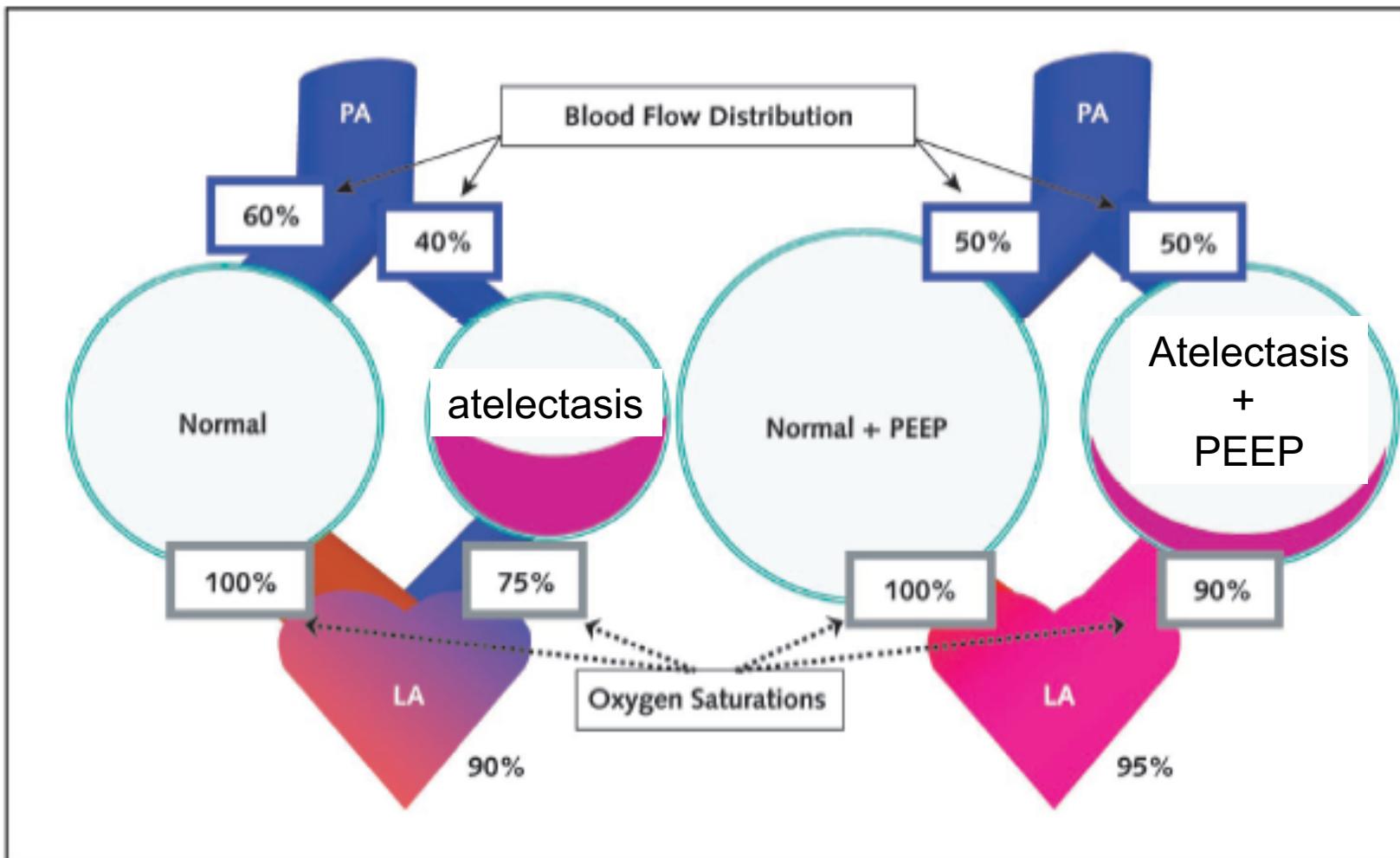


J.B. Borges. Curso de Ventilación Pediátrica. Madrid 2010.

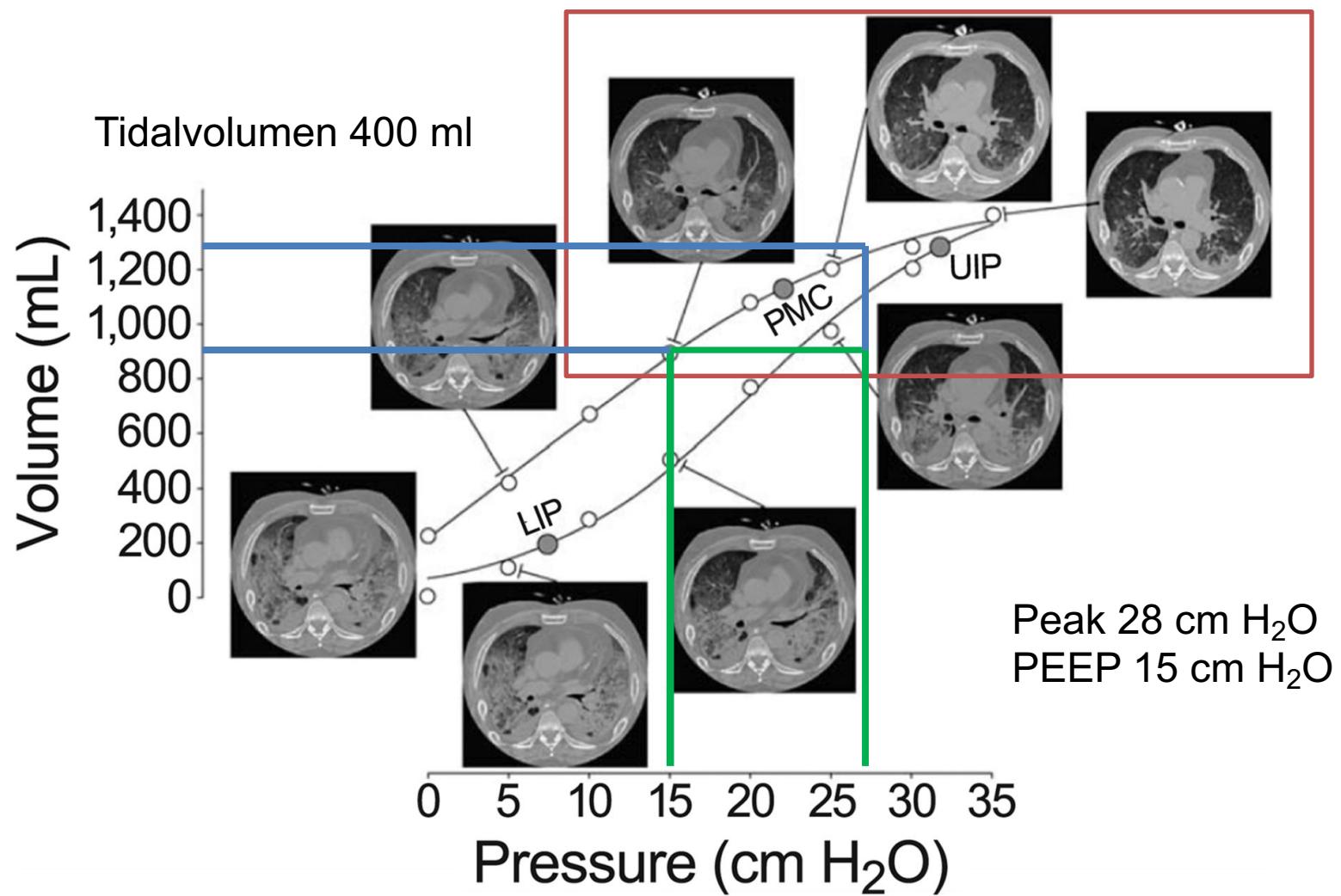


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Principle of the Open Lung Concept



CT Scan - Visualization of a Breathing Cycle

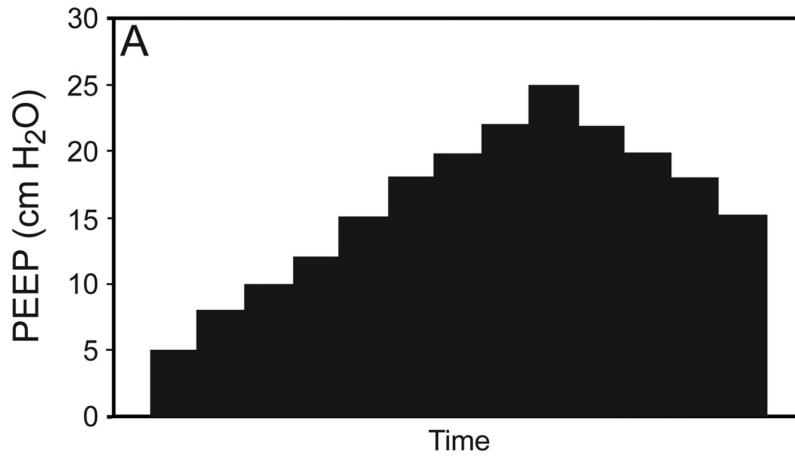


Dean R Hess Respir Care 2015;60:1688-1704

(c) 2012 by Daedalus Enterprises, Inc.

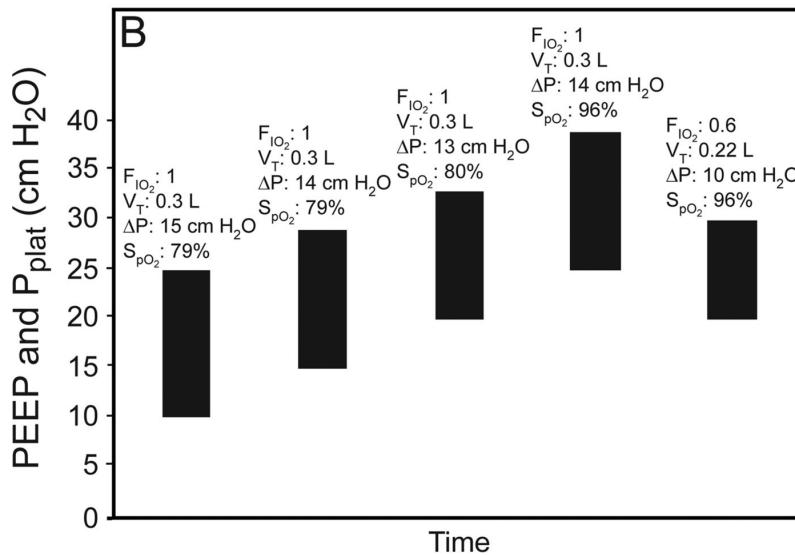


Schematic step-by-step recruitment maneuver OPEN THE LUNG



BIPAP	pressure
Step 1	7/20
Step 2	12/25
Step 3	17/30
Step 4	22/35
Step 5	27/40

30-90 s per step



IPPV PEEP

Step 1, TV 500	7
Step 2, TV 500	12
Step 3, TV 500	17
Step 4, TV 500	22
Step 5, TV 500	27

30-90 s per step



Dean R Hess Respir Care 2015;60:1688-1704

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Table 2. Ventilatory parameters, respiratory system mechanics and ventilatory efficiency variables.

Variables		Pre OLA	Pre RM-5	Pre RM-5 vs. Pre OLA p value	OLA	RM-5	RM-5 vs. OLA p value
Ventilatory parameters n = 36	VT (ml)	347±38	361±43	0.491	350±36	361±42	0.491
	PEEP, cmH ₂ O	5.0±0.0	5.0±0.0	1.00	8.0±2.3	5.0±0.0	<0.001
	RR, bpm	14±2	14±1	0.667	14±2	14±1	0.667
Respiratory system mechanics n = 36	DP (cmH ₂ O)	7.7±1.0	7.7±1.3	1.00	5.6±1.0	7.4±1.0	<0.001
	Pplat (cmH ₂ O)	13.3±1.2	14.6±1.2	<0.001	13.7±1.9	12.2±0.8	0.131
	Cdyn (ml·cmH ₂ O)	53±13	59±19	0.945	68±25	61±19	0.903
	Raw (cmH ₂ O·l·s)	11±4	12±4	0.314	11±4	11±3	0.272
Ventilatory efficiency n = 29	VDBohr	0.58±0.11	0.59±0.08	0.224	0.56±0.11	0.56±0.09	0.241
	VDaw/VT	0.36±0.12	0.33±0.06	0.314	0.32±0.11	0.31±0.06	0.771
	VDalv/VTalv	0.35±0.16	0.38±0.11	0.050	0.33±0.15	0.37±0.10	0.035
	VTCO ₂ .br (ml)	8.29±2.89	8.81±2.02	0.861	8.20±2.29	8.68±1.90	0.963
	FECO ₂ (%)	4.06±0.75	3.64±0.48	0.271	3.97±0.69	3.73±0.82	0.421
	SnIII (mmHg·ml)	1.47±0.99	1.19±0.62	0.617	1.30±1.13	1.02±0.59	0.865

This table shows differences in respiratory system mechanics and ventilatory efficiency between the pre-OLA against pre-RM-5 and OLA against RM-5. Values are presented as mean and standard deviation (SD). VT = tidal volume, PEEP = positive end-expiratory pressure, RR = respiratory rate, DP = driving pressure, Pplat = plateau pressure, Cdyn = dynamic respiratory system compliance, Raw = airway resistance, VDaw = airway dead space to tidal volume, VDBohr = Bohr dead space, VDalv/VTalv = alveolar dead space normalized to alveolar VT, VCO₂.br = amount of expired CO₂ within one breath, FECO₂ = mixed expired CO₂ in one breath, SnIII = slope of phase III normalized to VT.

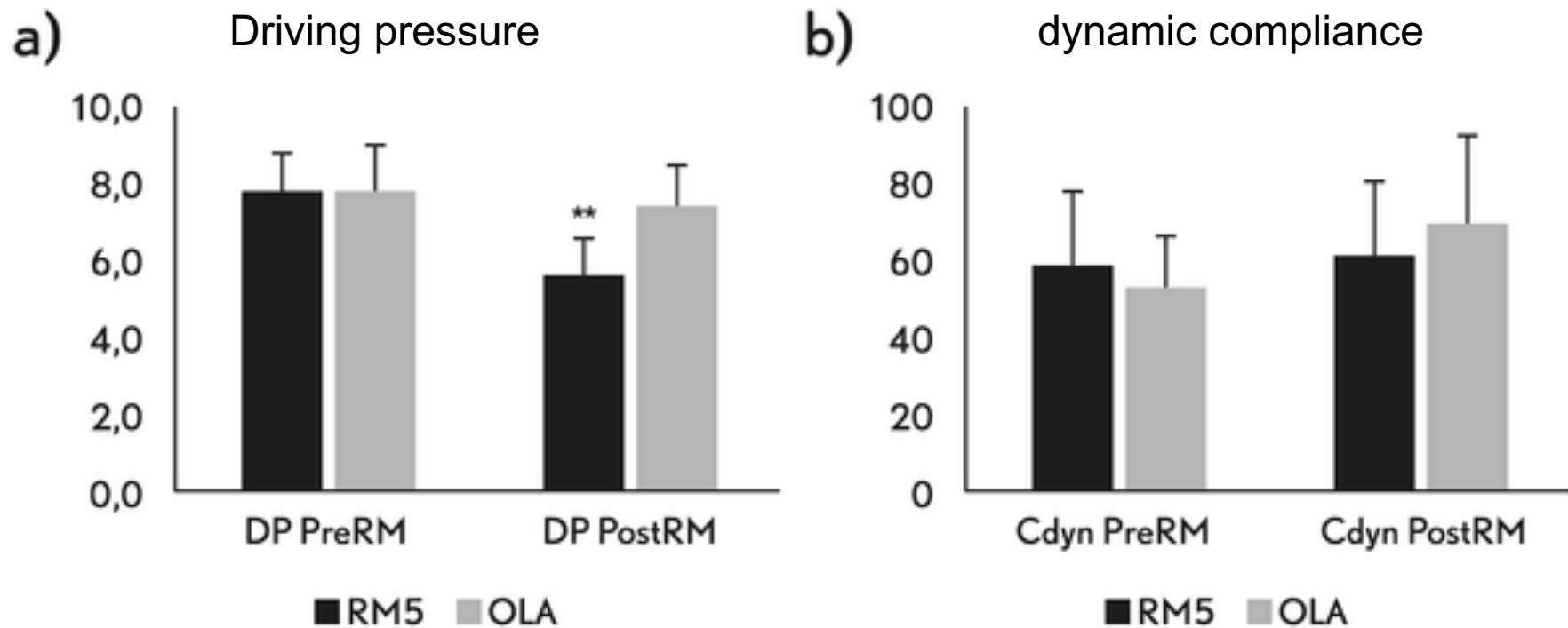
<https://doi.org/10.1371/journal.pone.0177399.t002>

Ferrando C, Suarez-Sipmann F, Tusman G, León I, Romero E, et al. (2017) Open lung approach versus standard protective strategies: Effects on driving pressure and ventilatory efficiency during anesthesia - A pilot, randomized controlled trial. PLOS ONE 12(5): e0177399. <https://doi.org/10.1371/journal.pone.0177399>

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0177399>



Fig 2. Respiratory system mechanics and ventilatory efficiency study variables.



Ferrando C, Suarez-Sipmann F, Tusman G, León I, Romero E, et al. (2017) Open lung approach versus standard protective strategies: Effects on driving pressure and ventilatory efficiency during anesthesia - A pilot, randomized controlled trial. PLOS ONE 12(5): e0177399. <https://doi.org/10.1371/journal.pone.0177399>
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0177399>



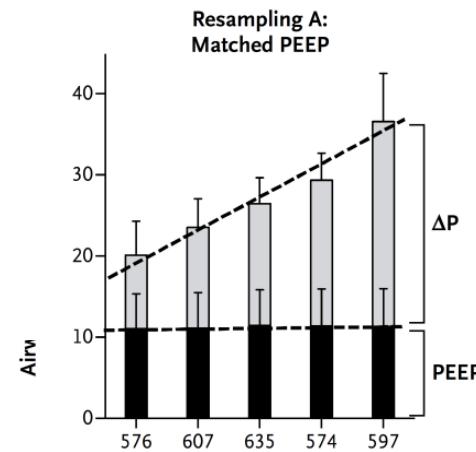
The higher the Peak Pressure – the higher the Mortality rate

› Marcello B.P. Amato et al, New Engl J Med 2015

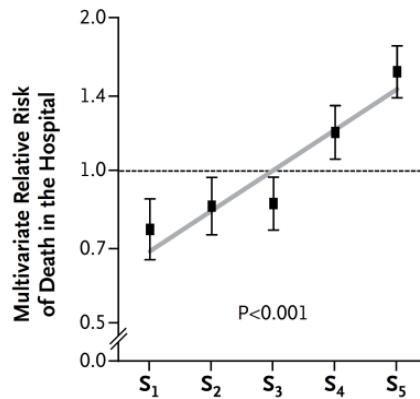
Driving pressure and survival in the acute respiratory distress syndrome

3562 patients:

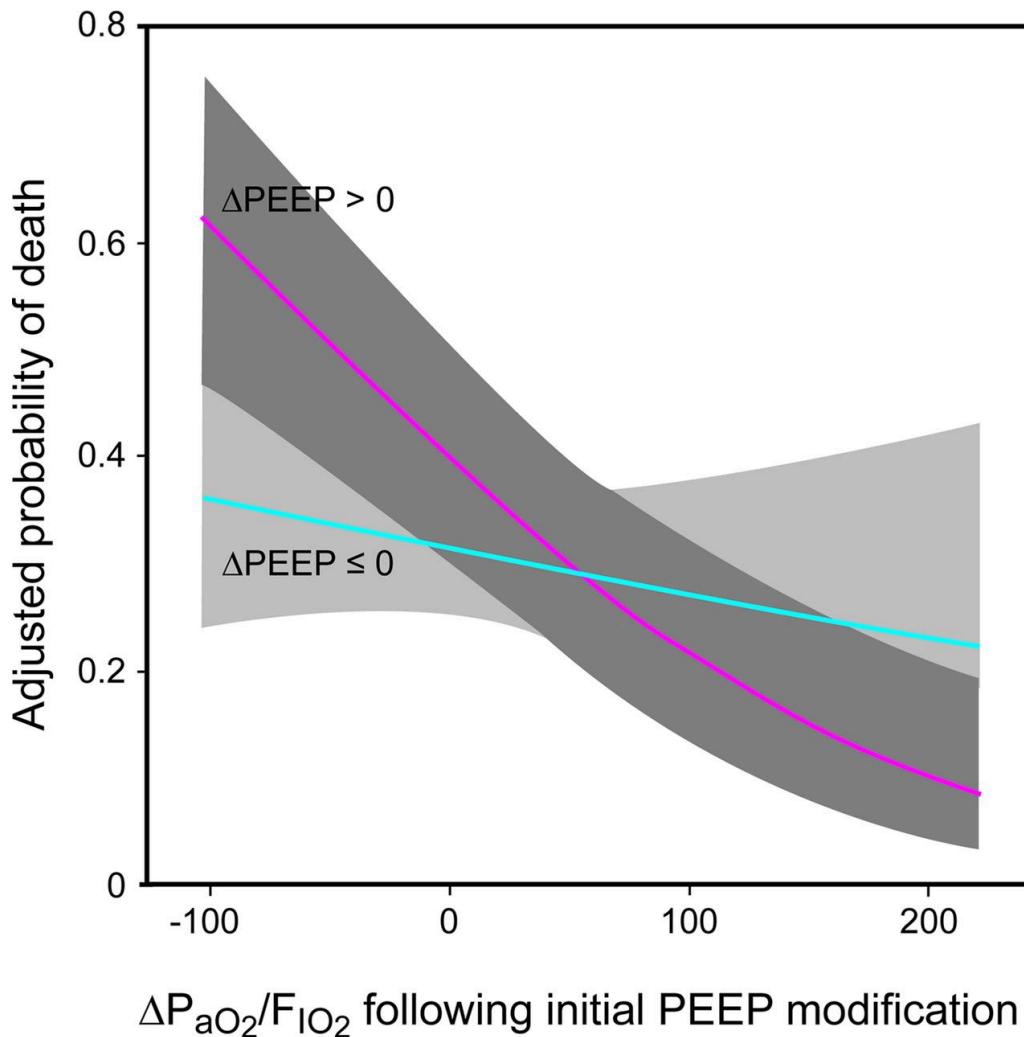
Driving pressure
with the same PEEP



Mortality



Oxygenation and Mortality depending on recruitment and PEEP

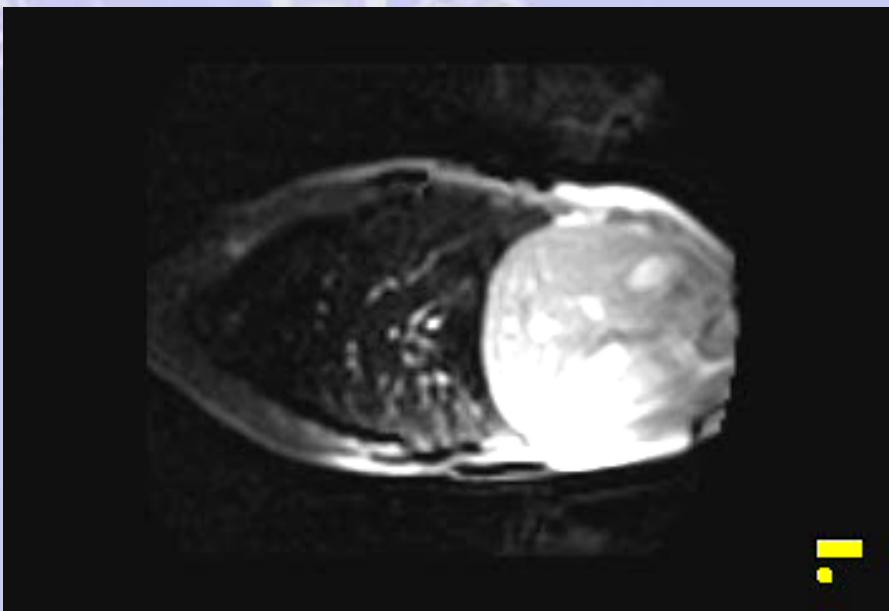


Dean R Hess Respir Care 2015;60:1688-1704

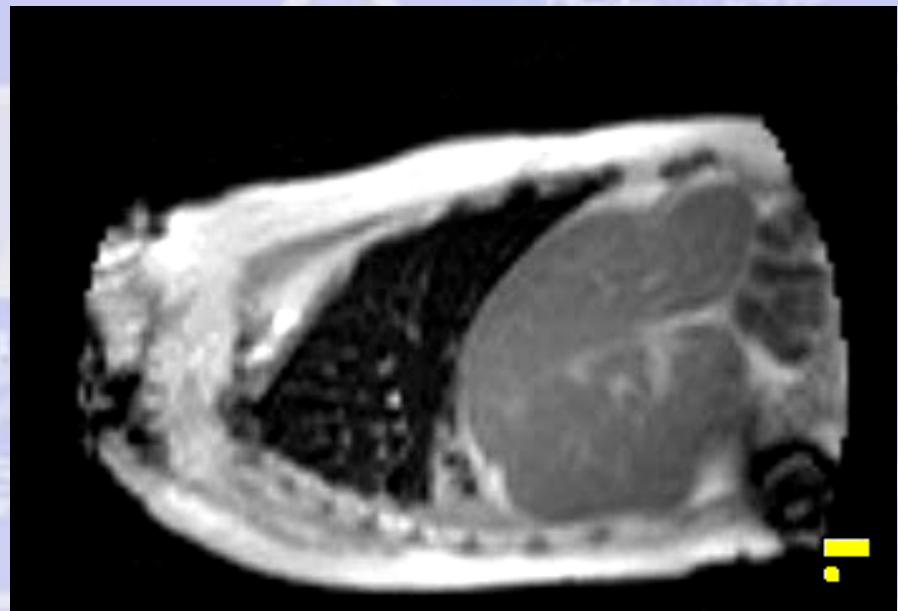
(c) 2012 by Daedalus Enterprises, Inc.



spontane ventilation



Volume controlled ventilation

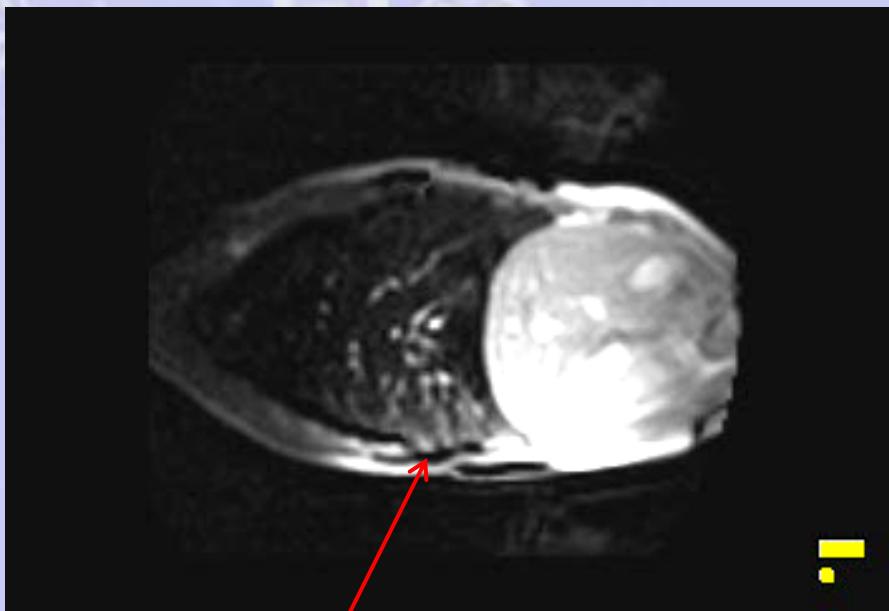


Prof. Javier García Fernández MD, Ph.D, MBA.
Chief of Anesthesia & Critical Care Department
Puerta de Hierro University Hospital, Madrid-Spain



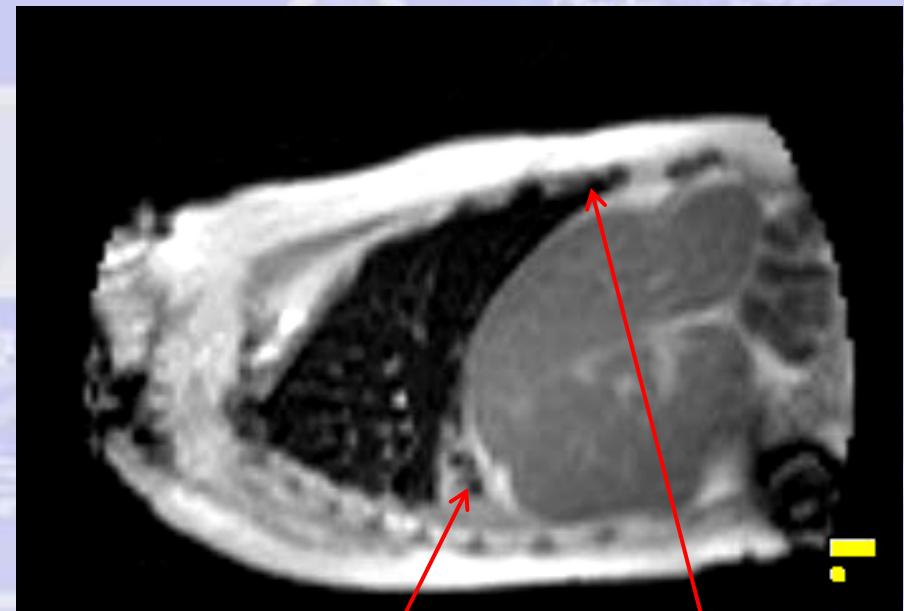
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spontane ventilation



atelektasís

Volume controlled ventilation



atelektasis

overextension

Prof. Javier García Fernández MD, Ph.D, MBA.
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Breathing gas composition

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You all know:

We are not using nitrous oxide in Germany!

95 % of the anesthesia departments
stopped using N₂O because of patient safety

Advantages of N ₂ O	Disadvantgates of N ₂ O
opioid sparing effect	minor analgesic effect = 0,05 mg fentanyl
prevents awareness	nausea & vomiting
second gas effect for inhalational rapid induction in children	hypoxia by redistribution
NMDA receptor effect	FiO ₂ less than 40 %
reducing MAC for volatile anesthetics	contraindicated in vegetarians
no metabolism	effects on methionine metabolism
	contraindicated during early pregnancy
	green house gas – ozone depletion



Nitrous oxide is a hypoxic gas

Don't use N₂O!

Just say NO to N₂O

Dienstag | 5. Mai | 22:35 Uhr | LOGIN | REGISTRIEREN | RSS | Mobil | H

LAUSITZER RUNDSCHEIN

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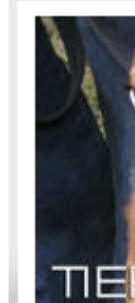
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Die quälende Suche nach der Wahrheit in Hoyerswerda

HOYERSWERDA. Im Klinikum Hoyerswerda starben im Sommer 2004 vier Mütter bei Schnittentbindungen. In drei Fällen war ein defektes Narkosegerät am Tod der Frauen schuld. Drei Ärzte und ein Techniker erhielten deshalb Strafbefehle wegen fahrlässiger Tötung. Ein weiterer Strafbefehl gegen einen Arzt wird dieser Tage erlassen. Für die Hinterbliebenen sind jedoch noch viele Fragen offen.

"Für mich ist das nie vorbei", sagt Ramona Deak und schüttelt den Kopf. Jeden Tag fährt sie auf dem Weg zur Arbeit in Hoyerswerda am Klinikum vorbei. "Wenn ich das Haus sehe, den Hubschrauberlandeplatz, dann ist alles sofort wieder da."

Von hier aus wurde Kathrin, die damals 23-jährige Tochter von Ramona Deak im August 2004 in tiefer Bewusstlosigkeit nach einem Kaiserschnitt eilig nach Dresden geflogen. Drei Tage später war sie tot, die letzte von vier Frauen, die damals kurz hintereinander bei Entbindungen starben.





Begraben im Heimatort. Kathrin Deak wurde nur 23 Jahre alt. Sie starb im Klinikum Hoyerswerda durch den Einsatz eines defekten Narkosegerätes bei der Entbindung ihres ersten Kindes.

Foto: Wendler

Narkoseärzten ignoriert worden sein. Über ihren Anwalt konnt was in den Ermittlungsakten steht. "Eine Hebamme hat gesagt, dass Kathrin die Atemmaske nicht wollte und weggeschoben hat. Ein Arzt hat sie ihr dann wieder auf das Gesicht gedrückt", sagt sie und kämpft mit den Tränen.

Im ersten Fall blieb die Ursache ungeklärt, weil die Angehörigen eine Obduktion ablehnten. Die anderen drei Mütter wurden jedoch laut Gutachten mit einem Narkosegerät vom Typ Sulla 808 V durch hochdosiertes Lachgas regelrecht erstickt. Ein Wartungstechniker hatte nach einer Routinekontrolle im Inneren des Gerätes Anschlussschläuche für das Narkosegas und den Sauerstoff vertauscht. Alarmsignale des Gerätes sollen beim Einsatz im Operationssaal von den

operationssaal: (Kein Ergebnis)

Lachgasbedingte Todesfälle

Komplikationen durch Verwechslungen in der Lachgaszufuhr

In der Anästhesiologie steht einer extrem hohen Zahl an durchgeführten Eingriffen eine extrem niedrige Komplikationsrate gegenüber [13, 15]. Allerdings kommt es aufgrund der hohen Fallzahlen trotz der niedrigen Mortalitätsraten immer noch zu 30–50 jährlichen anästhesiebedingten Todesfällen in Deutschland, Österreich und der Schweiz [9]. Zirka 10% der tödlichen Anästhesiekompplikationen sind dabei auf eine Verwechslung von Sauerstoff- und Lachgasanschlüssen und durch reine Lachgasbeatmung zurückzuführen [9]. In dieser Übersicht soll – im Vergleich zu einem früheren Artikel [9] – der Untersuchungsraum über die deutschsprachigen Länder hinaus ausgeweitet werden. Entsprechende Möglichkeiten zur Verhinderung von Lachgaskomplikationen werden diskutiert.

Methodik

Aufgrund fehlender fachwissenschaftlicher Publikationen wurden in einem früheren Artikel Zeitungsarchive zur Detektion tödlicher lachgasbedingter Komplikationen ausgewertet [9]. In ähnlicher Weise diente nun das Internet als Datenquelle.

Ergebnisse

Folgende Fälle tödlicher lachgasbedingter Komplikationen konnten eruiert werden:

- **Fall 1:** In einem neu eröffneten Zentrum für Wirbelsäulenchirurgie in Österreich wird ein 43-jähriger Patient fälschlicherweise mit reinem Lachgas beatmet, nachdem die Zuleitungen zum Narkosegerät falsch angebracht wurden. Der Patient stirbt.
- **Fall 2:** Ein 19-jähriger Mann wird in Deutschland nach einem Verkehrsunfall in ein Krankenhaus eingeliefert. Durch eine Verwechslung der Gasleitungen im Keller des Krankenhauses erfolgt eine tödliche Beatmung mit reinem Lachgas.
- **Fall 3:** Die Sauerstoffzuleitung einer Herz-Lungen-Maschine in der Schweiz wird fälschlicherweise an die Lachgasversorgung angeschlossen; ein 53-jähriger Patient stirbt.
- **Fälle 4–6:** Drei Patientinnen sterben innerhalb kurzer Zeit während einer Sectio caesarea in Allgemeinanästhesie in einem Krankenhaus in Deutschland. Untersuchungen ergeben, dass die Lachgas- und die Sauerstoffleitungen im Narkosegerät vertauscht worden waren.
- **Fall 7:** In Großbritannien wird ein 3-jähriges Mädchen in der Notfallaufnahme mithilfe einer Lachgasinhalation analgosediert. Aufgrund eines Verwechslungsfehlers im Beatmungs-

gerät atmet das Kind reines Lachgas und erstickt.

■ **Fälle 8 und 9:** In einer Klinik in den USA wird 2 Patientinnen während einer Routineanästhesie aufgrund einer Verwechslung der Gaszuleitung akidental reines Lachgas zugeführt; beide Patientinnen sterben.

■ **Fälle 9–15:** In einer Klinik in Italien wird im April 2007 nach Auskunft der Staatsanwaltschaft die komplette Gasversorgung der neu eröffneten Intensivstation fälschlicherweise an die Lachgasversorgung angeschlossen; 6 Menschen sterben innerhalb von 24 h.

Die Ergebnisse sind zusammenfassend in
■ Tab. 1 wiedergegeben.

Diskussion

Über die Gefahren bei Analgosedierung oder Narkose mit Lachgas ist bereits im Jahr 1872 in der *New York Times* berichtet worden: Bei einer Routineanästhesie zur Zahnektomie wurde einer Patientin aufgrund zunächst unzureichender Narkosewirkung über mehrere Minuten reines Lachgas zugeführt. Wenngleich die Hypoxie als Todesursache natürlich aus solch einer Quelle nicht bewiesen werden

Dieses Projekt wurde lediglich aus Mitteln der Abteilung gestaltet.

30 – 50 patients
die during anesthesia
in D, CH, A

10%, = 3-5 patients

because oxygen and
Nitrous oxide were
switched.

Oxygen / Air during anesthesia

$\text{FiO}_2 0,3$ or High oxygen concentration in the perioperative period?



Oxygen is toxic?

Free oxygen radicals?

Recommended in all
emergencies?

Misteries everywhere?



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Christian Hönenmann. 11-й Британо-Український Симпозіум. Київ, 2019

More mysteries: A clear recommendation by the WHO

Clean Care is Safer Care

[Clean Care is Safer Care](#)

Save Lives: Clean Your Hands

The evidence for clean hands

Campaigning countries

Information centre

News and events

Global guidelines on the prevention of surgical site infection

The first ever Global guidelines for the prevention of surgical site infection were published on 3 November 2016. They include a list of 29 concrete recommendations distilled by 20 of the world's leading experts from 26 reviews of the latest evidence. The recommendations have also been published in *The Lancet Infectious Diseases* and are designed to address the increasing burden of health care-associated infections on both patients and health care systems globally, alongside supporting tools issued by WHO. WHO will continue to issue tools in support of guideline implementation throughout 2017.

This guideline is a world first and will be welcomed by doctors and patients alike. We encourage you all to access and promote the guidelines, publications and supporting tools.



[Global guidelines on the prevention of surgical site infection](#)



Prevention of surgical site infections (WHO Global Guidelines 2016)



Video message from Professor Dame Sally



3 rd November 2016

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GLOBAL GUIDELINES FOR THE PREVENTION OF SURGICAL SITE INFECTION



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Global guidelines on the prevention of surgical site infection

Web appendices

- [Appendix 2: Summary of the systematic review on preoperative bathing](#)
pdf, 839kb
- [Appendix 3: Summary of the systematic review on decolonization with or without chlorhexidine gluconate body wash for the prevention of *Staphylococcus aureus* infection in nasal carriers undergoing surgery](#)
pdf, 261kb
- [Appendix 4: Summary of the systematic review on screening for extended-spectrum beta-lactamase colonization and the impact on surgical antibiotic prophylaxis](#)
pdf, 482kb
- [Appendix 6: Summary of the systematic review on mechanical bowel preparation and the use of oral antibiotics](#)
pdf, 711kb
- [Appendix 7: Summary of the systematic review on hair removal](#)
pdf, 770kb
- [Appendix 8: Summary of the systematic review on surgical site preparation](#)
pdf, 768kb
- [Appendix 9: Summary of the systematic review on antimicrobial skin sealants](#)
pdf, 537kb
- [Appendix 10: Summary of the systematic review on surgical hand preparation](#)
pdf, 779kb
- [Appendix 11: Summary of the systematic review on enhanced nutritional support](#)
pdf, 667kb
- [Appendix 12: Summary of the systematic review on the perioperative discontinuation of immunosuppressive agents](#)
pdf, 658kb

• [Appendix 13: Summary of the systematic review on perioperative oxygenation](#)
pdf, 731kb

• [Appendix 14: Summary of the systematic review on maintaining normal body temperature \(normothermia\)](#)
ndf, 346kb

• [Appendix 16: Summary of the systematic review on the maintenance of adequate circulating volume control/normovolemia](#)
pdf, 919kb

• [Appendix 17: Summary of the systematic review on drapes and gowns](#)
pdf, 814kb

• [Appendix 18: Summary of the systematic review on wound protector devices](#)
pdf, 920kb

• [Appendix 20: A systematic review and meta-analysis including GRADE qualification of the risk of surgical site infections after prophylactic negative pressure wound therapy compared with conventional dressings in clean and contaminated surgery.](#)

de Vries FEE, et al. Medicine 2016;95(36):e4673. doi: 10.1097/MD.0000000000004673.

• [Appendix 21: Summary of the systematic review on the use of surgical gloves](#)
pdf, 495kb

• [Appendix 22: Summary of the systematic review on the changing of surgical instruments](#)
pdf, 308kb

• [Appendix 23: Antimicrobial-coated sutures to decrease surgical site infections: a systematic review and meta-analysis](#)
Xiuwen Wu, et al. Eur J Clin Microbiol Infect Dis. 2016 Sep 2.

• [Appendix 25: Summary of the systematic review on surgical antibiotic prophylaxis prolongation](#)
pdf, 1.38Mb

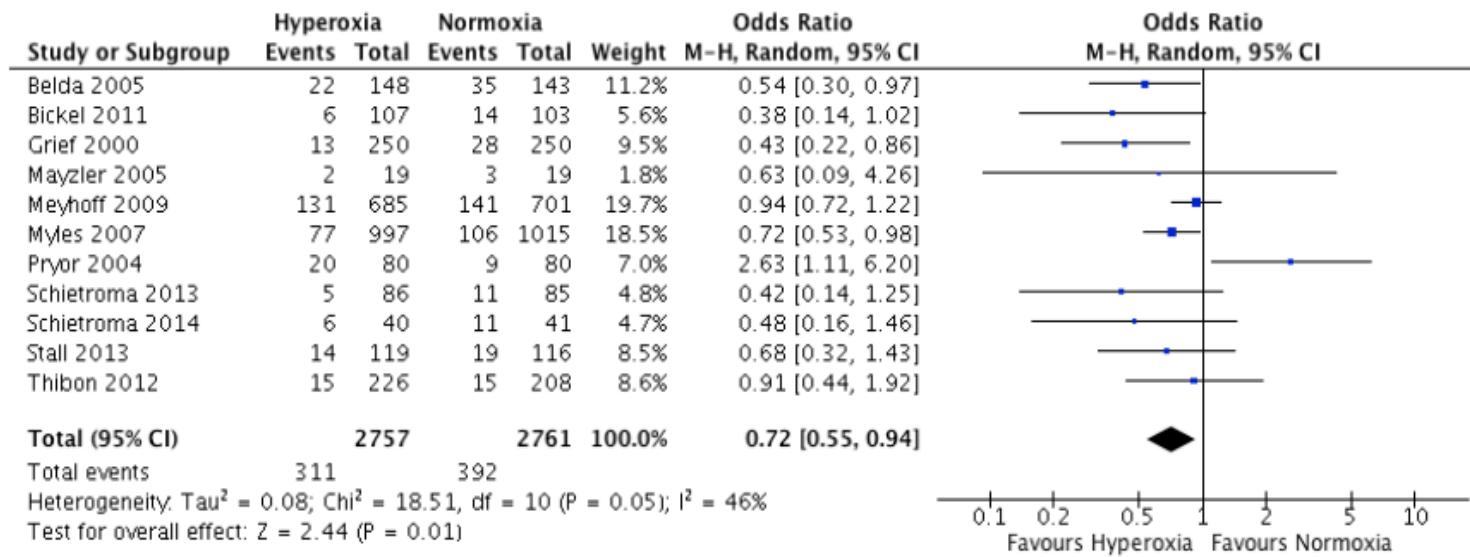
• And so on

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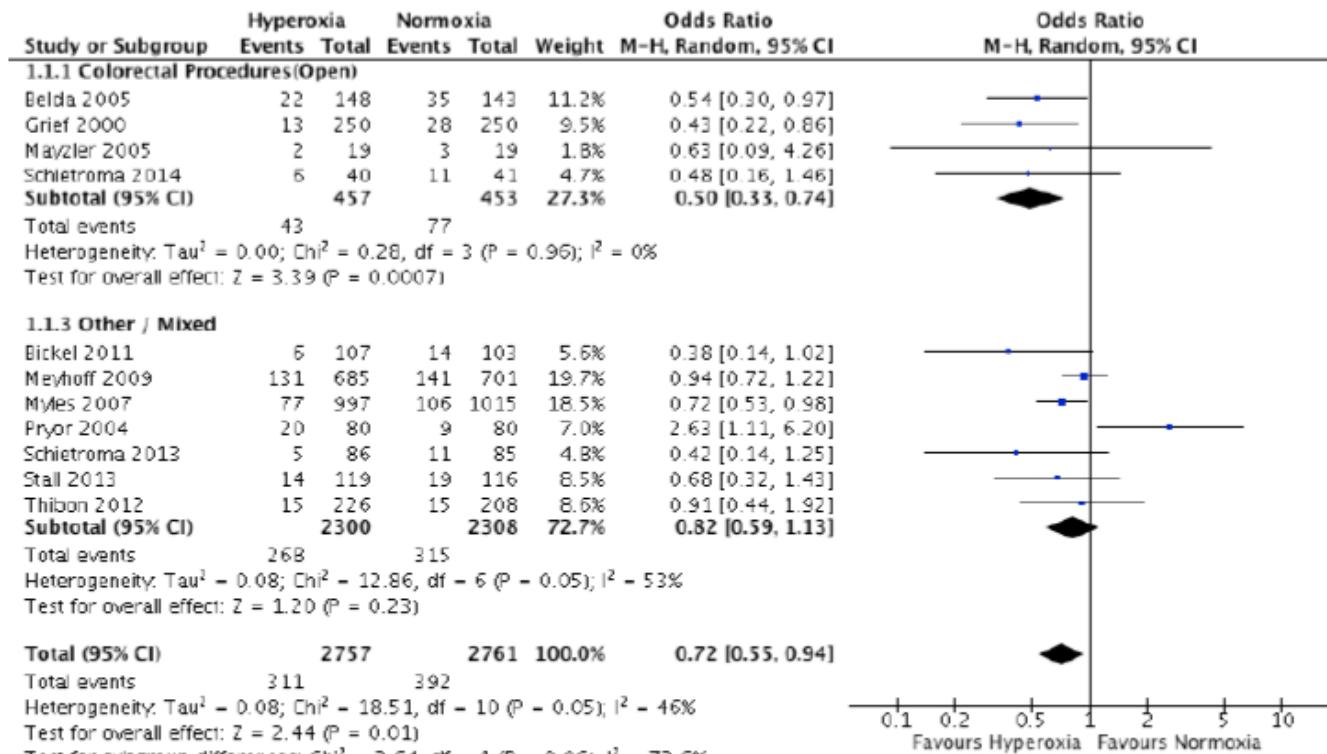
2) Administration of increased F_O_2 vs. standard oxygenation in patients undergoing general anaesthesia with endotracheal intubation



M-H: Mantel-Haenszel (test); CI: confidence interval

a) Subgroup analysis according to the type of surgery

- i. Administration of increased FiO_2 vs. standard oxygenation in patients undergoing colorectal surgery under general anaesthesia with endotracheal intubation (→ in forest plot 1.1.1)
- ii. Administration of increased FiO_2 vs. standard oxygenation in patients undergoing other or mixed surgical procedures under general anaesthesia with endotracheal intubation (→ in forest plot 1.1.3)



M-H: Mantel-Haenszel (test); CI: confidence interval



**WHO recommends
inspiratory FiO₂ of 0.8
for colon cancer surgery**



Oxygen and atelectasis

	30% oxygen group	100% oxygen group
	Protocol A (n=6)	Protocol B (n=6)
Mean (SD) age in years	44 (±9)	32 (±2)
Male/female	2/4	3/3
Mean (SD) body-mass index in kg/m ²	27.4 (8.5)	27.0 (5.3)
FIO ₂		
During induction of anaesthesia	0.3	0.3
30 min of continued anaesthesia	0.3	1.0
Mean (SD) area of atelectasis in cm ²		
Awake	0	0
Anaesthesia baseline	0.2 (0.2)	0.3 (0.6)
Anaesthesia 70 min	1.6 (1.6) [†]	4.7 (4.5) [†]

Atelectasis = all dense lung tissue within a range of -100 to +100 Hounsfield units in computed tomography scan at lung base.

*p <0.001 for difference between 30% and 100% oxygen groups.

†p=0.043 for difference from anaesthesia baseline.

Table 1: Demographic characteristics, FIO₂ during anaesthesia, and amount of atelectasis

We suggest that during the induction of general anaesthesia in patients with healthy lungs, gas composition has an important role for atelectasis formation and the changes in ventilation-perfusion relations. Use of a mixture including a poorly absorbed gas such as nitrogen might prevent the early formation of

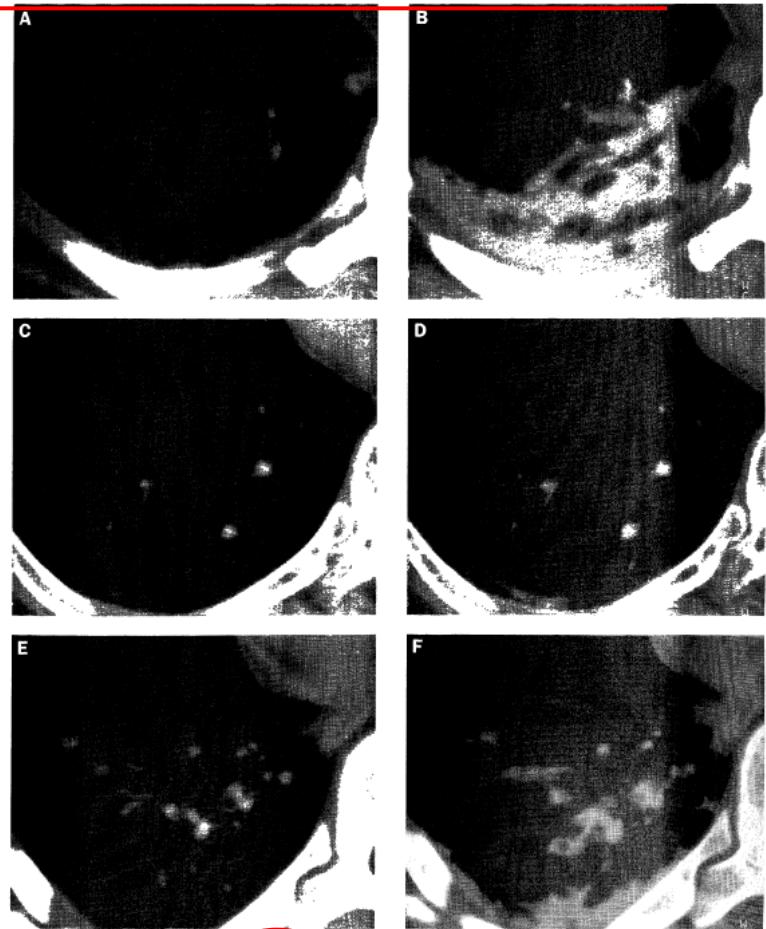


Figure: Computed tomography of lung in 3 patients
Window=500 HU (Hounsfield units), centre=–100 HU. Atelectasis=dense areas in dorsobasal parts of lungs after conventional anaesthesia induction and in patient 3 receiving inspired gas mixture $\text{FIO}_2=1.0$ at anaesthesia 70 min.
A: Patient 1, conscious. B: Patient 1, anaesthesia baseline, conventional induction with $\text{FIO}_2=1.0$, then 0.4. C: Patient 2, anaesthesia baseline, $\text{FIO}_2=0.3$ throughout study. D: Patient 2, anaesthesia 70 min. E: Patient 3, anaesthesia baseline, $\text{FIO}_2=0.3$ during induction then $\text{FIO}_2=1.0$ 30 min after induction. F: Patient 3, anaesthesia 70 min.

Prevention of atelectasis during general anaesthesia

THE LANCET

1345 • June 3, 1995

12 consecutive patients scheduled for elective surgery were assigned to the 30% oxygen group; they were randomly allocated to one of two treatment protocols (A and B). When the patients were awake, measurements were taken with all breathing air. Anaesthesia was induced (by propofol injection) while the lungs

were ventilated with 30% oxygen in nitrogen through a face mask. After orotracheal intubation the lungs were ventilated in both groups with 30% oxygen in nitrogen ($\text{FIO}_2=0.3$) through an endotracheal tube. For protocol A, FIO_2 was kept at 0.3 until the end of the study. For protocol B, FIO_2 was changed to 1.0



Oxygen concentration and characteristics of progressive atelectasis formation during anaesthesia

L. EDMARK¹, U. AUNER², M. ENLUND¹, E. ÖSTEERG¹ and G. HEDENSTIerna³

Departments of ¹Anaesthesiology and Intensive Care, ²Radiology, Central Hospital, Västerås, Sweden and ³Department of Medical Sciences, Clinical Physiology, University Hospital, Uppsala, Sweden

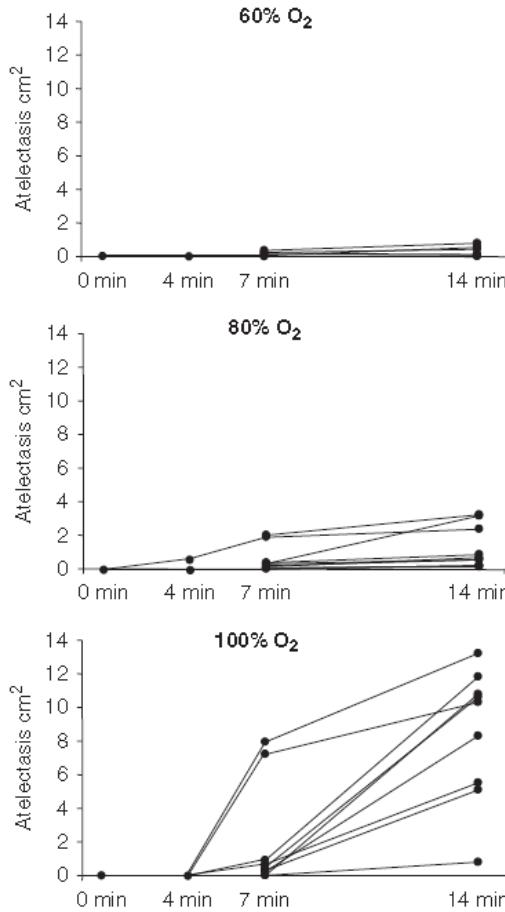


Fig. 3. Increase of the amount of atelectasis 1 cm above the right diaphragm during anaesthesia in individual patients in the early group with 60%, 80% or 100% oxygen for pre-oxygenation from awake to 4, 7 and 14 min after start of pre-oxygenation.



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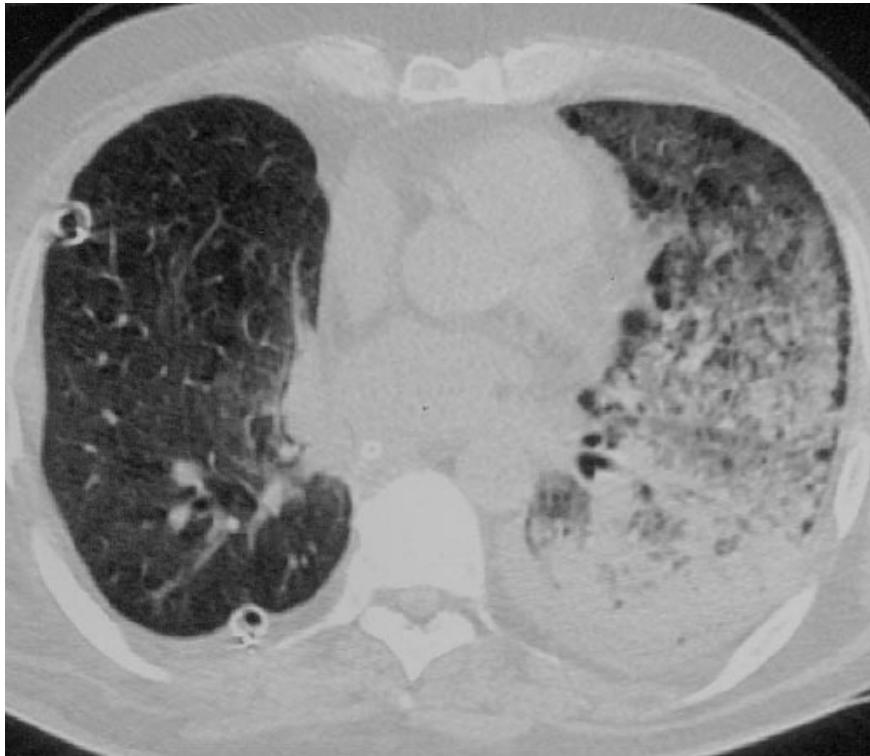
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doi: 10.1111/j.1399-6576.2010.02334.x



Atelectasis after one lung ventilation with high inspired Peak pressure, high Tidal Volume. Which side was operated? Which ventilated?



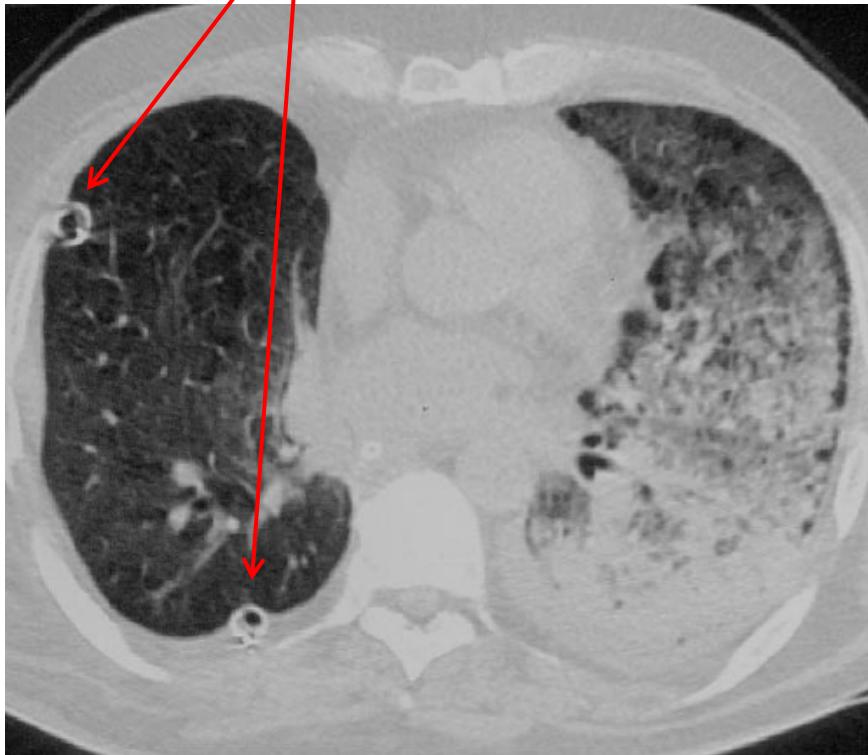
Prof. Javier García Fernández MD, Ph.D, MBA.
Chief of Anesthesia & Critical Care Department
Puerta de Hierro University Hospital
Madrid-Spain

Padley SP, Jordan SJ, Goldstraw P, et al. Asymmetric ARDS following pulmonary resection: CT findings initial observations. Radiology 2002; 223: 468–473.



Atelectasis due to one lung ventilation with high inspired Peak pressure and high tidal volume

Postoperative thoracic drain



Pulmonary lung segement resection



Prof. Javier García Fernández MD, Ph.D, MBA.
Chief of Anesthesia & Critical Care Department
Puerta de Hierro University Hospital
Madrid-Spain

Padley SP, Jordan SJ, Goldstraw P, et al. Asymmetric ARDS following pulmonary resection: CT findings initial observations. Radiology 2002; 223: 468–473.



Prevent intraoperative Atelectasis

- 1. $\text{FiO}_2 \leq 0,8$**
- 2. Low inspired peak pressures**
- 3. After intubation: PEEP => 5-7 (10) mbar
Avoid disconnection / LM if possible**
- 4. lung recruitment manouver**
- 5. Spontaneous ventilation / pressure controlled**



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From: Lung-protective Ventilation in the Operating Room: Time to Implement?

Anesth. 2014;121(1):184-188. doi:10.1097/ALN.0000000000000274

Who has the most benefit from lung protective ventilation strategies during anesthesia?

The moderate and high risk patient.

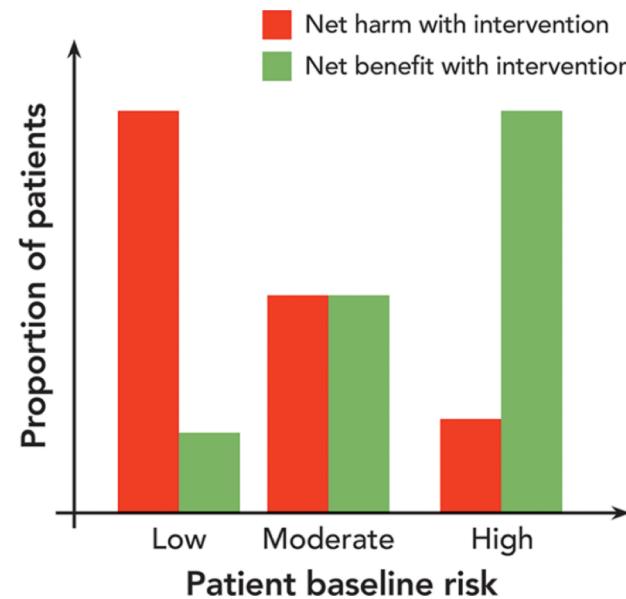


Figure Legend:

Knowledge translation decision making is influenced by baseline patient risk. The benefit of an intervention can be described by a relation between the risk of no treatment (i.e., the patient's baseline risk), the benefit of the intervention (green bars), and the risk of harm posed by the intervention (red bars). As the patient's baseline risk decreases, the harm of the intervention will eventually predominate over the intervention's therapeutic benefit. As such, implementation of an intervention aimed at a huge population of low baseline risk is unwise; instead, further study is advised. In contrast, an extremely high-risk population, such as those with acute respiratory distress syndrome, is more likely to benefit from the implementation of a new intervention.

Date of download: 4/16/2019

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From: Lung-protective Ventilation in the Operating Room: Time to Implement?

Anesth. 2014;121(1):184-188. doi:10.1097/ALN.0000000000000274

Please start implementation today.

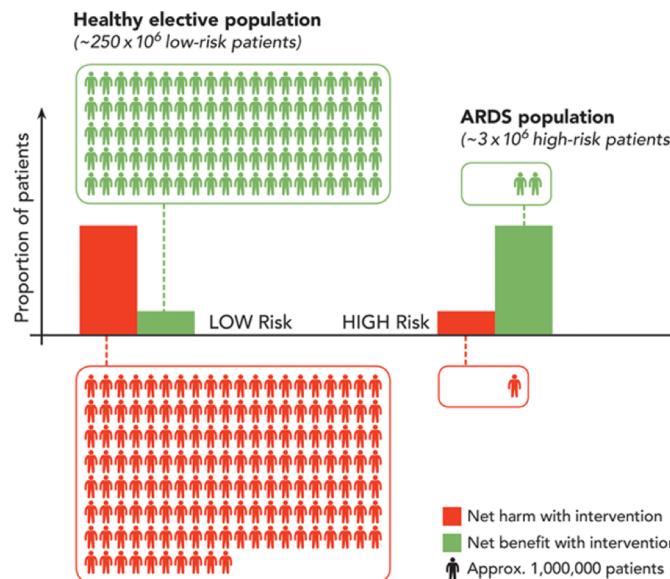


Figure Legend:

The effects of population size and baseline risk on clinical decision making. The schematic above outlines the potential effects of a new ventilation strategy as implemented in a large, low-risk population (left) or in a smaller, high-risk population (right). Green shading represents benefit, whereas red represents harm. In the large, low-risk population, the proportion of harm of the intervention will predominate, because baseline risk is exceedingly low (as indicated in fig. 1). In addition, the large population size (thought to be 250 million people per year) results in a large absolute number of patients being harmed, in spite of a low risk of harm. In the high-risk population of smaller size (right), there is more opportunity for the benefit of the treatment to be actualized. As such, a greater percentage of patients will benefit, and due to the small population size (an estimate of 3.2 million cases of acute respiratory distress syndrome [ARDS] worldwide per year), a smaller absolute number will be harmed. This effect forms the basis for the suggestion that an intervention that will be applied to a large, low-risk population requires extensive study before implementation, because the potential for harm, in terms of absolute patient number, is high.





- Low tidal volume 5-7 (8) ml/kg)
- Respiratory rate (12-16 / min)
- If possible use Peep (5 - 7 (10) mmHg)

Endotracheal tube, PCV/BIPAP

PEEP	RR	Peak
7	+	13 = 20



End of part 1!
Vielen Dank für Ihre Aufmerksamkeit !



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www.kk-om.de



Part 2: Circular circuits & minimal & low flow techniques in anaesthesia: Yesterday – today – tomorrow



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Priv.-Doz. Dr. med. Christian Höinemann

Chefarzt im Kollegialsystem (CA Dr. Olaf Hagemann)
Abteilung für Anästhesie und operative Intensivmedizin

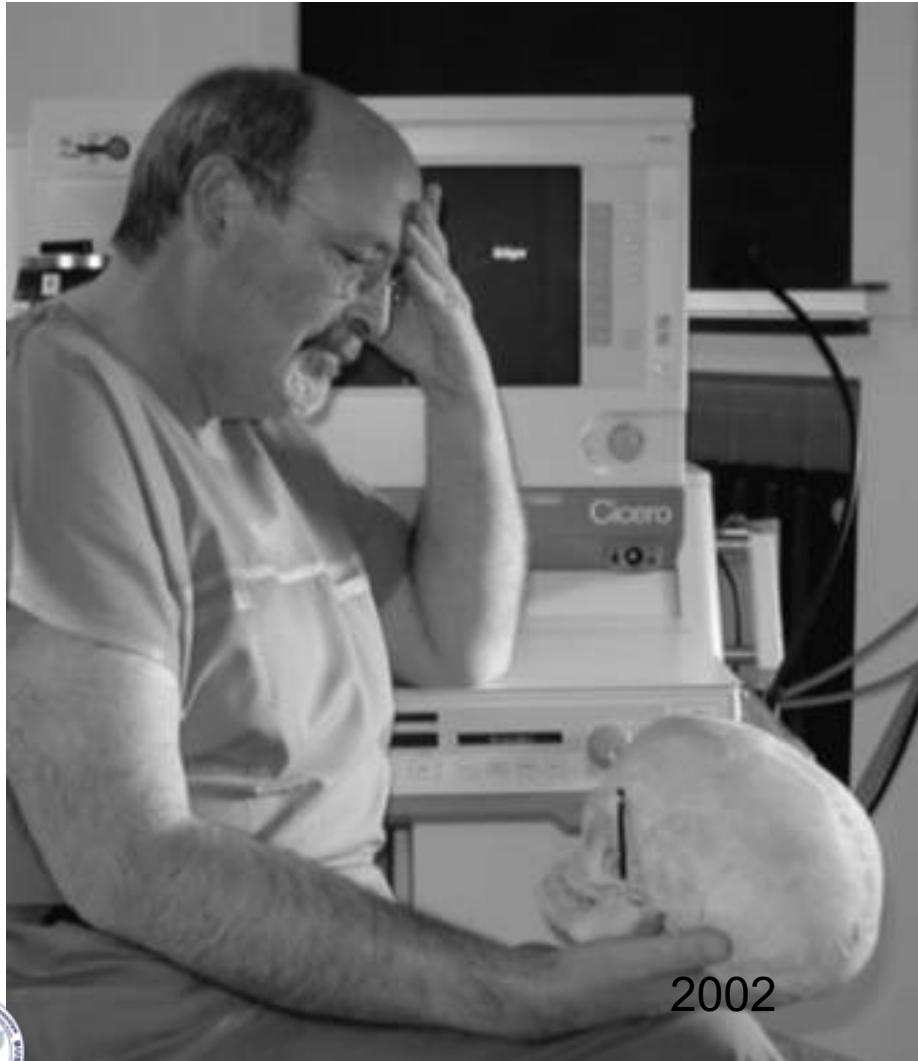


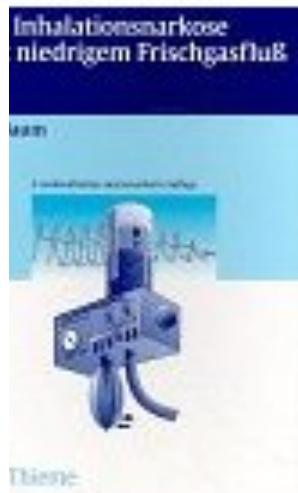
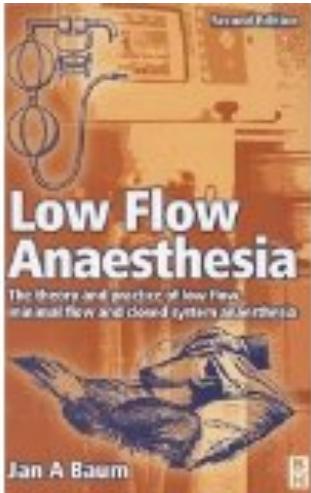
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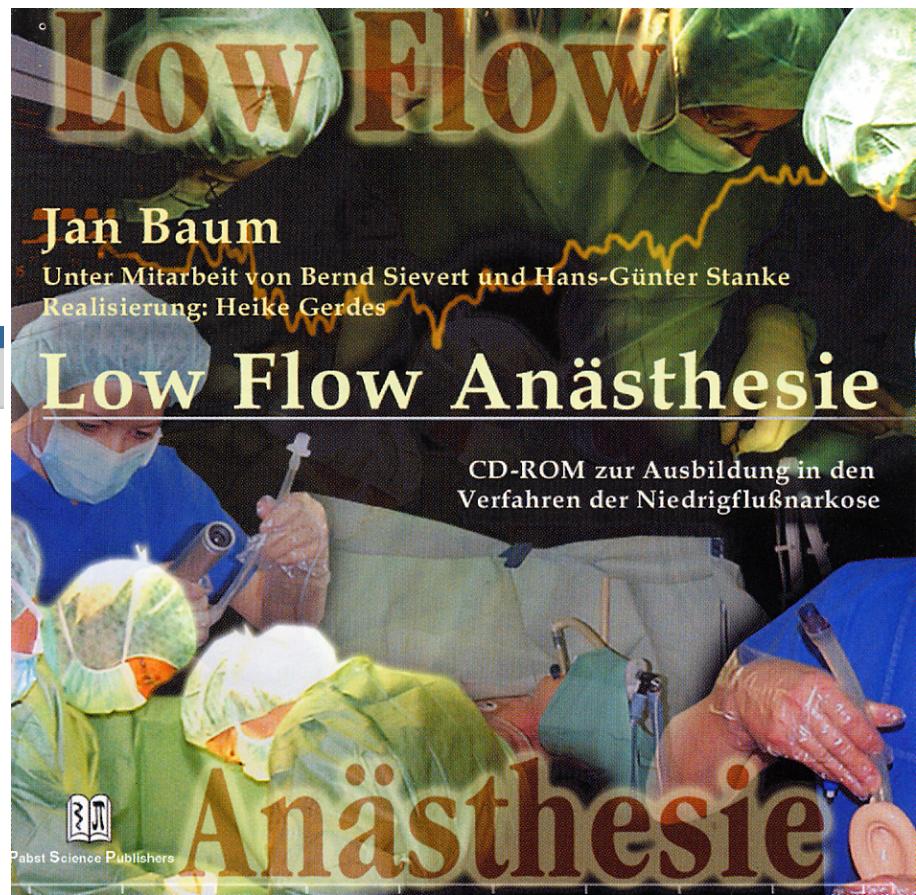
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Professor Dr. Jan Baum investigations and doctoral thesis

Eur J Anaesthesiol. 2001 Jul;18(7):458-66.

Minimal-flow anaesthesia with controlled ventilation: comparison between laryngeal mask airway and endotracheal tube.

Hönemann CW, Hahnenkamp K, Möllhoff T, Baum JA.

Klinik und Poliklinik für Anästhesiologie und operative Intensivmedizin, Universitäts Klinikum Münster, Germany.

Abstract

BACKGROUND AND OBJECTIVE: Minimal- and low-flow anaesthesia (fresh gas flow below 1 L min⁻¹) provide many advantages, including reduced cost, conservation of body heat and airway humidity. An airtight seal is essential between the airway device and the airway of the patient. Therefore, we investigated whether the airtight seal created by a laryngeal mask airway allows controlled ventilation of the lungs when the fresh gas flow is reduced to 0.5 L min⁻¹ and compared this with an endotracheal tube.

METHODS: In a prospective clinical study, 207 patients were managed using a laryngeal mask or an endotracheal tube. After intravenous induction of anaesthesia and 15 min of high fresh gas flow, the flow was reduced to 0.5 L min⁻¹. The breathing system was monitored for airway leaks, and the patients were assessed for complications after airway removal and postoperative discomfort.

RESULTS: Both the laryngeal mask and endotracheal tube allowed fresh gas flow reduction to 0.5 L min⁻¹ in 84.7% and 98.3% of cases respectively (small leaks: 12% laryngeal mask, 1.7% endotracheal tube). Three patients with the laryngeal mask (3.3%) had airway leaks that were too large to permit any reduction in the fresh gas flow.

CONCLUSIONS: The use of the laryngeal mask airway was more likely to be associated with a gas leak than use of an endotracheal tube; however, if modern anaesthesia machines and monitors are used, in 96.7% of the patients managed with a laryngeal mask a reduction in the fresh gas flow to 0.5 L min⁻¹ was possible. The incidence of coughing and postoperative complaints (sore throat, swallowing problems) was higher after use of an endotracheal tube.

PMID: 11437874 [PubMed - indexed for MEDLINE]



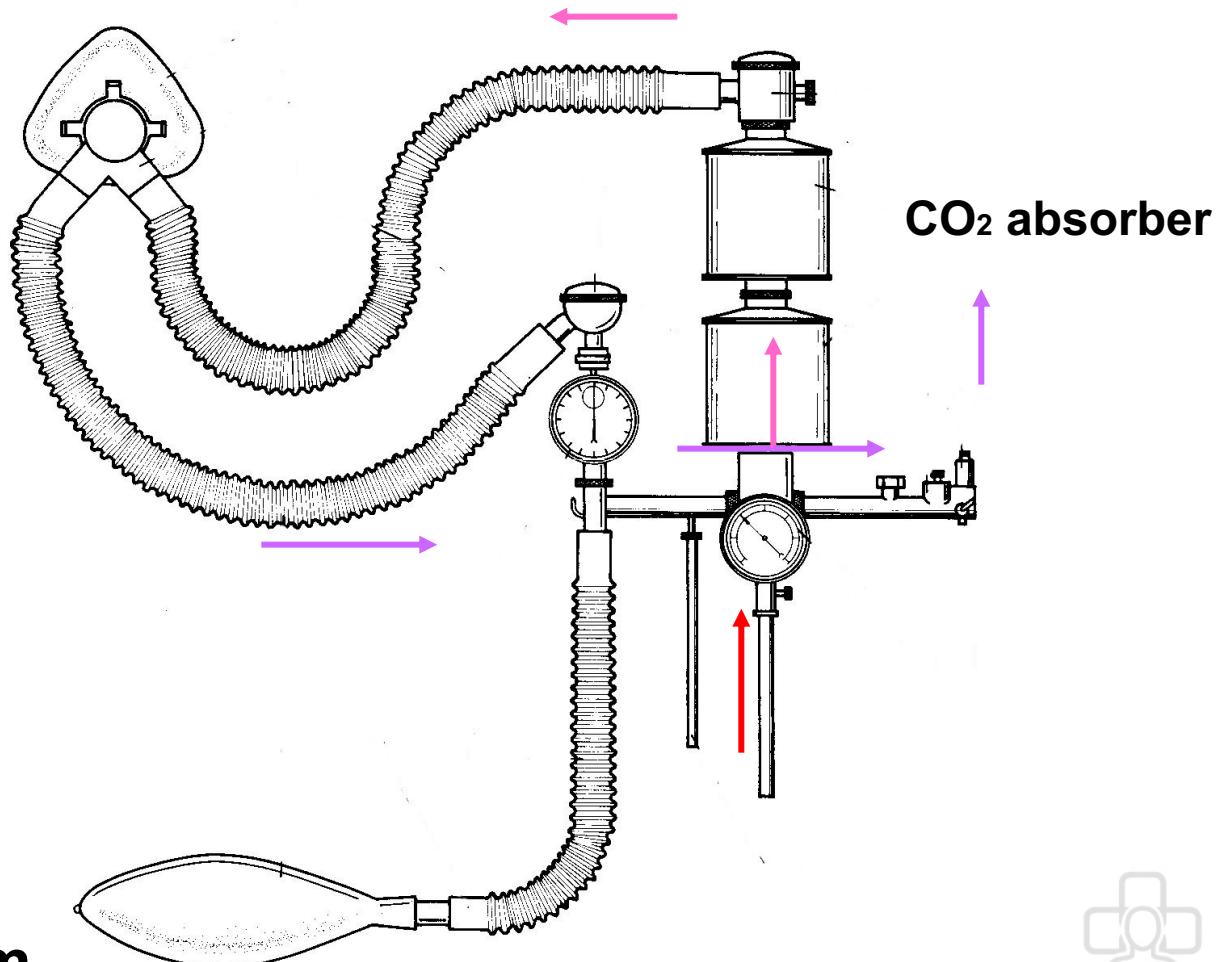
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1. The Re-Breathing System



The Anaesthesia circle system by Gauss und Wieland 1925



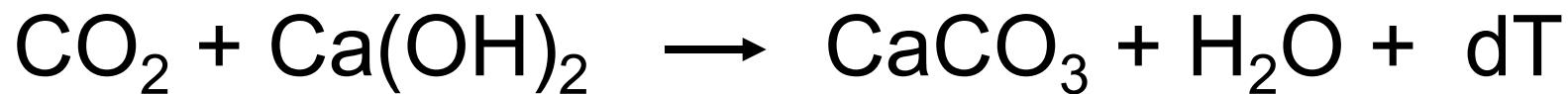
Circle System,
a valve controlled rebreathing system

Gauss und Wieland 1925
Narcylennarkoseapparat

60

Carbon dioxide absorption

The chemical reaction of CO₂ within the absorber



dT=heat

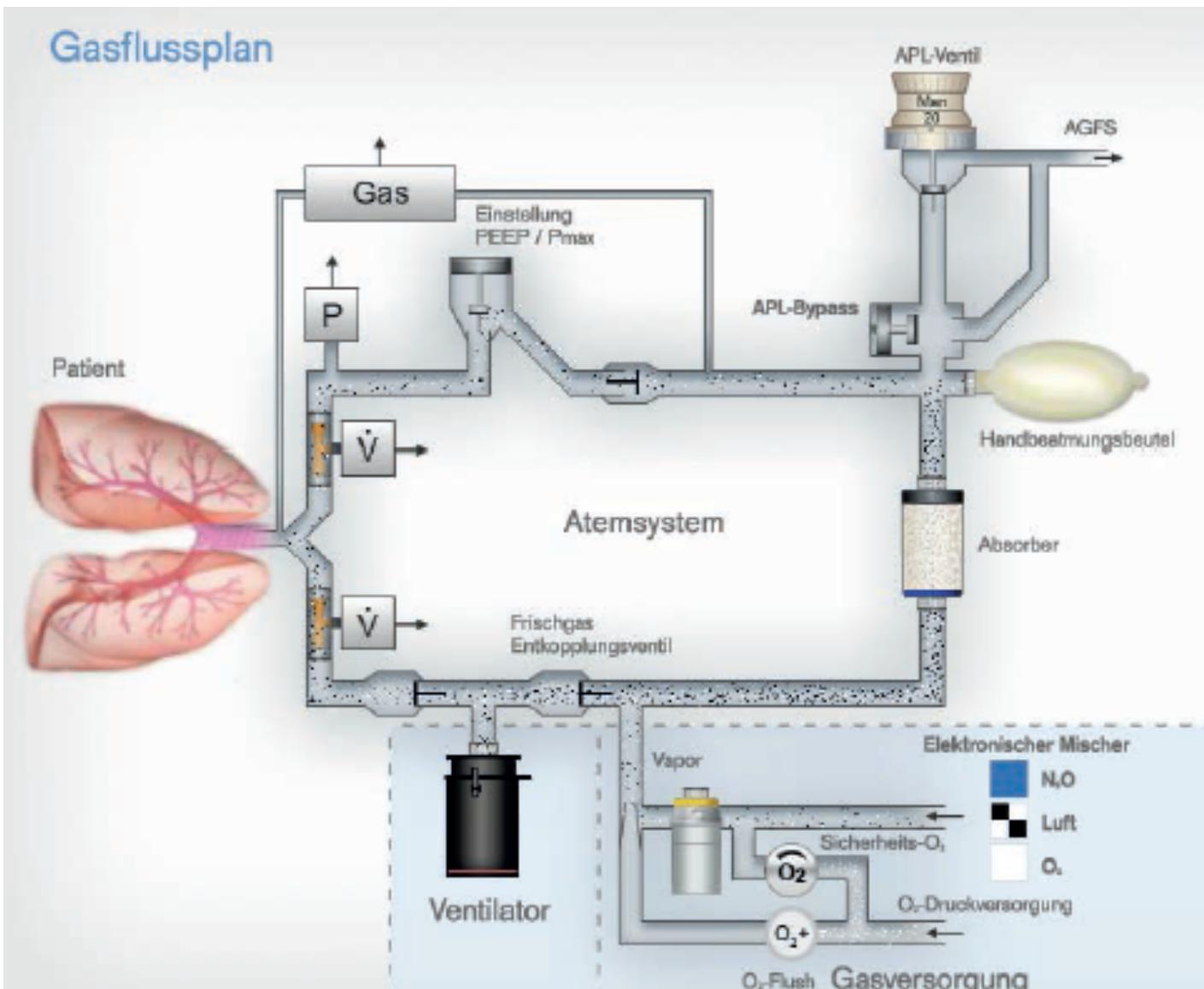


USA: Soda lime: sodium or calcium hydroxide

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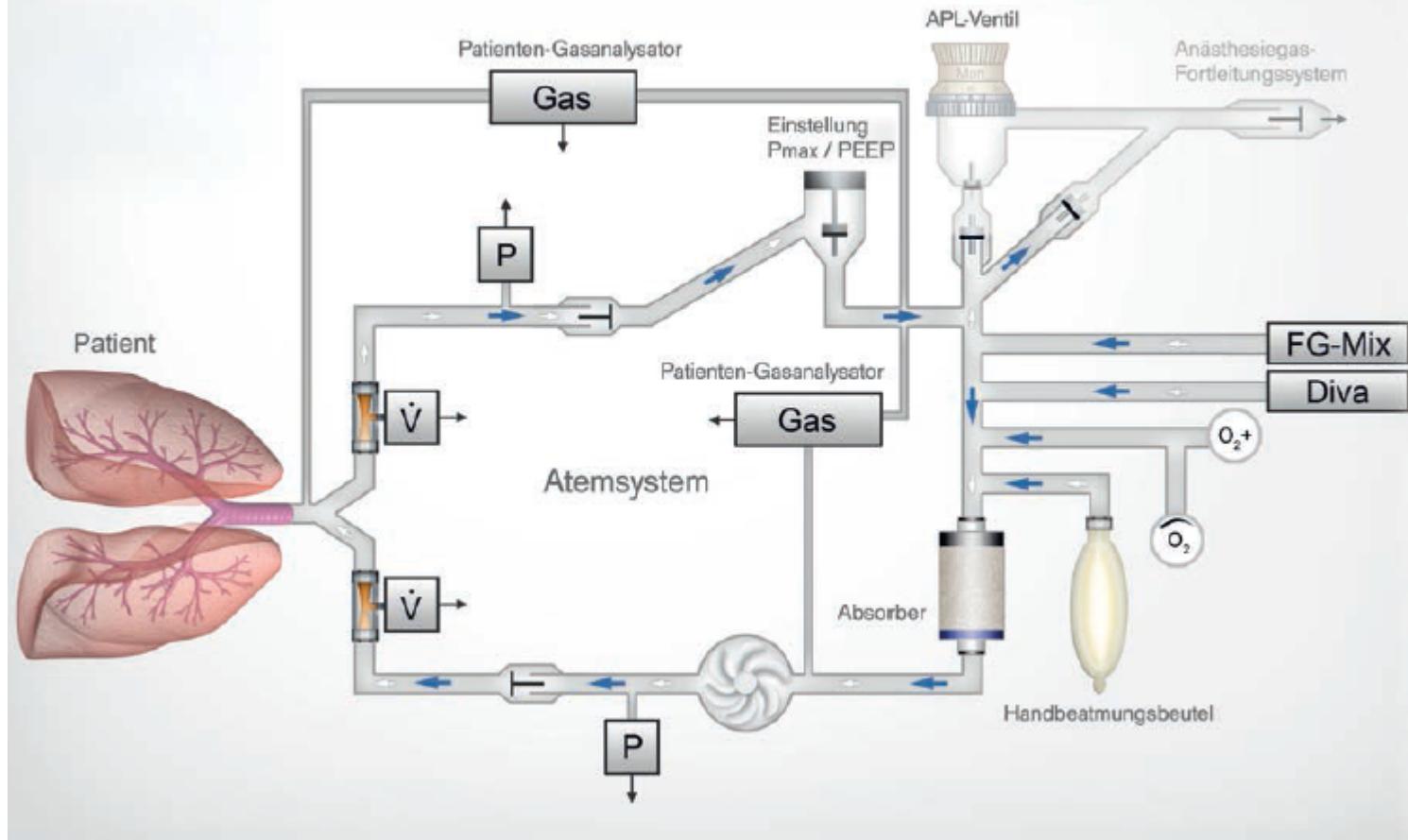
Primus gas flow diagram



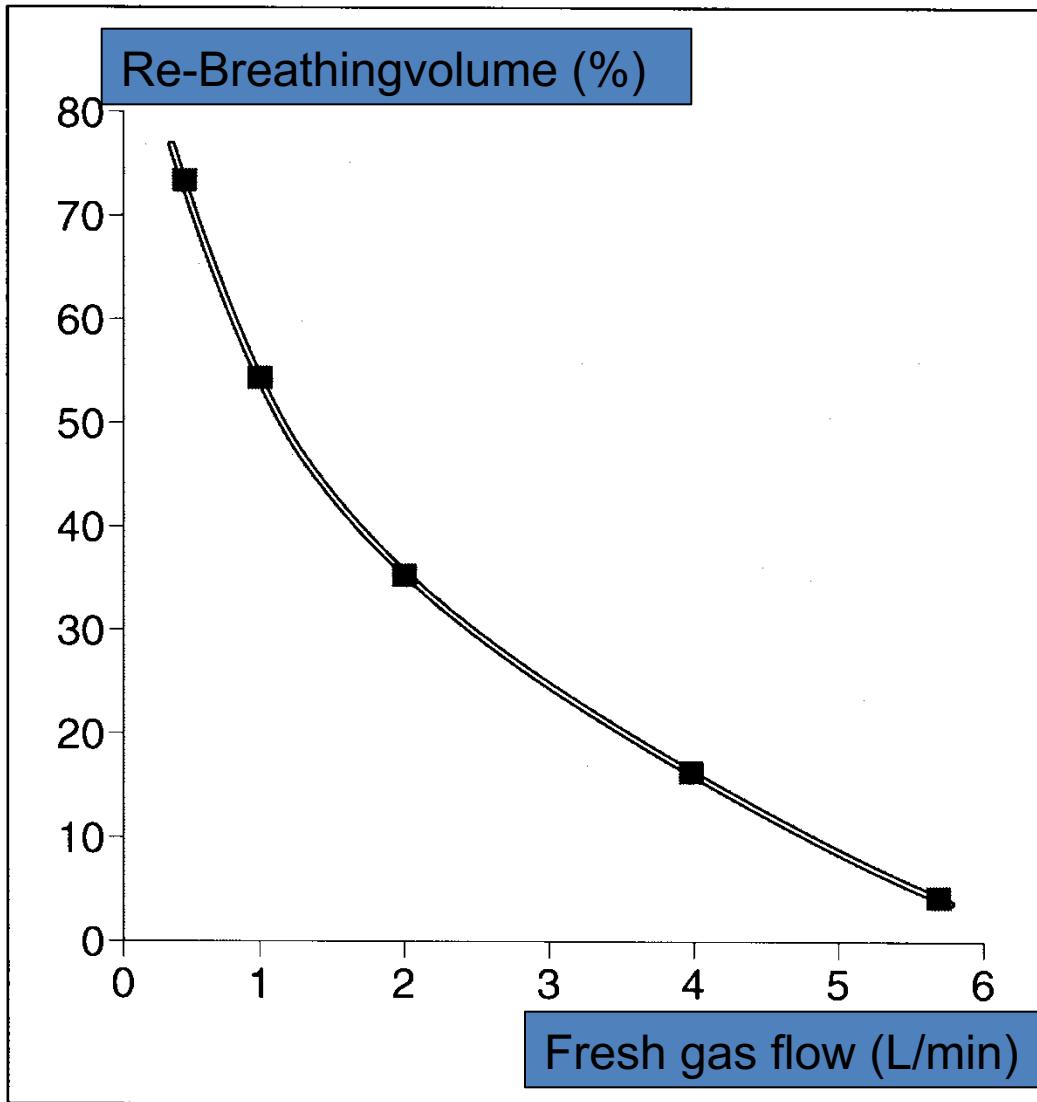


Zeus gas flow diagram

Gasflussplan



As lower the fresh gas flow → the Re-breathingvolume increases



How to use a circle System:



Katholische Kliniken
Oldenburger Münsterland
— St. Marienhospital Vechta —

Open

- high fresh gas flow ($> 6 \text{ L/min}$)
- without Re-Breathing

Semi closed

- Fresh gas flow reduced
- Flow between 0.5-6 L/min
- partial Re-Breathing

Closed system

- Complete Re-Breathing
- fresh gas flow very low
- flow between 0.1-0.5

Jan Baum

Die Inhalationsnarkose
mit niedrigem Frischgasfluß
Tieme Verlag 1992, 2. Auflage



Uptake of gases during inhalational anesthesia

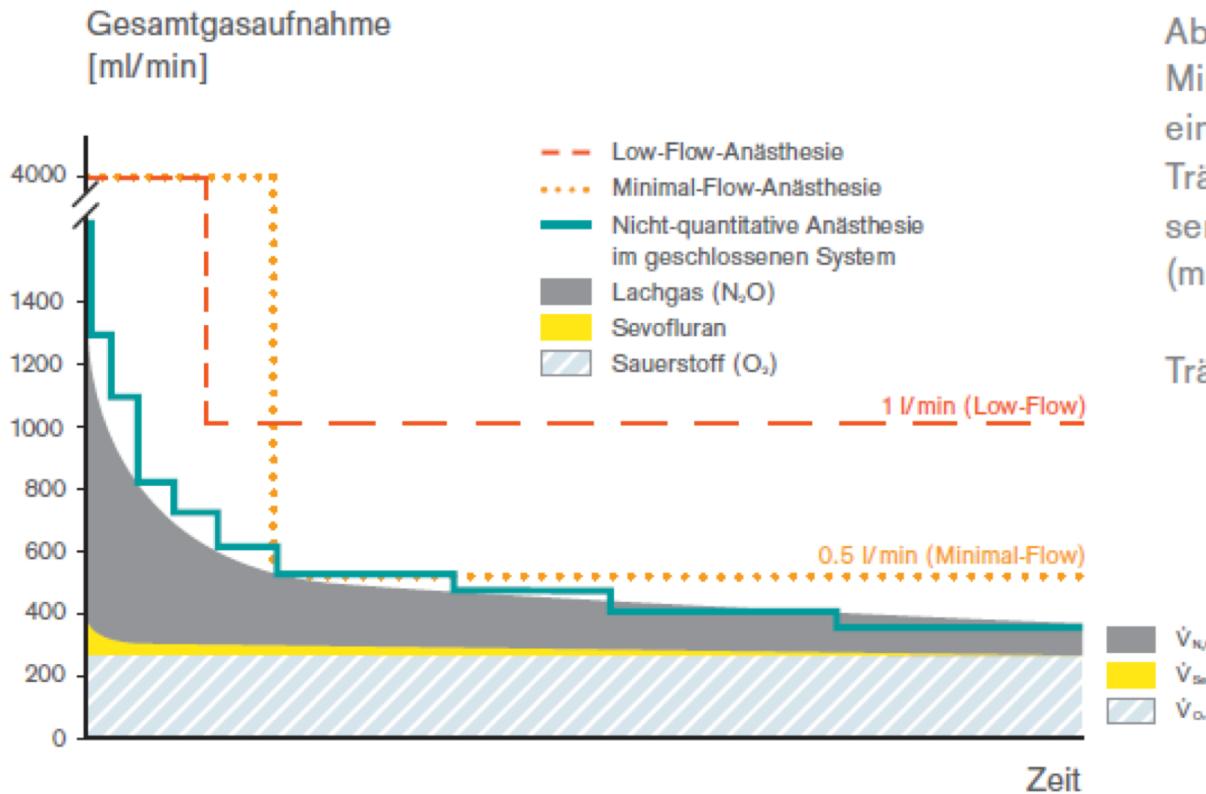
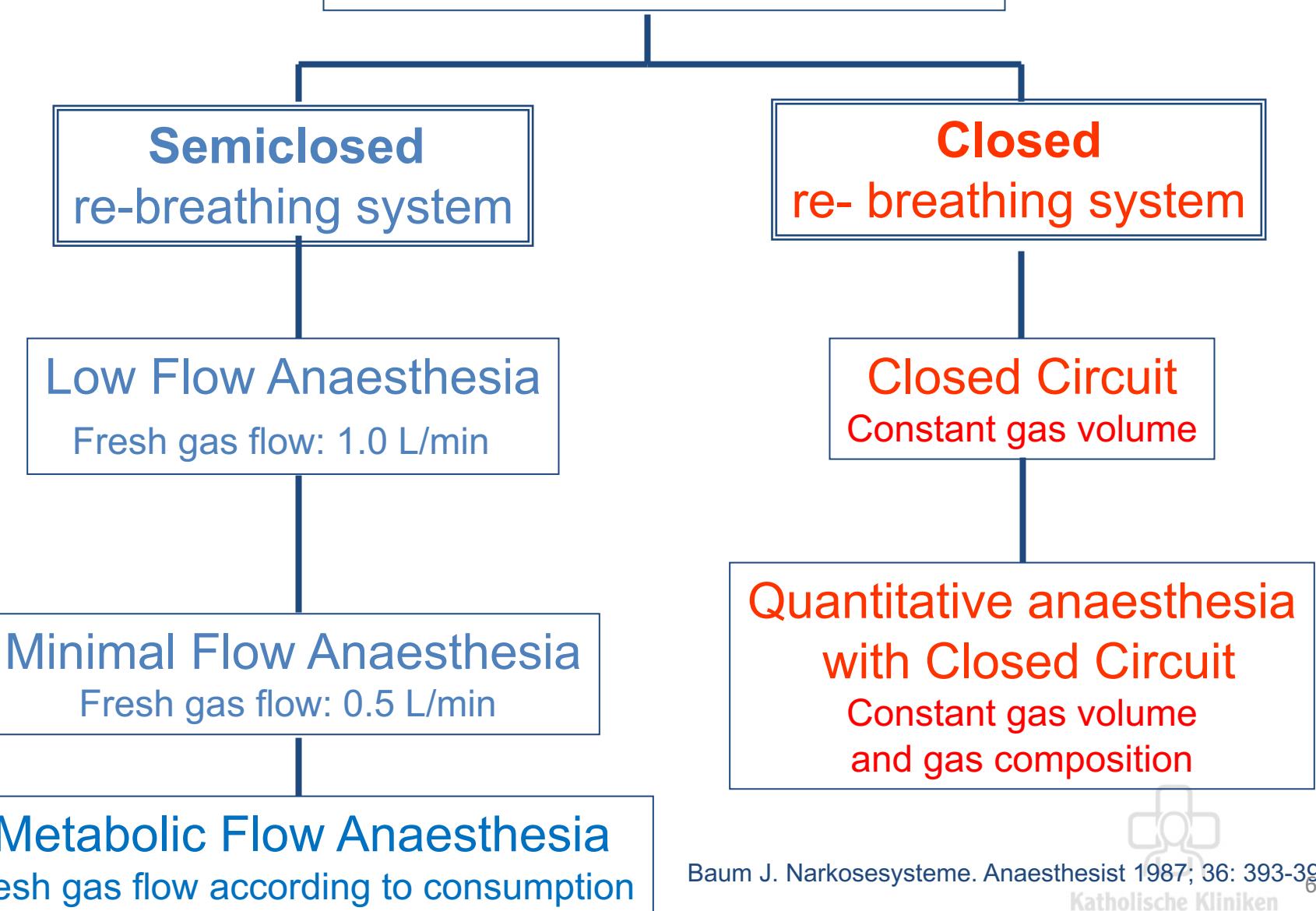


Abb. 2: Low-Flow- und Minimal-Flow-Anästhesie mit einem O_2/N_2O -Gemisch als Trägergas im halbgeschlossenen Atemsystem Primus (modifiziert nach: Baum JA⁶)

Trägergase: O_2/N_2O

Low flow anesthesia



Baum J. Narkosesysteme. Anaesthesist 1987; 36: 393-399

Katholische Kliniken
Oldenburger Münsterland



2. Advantages of low / minimal / metabolic flow and closed circuit anaesthesia

Remember part 1

Open Lung concept and lung protective ventilation

Reducing the fresh gas flow during anaesthesia leads to

1. More humidified anaesthetic Gases
2. Anaesthetic gas temperature increases more rapidly
3. Better mucociliary clearance
4. Increase in pulmonary function



Economical reasons

Saving volatile anesthetics



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

Economical reasons

Costs for inhalational anaesthetics

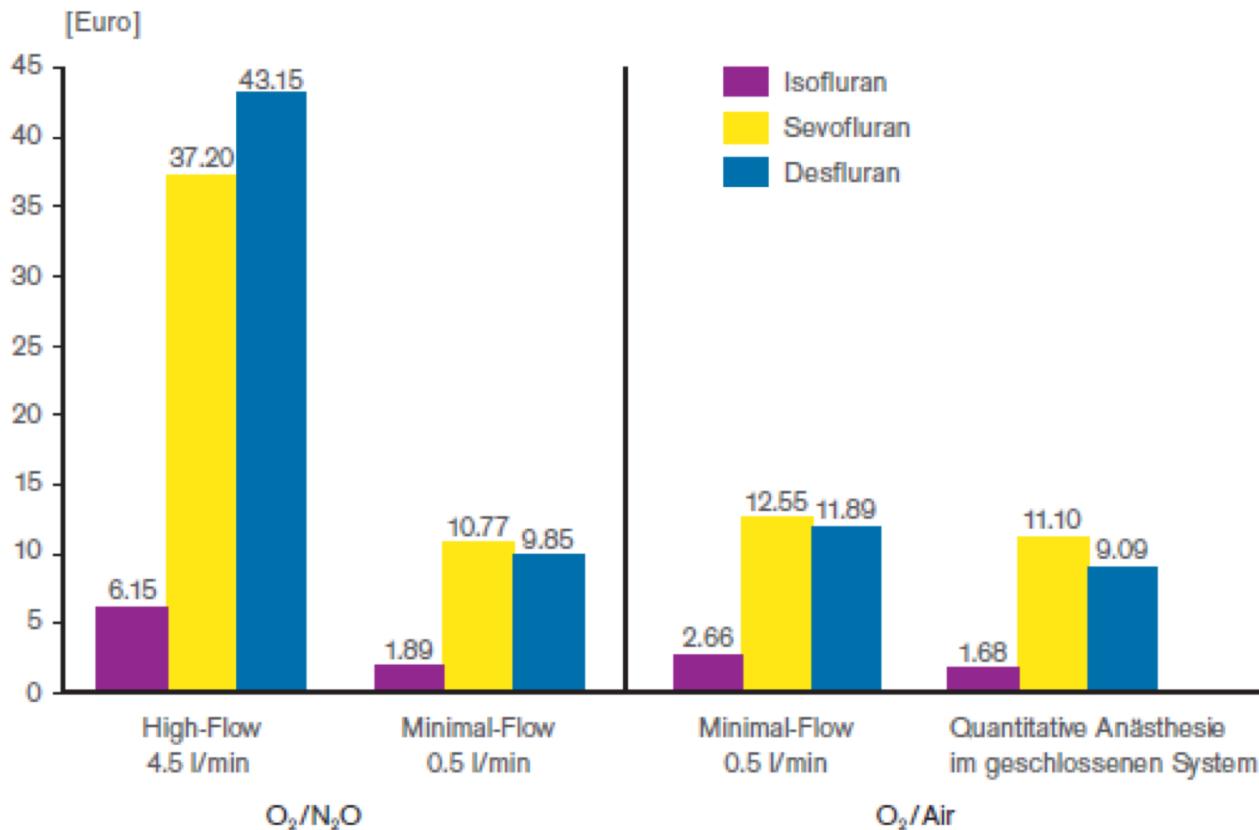
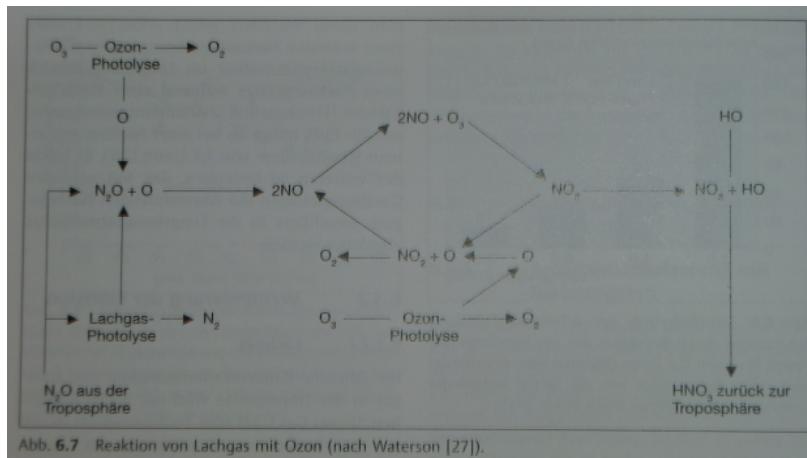


Abb. 14: Kosten der Inhalationsanästhetika in Euro auf Basis einer 2-Stunden-Inhalationsanästhesie

Vergleich der unterschiedlichen Narkoseführungen

Ecological reasons

Reaction of Nitrous oxide with ozone (Waterson)



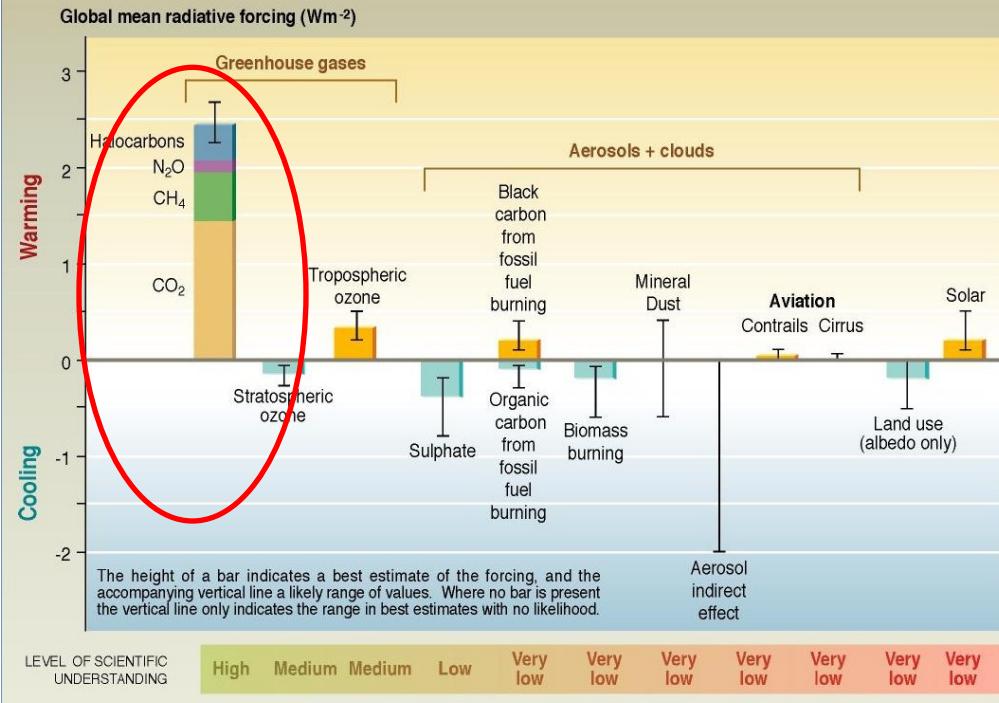
Hole in the ozone layer over the Antarktis (July 2005): nitrous oxide, the killer for the ozone layer? (Spiegel online)



Nitrous oxide is

the most important ozone-depleting
and heat-trapping greenhouse gas.

Anthropogenic and natural forcing of the climate for the year 2000, relative to 1750



techniques in anaesthesia

Yesterday – today - tomorrow

Type of anaesthesia

High flow anaesthesia

Low flow anaesthesia

Minimal flow anaesthesia

Metabolic flow anaesthesia

Non-quantitative closed circuit anaesthesia

Quantitative closed circuit anaesthesia

yesterday

today

tomorrow

fresh gas flow

> 2 L/min

O₂ + N₂O

= 1 L/min

O₂ + AIR

= 0,5 L/min

= 0,35 L/min

intermittent manually
adjusted fresh gas flow

O₂

closed loop controlled fresh
gas flow

3. How to do low / minimal / metabolic flow and closed circuit anaesthesia?



$O_2 + N_2O + \text{volatile anaesthetic}$



Remember: We never use nitrous oxide!

- Building a new OR – no tubing / no cost
- No technical support of nitrous oxide tubes and valves
- No cost due to service of tanks and delivery
- No pollution of the environment / OR



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O_2 + Air + volatile anaesthetic



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Oldenburger Münsterland

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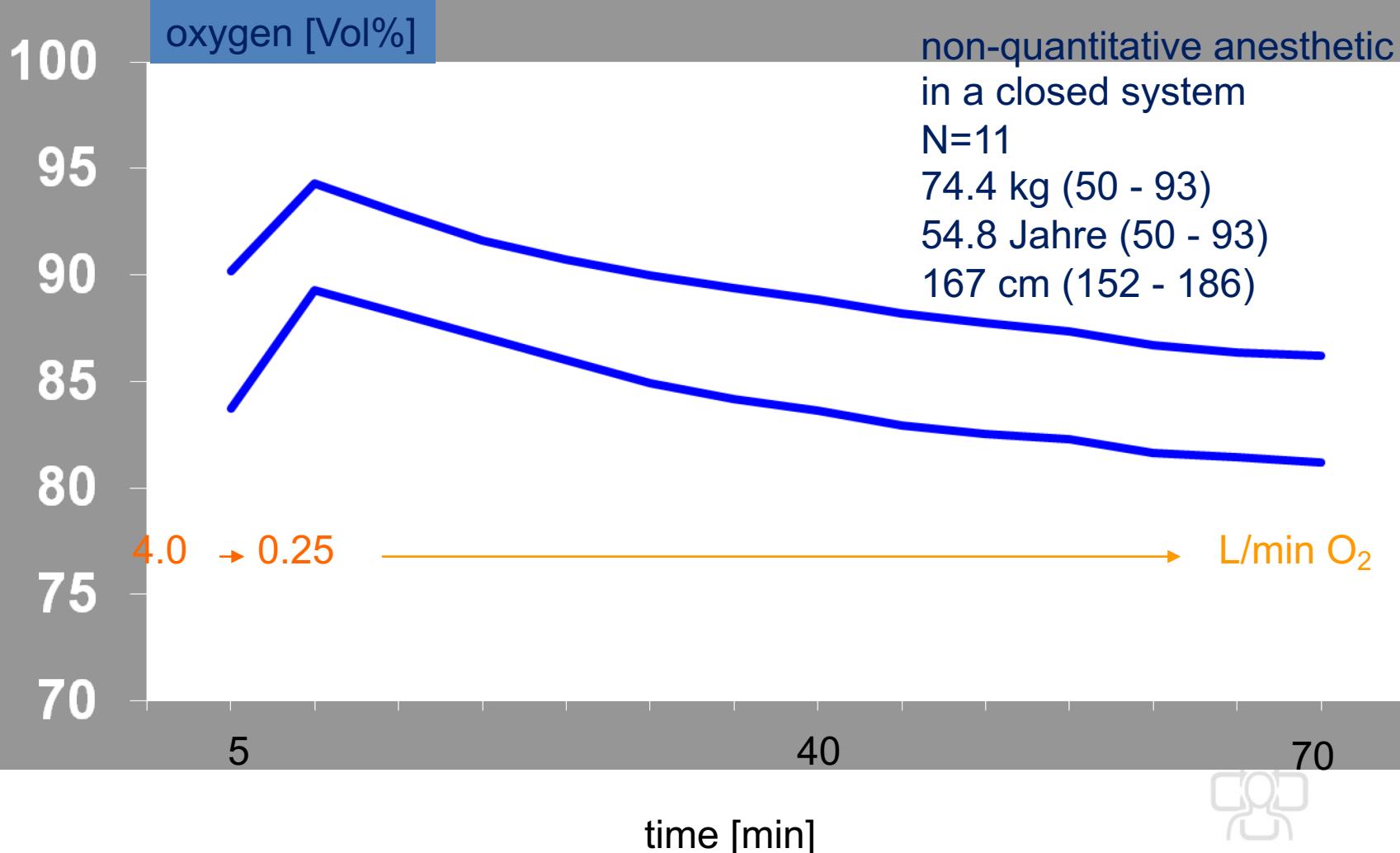
Christian Höinemann. 11-й Британо-Український Симпозіум. Київ, 2019

I can show the practice in the OR



O_2 + volatile anaesthetic





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100 % oxygen for delivery of volatile anesthetics

in Vechta/Damme/Muenster in 214564 patients (16.04.2019)



Oxygen in high concentrations - contraindications

- neonates
Body weight < 1,5 kg, gestations week between 28.-34.
- Patients with acid aspiration
- Extrem COPD patients
FEV1 < 30%
- Patients under medication during chemotherapy
Cyclophosphamid, Bleomycin, Mitomycin, Carmustin
- Lasersurgery
- ??



The practice
We call it the
metabolic flow anesthesia

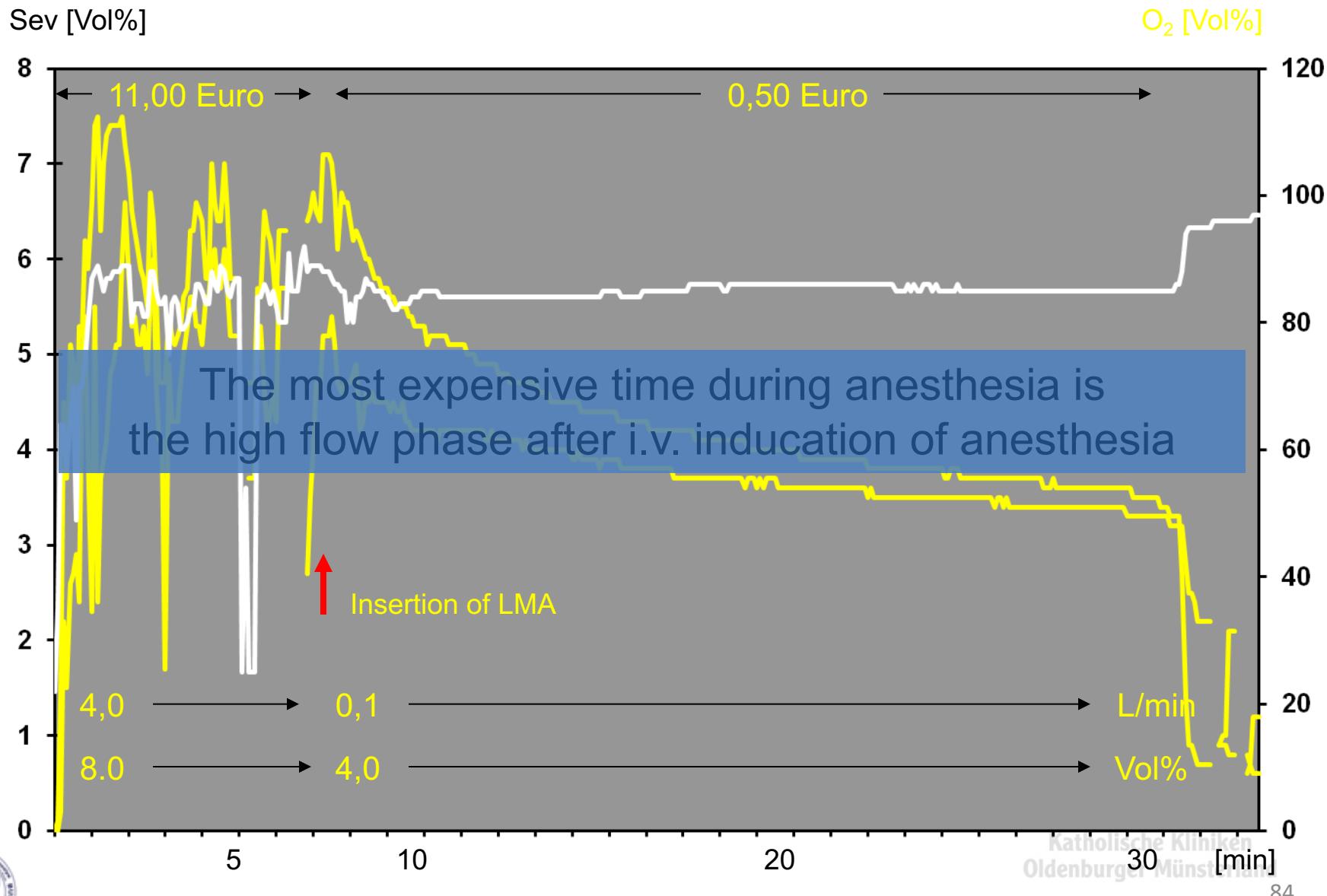


Our practice in Vechta, with ready room

- Präoxygenation, 6 L O₂, FiO₂ 1,0, 2-3 min
- 1 mg/kg Lidocain i.v. for induction
- i.v. propofole 1,5 – 2 – (2,5) mg/kg
- analgesic 0,1 – 0,25- (0,5) µg/kg KG sufentanile
- Rocuroniumbromide 0,4-0,6 mg/kg KG
- If no further instrumentation like CVP or art. line is necessary no volatile anaesthetic in the ready room, go directly to the OR
- otherwise dial in sevoflurane vapor to 8 Vol/% and reduce FGF 1 L/min with FiO₂ 1,0 until you reach 0,7 – 0,9 MAC



3,5 y., 15 kg, Circumcision, Closed System Anaesthesia, Cicero,
LMA # 2, mechanical ventilation, TV: 170 ml, f: 16



11 Nov. 2009

09:08 100 %

Man.S spont.

insp. exsp.

78

%

O₂**0**

%

N₂O**1.6**

%

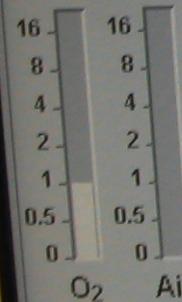
Iso.

1.1

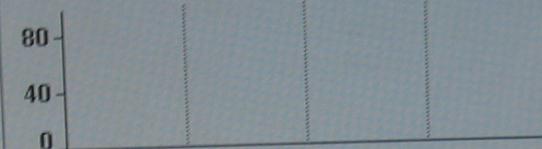
%

MAC

Alter: 40

0.9

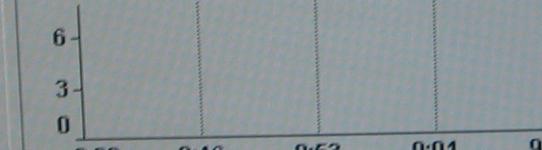
MAC Trend

N₂O Trend

Iso. Trend



Sev. Trend

etCO₂ **27**

mmHg

inCO₂ **1**MV **3.2**V_T **175**Freq. **6**PEAK **6**PLAT **0**PEEP **--**Alarm
Grenzen

A.-Gase

MV / CPAT
CO₂ / O₂Gesamt
Trend
Timer
starten

FRISCHGAS

O₂
%**100**Flow
L/min**1.00**12. Nov. 2009, 08:11, männlich, 66 J.
Primus Narkosegerät, diag. Laps

85

Cost reduction for volatile anesthetics (2 h)

Euro

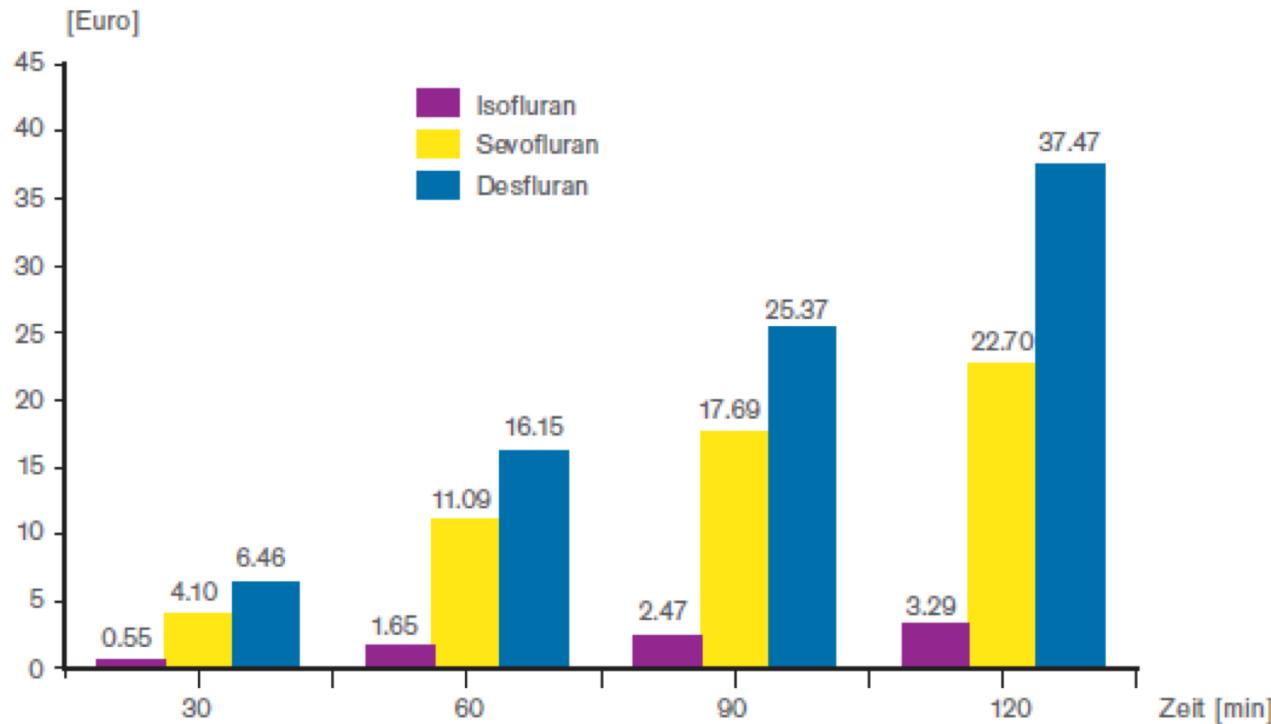


Abb. 13: Kosteneinsparungen in Euro durch Minimal-Flow-Anästhesie von 0.5 l/min im Vergleich zur Standardtechnik mit einem Frischgasflow von 3 l/min



Our practice with Primus / Perseus fresh gas decoupled rebreathing system

- In the OR:
- Sevoflurane (Vapor 8 %), fresh gas flow 1 L/min ca. 3-5 min (until MAC 0,9, ca. 4,6-6,5 Vol/%)
- Sevoflurane (Vapor 4-5%), fresh gas flow 0,35 L/min (MAC 0,8-1,1)
- Propofol (20-50 mg) if you need quick changes in anesthetic state
- Increase FGF up to 0,5-0,75 L/min, Vapor 8%.
- Reduction of FGF auf 0,35L/min, if MAC is achieved (MAC max. 1,2), Vapor 6%.



Propofol plasma concentration after 2 mg/kg bolus



St. Marienhospital
Vechta

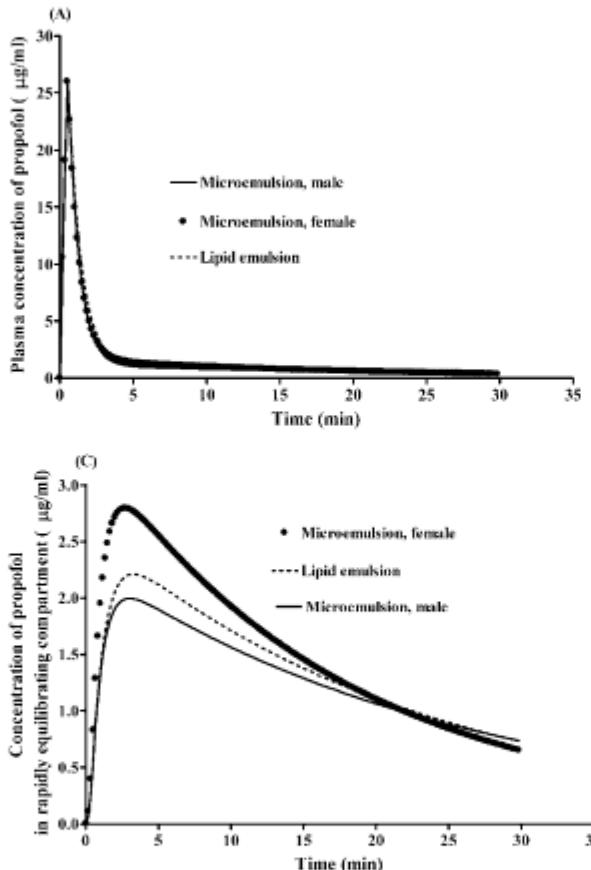


Fig. 5. Simulation of an intravenous bolus of propofol 2 mg/kg for lipid emulsion and microemulsion of propofol in a subject whose age, body weight, and height are 44 yr, 65 kg, and 170 cm, respectively. (A) Predicted plasma concentration, (B) predicted effect site concentration, (C) predicted concentration in rapidly equilibrating compartment, (D) predicted concentration in slowly equilibrating compartment.

Anesthesiology 2007; 106:924-34

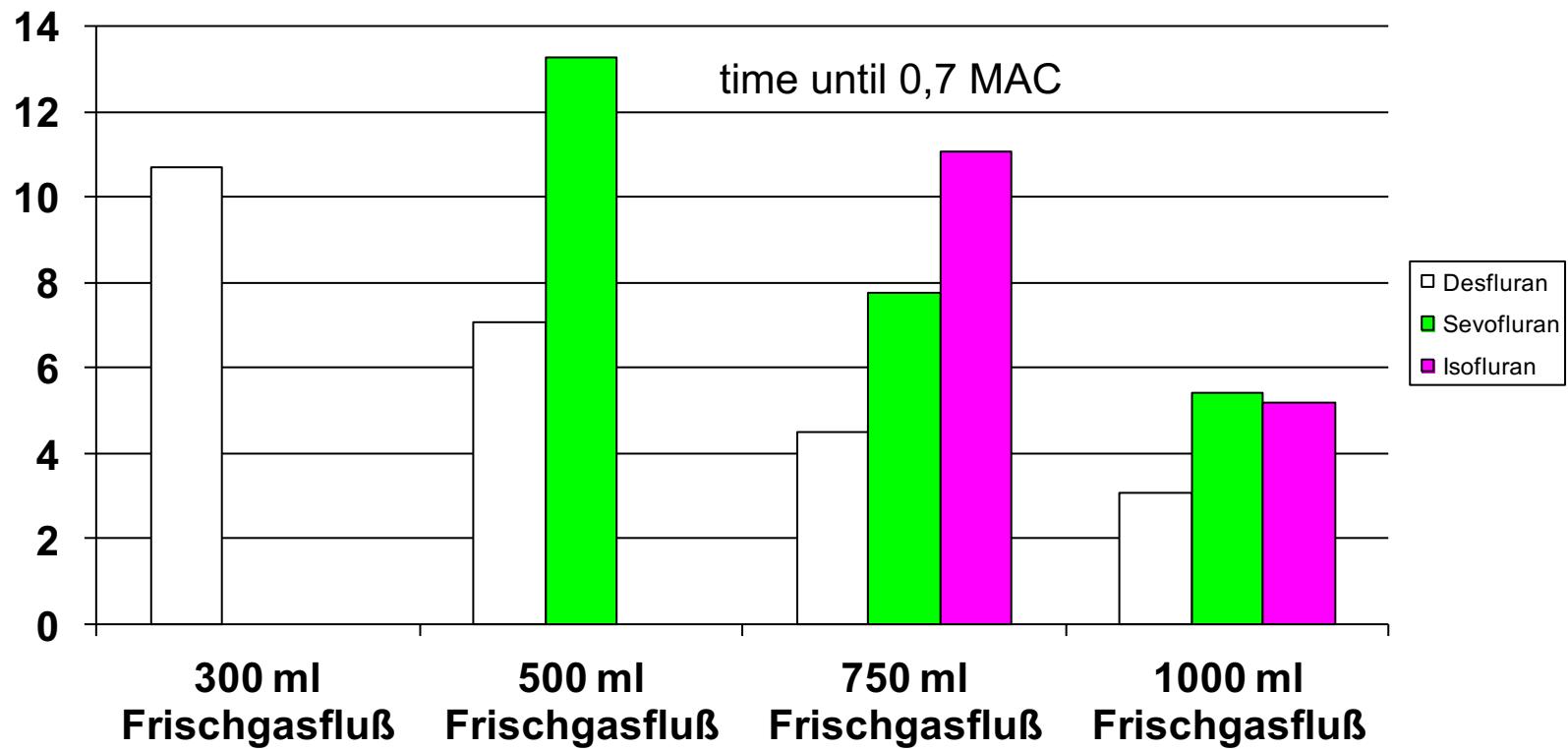
Copyright © 2007, the American Society of Anesthesiologists, Inc. Lippincott Williams & Wilkins, Inc.

Pharmacokinetics and Pharmacodynamics of Propofol Microemulsion and Lipid Emulsion after an Intravenous Bolus and Variable Rate Infusion

Kye-Min Kim, M.D.,* Byung-Moon Choi, M.D.,† Si-Won Park, M.D.,† Soo-Han Lee, Ph.D.,‡ Lane V. Christensen, B.S.,§ Jiaye Zhou, M.S.,|| Byung-Hoon Yoo, M.D.,* Hye-Won Shin, M.D.,# Kyun-Seop Bae, M.D.,** Steven E. Kern, Ph.D.,† Sung-Hong Kang, Ph.D.,†† Gyu-Jeong Noh, M.D.,§§

2 mg/kg bolus propofol allows anaesthesia for 8-12 min (MAC 0,7).

Increase of volatile anesthetics with low fresh gas flows (Cato, Dräger®)



nach Dr. Hauenschild

Increase of volatile anesthetics with low fresh gas flows, Primus, Zeus, Dräger®

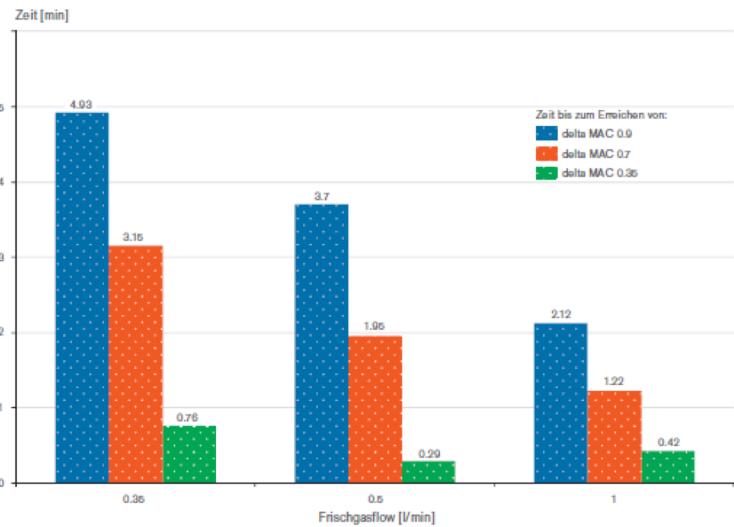


Abb. 26: Daten des
Primus – Sevofluran

Maximale Abgabeleistung
des Vapors 8 Vol.-%
(dies entspricht ungefähr
4 × MAC)

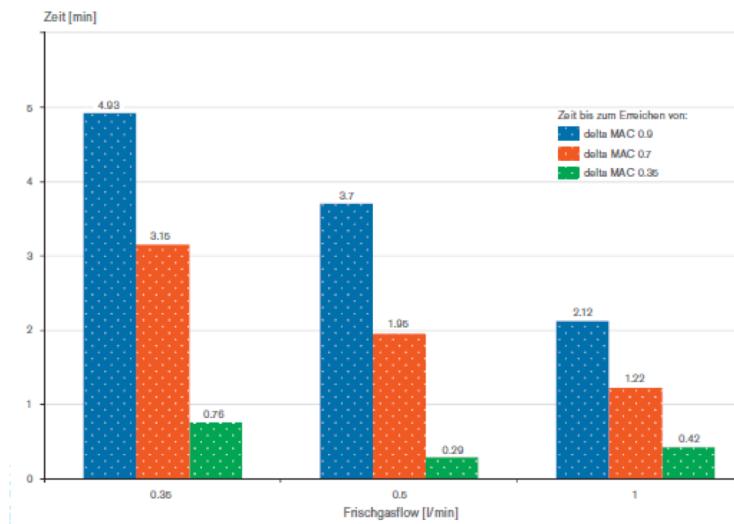


Abb. 26: Daten des
Primus – Sevofluran

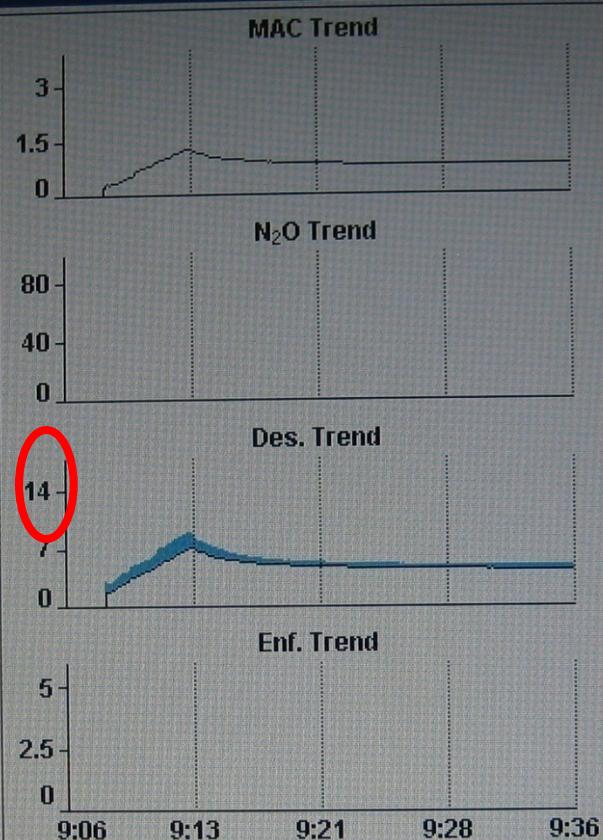
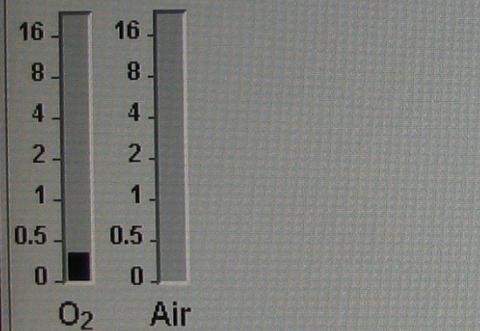
Maximale Abgabeleistung
des Vapors 8 Vol.-%
(dies entspricht ungefähr
4 × MAC)

Pressure

sync

	insp.	exsp.	%
O ₂	86	82	%
N ₂ O	0	0	%
Des.	7.1	6.0	%

MAC Alter: 66 1.1



etCO ₂	34 mmHg	Alarm Grenzen
inCO ₂	1	
MV	4.2	A.-Gase
V _T	461	
Freq.	9	MV / CPAT CO ₂ / O ₂
PEAK	12	
PLAT	12	
PEEP	0	
Gesamt Trend		
Timer starten		

FRISCHGAS

O₂ % 100
Flow L/min 0.35

P_{INSP} hPa 12

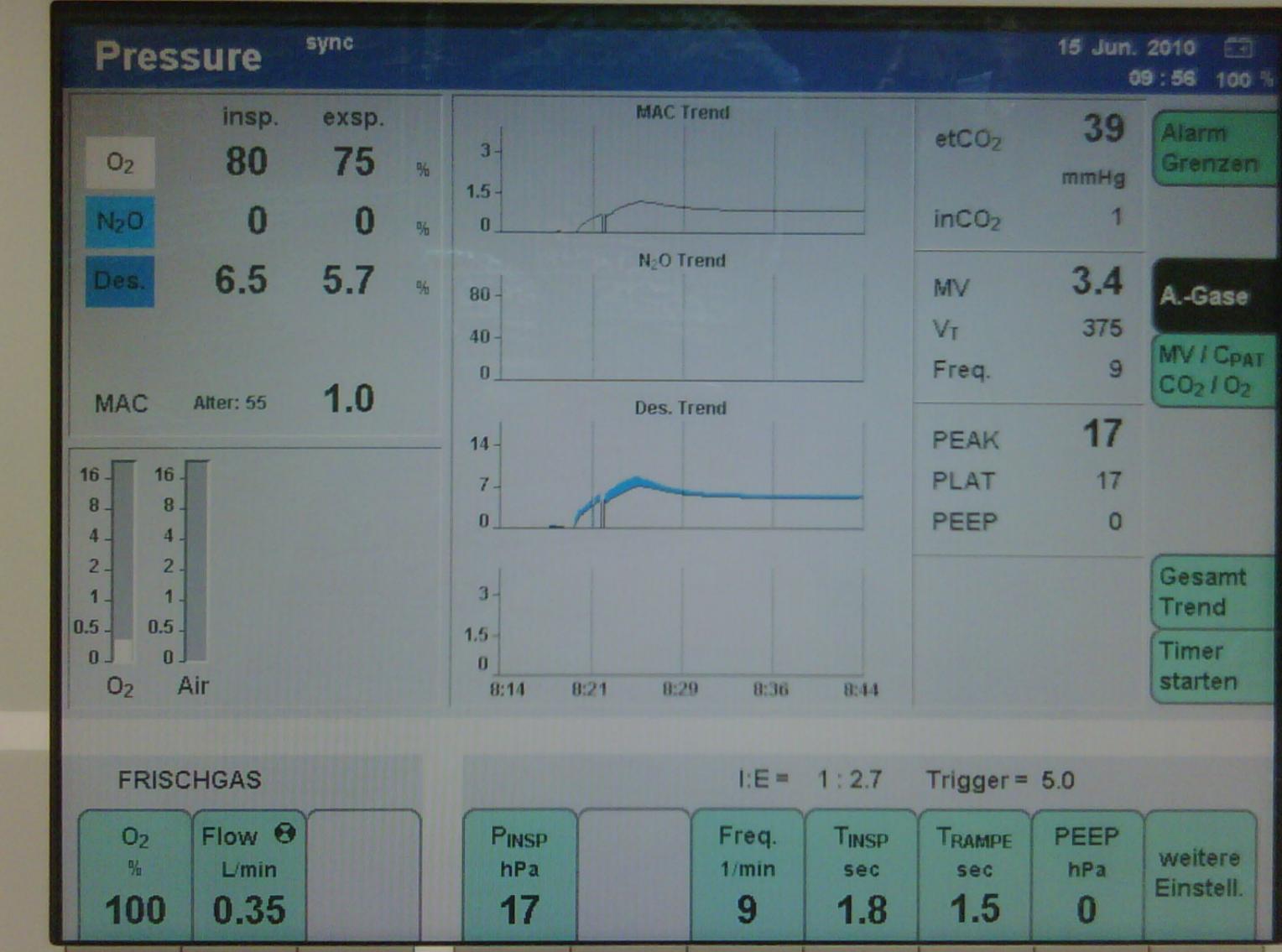
I:E = 1 : 2.3 Trigger = 5.0

Freq. 1/min 9
T_{INSP} sec 2.0

T_{RAMPE} sec 1.5
PEEP hPa 0

weitere Einstell.

12. Nov. 2009, 08:11, male, 66 J.
Primus, diag. Laps

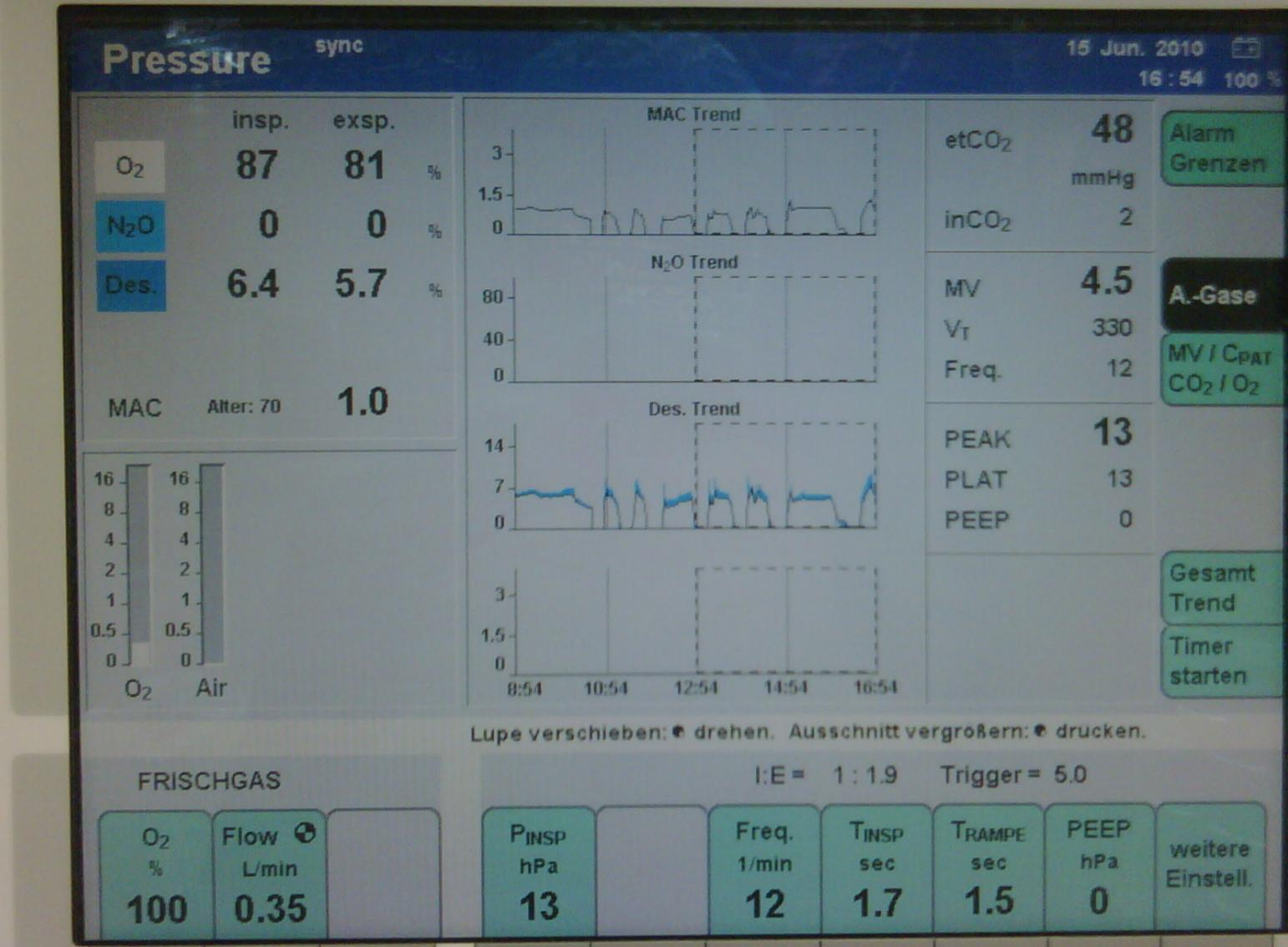


Metabolic flow (withdrawal)

Anesthesia withdrawal

- Vaporizer can be closed 10 min before end of surgery.
- In the recovery room what ever is needed.

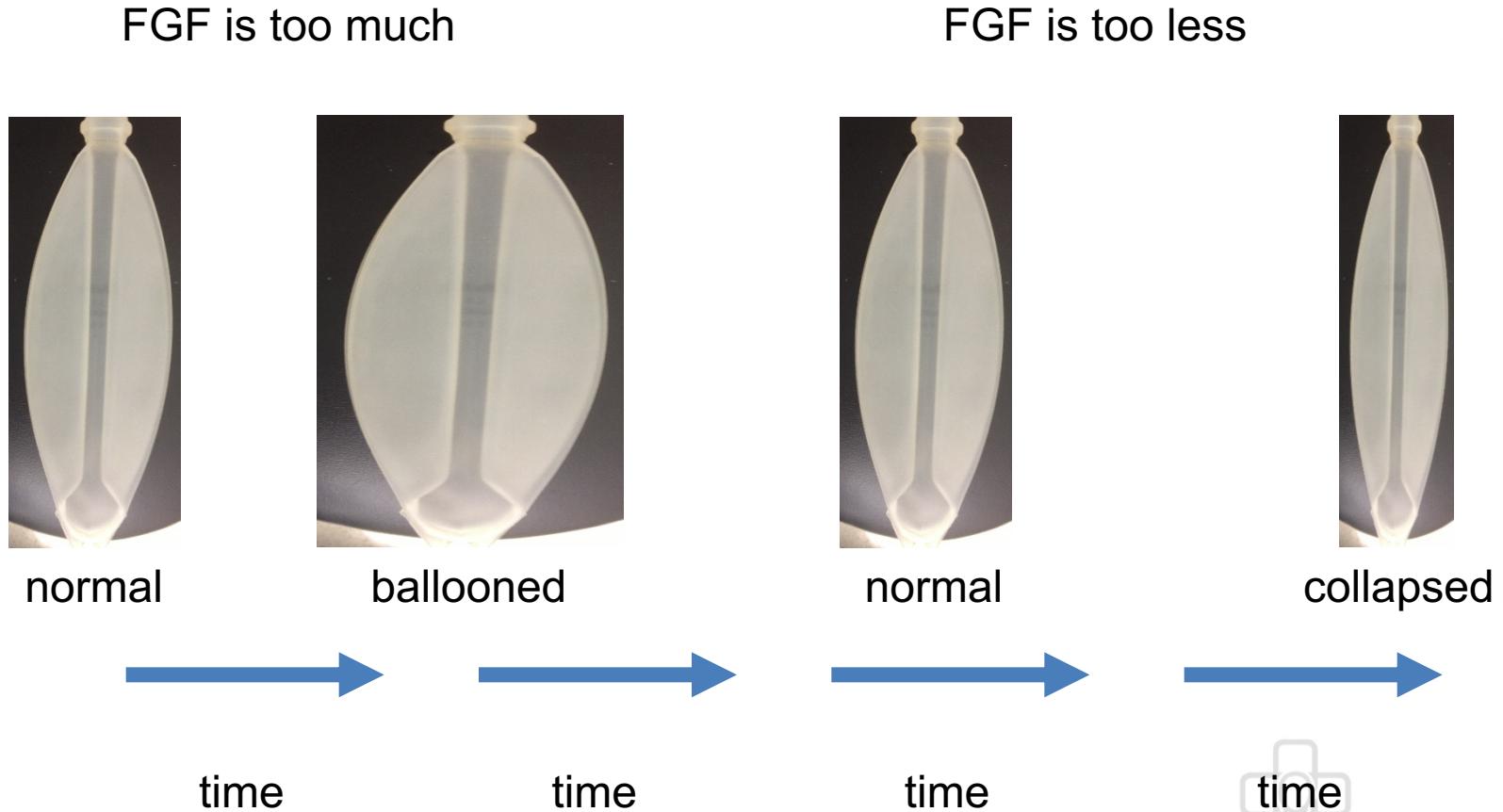




4. How do you know you have a stable inspired oxygen and volatile anesthetic concentration?



The reservoir bag is telling the truth



Believe what you measure !

Inspired oxygen concentration, FiO_2

Exspired concentration of the volatile anaesthetic

Peak pressure, pplat pressure and PEEP

Oxygensaturation (SaO_2)

Endtidal CO_2



Technical help from the anaesthesia machine!

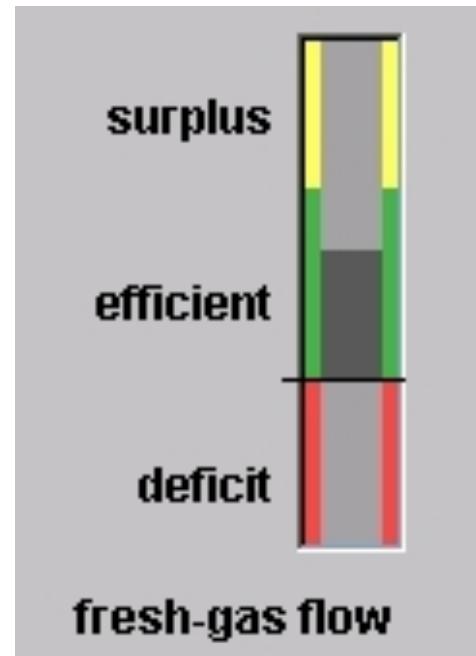
- Econometer
- Smart Applications

VaporView / FiO₂ Prediction



Econometer (Primus[©])

- The econometer / low Flow Wizard gives the user a direct graphical feedback, how efficient his anesthesia is:
 - Green Area: \dot{V}_U
Fresh Gas Flow is in the range of the assumed and calculated consumption (uptake + leakages + transferred CO₂ volume to Absorber)
 - Yellow Area: \dot{V}_U
Fresh Gas Flow is more than 1 l/min above the actual gas
 - Red Area: \dot{V}_D
Fresh Gas Flow is less than actual gas consumption (Fresh gas shortage)



Integrated electronic „low flow trainer“ for qualitative displaying of fresh gas use efficiency

Econometer (PerseusA500[©])



Take home message



1. Economical reasons (90 % savings)
2. Ecological reasons (less greenhouse gas)
3. Medical reasons (humidity & temperature of gases)
4. Easy and save to use

Please use fresh gas flows as low as possible!



Preoxygenation: 6 L Oxygen ----- i.v. Induction

Wash in period: FGF 1 L Oxygen + volatile vaporizer open completely (MAC 0.9)

Steady state, surgery period: FGF 0.35 L/min + Vaporizer 2/3 of maximum (MAC 0.9)

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

Low Flow Booklet – published Nov. 13 2014 (German)

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

English version is comming up soon



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



Low-Flow-, Minimal-Flow- und Metabolic-Flow-Anästhesien
Klinische Techniken zur Nutzung von Rückatemsystemen

Christian Hönenmann
Bert Mierke

Dräger. Technik für das Leben®

Prämedikation

Prämedikation nach gewohntem Schema

Einleitung

- Präoxygениierung 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: Einleitungsopiod eventuell bis 20 % höher dosieren)
- Endotracheale Intubation oder Einkragen 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
- Änderung der Narkosemittelkonzentration siehe Tipp und Tricks

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 Nährt, vor Extubation: Spülen des Systems mit 100 % Sauerstoff mit 6 l/min.
- Postoperative Betreuung des Patienten entsprechend den üblichen abteilungsinternen Verfahrensweisen.

*Alle Angaben sind klinisch erprobte Orientierungswerte. Sie müssen aber im Einzelfall unbedingt der individuellen Reaktionslage des Patienten, den Leistungsmerkmalen der verwendeten Geräte und den operativen Erfordernissen entsprechend angepasst werden.

906956 © 2015 Priv.-Doz. Dr. med. Christian Hönenmann (Vechta),
Dr. med. Bert Mierke (Damme) | www.kk-m.de | www.krankenhaus-damme.de
Mit freundlicher Unterstützung der Drägerwerk AG & Co. KGaA | www.draeger.com



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

Prämedikation

Prämedikation nach gewohntem Schema

Einleitung

- Präoxygениierung 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: Einleitungsopiod eventuell bis 20 % höher dosieren)
- Endotracheale Intubation oder Einkragen einer Larynxmaske
- Anschluss des Patienten an das Kreissystem

Initialphase

- Einstellungen Frischgasflow
Sauerstoff 1 l/min, Air 3 l/min (40 % Sauerstoff und 4 l/min Frischgasflow)
- Vapor-Einstellungen

Isofluran	2,5 Vol-%
Sevofluran	3,5 Vol-%
Desfluran	6 Vol-%
- Die inspiratorische Sauerstoffkonzentration wird sich zwischen 35 und 40 Vol.-% einpendeln.

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

- Verminderung Frischgasflow für Sauerstoff auf 0,3 l/min, für Air auf 0,2 l/min (60 % Sauerstoff und 0,5 l/min Frischgasflow)
- Erhöhung der Vapor-Einstellung für

Isofluran auf	5 Vol.-%
Sevofluran auf	5 Vol.-%
Desfluran auf	8 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.-% 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 Minuten vor OP-Ende.
- Beibehalten des niedrigen Flusses von 0,5 l/min.
- Überführen des Patienten zur Spontanatmung.
- Nach Ende der Nährt, vor Extubation: Spülen des Systems mit 100 % Sauerstoff mit 6 l/min.
- Postoperative Betreuung des Patienten entsprechend den üblichen abteilungsinternen Verfahrensweisen.



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

Prämedikation

Prämedikation nach gewohntem Schema

Einleitung

- Präoxygениierung 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 Einkragen einer Larynxmaske
- Anschluss des Patienten an das Kreissystem

Initialphase

- Einstellungen Frischgasflow
Sauerstoff 1,4 l/min, Lachgas 3 Vmin (32 % Sauerstoff und 4,4 l/min Frischgasflow)
- 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 Erreichen des Ziel-MAC-Wertes von 0,8 bis 1

- Verminderung Frischgasflow auf insgesamt 0,5 Vmin (Sauerstoff 0,3 Vmin, Lachgas 0,2 Vmin (60 % Sauerstoff und 0,5 l/min Frischgasflow))
- 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 Nährt, vor Extubation: Spülen des Systems mit 100 % Sauerstoff mit 6 l/min.
- Postoperative Betreuung des Patienten entsprechend den üblichen abteilungsinternen Verfahrensweisen.





Thanks for your kind attention?



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