



VRIJE
UNIVERSITEIT
BRUSSEL








EEN DIEPERE DIUK IN DE DUIKWERELD

25
MAART

SPREKERS

Prof. Dr. K. Tournoy
Is COVID nog een issue voor de duiksport?

Prof. Dr. C. Mathieu & M. Roden
Duiken en diabetes, do's en don'ts!

Dr. H. van Bogaert
Decompressiestress, wat moet je ermee?

Dr. P. Germonpré
Immersielongoeedeem, kopje onder?

Dr. C. De Maeyer
De oudere duiker, een risico?

Campus VUB Etterbeek
U-residence

Duikant* GRATIS
Duikfederatie 30 EURO
Overig 50 EURO

Van 9u00
Tot 13u30

*Aangehouden duikants NELOS-VUB
Leden SKA & NELOS

INSCHRIJVEN: WWW.DUIKARTS.BE/SYMPOSIUM.HTML





Vrije Universiteit Brussel
Human Physiology Research Group (MFYS)
WWW.BLITS.ORG




SPORT + KEURINGSARTSEN

1

- **09.00 – 09.35:** **Is COVID nog een issue voor de duiksport in 2023 ? Een update.**
Prof. Dr. K Tournoy, longarts OLV Aalst en Universiteit Gent.
- **09.40 – 10.15:** **Duiken en diabetes, do's en don'ts**
Prof. Dr. Chantal Mathieu, endocrinoloog UZLeuven
Michel Roden, ervaringsdeskundige.
- **10.20 – 10.55:** **Decompressiestress, wat moet je ermee?**
Dr. Herman van Bogaert, huisarts, sportarts, duikarts
- **10.55 – 11.15:** **Koffiepauze – bezoek standen**
- **11.15 – 11.50:** **Immersielongoeedeem, kopje onder?**
Lt.Kol. Dr. Peter Germonpré, duikarts, hyperbare geneeskunde.
- **11.55 – 12.30:** **De oudere duiker, een risico?**
Dr. Cathérine De Maeyer, cardioloog, UZAntwerpen
- **12.30 – 13.30:** **Lunch**



RDSM
Medisch Materiaal
en
Telegeneeskunde



2

Is COVID-19 still an issue for SCUBA divers ?

K Tournoy
kurt.tournoy@olvz-aalst.be
March, 25th 2023



3

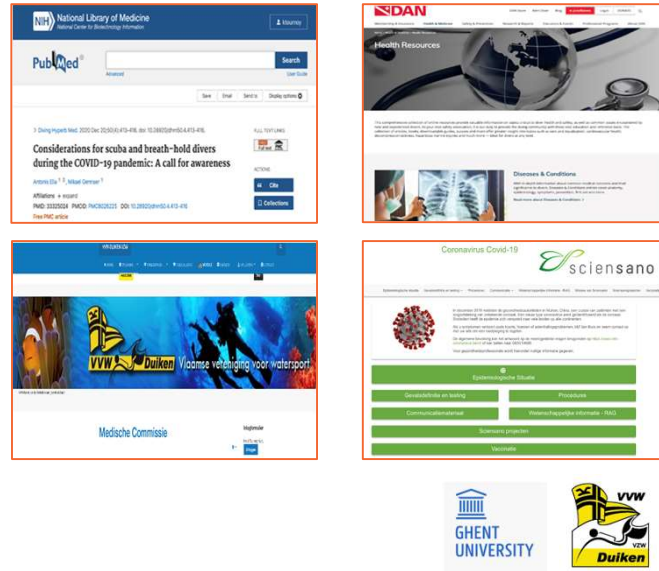
What's on the menu ?

- What is the current COVID status ?
- Does COVID imply additional risks for divers ?
- New data about COVID and SCUBA
- COVID advices for divers revisited



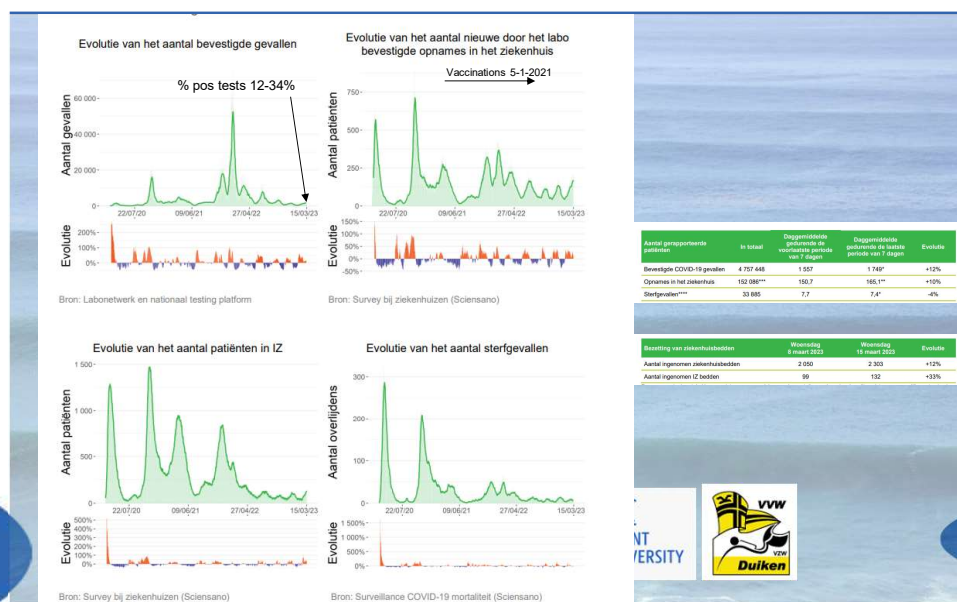
4

Information resources



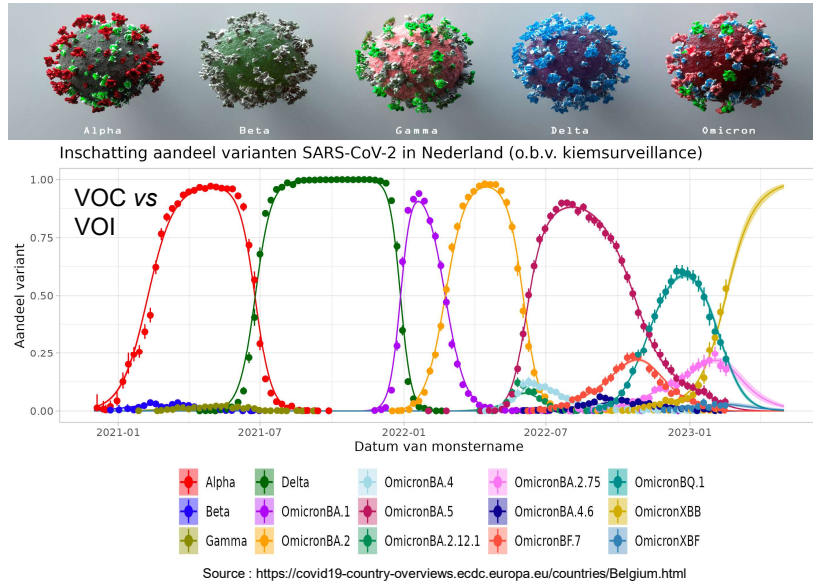
5

Current COVID status



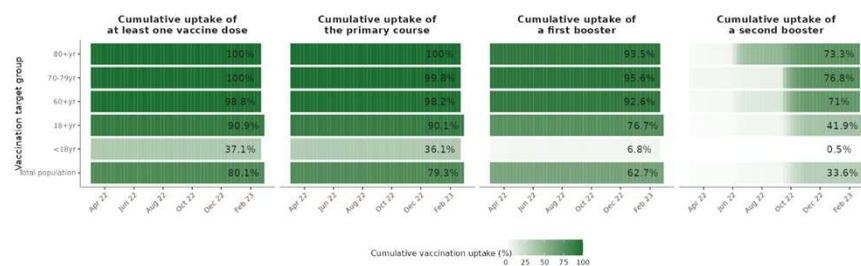
6

Molecular surveillance SARS-CoV-2



7

Vaccination started 5-1-2021



Source: ECDC database compiled from public online sources: Hospital occupancy, ICU occupancy, GISAID variants, TESSy COVID-19: 14-day case notification rate, Test positivity (%), 14-day case rate, Hospital admissions, 14-day death rate, Vaccination uptake

Profylaxis in 2023 :

- One yearly booster for the winter-peak for >50yrs / risk groups (sept-dec 2023) – BA4/BA5 variant Pfizer
- Evusheld no longer recommended (inefficacy against BQ.1 and XBB variant)



8

How do we manage COVID ?

- **Mild** (pauci-symptomatic / no lower resp ss)
- **Moderate** (resp ss or abno rx, Sat >93%)
- **Severe** (resp rate>30 or sat <93 or PaO₂/FiO₂ <300 or infiltrates >50%)
- **Critically ill** (ARDS or Sepsis or low Consciousness or MOF)

Source : https://covid-19.sciensano.be/sites/default/files/Covid19/COVID-19_InterimGuidelines_Treatment_ENG.pdf
Publication date : jan 2023 version 34



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How do we manage COVID ?

- **Mild** (no lower resp ss) : Antivirals to immunocompromized pts (eg Paxlovid)
- **Moderate** (resp ss or abno rx, Sat >93%): Antivirals to immunocompromized pts
- **Severe** (resp rate>30 or sat <93 or PaO₂/FiO₂ <300 or infiltrates >50%)
 - Oxygen
 - LMWH
 - Dexamethason 6mg – 10d
 - Additional options
 - Tocilizumab (anti-IL6) in case of rapid progression (moderate evidence IB)
 - Remdesivir (low evidence)
 - Baricitinib (JAK/low evidence) en Tofacitinib (JAK/low evidence)
- **Critically ill** (ARDS or Sepsis or low Consciousness or MOF)
 - Oxygen
 - LMWH
 - Dexametason 6 mg – 10 d
 - Additional options
 - Tocilizumab (moderate evidence IB – not reimbursed)



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SCUBA after COVID-19 disease

ESC European Society of Cardiology
European Journal of Preventive Cardiology (2022) 28, 1-7
https://doi.org/10.1093/eurjpc/ckab441

POSITION PAPER
Infectious/Communicable Diseases

Cardiopulmonary assessment prior to returning to high-hazard occupations post-symptomatic COVID-19 infection: a position statement of the Aviation and Occupational Cardiology Task Force of the European Association of Preventive Cardiology

Rienk Rienks¹, David Holdsworth^{2,3}, Constantinos H. Davos⁴, Martin Halle⁵

ESC European Society of Cardiology
European Journal of Preventive Cardiology (2022) 28, x290
https://doi.org/10.1093/eurjpc/ckab446

LETTER TO THE EDITOR

Return to diving after COVID-19

Kay Tetzlaff⁶ *

Concept :

- Pre-existing risk factors
- Severity of COVID

determine the need for and 'intensity' of a medical FTD reassessment

Reassessment should ensure

- Normal cardiopulmonary functioning
- Normal pulmonary structure



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COVID severity and reassessments

This issue is that there is no clear clinical cut-off that ensures the absence of functional or structural abnormalities post-COVID.

Diving and Hyperbaric Medicine Volume 50 No. 4 December 2020

413

Short communication

Considerations for scuba and breath-hold divers during the COVID-19 pandemic: A call for awareness

Antonis Elias¹, Mikael Gennser²

- There is ample data that shows that for hospitalized COVID, the risk is high.
- There is few data that shows that for asymptomatic or mild COVID, the risk is not nil
 - even for extended periods, though lower than for hospitalized pts.



- RX Bandirali M, Sconfienza LM, Serra R, Brembilla R, Albano D, Pregliasco FE, et al. Chest Radiograph Findings in Asymptomatic and Minimally Symptomatic Quarantined Patients in Codogno, Italy during COVID-19 Pandemic. Radiology. 2020;295(3):E7-E. PubMed PMID: 32216718. Epub 2020/03/27. eng.
- CT Uysal E, Kiliçer A, Cebeci H, Özer H, Demir NA, Öztürk M, et al. Chest CT findings in RT-PCR positive asymptomatic COVID-19 patients. Clin Imaging. 2021;77:37-42. PubMed PMID: 33640789. Epub 2021/01/30. eng.



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COVID and SCUBA diving

Lee et al. *Respiratory Research* (2022) 23:222
https://doi.org/10.1186/s12931-022-02163-4

Respiratory Research

RESEARCH

Open Access

Pulmonary function and chest computed tomography abnormalities 6–12 months after recovery from COVID-19: a systematic review and meta-analysis

Jong Hyuk Lee¹, Jae-Joon Yim² and Jinyoung Park^{1*}

*Correspondence: jpark@knu.ac.kr

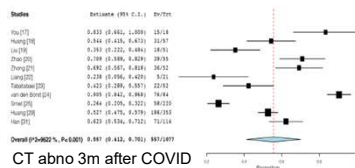
BMC Pulmonary Medicine

RESEARCH ARTICLE

Open Access

Radiological and functional lung sequelae of COVID-19: a systematic review and meta-analysis

Matsuo So¹, Hiroki Kubota², Koichi Fukunaga³, Hirotaka Takagi⁴ and Toshiaki Kuno^{2*}



CT abno 3m after COVID

- Impaired DLCO: at 6m 39% / at 12 m 31%
- Restriction: at 6m 13% / at 12 m 5%
- GGO: at 6-12m pooled 34%
- Pulm fibrosis: at 6-12m pooled 32%
- There is a correlation between COVID severity and persistence of impaired DLCO and Pulm fibrosis



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Data for divers

frontiers | Frontiers in Physiology

TYPE Original Research
PUBLISHED 12 November 2022
DOI: 10.3389/fphys.2022.1022370

Check for updates

OPEN ACCESS

EDITED BY
Karl T. F. F. University Hospital of Tübingen,
Germany

REVIEWED BY
Rafael Van Helle,
Amsterdam University Medical Center,
Netherlands

Symptomatic or asymptomatic SAR-CoV-2 positive divers should be medically evaluated before returning to scuba diving

Jean Morin¹, Nicolas Vallée², Pierre-Louis Dufresne¹

Medical evaluation 4 wks post COVID

	Total	Group 1	Group 2	Group 3
Initial symptoms	—	Respiratory	Non respiratory	Asymptomatic
Number of subjects, (% of total)	143	52 (36%)	70 (49%)	21 (15%)
Age, in years (mean, SD)	33.3 ± 7.4	35.4 ± 6.9	32.2 ± 6.9	32.5 ± 6.8
Duration of symptoms, in days (mean, SD)	8.5 ± 4.6	10 ± 7.5	7.4 ± 6.7	0
N° of subjects with abnormalities on spirometry (% of subgroup)	20 (14%)	11 (55%)	4 (20%)	5 (25%)
N° of subjects with covid-related images on chest CT scan (% of subgroup)	24 (16.8%)	13 (54%)	6 (25%)	5 (21%)
Time to return to diving, in days (median, IQR)	45 (30, 64)	50 (42, 71)	46 (30, 71)	30 (21, 31)



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Function and structure

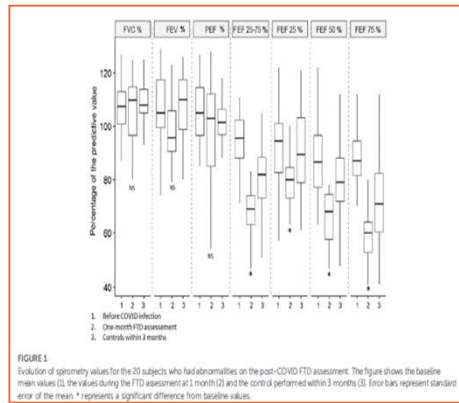


FIGURE 2
Asymptomatic diver with a chest CT scan performed 1 month after a positive PCR test. A characteristic appearance of very mild COVID-19-related lung involvement with limited bilateral ground glass opacities can be noted.

conclusion : Our study confirms the need for standardized follow-up in all divers after COVID-19 infection and for maintaining a rest period before resuming diving activities.



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Data for divers

2022 March;52(1)

Diving Hyperb Med. 2022 March 31;52(1):35-43. doi: 10.28920/dhm52.1.35-43. PMID: 35313371.

Post COVID-19 fitness to dive assessment findings in occupational and recreational divers

Bengusu Mirasoglu¹, Gulsen Yetis¹, Mustafa Erelel¹, Akin Savas Toklu¹

¹ Istanbul University, Istanbul Faculty of Medicine, Underwater and Hyperbaric Medicine Department, Istanbul, Turkey

Results: Forty-three divers were analysed. Thirteen divers were restrained from diving, all due to persistent COVID-19 related changes in lung CT. The prevalence of CT with at least one lung lesion was 68.2% at the time of diagnosis, 73.3% in the first three months after diagnosis and 19.2% later. The most common CT findings were glass ground opacities and fibrotic changes. Demographic characteristics and COVID-19 history of divers deemed 'unfit' were similar to those deemed 'fit'.

Conclusions: Divers who recover from COVID-19 should undergo FTD assessments before resuming diving. A chest CT performed at least three months after diagnosis may be suggested.



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ESC position paper / occupational

COVID-19 infection.			Clinical and Occupational Advice
1 Jan 2020	4 weeks ago	Present	
1.	Critical care hospitalisation (ITU/HDU/CPAP) at any time		TEST after recovery
2.	Other HOSPITALISATION/SEVERE symptoms at any time		TEST after recovery
3.		Symptoms now	Manage cfr guidelines
4.	MODERATE symptoms		TEST after recovery
5.	MILD symptoms		No testing / gradual return to ex
6.	NO symptoms at any time		No testing / return to ex

This sheme
has been adapted



European Society of Cardiology
European Journal of Preventive Cardiology (2022) 28, e206

LETTER TO THE EDITOR

Return to diving after COVID-19

Kay Tetzlaff



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There are many guidelines

ESC European Society of Cardiology
European Journal of Preventive Cardiology (2022) 28, e206
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Infectious/Communicable Diseases

Cardiopulmonary assessment prior to returning to high-hazard occupations post-symptomatic COVID-19 infection: a position statement of the Aviation and Occupational Cardiology Task Force of the European Association of Preventive Cardiology

Rienk Rienks¹, David Holdsworth^{2,3}, Constantinos H. Davos ⁴, Martin Halle ⁵

278 Diving and Hyperbaric Medicine Volume 50 No. 3 September 2020
Diving and Hyperbaric Medicine Volume 52 No. 1 March 2022

Diving after SARS-CoV-2 (COVID-19) infection: Fitness to dive assessment and medical guidance

Charlotte Sadler¹, Miguel Alvarez Villela², Karen Van Hoesen³, Ian Grover⁴, Michael Lang⁵, Tom Neuman⁶, Peter Lindholm⁷

¹ Department of Emergency Medicine, School of Medicine, Division of Hyperbaric Medicine, University of California, San Diego, California, USA

Société Belge de Médecine Hyperbare et Subaquatique asbl
Belgische Vereniging voor Overdruk- en OnderwaterGeneeskunde vzw

Position of the Belgian Society for Diving and Hyperbaric Medicine (SBMHS-BVOOG) on Diving after COVID-19 pulmonary infection

April 12th, 2020

The Diving Medical Advisory Committee

DMAC, 66 Buckingham Gate, London SW1E 6AU, UK
Tel: +44 (0) 20 7814 5520 www.dmac-diving.org
info@dmac-diving.org

Return to Diving after COVID-19

DMAC 33 Rev. 4 – June 2022 Supersedes DMAC 33 Rev. 3, which is now withdrawn

45 RESEARCH PREVENTION COMMUNITY EDUCATION SERVICES

FITNESS TO DIVE AFTER COVID – UPDATE

A new guideline for determining fitness to dive based on the type and severity of symptoms

In response to further inquiries, our existing understanding of the impact of COVID-19 on divers, and assessing the activities of a returning or vaccinated diver, the Dive Medical Advisory Committee (DMAC) has updated its recommendations for returning to diving after COVID-19.

Previously, the Dive Medical Advisory Committee (DMAC) in consultation with the World Association of Diving Training (WADT) has issued separate guidance relating to the World Underwater Association (WUA) and recently issued its guidance on the basis of a consensus-based approach to the guidelines for return to diving after COVID-19.

Update 9 april 2022 van de adviezen dd oktober 2021

Duikgeschiktheidsadvies van de geneeskundige commissies VZW-NELOS-LIFRAS in kader van de Covid-19-problematiek

Namens de leden van de Geneeskundige Commissies VZW, NELOS en LIFRAS:



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COVID and diver's diseases ?

The precautionary principle must rule for divers

- Concerning the risk of viral spreading
- Concerning vaccination
- Concerning diving after COVID
- Concerning risks for BT, IPE and DCS

Diving and Hyperbaric Medicine Volume 50 No. 4 December 2020

413

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Antonis Elia¹, Mikael Gehrner¹



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Put it all together please !

Group 1

- Mild (pauci-symptomatic / no lower resp sx)
- Moderate (resp sx or abno rx, Sat >93%)
- Severe (resp rates >30 or sat <93 or PaO2/FiO2 <300 or infiltrates >50%)
- Critically ill (ARDS or Sepsis or low Consciousness or MOF)

Who : critically ill or severely ill / loss of exercise tolerance / long COVID (>4wks)

Action : retest CPET / PFT / CT chest / low threshold for MRI heart

No diving : at least 3m after discharge from hospital and after positive re-evaluation



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Put it all together please !

Group 2

- Mild (pauci-symptomatic / no lower resp tr)
- Moderate (resp ss or abno rx, Sat >93%)
- Severe (resp rates <30 or sat <93 or PaO2/FiO2 <300 or infiltrates >50%)
- Critically Ill (ARDS or Sepsis or low Consciousness or MOF)

Who :

Group 2A : positive test without (respiratory) symptoms *and* symptom free after 3 days

Group 2B : positive test with mild (respiratory) symptoms *or* lasting more than 3 days

Action : none – BUT CAUTION IS WARRANTED cfr DATA / DAN / ECS / Chicago / DMAC
to propose spirometry or chest X-ray/low dose CT

No diving : 2A : no diving for 7 days after resolution of symptoms

: 2B : no diving for 28 days after resolution of symptoms (or after positive re-evaluation)



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Put it all together please !

Group 3

- Mild (pauci-symptomatic / no lower resp tr)
- Moderate (resp ss or abno rx, Sat >93%)
- Severe (resp rates <30 or sat <93 or PaO2/FiO2 <300 or infiltrates >50%)
- Critically Ill (ARDS or Sepsis or low Consciousness or MOF)

Who : no COVID

Action : none, only prevention

No diving : not applicable



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Conclusions

- COVID is still there, it will probably also remain
- Yearly vaccinations for 50+ will be advised
- The majority post COVID have a very prosperous outcome and do not need FTD* tests, although data are suggestive for low thresholds to test (group 2B)
- A minority do have short lived but more severe ss, or do develop any type of 'long COVID'. In these reassessment FTD* should be considered.

* Fitness to dive (SCUBA)



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Thank you



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- 09.00 – 09.35: Is COVID nog een issue voor de duiksport in 2023 ?
Een update.
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Dr. Cathérine De Maeyer, cardioloog, UZAntwerpen
- 12.30 – 13.30: Lunch



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Medisch Materiaal
en
Telegeneeskunde



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Duiken en diabetes

Chantal Mathieu, MD PhD

Endocrinology

Catholic University of Leuven (KU Leuven), Belgium



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Speaker disclaimer

CM serves or has served on the advisory panel for Novo Nordisk, Sanofi, Merck Sharp and Dohme Ltd., Eli Lilly and Company, Novartis, AstraZeneca, Boehringer Ingelheim, Roche, Medtronic, ActoBio Therapeutics, Pfizer, Imcyse, Insulet, Zealand Pharma, Avotres, Mannkind, Sandoz and Vertex. Financial compensation for these activities has been received by KU Leuven; KU Leuven has received research support for CM from Medtronic, Imcyse, Novo Nordisk, Sanofi and ActoBio Therapeutics; CM serves or has served on the speakers bureau for Novo Nordisk, Sanofi, Eli Lilly and Company, Boehringer Ingelheim, Astra Zeneca and Novartis. Financial compensation for these activities has been received by KU Leuven.

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Programma

- Het probleem met diabetes en duiken
- Diabetes
- Veilig duiken met diabetes
 - Voor de duiker
 - Voor de medische teams



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Het probleem van diabetes en duiken

- Voorafbestaande complicaties van diabetes
- Verminderde cognitie of verminderd bewustzijn door gestoorde glycemie:
 - Hypoglycemie
 - Hyperglycemie
- Effect van duiken (hyperbare exposure) op complicaties, op glycemie en op glycemiemeting

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Effect van duiken op glycemie (meting)

- Hyperbare toestand beïnvloedt op zich glycemie niet
- Duiken verlaagt de glycemie met 50-100mg/dl afhankelijk van intensiteit van duik
- Sensoren amper gevalideerd in hyperbare omstandigheden en komen vaak los



Dear G de et al Undersea Hyperbaric Med 2004; Jendle J et al J Diabet Sci Tech 2018; Jendle J et al. Diving and Hyperbaric Medicine 2012; Lormeau B et al Diab Metab 2005; Peleg RK et al Diving Hyperbaric Med 2013

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Het probleem van diabetes en duiken

- **Voorafbestaande complicaties van diabetes**

- Verminderde cognitive of verminderd bewustzijn door gestoorde glycemie:

- Hypoglycemie
- Hyperglycemie

- Effect van duiken (hyperbare exposure) op complicaties, op glycemie en op glycemiemeting

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Complications of diabetes

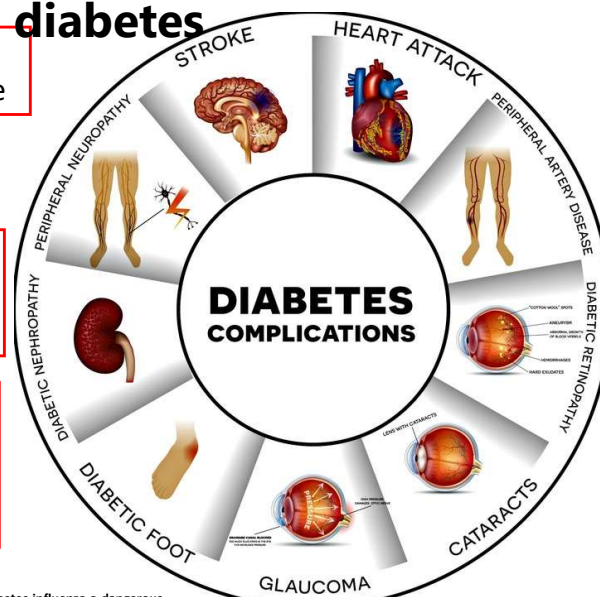
6th cause of mortality worldwide

Leading cause of end-stage renal disease in Europe

Leading cause of non-traumatic foot amputations in Europe

More than double the risk of stroke, myocardial infarction and cardiovascular death

Leading cause of blindness in Europe



Graphic source: https://www.huffpost.com/entry/diabetes-influenza-a-dangerous-combination_b_5a0909dde4b0cc46c52e6bde

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Physical fitness check

- Algemeen fysiek onderzoek (fitness, bloeddruk)
- Oogarts: geen oogbloedingen, stabiele oogfundus
- Cardiaal (bij twijfel: cardiologisch advies):
 - Hartfalen
 - Klepproblemen (AS)
 - Inspanningsproef (cycloergometrie)

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Het probleem van diabetes en duiken

- Voorafbestaande complicaties van diabetes
- Verminderde cognitie of verminderd bewustzijn door gestoorde glycemie:
 - Hypoglycemie
 - Hyperglycemie
- Effect van duiken (hyperbare exposure) op complicaties, op glycemie en op glycemiemeting

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How easy it was....not so long ago.



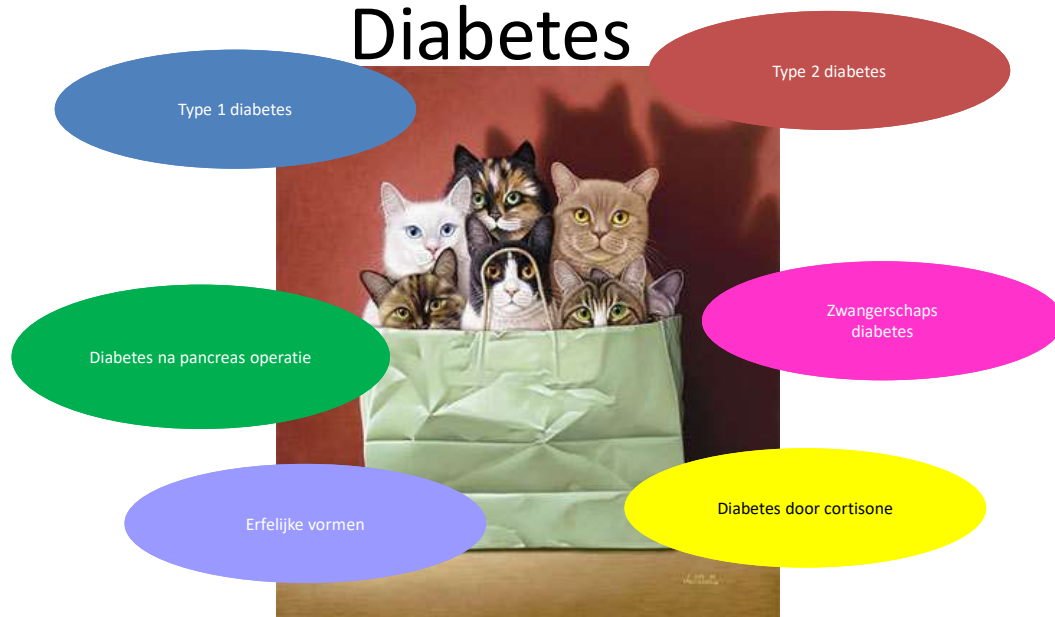
Stages Types	Normoglycaemia	Hyperglycaemia			
	Normal glucose tolerance	IGT and/or IFG	Diabetes Mellitus		
			Not insulin requiring	Insulin requiring for control	Insulin requiring for survival
Type 1	←————→				→
• Autoimmune • Idiopathic					
Type 2*	←————→			→	→
• Predominantly insulin resistance • Predominantly insulin secretory defects					
Other specific types*	←————→			→	→
Gestational diabetes*	←————→			→	→



Alberti KGMM, Zimmet PZ. Diabetic Medicine 1998.

35

Diabetes



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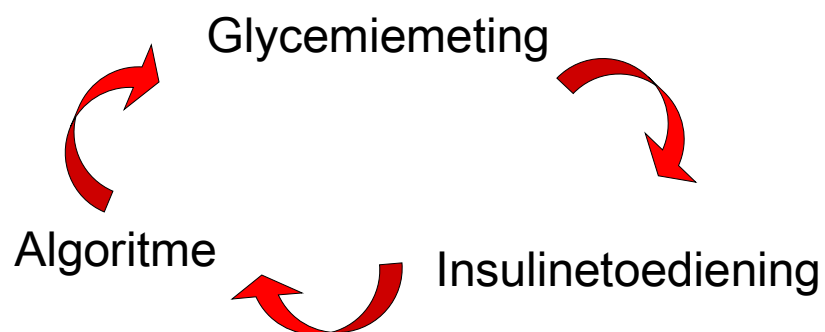
Type 1 diabetes
= Destructie
van de insuline-producerende betacel



Behandeling: Vervangen
van alle functies van de
betacel

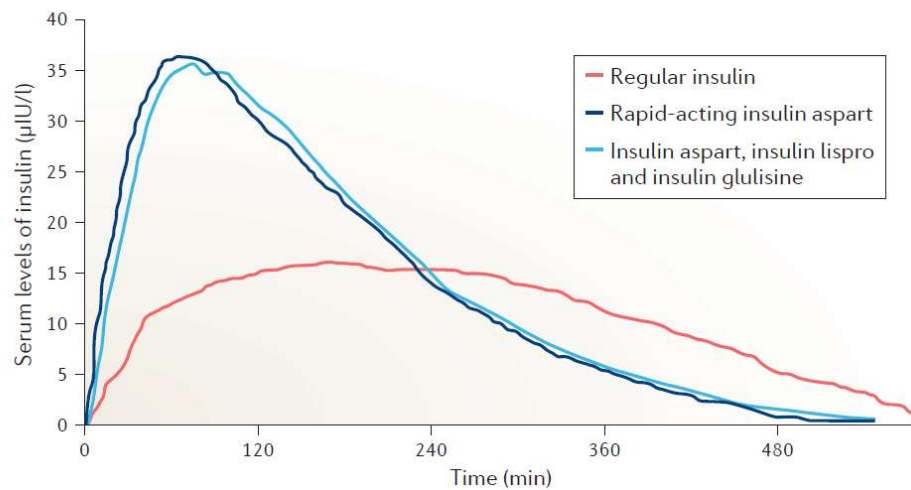
37

Vervanging van de betacel



38

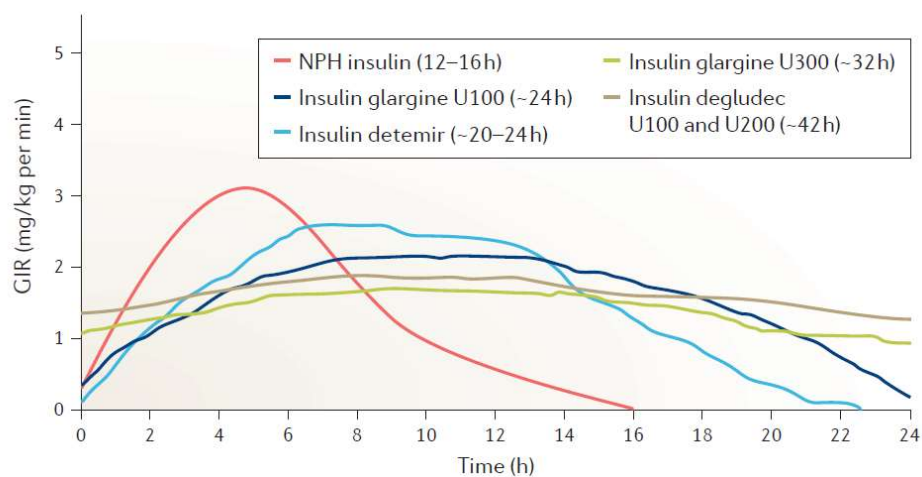
Pharmacokinetic profiles of rapid-acting insulins



Mathieu C. et al. Nat Rev Endocrinol 2017

39

Pharmacokinetic profiles of long-acting insulins

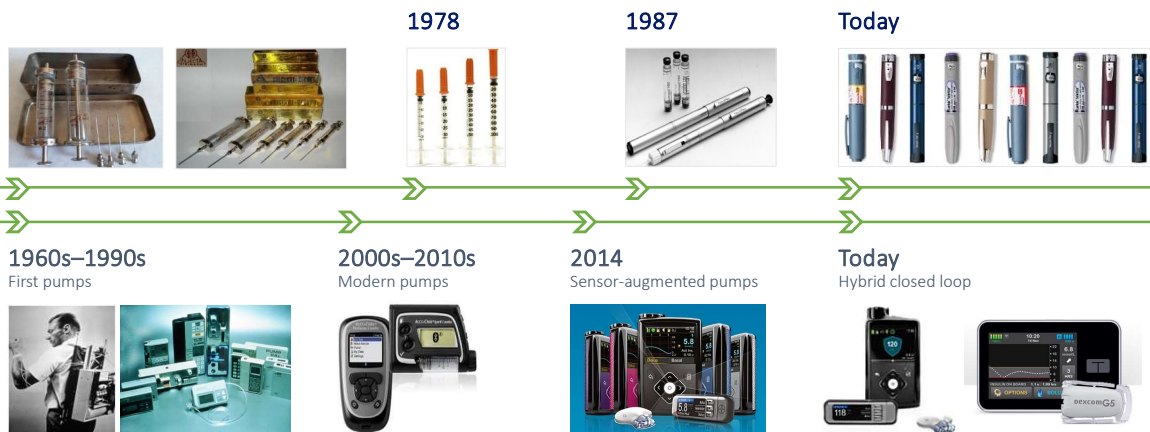


Mathieu C. et al. Nat Rev Endocrinol 2017

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1920s to today: Insulin delivery devices have evolved to make therapy simpler and more convenient



41

Insulinpumpen

Medtronic VEO



Roche Combo



Ypsomed



Medtronic 640G



Roche Insight



Omnipod



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1920s to today: Glucose testing evolves from chemistry-based tests through home-based meters to continuous glucose monitoring



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Nieuwe manieren van meten



Medtronic



Dexcom



44

Nieuwe manieren van analyseren

Glucose Pattern Insights

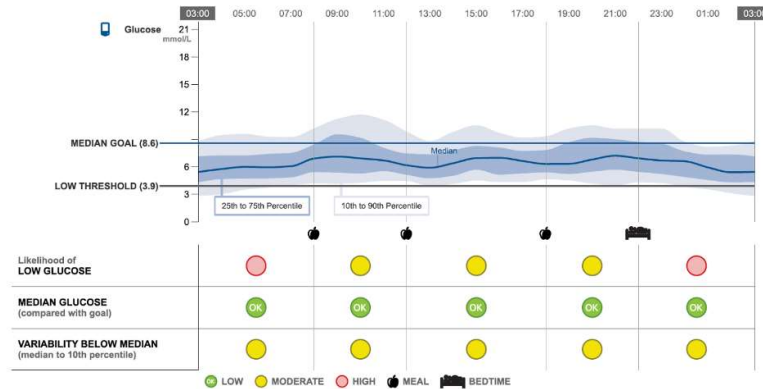
13 September 2014 - 10 October 2014 (28 days)

LOW-GLUCOSE ALLOWANCE SETTING: Medium

MEDIAN GOAL SETTING: 8.6 mmol/L (A1c: 7.0% or 53 mmol/mol)

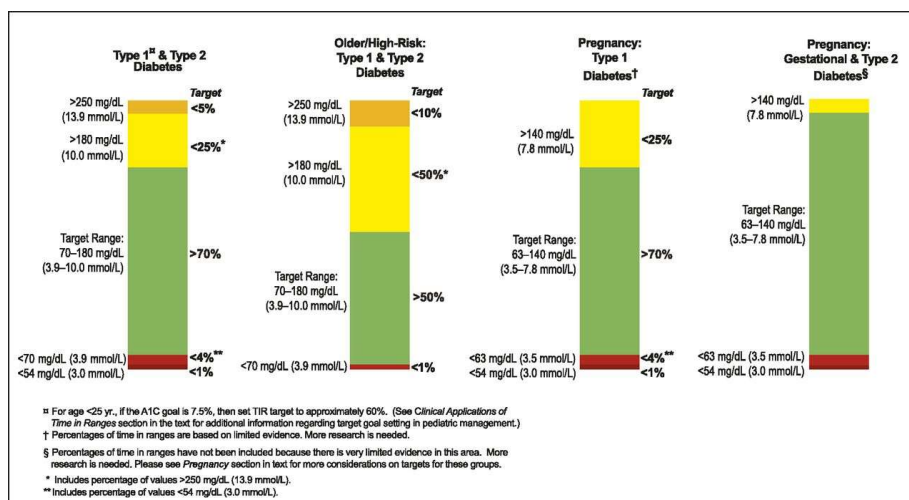
FreeStyle Libre 

Estimated A1c 5.8% or 40 mmol/mol



45

Nieuwe manieren van analyseren



Battelino T et al. Diabetes Care 2019

46

Hybrid Closed Loop ("artificiële pancreas")



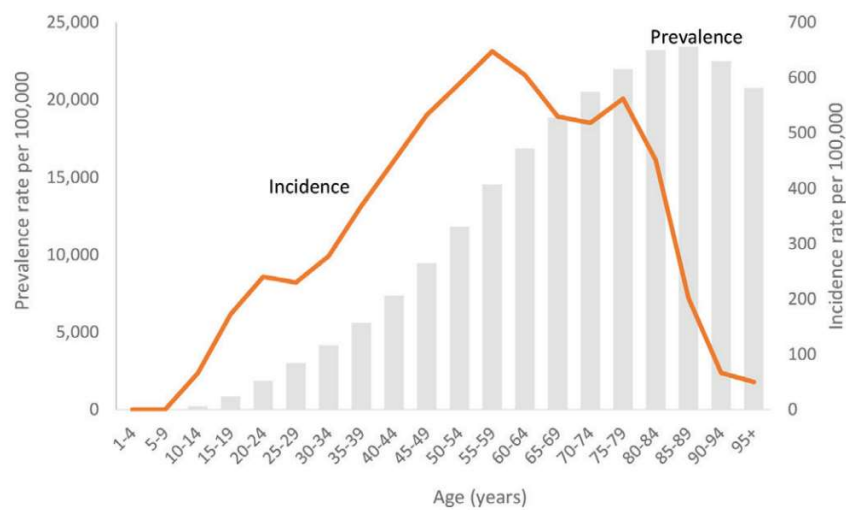
Tandem Control IQ
(Tandem pomp en Dexcom G6 sensor)



Medtronic 780G

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Evolution of type 2 diabetes worldwide

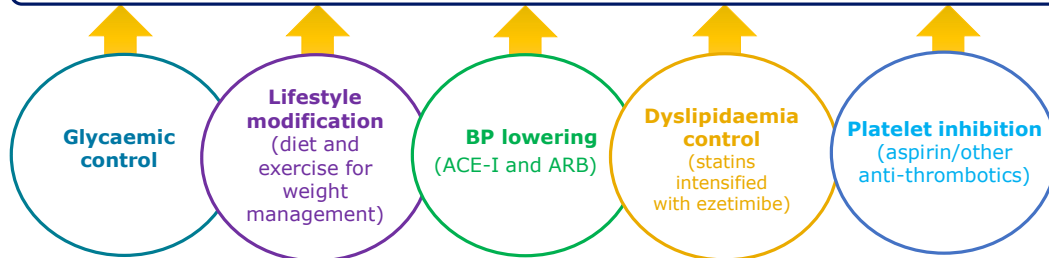


Khan MAB et al. J Epidemiol Glob Health 2021

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Multifactorial approach improves outcomes

Management of diabetes and its complications

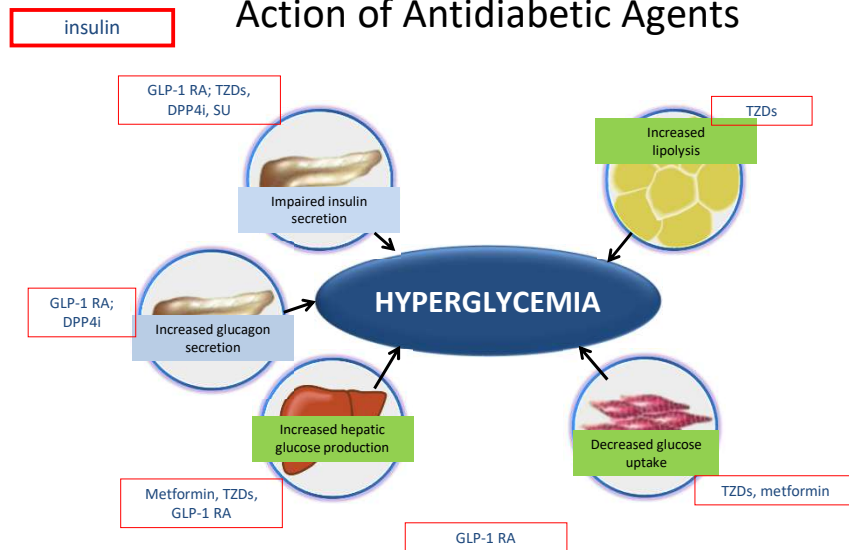


- The ADA recommends that most adults with diabetes achieve the following targets:¹
 - HbA_{1c}: <7.0%
 - Physical activity: ≥150 mins per week*
 - Blood pressure: <140/90 mmHg
 - Triglycerides: <150 mg/dL (1.7 mmol/L)
 - HDL-C: ≥50 mg/dL (1.3 mmol/L)
 - LDL-C: <100 mg/dL (2.6 mmol/L)

*Physical activity of moderate to vigorous intensity.
ACE-I, angiotensin-converting enzyme inhibitor; ADA, American Diabetes Association; ARB, angiotensin receptor blocker; BP, blood pressure; HDL-C, high-density lipoprotein cholesterol.
1. American Diabetes Association. *Diabetes Care* 2018;41(Suppl. 1):S13-S27.

49

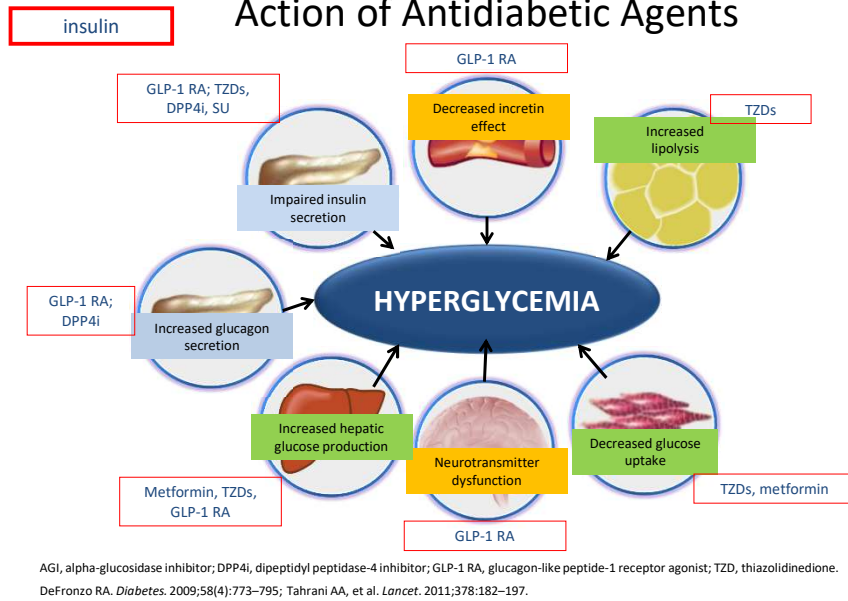
Pathogenesis of type 2 diabetes and site of Action of Antidiabetic Agents



AGI, alpha-glucosidase inhibitor; DPP4i, dipeptidyl peptidase-4 inhibitor; GLP-1 RA, glucagon-like peptide-1 receptor agonist; TZD, thiazolidinedione.
DeFronzo RA. *Diabetes*. 2009;58(4):773-795; Tahrani AA, et al. *Lancet*. 2011;378:182-197.

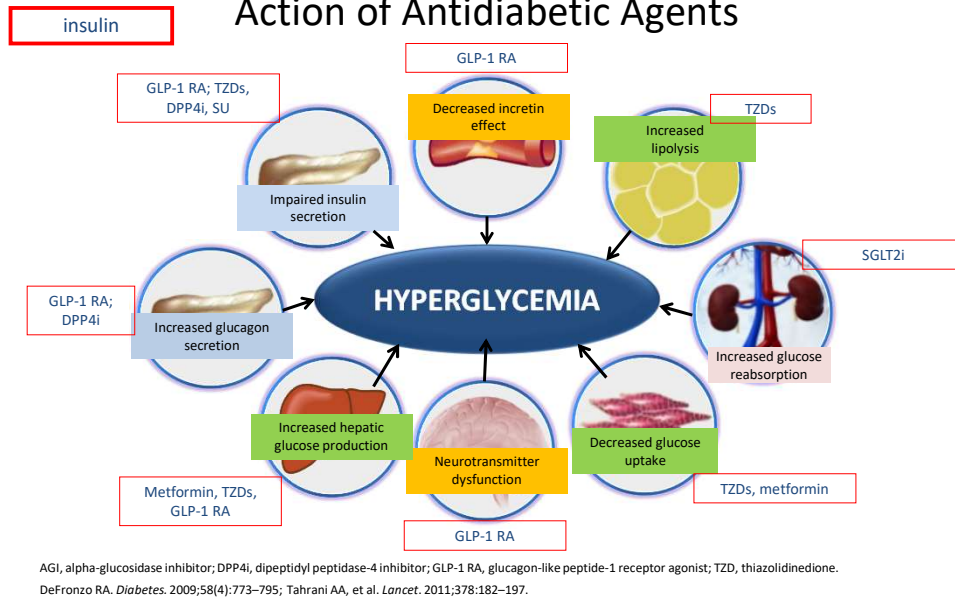
50

Pathogenesis of type 2 diabetes and site of Action of Antidiabetic Agents



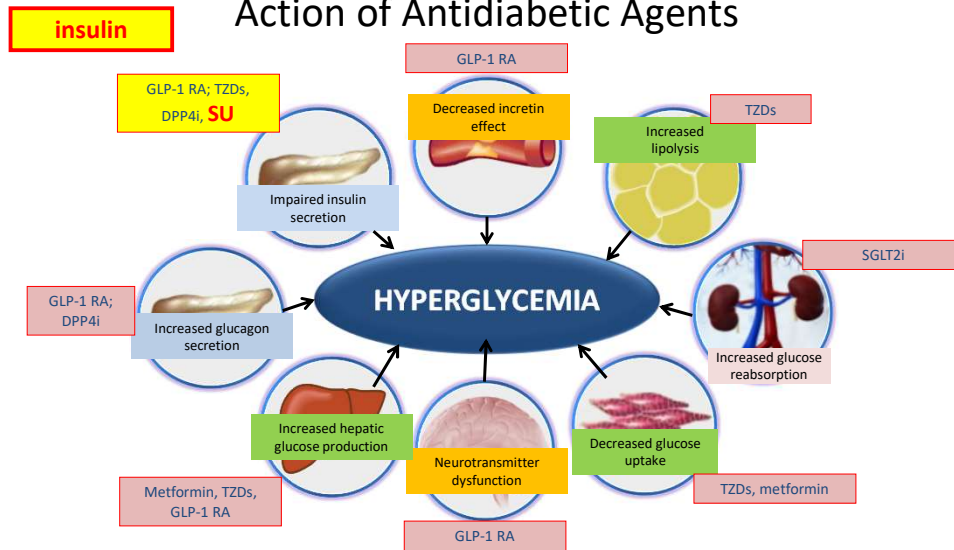
51

Pathogenesis of type 2 diabetes and site of Action of Antidiabetic Agents



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Pathogenesis of type 2 diabetes and site of Action of Antidiabetic Agents



AGI, alpha-glucosidase inhibitor; DPP4i, dipeptidyl peptidase-4 inhibitor; GLP-1 RA, glucagon-like peptide-1 receptor agonist; TZD, thiazolidinedione. DeFronzo RA. *Diabetes*. 2009;58(4):773–795; Tahrani AA, et al. *Lancet*. 2011;378:182–197.

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DPP-4 inhibitoren (gliptines)

+ metformine

- alogliptine: Vipidia® Vipdomet®
- linagliptine: Trajenta® Jentaduet®
- sitagliptine: Januvia® Janumet®
- vildagliptine: Galvus® Eucreas®

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GLP1-receptoragonisten (GLP1-RA)

- | | | | |
|-----------------|------------|--------|-----------------|
| - exenatide: | Byetta® | 2x /d | |
| - liraglutide: | Victoza® | 1x /d | |
| - lixisenatide: | Lyxumia® | 1x /d | |
| - exenatide LA: | Bydureon® | 1x /wk | |
| - dulaglutide: | Trulicity® | 1x /wk | |
| - semaglutide: | Ozempic® | 1x /wk | Rybelsus® 1x /d |

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Eenmaal daagse GLP1-RA

Byetta (Exenatide)

- 2x/d injectie SC
- Start 1 maand 2x/d 5µg
- Daarna 2x/d 10µg



Victoza (Liraglutide)

- Start 0,6µg → 1,2µg → 1,8µg
- 1x/d injectie SC



Lyxumia (Lixisenatide)

- 1x/d injectie SC
- 10µg en 20µg
- mag gecombineerd worden met 1 injectie basaal insuline



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Wekelijkse GLP1-RA

Bydureon® (Exenatide LAR)



Ozempic® (semaglutide)

0.25, 0.5, 1mg



Trulicity® (Dulaglutide)

0.75, 1.5mg



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Orale GLP1-RA: Semaglutide



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SGLT-2 inhibitoren (gliflozines)

+ metformine

- canagliflozine: Invokana® Vokanamet®
- dapagliflozine: Forxiga® Xigduo®
- empagliflozine: Jardiance® Synjardy®

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Duiken en diabetes

Glucose controle



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Guidelines

Country/region	Australia	South Pacific	Sweden	United Kingdom	USA
Scientific society/ source	ADS	SPUMS	Örebro University	UKDMC	UHMS/DAN
Year	2016	2010	2012 & 2019 (update)	2005	2005
<i>BG management on the day of diving</i>					
General recommendations on lead-up to dive day	No diving if unwell or BG follows an unstable pattern. Adequate hydration, avoid alcohol for 24 h before dive. For T2D on SUs, omit SU on the day of dive	No diving if unwell, excessively anxious or BG follows an unstable pattern. Adequate hydration	CGM use is recommended. If SMBG used, monitor BG 4–8 times daily. If treated with CSII adjust the basal rate (~50%) 90–120 min before dive to prevent hypo. The pump should be removed shortly before diving	Fit and mentally prepared. Adequate hydration. Aim BG levels at the higher normal range	No diving if unwell, excessively anxious or BG follows an unstable pattern. Adequate hydration
<i>Pre-dive</i>					
BG testing	Test BG 60 min, 30 min and immediately pre-dive to ensure no downward trend	Test BG 60 min, 30 min and immediately pre-dive to ensure no downward trend	Test BG 60 min, 30 min and immediately pre-dive to ensure no downward trend	n.r.	Test BG 60 min, 30 min and immediately pre-dive to ensure no downward trend
BG threshold to allow diving	8.3–16.7 mmol/L and stable or rising immediately pre-dive	9 mmol/L and stable or rising immediately pre-dive	7–12 mmol/L and stable	n.r.	8.3 mmol/L and stable
BG and carb management protocol	6.6–8.3 mmol/L: oral 15 g carb <6.6 mmol/L: oral 30 g carb	n.r.	Meal 1.5–2 h before diving. Additional 15–30 g carb/70 kg BW before diving. If BG < 5 mmol/L or falling, additional 10–15 g carb prior to dive	n.r.	n.r.
Postpone dive if	>16.7 mmol/L and check ketones	BG < 9 mmol/L or falls between any two checks	n.r.	n.r.	BG < 8.3 mmol/L or falls between any two checks
Cancel dive if	Ketones > 1 mmol/L	> 16 mmol/L	n.r.	n.r.	n.r.
<i>Post-dive</i>					
BG management at end of dive	Check BG immediately post-dive and manage appropriately	Check BG immediately post-dive	Check BG immediately post-dive	Check BG on arrival on boat. Any hypo symptoms should be immediately reported	Check BG immediately post-dive
BG management for the rest of the day	n.r.	Frequent BG checks for 12–15 h after dive	n.r.	n.r.	Frequent BG checks for 12–15 h after dive
Documentation	Log all dives and BG management for future use	Log all dives and BG management for future use	Keep logbook of dives and BG management	n.r.	Log all dives and BG management for future use
<i>Management of hypoglycemia during diving</i>					
Training and preparation	n.r.	n.r.	Practice in ingesting gels underwater is recommended	n.r.	n.r.
Signal in case of hypoglycemia	L-shape made by thumb and index finger	L-shape made by thumb and index finger	L-shape made by thumb and index finger	n.r.	L-shape made by thumb and index finger

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Guidelines

Country/region	Australia	South Pacific	Sweden	United Kingdom	USA
Oral glucose	If trained, glucose paste can be consumed underwater, but the priority should be to ascend to surface	Should be carried in readily accessible and ingestible form at surface and during all dives	Carb gel or glucose/fructose solution should be carried by both diver and partner	Oral glucose tablets or tube of glucose paste should be kept in dive kit. A member of the diving group should be familiar to their use (not required for T2D on diet control or metformin)	Should be carried in readily accessible and ingestible form at surface and during all dives
Protocol upon symptoms suggestive of hypoglycemia underwater	The diver should ascend to the surface immediately, establish positive buoyancy, ingest glucose and leave the water. The informed dive partner should assist with this process. If trained, glucose paste can be consumed underwater, but the priority should be to ascend to surface	The diver should surface, establish positive buoyancy, ingest glucose and leave the water. Assistance should be available via informed partner	Signal partner then go to either decompression level or start pair ascent to surface. Carb gel should be ingested whilst underwater prior to ascent. If hypo confirmed take 20 g carbs if fully awake or 1 g glucagon IM if unconscious	n.r.	The diver should surface, establish positive buoyancy, ingest glucose and leave the water. Assistance should be available via informed partner
Parenteral glucose/glucagon	n.r.	Should be available at surface (strongly recommended)	Should be available at surface	Should be carried in dive kit. A member of the diving group should be familiar to use	Should be available at surface (strongly recommended). Person at surface should be familiar to use

Abbreviations: ADS: Australian Diabetes Society; SPUMS: South Pacific Underwater Medicine Society; UKDMC: United Kingdom Diving Medical Committee; UHMS: Undersea and Hyperbaric Medical Society; DAN: Divers Alert Network; n.r.: no specific recommendation; BG: blood glucose; h: hour(s); min: minute(s); carb: carbohydrates; g: grams; BW: body weight; T2D: type 2 diabetes; SU: sulfonylurea; hypo: hypoglycemia; CGM: Continuous glucose monitoring; SMBG: Self-monitoring of blood glucose; CSII: Continuous subcutaneous insulin infusion.

Reviewed in Koufakis T et al Eur J Sport Sci 2020

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Praktische tips voor duikers

- Openheid
 - Bereidheid om te leren
 - Licht uw arts in
 - Licht uw duikteam in
 - Zorg dat uw duikpartner volledig opgeleid is
- Wees realistisch en vermijd overmoed
- Stapsgewijs!

BLIJF BOVEN 30 meter TOT VOLDOENDE ERVARING

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Praktische tips voor duikers: voor de duik

- Leidt duikpartner(s) op
- **ALTIJD** koolhydraten op lichaam van duiker en partner(s)
- Spreek signalen af: L-teken
- Oefen op welke actie ondernemen bij hypoglycemie:
 - RESURFACE ASAP** voor inname koolhydraten dus
 - LIEFST geen decompressie diepte
 - LIEFST geen 'overhead' duiken

Meer ervaren duikers (teams): inname glucose onder water

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Praktische tips voor duikers: voor de duik

- Basale insuline:
 - Als 'korterwerkend' vb. Glargine U100 (Lantus): verminder avond voor duik met 10-20%
 - Langerwerkende basale insulins (vb Degludec, Tresiba): geen zin om te verlagen, tenzij als enkele dagen na mekaar duiken
- Stabiele glycemie voor duiken (minstens 120mg/dl- liefst 120-220mg/dl)- Frequent meten
- Maaltijd met insuline bolus liefst meer dan 3h voor duik (als korter op duik: verminder snelwerkende insuline)
- Koolhydraten net voor duik (30g)

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Praktische tips voor duikers: voor de duik

- Pompen en sensoren: 'water resistant', maar niet gevalideerd- enkel tot 2.5-3.5 meter, korte tijd
 - Basaal ritme verminderen 90-120min voor duik (iets hogere glycemie)
 - Als glycemie niet boven 120mg/dl voor duik: zeker 30g koolhydraten bijnemen
 - Deconnecteren voor duik
 - Beperk duik tot 45-60 minuten

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Praktische tips voor duikers: na de duik

- Meet onmiddellijk de glycemie
- Neem koolhydraten (aangepast aan glycemie)
- Koppel pomp aan

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Praktische tips voor duikers: tijdens de duik

- Check op regelmatige tijdstippen met duikpartner



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Duiken en diabetes

Selectie



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Guidelines

Country/region	Australia	South Pacific	Sweden	United Kingdom	USA
Scientific society/ source	ADS	SPUMS	Örebro University	UKDMC	UHMS/DAN
Year	2016	2011	2012 & 2019 (update)	2005	2005
<i>Suitability for diving</i>					
Age	≥18	≥18	n.r.	n.r.	≥18 (≥16 in case a specialised training course completed)
Diabetes control	HbA1c ≤ 74.9 mmol/mol	HbA1c ≤ 74.9 mmol/mol	HbA1c < 63 mmol/mol	"Satisfactory control" according to treating physician	HbA1c ≤ 74.9 mmol/mol
Changes in diabetes medication	>1 y since insulin initiation, >3 m since significant changes in regimen	>1 y since insulin initiation (>6 m for T2D), >3 m since significant changes in regimen	n.r.	n.r.	>1 y since insulin initiation (>6 m for T2D), >3 m since significant changes in regimen
Self-management	Accurate use of glucose monitoring device, good knowledge of insulin, carb and exercise interaction	Good knowledge of insulin, carb adjustment	Good knowledge of insulin, carb adjustment. 4-6 BG measurements / day during the week before dive. CGM use is recommended	n.r.	Good knowledge of insulin, carb adjustment
Hypoglycemia history	No severe hypo during the last 12 m	No severe hypo during the last 12 m	No severe hypo during the last 12 m	No severe hypo during the last 12 m	No severe hypo during the last 12 m
Hypoglycemia awareness	No hypo unawareness	No hypo unawareness	No hypo unawareness	n.r.	No hypo unawareness
History of hospitalisation	No history of hospitalisation or ED attendance for hypo during the last 12 m	n.r.	No recurrent episodes of hospitalisation	No diabetes-related hospitalisation during the last 12 m	n.r.
Complications	No macrovascular and microvascular (apart from background retinopathy) complications	No significant complications	n.r.	n.r.	No significant complications
Absence of microalbuminuria	Yes	Yes	Yes	Yes	Yes
Absence of neuropathy	Yes	Yes	Yes	Yes	Yes
Absence of retinopathy greater than background retinopathy	Yes	Yes	Yes	Yes	Yes
Screening for heart disease	> 40 yo cardiac stress testing	> 40 yo cardiac stress testing	n.r.	>50 yo cardiac stress testing	>40 yo cardiac stress testing and follow-up as per local recommendations

Reviewed in Koufakis T et al Eur J Sport Sci 2020

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Guidelines

Country/region	Australia	South Pacific	Sweden	United Kingdom	USA
Medical assessment	Diabetes doctor (GP or endocrinologist) and doctor with post-graduate diving examiner's qualification	Diabetes doctor (GP or endocrinologist) and doctor with post-graduate diving examiner's qualification	Specialist in diabetology and physician authorised in diving medicine. Evaluation of CGM readings is recommended	Physician should certify that "diver is mentally and physically fit to dive"	Diabetes doctor (GP or endocrinologist) and doctor with post-graduate diving examiner's qualification
Frequency of medical check-up	Annual	Annual	Annual	Annual	Annual
Scope of diving					
No of dives / surface intervals	> 1 h surface interval Longer surface intervals after 2nd dive of the day	≤ 2 dives / day > 2 h surface interval	n.r.	≤ 2 dives/day ≤ 3 consecutive days	n.r.
Duration of dive	≤ 1 h	≤ 1 h	n.r.	n.r.	≤ 1 h
Depth	n.r.	≤ 30 m	≤ 25 m	≤ 30 m (until diver is highly experienced regarding the effect of diving on diabetes control)	≤ 30 m
Dives requiring decompression stops	Not recommended	Not recommended	n.r.	n.r.	Not recommended
Dives in overhead environments (e.g. caverns, wrecks)	Not recommended	Not recommended	n.r.	n.r.	Not recommended
Diving partner	Partner should be informed of condition and aware of appropriate response in case of hypoglycemia. Partner should not have diabetes	Partner should be informed of condition and aware of appropriate response in case of hypoglycemia. Partner should not have diabetes	Partner should not have diabetes	Partner should be regular and aware of appropriate response in case of hypoglycemia or trained nurse, paramedic, etc. Partner should not have diabetes	Partner should be informed of condition and aware of appropriate response in case of hypoglycemia. Partner should not have diabetes

Abbreviations: ADS: Australian Diabetes Society; SPUMS: South Pacific Underwater Medicine Society; UKDMC: United Kingdom Diving Medical Committee; UHMS: Undersea and Hyperbaric Medical Society; DAN: Divers Alert Network; n.r.: no specific recommendation; y: year(s); m: month(s); T2D: Type 2 Diabetes; carb: carbohydrates; BG: blood glucose; hypo: hypoglycemia; yo: year-old; ED: Emergency Department; GP: General practitioner; h: hour(s); m: metre(s); CGM: Continuous Glucose Monitoring.

Reviewed in Koufakis T et al Eur J Sport Sci 2020

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Praktische tips voor artsen

- Openheid- bereidheid om met patiënt te leren
- Geïndividualiseerde benadering
- Wees streng:
 - Verwikkelingen
 - Slechte glycemiecontrole
 - Weinig motivatie
 - Niet willen meten

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Praktische tips voor Artsen: Selectie

- Mensen die ervaren zijn met hun diabetes en hun medicatie kennen
- Algemene controle: goede HbA1c (<8%)- TIR (>60%)
- Geen ernstige verwickelingen (milde retinopathie aanvaard)
- Geen voorgeschiedenis van ernstige hypoglycemie in het laatste jaar of verhaal van hypoglycemia unawareness
- Bij hypoglycemiërende medicaties (hypoglycemierisico): frequent meten glycemie voor duik en na duik, gebruik van sensoren helpt
- Logboek ter evaluatie impact duik op glycemies (leercurve)
- Jaarlijks evaluatie door endocrinoloog met interesse in duiken en door arts gespecialiseerd in duiken

Naar Jendle J et al Diving and Hyperbaric Medicine 2020; UHMS-DAN Guidelines 2005; Guidelines reviewed in Koufakis T et al Eur J Sport Sci 2020

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Conclusie

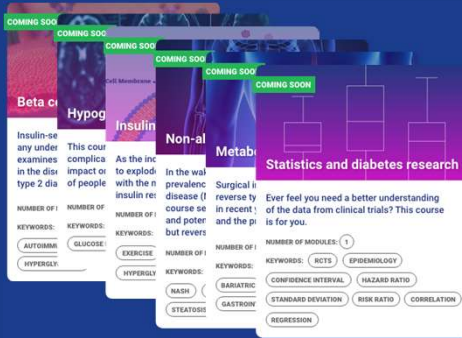
S

- Duiken en diabetes blijft een risicovolle onderneming, die inzet vereist van
 - De duiker
 - Het team
 - De medische teams rond de mensen met diabetes
- Mits voldoende physical fitness (cave verwickelingen), inzicht in aandoening (insuline dosis aanpassen) en grote discipline in zelfzorg en –monitoring, is duiken met diabetes mogelijk

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More than
50,000
site visitors,
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From 185 countries
Reaching every inhabited continent



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DUIKEN
met
DIABETES

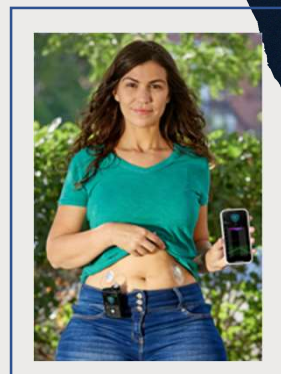
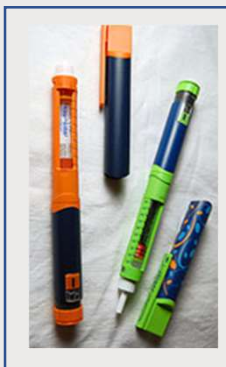
76

Mijn ervaringen



77

2003 - 2023



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Sensoren



Dexcom One



Abbott Freestyle Libre 2



Medtronic Guardian 4



Dexcom G6



Guardian 3-4

Maximum diepte: 1,5m – 2,5m

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KEN JEZELF

- Je lichaam**
- Je aandoening**
- Je sport**
- Je limieten**

Waar liggen de problemen?

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COMMUNICATIE !

Wat zeg je?

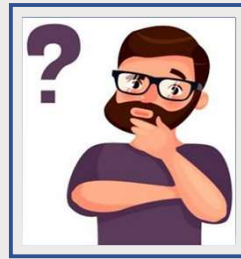
- **Wat heb ik?**
- **Wat kan er gebeuren?**
- **Wat kan je dan doen?**
- **Waar vind je alle materiaal?**
- **Wat is het noodnummer?**

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COMMUNICATIE !

Tegen wie?

- **Duikleider**
- **Duikbuddy's**
- **Kantveiligheid**



***Zwijgen is gevaarlijk
voor iedereen!***

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AANPASSINGEN

- **Hypoglycemische problemen oplossen onder water testen**
- **“Stop duik”-teken bij probleem**
- **2*- duiker is voldoende**
 - **Minder verantwoordelijkheid**
 - **Meer tijd om jezelf te monitoren**



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Bedankt!



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- 09.00 – 09.35: Is COVID nog een issue voor de duiksport in 2023 ?
Een update.
Prof. Dr. K Tournoy, longarts OLV Aalst en Universiteit Gent.
- 09.40 – 10.15: Duiken en diabetes, do's en don'ts
Prof. Dr. Chantal Mathieu, endocrinoloog UZLeuven
Michel Roden, ervaringsdeskundige.
- 10.20 – 10.55: **Decompressiestress, wat moet je ermee?**
Dr. Herman van Bogaert, huisarts, sportarts, duikarts
- 10.55 – 11.15: Koffiepauze – bezoek standen
- 11.15 – 11.50: Immersielongoedeem, kopje onder?
Lt.Kol. Dr. Peter Germonpré, duikarts, hyperbare geneeskunde.
- 11.55 – 12.30: De oudere duiker, een risico?
Dr. Cathérine De Maeyer, cardioloog, UZAntwerpen
- 12.30 – 13.30: Lunch



RDSM
Medisch Materiaal
en
Telegeneeskunde



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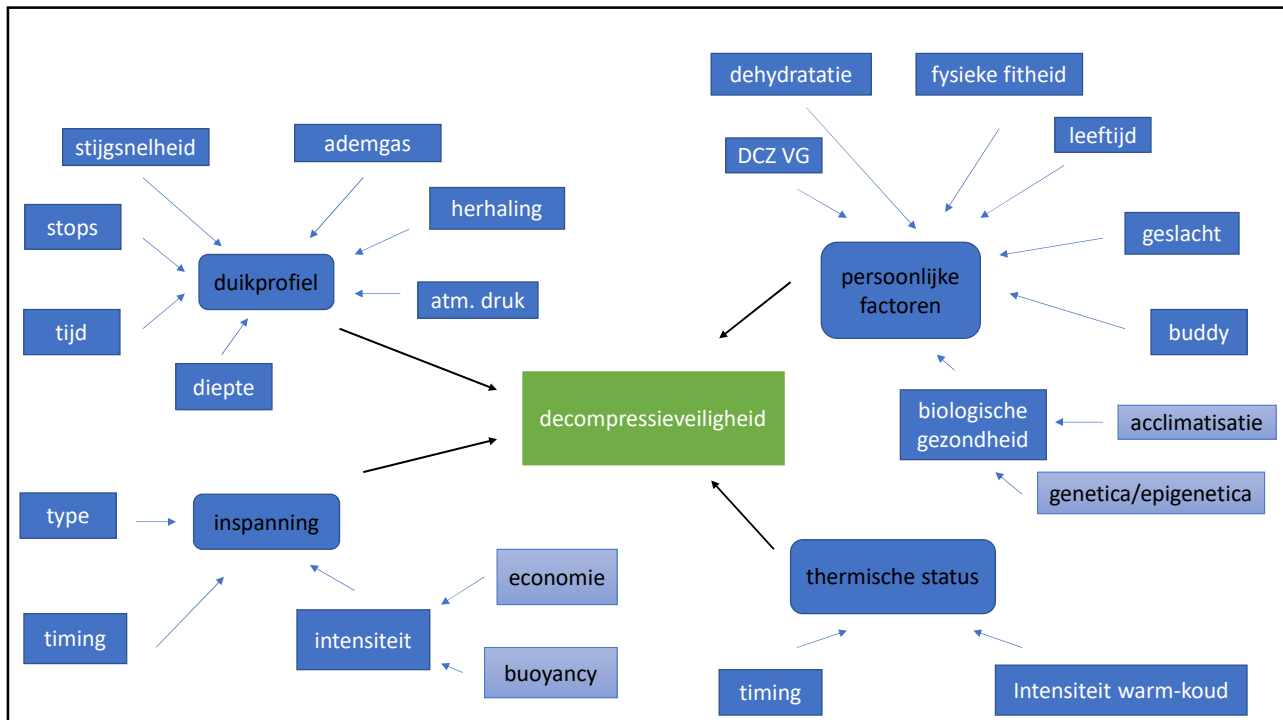
Het denken onderwerpt zich niet.

BEHOEDZAAM OMGAAN MET DECOMPRESSIESTRESS

Dr. Herman Van Bogaert

VUB VRIJE UNIVERSITEIT BRUSSEL

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WAAROM?

Duikwereld is veranderd

- ▶ Technisch duiken tot diepte > 100m
- ▶ Vrijduiken tot grote diepte

Dankzij de huidige duikcomputers

- ▶ Ongelooflijke verandering in de duikplanning
- ▶ Ingewikkelde duikprofielen zonder rekenwerk zijn mogelijk

Gevaar voor onrealistische verwachtingen en een blind vertrouwen in technologie

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DAAROM EEN PRAATJE OVER

Risicofactoren in het ontstaan van decompressieziekte

Factoren die de veiligheid beïnvloeden

Praktische tips om decompressiestress te verminderen

DUIKCOMPUTERS

Verschillende algoritmes

- ▶ Wiskundige modellen
- ▶ Niet of nauwelijks getest op mensen
- ▶ Menselijke fysiologie is veel meer dan wiskunde
- ▶ Elke duiker is op zich een menselijk experiment

De duikcomputer geeft veel info en geeft een **idee** van de risico's, maar het is de duiker die de risico's **beheer(s)t**. Een duikcomputer krijgt nooit decompressieziekte, duikers wel.

Duikalgoritme  realiteit !

KORT OVERZICHT VAN ALGORITMEN

TWEE TYPES

Gas content model

Haldane
Bühlmann
DCIEM

Pretentieloos
Puur gebaseerd op diepte en tijd

Bubble model

VPM
RGBM

Onstaan en mechanica van bellen
Radius van bellen nooit gemeten

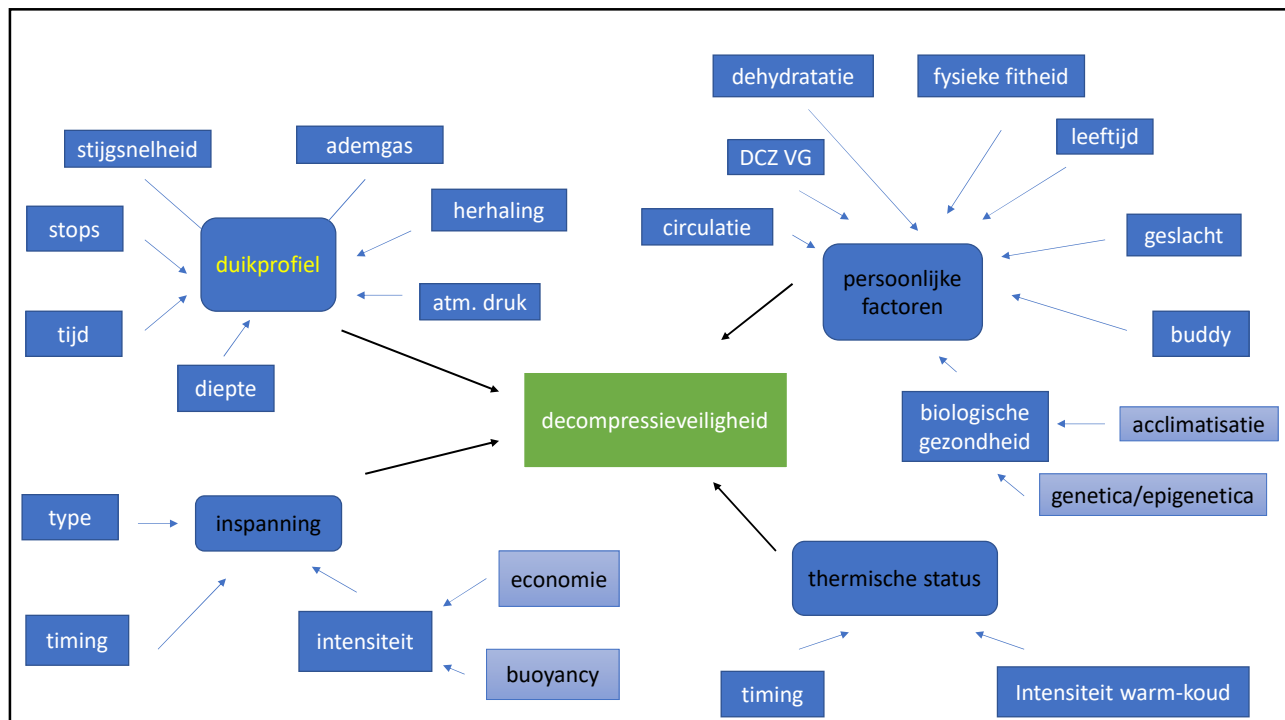
ALL MODELS ARE WRONG BUT SOME ARE USEFUL
GEORGE BOX 1976

DECOMPRESSIEZIEKTE

0,3-3,5/10,000 duiken (Dardeau et al 2012)

Decompressieongeval is steeds een persoonlijke confrontatie voor de duiker!

- ▶ Men kijkt typisch naar allerlei externe factoren (warmte, vermoeidheid, dehydratatie,...) maar er zijn duizenden processen in het lichaam die de duikveiligheid beïnvloeden.
- ▶ DUIKPROFIEL is de olifant in de kamer. Allerbelangrijkste factor!



DUIKPROFIEL

Duikdiepte $P \propto \sqrt{t}$

Stijgsnelheid

- ▶ Heel belangrijke factor!
- ▶ Recente studie vroegtijdig stopgezet: teveel belvorming bij stijgsnelheid 18m/min
- ▶ Advies 9m/min

Ademgas

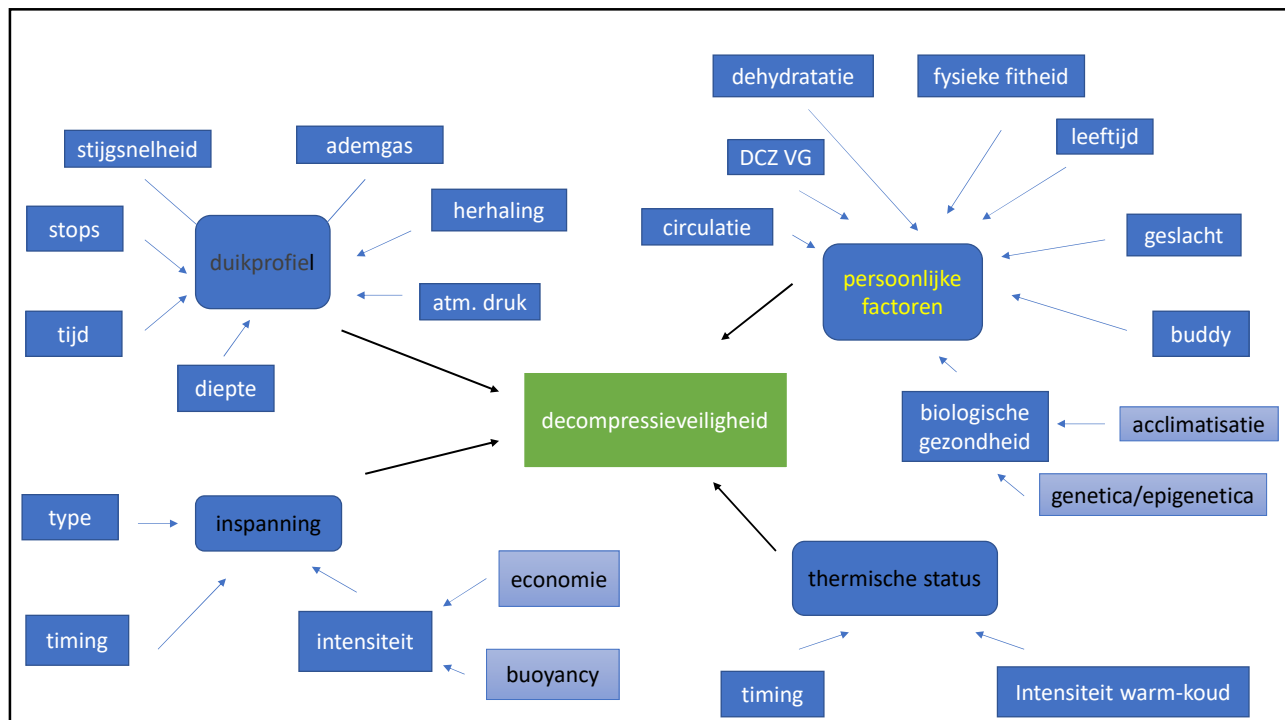
- ▶ Nitrox is maar veiliger indien gebruikt in combinatie met luchttabellen
- ▶ Opgelet met zuurstoftoxiciteit

Herhalingsduiken

- ▶ Op zich geen probleem, tenzij men steeds tegen de limieten aan duikt

Atmosferische druk

- ▶ Studie in VK < meer DCZ bij lage luchtdruk
- ▶ Bergmeren, vliegen na duiken, nemen van bergovergangen na duiken



PERSOONLIJKE FACTOREN

Circulatie

- ▶ PFO
- ▶ Longshunts

Bij 13% van de diepe duikers is er passage van bellen van rechts naar links. Voornamelijk bij zware inspanning is er passage via de longen

Biologische gezondheid

- ▶ Weinig kennis over effect van medicatie
- ▶ Genetische aanleg "kies je ouders goed"
- ▶ Epigenetica = genetische expressie tgv stressoren kan getraind worden

Acclimatisatie

- ▶ Dagelijks duiken heeft een beschermend effect op DCZ

PERSOONLIJKE FACTOREN

Dehydratatie

- ▶ Streef naar een goede balans
- ▶ Teveel vocht verhoogt het risico op immersie longoedeem

Voorgeschiedenis DCZ

- ▶ Aanpassen van duikprofiel essentieel

Leeftijd

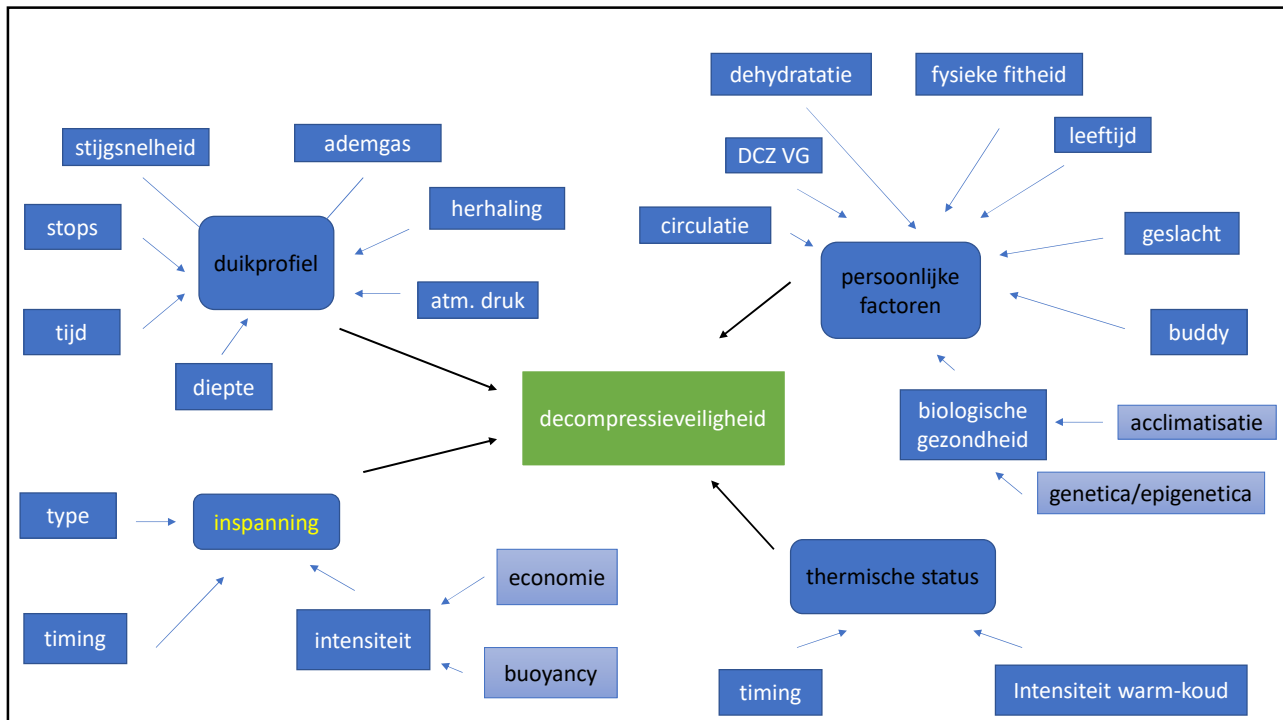
- ▶ Man van middelbare leeftijd met overgewicht = meer bellen

Geslacht

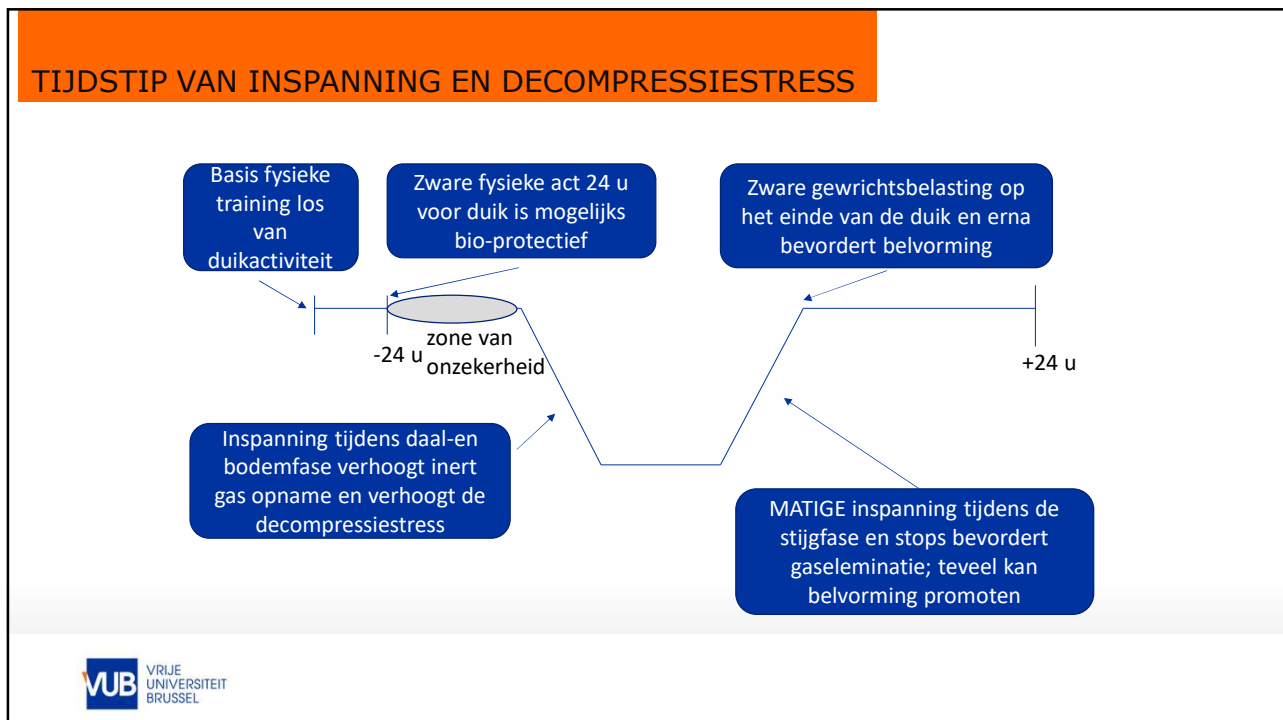
- ▶ Luchtvaart < meer DCZ in de eerste helft van de menstruele cyclus
- ▶ Epidemiologisch geen verhoogde gevoeligheid bij vrouwen terug te vinden. Voorzichtiger duikprofiel?

Buddy

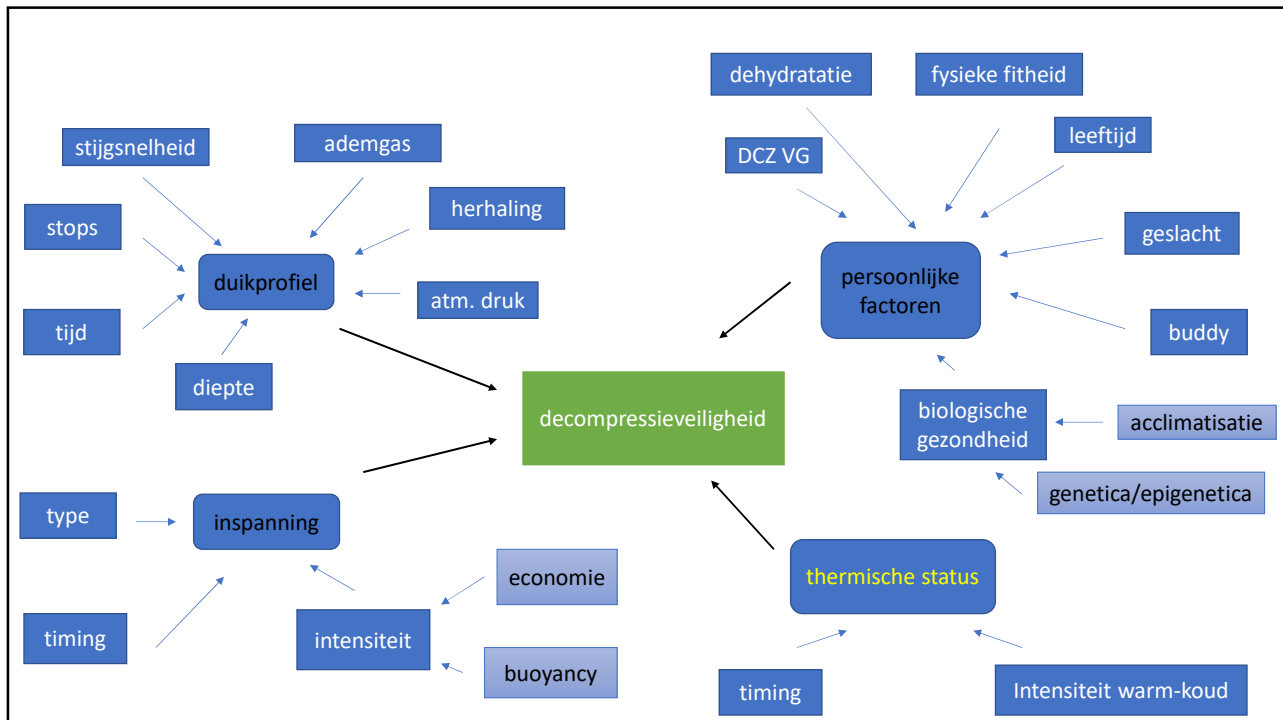
- ▶ Gedrag van buddy beïnvloedt je eigen duikprofiel



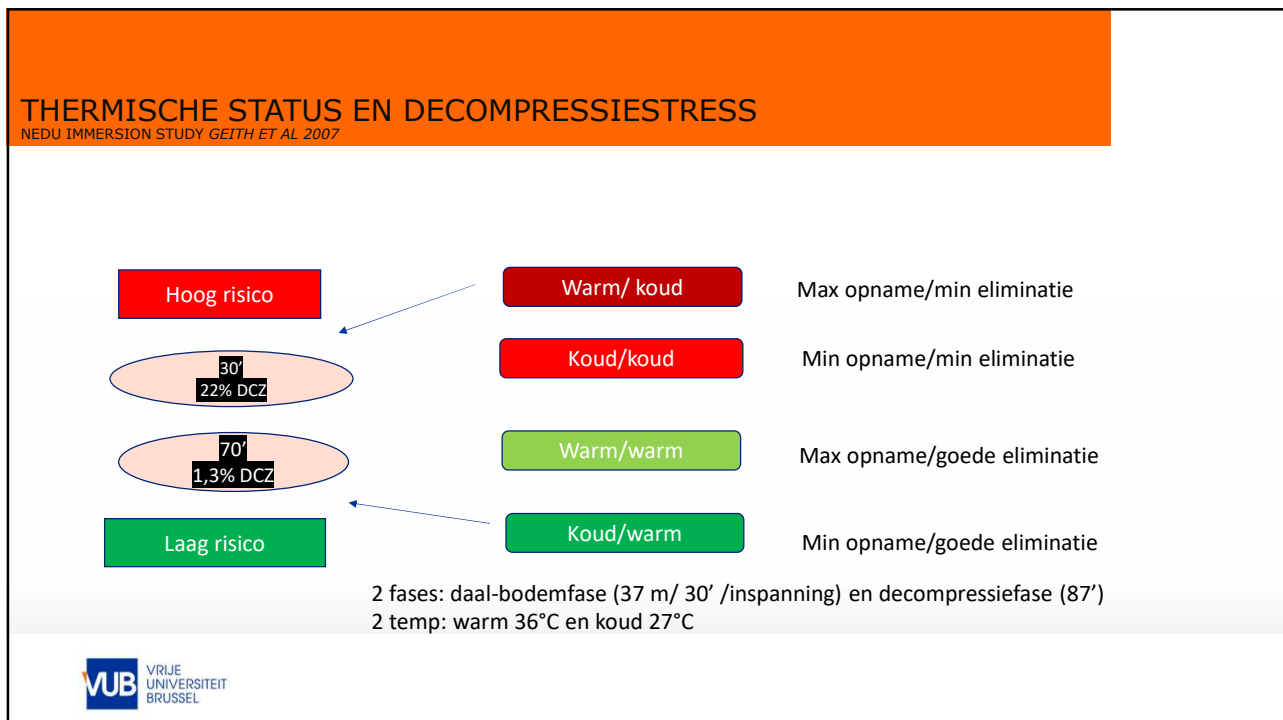
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GRADIËNT FACTORS

M- waarde (oa Bühlmann tabellen)

- ▶ = max toegestane inert gas druk in een compartiment voor een bepaalde diepte
- ▶ Theoretische limiet voor veilige decompressie
- ▶ Bellen en DCZ kunnen zich toch voordoen binnen deze limieten

Gradiënt factoren bepalen het percentage van de M waarde toegestaan tijdens het stijgen

Twee waarden

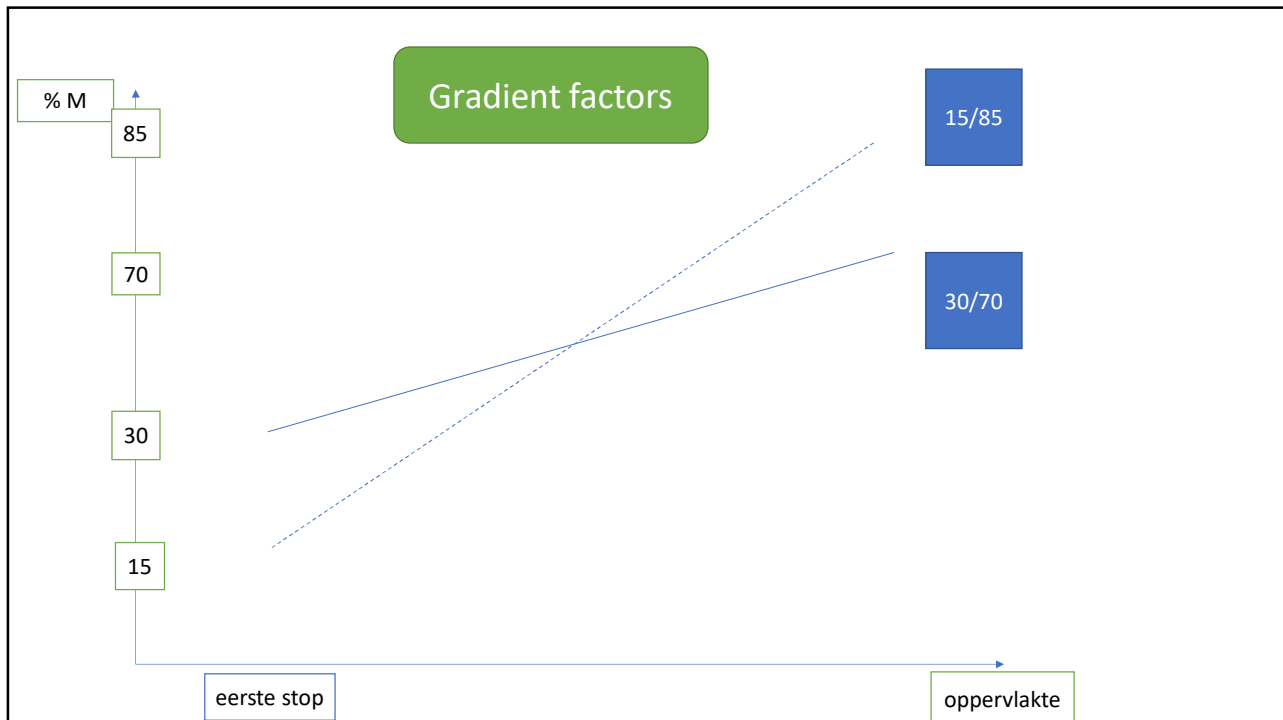
- ▶ Eerste waarde bepaalt de diepte van de eerste decompressiestop
- ▶ Tweede waarde bepaalt het toegelaten percentage van de M waarde bij het bereiken van de oppervlakte

GRADIËNT FACTORS

Verschillende types duikcomputers hebben aanpasbare GF (oa VR Tec, Shearwater Perdix/Petrel,...)

Voorbeeld GF 20/80

- ▶ **Eerste stop** wanneer het leidend weefsel 20% van de M waarde heeft bereikt
- ▶ Bij het bereiken van de **oppervlakte** mag de druk van het inert gas 80% van de M waarde bereiken
- ▶ Relatief "liberaal" waarbij een diepe stop waarschijnlijk is



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WAT TE ONTHOUDEN?

- Bijna alle factoren zijn aanpasbaar
- Kleine aanpassingen kunnen de veiligheid merkbaar verhogen
- Vermijd vierkante duiken, ga voor traag en getrapt stijgen
- Eerste duik het diepst, enkel als dit zinvol is
- Geen diepe stops
- Halve druk is niet hetzelfde als halve diepte!
- Leer uw computer kennen en stel hem conservatief in
- Verlenging van de decompressietijd is de beste verzekering

110

- 09.00 – 09.35: Is COVID nog een issue voor de duiksport in 2023 ?
Een update.
Prof. Dr. K Tournoy, longarts OLV Aalst en Universiteit Gent.
- 09.40 – 10.15: Duiken en diabetes, do's en don'ts
Prof. Dr. Chantal Mathieu, endocrinoloog UZLeuven
Michel Roden, ervaringsdeskundige.
- 10.20 – 10.55: Decompressiestress, wat moet je ermee?
Dr. Herman van Bogaert, huisarts, sportarts, duikarts
- 10.55 – 11.15: **Koffiepauze – bezoek stand RDSM**
- 11.15 – 11.50: Immersielongodeem, kopje onder?
Lt.Kol. Dr. Peter Germonpré, duikarts, hyperbare geneeskunde.
- 11.55 – 12.30: De oudere duiker, een risico?
Dr. Cathérine De Maeyer, cardioloog, UZAntwerpen
- 12.30 – 13.30: Lunch



RDSM
Medisch Materiaal
en
Telegeneeskunde



111

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DEFENSIE
Medische Component

Immersie longoedeem – kopje onder ?

Dr Peter Germonpré
Medical Director
Center for Hyperbaric Oxygen Therapy
Military Hospital Brussels
Tel +32 2 443 2183
E-mail: pgermonpre@gmail.com
24/24 Diving Emergency Hotline: 0800 12382



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DEFENSIE
Medische Component

Immersion Pulmonary Oedema – Drowning from within

Dr Peter Germonpré
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Immersion Pulmonary Oedema

- “Acute pulmonary oedema after physical effort, cold water, stress, negative pressure breathing (snorkel, dive regulator at depth)”
- References:
 - Peacher DF, Martina SD, Otteni CE, Wester TE, Potter JF, Moon RE. Immersion Pulmonary Edema and Comorbidities: Case Series and Updated Review. *Med. Sci. Sports Exerc.*, Vol. 47, No. 6, pp. 1128–1134, 2015
 - Desgraz B, Sartori C, Saubade M, Heritier F, Gabus V. Oedeme pulmonaire d’immersion. *Rev Med Suisse* 2017 ; 13 : 1324-8
 - Wilmshurst PT. Immersion pulmonary oedema: a cardiological perspective. *Diving and Hyperbaric Medicine*. 2019 March 31;49(1):30–40. doi: 10.28920/dhm49.1.30-40.
 - Henckes A, Cochard G, Gatineau F, Louge P, Gempp E, Demaistre S, Nowak E, Ozier Y. Risk factors for immersion pulmonary edema in recreational scuba divers: a case-control study. *Undersea Hyperb Med*. 2019;46(5):611-618. PMID: 31683358.

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Immersion Pulmonary Oedema

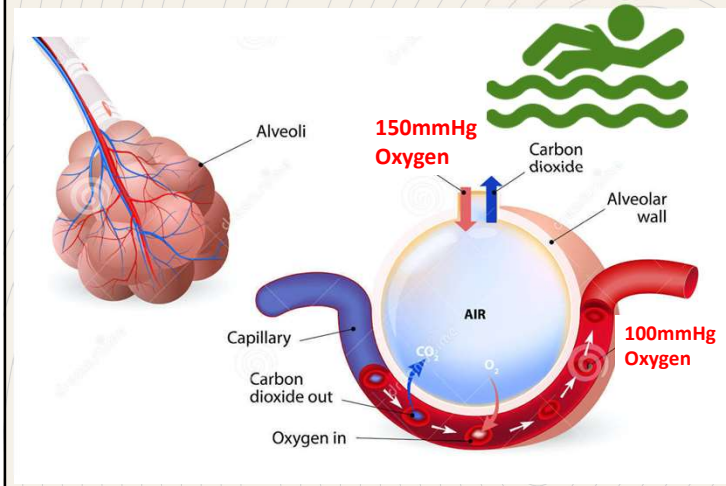
- Synonyms: “Submersion Induced Pulmonary Edema (SIPE)”, “Cold Induced Pulmonary Oedema (CIPO)”, “Immersion Pulmonary Edema (IPE)”, “Swimmers Pulmonary Edema”, “Negative Pressure Pulmonary Oedema”
- Why is it important ?
 1. Frequent !
 - 1995 Survey of 460 active SCUBA divers: 1% had experienced symptoms consistent with IPO
 - Recurrence: up to 30% risk
 2. Underreported
 3. May be fatal in SCUBA divers



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How pulmonary oedema kills the diver:

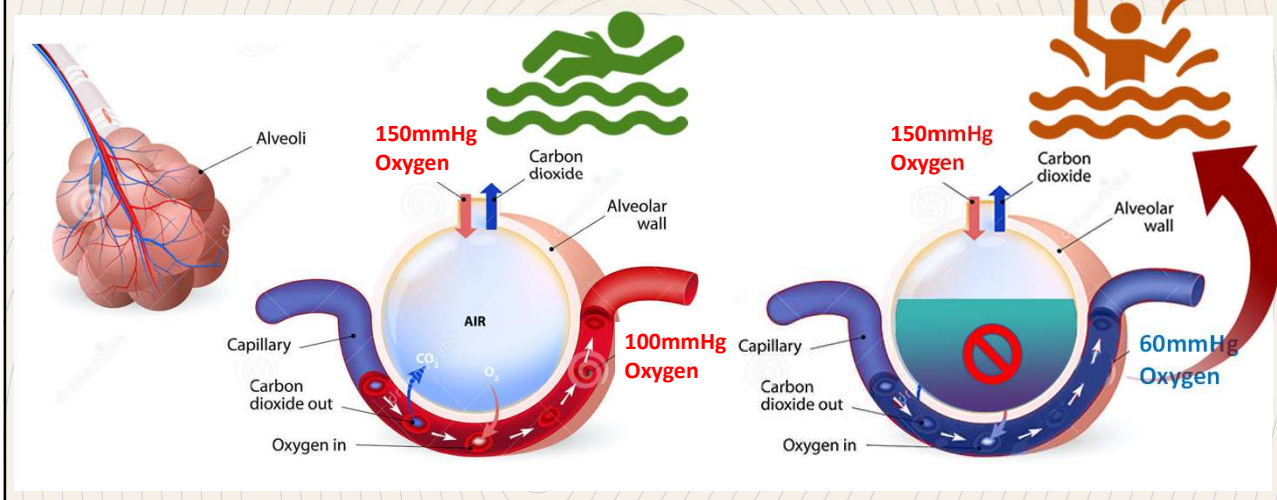
Normal (surface): 1 Atmosphere pressure



117

How pulmonary oedema kills the diver:

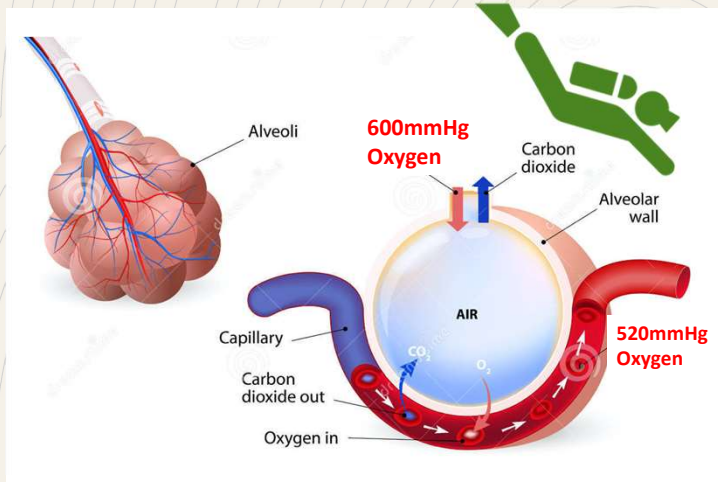
Normal (surface): 1 Atmosphere pressure



118

How pulmonary oedema kills the diver:

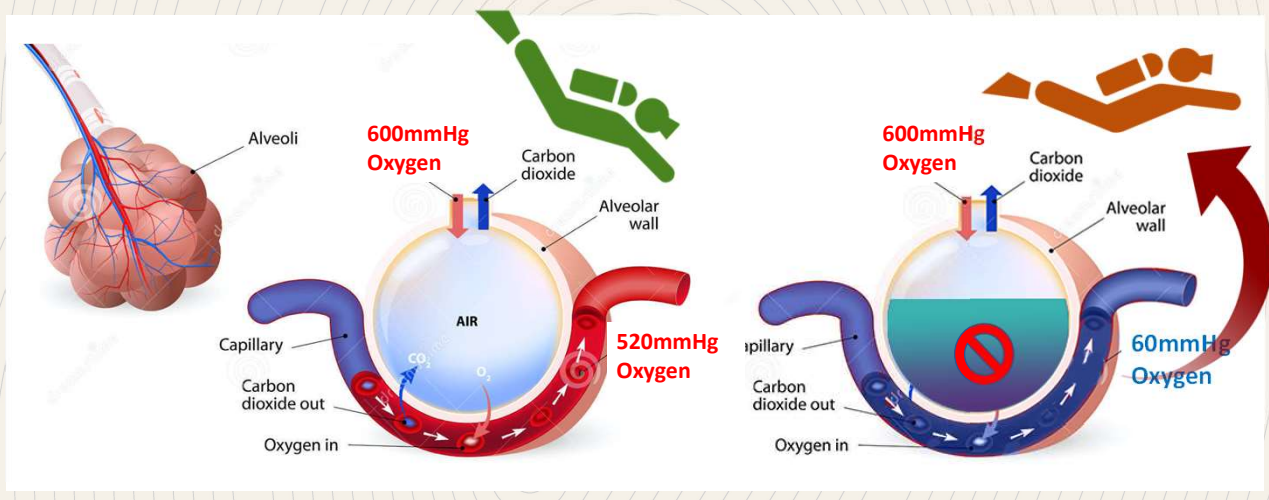
At depth (30m): 4 Atmospheres pressure



119

How pulmonary oedema kills the diver:

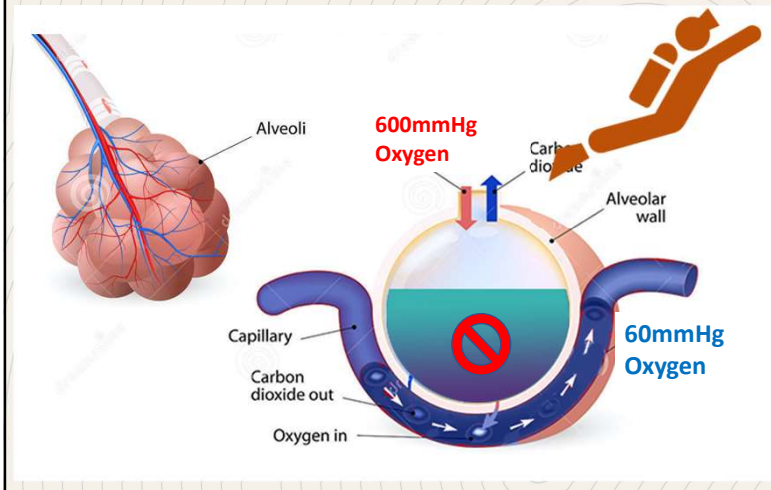
At depth (30m): 4 Atmospheres pressure



120

How pulmonary oedema kills the diver:

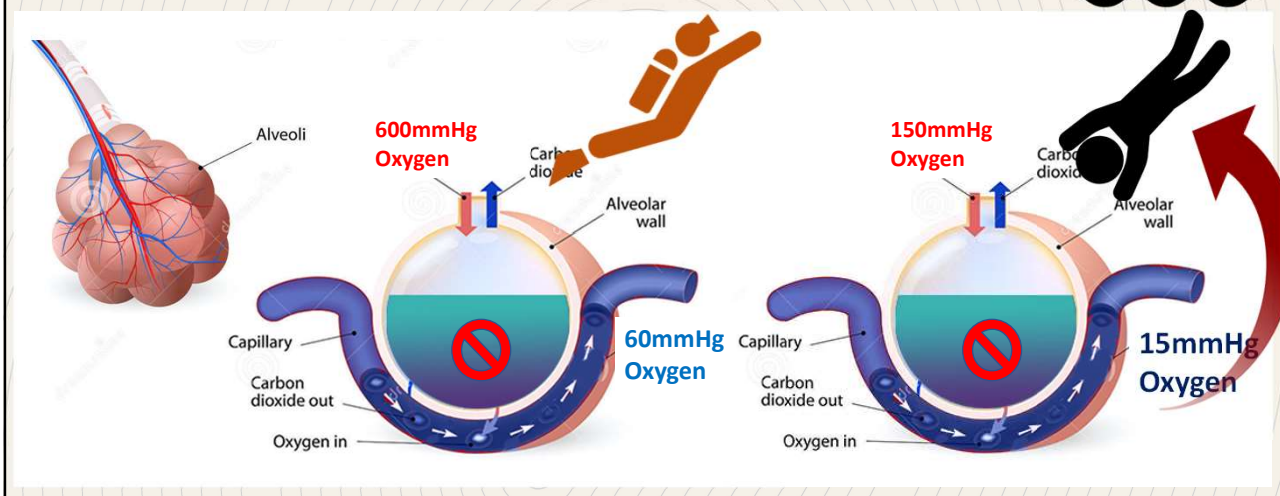
Return to surface: 4 → 1 Atmosphere pressure



121

How pulmonary oedema kills the diver:

Return to surface: 4 → 1 Atmosphere pressure



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Gast (registreren)

zoekwoord Alles

Nieuws / Kustwacht / Zeeland

Duiker omgekomen in de Oosterschelde

Geplaatst door ErwinHermanns op vrijdag 8 juli 2011 08:08

Wemeldinge - Donderdagavond is een duiker om het leven gekomen bij een duikongeval in de Oosterschelde ter hoogte van Kattendijke. Reddingsdiensten hebben de man nog gereanimeerd, maar dat heeft niet meer mogen baten.

Omstreeks 22.00 uur kreeg de politie de melding dat de duiker niet boven was gekomen. Hij was eerder die avond met twee duikmaten, ook ervaren duikers uit België, te water gegaan. Na de duik, die enige tientallen meters diep ging, bleef de []-jarige man onder water. Korte tijd later werd de man drijvend aangetroffen door de ter plaatse gegane boot van de KNRM, die hem aan boord namen en reanimeerden. Het slachtoffer is vervolgens in Wemeldinge aan land gebracht, waar door ambulancepersoneel de dood door verdrinking werd vastgesteld.

Naast de boten van de KNRM en de Waterpolitie, is ook de brandweer en een ambulance ter plaatse geweest, alsmede een traumahelikopter en een Belgische reddingshelikopter. Het slachtoffer was een ervaren duikinstruuteur, woonachtig in [] (B.).

Reacties: 0 | [Klik hier om te registreren](#)

Extra

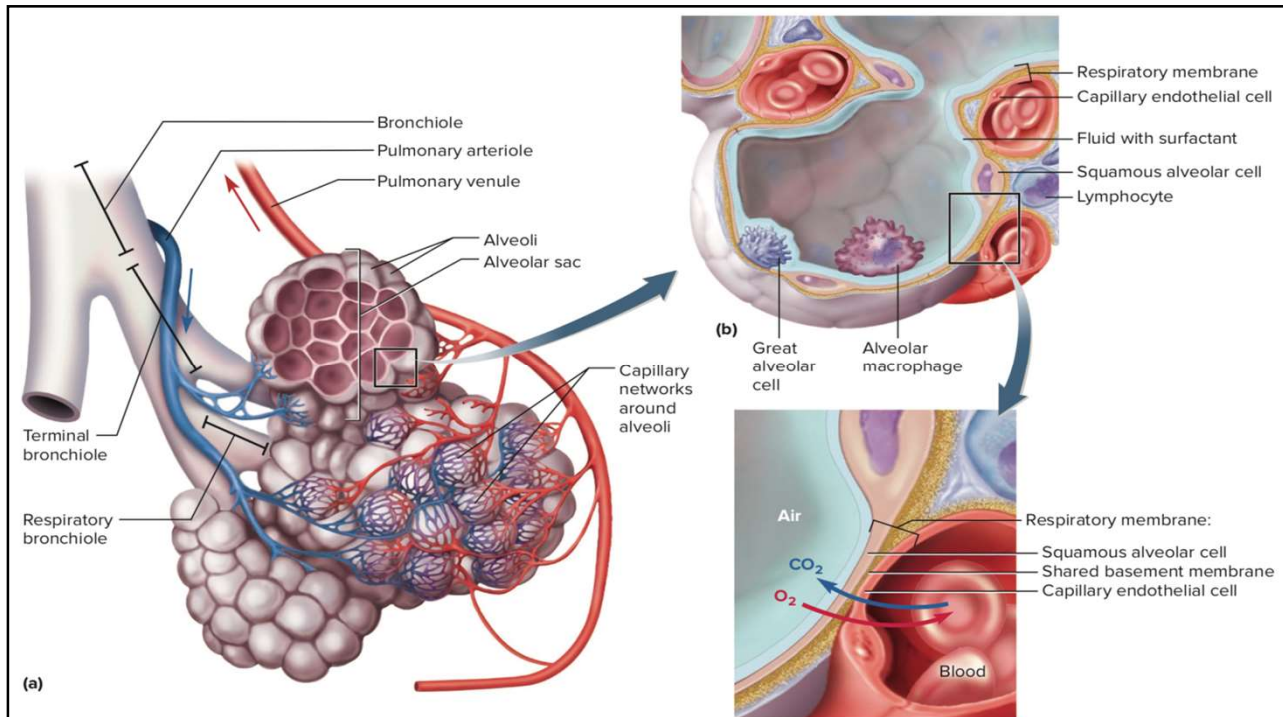
Fotomateriaal

Foto: archief EHF

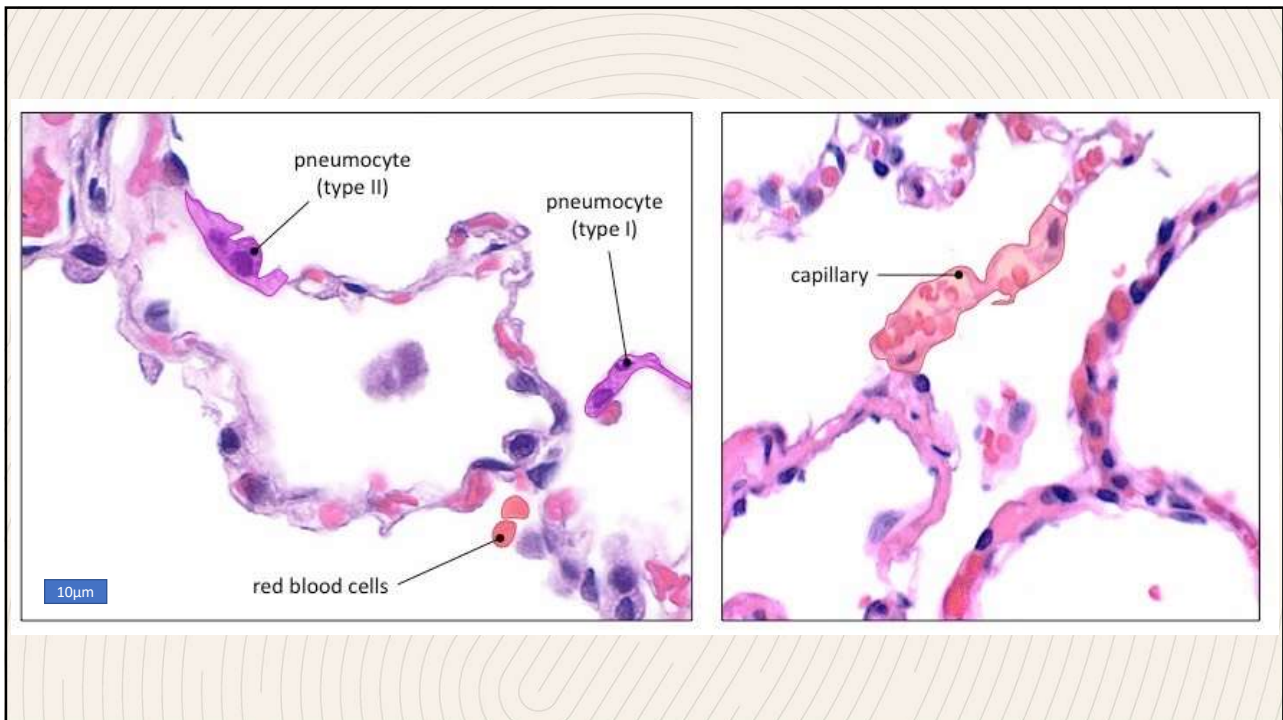
Ander Kustwacht-nieuws

- 03-07 Duitse jongen (16) verdronken Noordwijk aan Zee
- 01-07 Brand op boot sportvissers op Noordzee
- 29-06 Landelijke 06-polsbandjesactie van start
- 28-06 Koningin brengt werkbezoek aan KNRM IJmuiden
- 27-06 58 vermiste kinderen herenigd door Reddingsbrigade
- 21-06 Student van de Maritieme Academie Den Helder op oce
- 19-06 KNRM Katwijk assisteert in Scheveningen bij zoekact

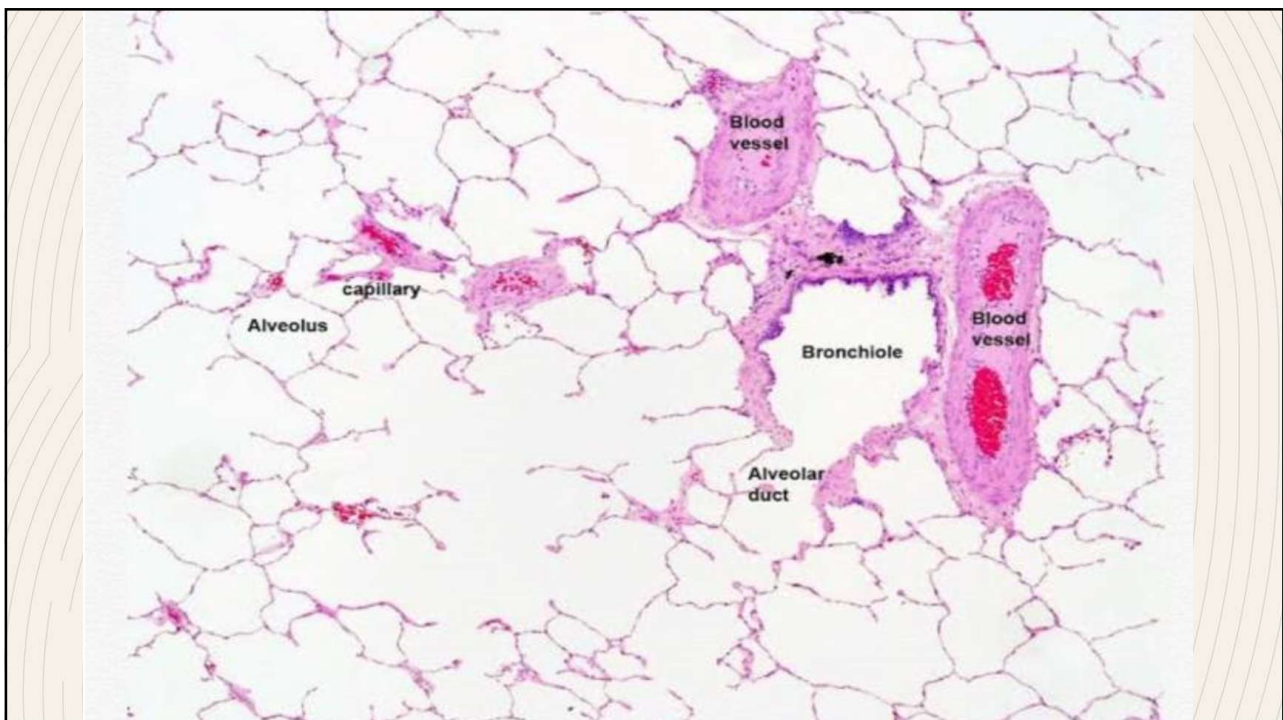
123



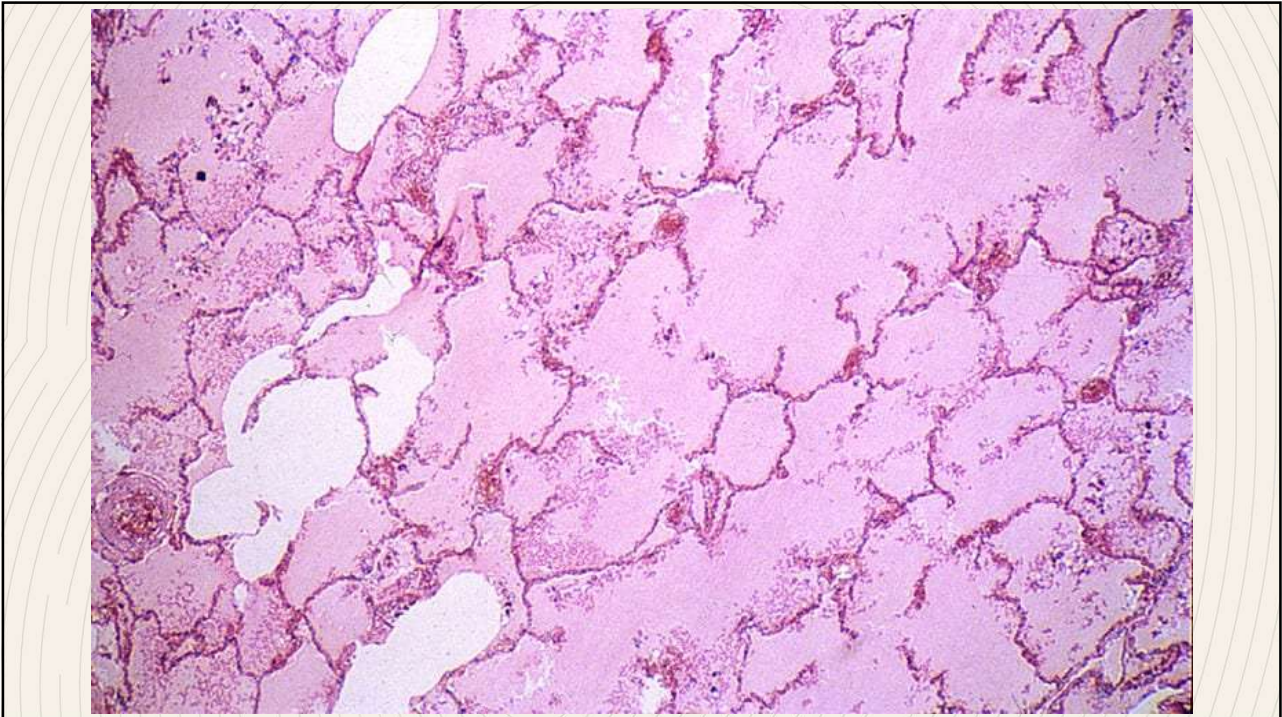
124



125



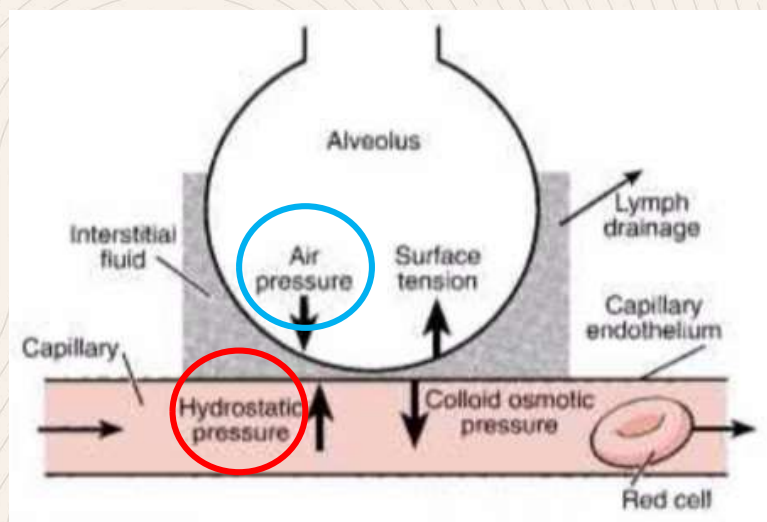
126



127

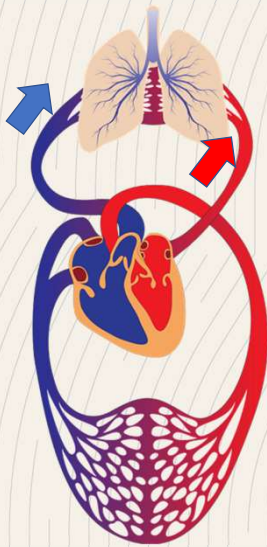
What causes Immersion Pulmonary Oedema ?

- Balance between fluid 'leak' and fluid evacuation
- Variable pressures:
 - Hydrostatic (heart)
 - Air pressure (lung)



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Immersion Pulmonary Oedema (1 – Heart)

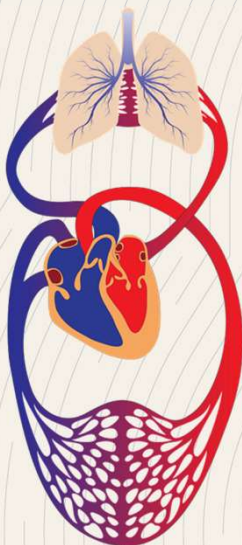


Possible factors during diving:

- Increased venous return: *immersion “blood shift”, excessive fluid intake*
- Physical effort: *increased heart rhythm, muscle contraction*
- Vasoconstriction: *cold, oxygen*
- Heart valve disease: *decreased pump function*
- Heart insufficiency: *hypertension, LV Hypertrophy*

129

Immersion Pulmonary Oedema (1 – Heart)



Possible factors during diving:

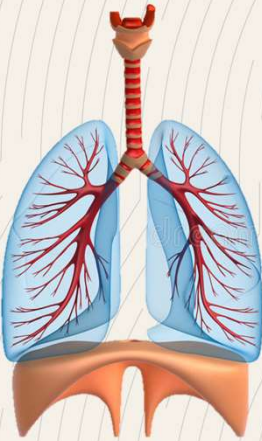
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- Physical effort: *increased heart rhythm, muscle contraction*
- Vasoconstriction: *cold, oxygen*
- Heart valve disease: *decreased pump function*
- Heart insufficiency: *hypertension, LV Hypertrophy*

> 70% of recreational IPO cases have significant cardiovascular risk factors

Peacher DF et al. 2015

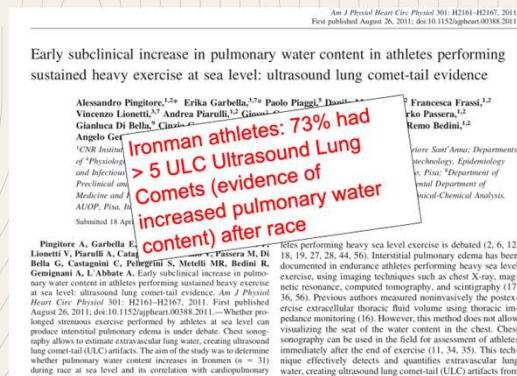
130

Immersion Pulmonary Oedema (2 – lungs)



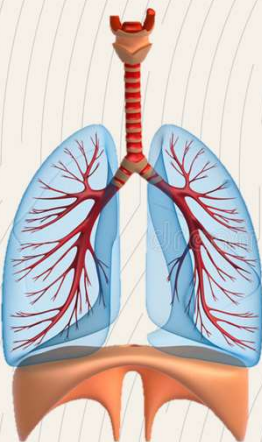
Possible factors during diving:

- Exercise = increased transalveolar fluid pressure
- “Pulmonary capillary stress failure”



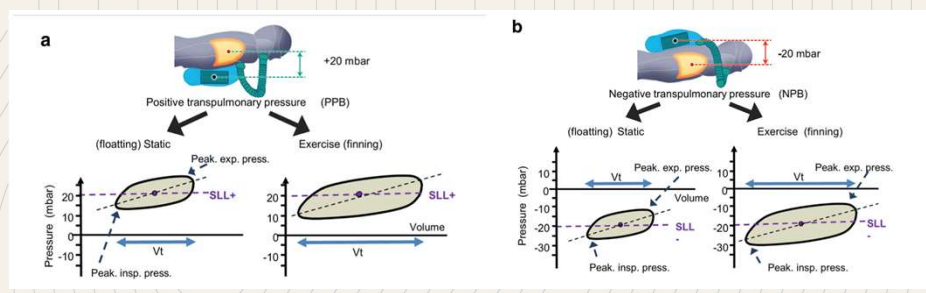
131

Immersion Pulmonary Oedema (2 – lungs)



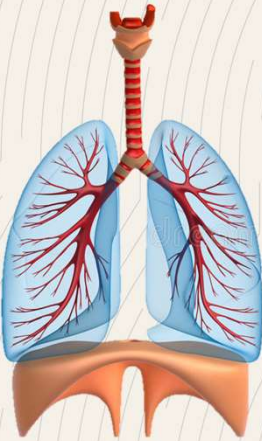
Possible factors during diving:

- Exercise = increased transalveolar fluid pressure
 - “Pulmonary capillary stress failure”
- Negative pressure breathing
 - CCR divers (back-mounted counterlung)



132

Immersion Pulmonary Oedema (2 – lungs)

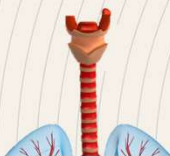


Possible factors during diving:

- Exercise = increased transalveolar fluid pressure
 - “Pulmonary capillary stress failure”
- Negative pressure breathing
 - CCR divers (back-mounted counterlung)
 - Head-up position vs horizontal position
 - Resistance of breathing apparatus (regulator, snorkel)

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Immersion Pulmonary Oedema (2 – lungs)



Possible factors during diving:

- Exercise
- Negative pressure breathing

ORIGINAL RESEARCH ARTICLE

Open Access



Observational study of potential risk factors of immersion pulmonary edema in healthy divers: exercise intensity is the main contributor

A. Boussuges^{1*}, K. Ayme¹, G. Chaumet², E. Albier³, M. Borgnetta³

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ORIGINAL RESEARCH ARTICLE

Open Access



The Key Roles of Negative Pressure Breathing and Exercise in the Development of Interstitial Pulmonary Edema in Professional Male SCUBA Divers

Diving and Hyperbaric Medicine Volume 48 No. 1 March 2018

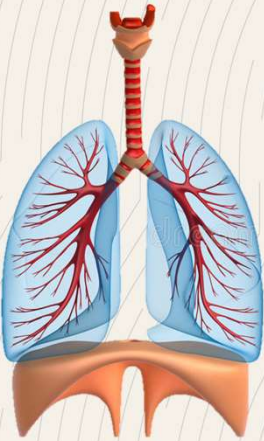
Nicolas Brocq¹, Bruno Schmid¹,
David Hunter Maciver^{1,2*}

Immersion pulmonary oedema in a healthy diver not exposed to cold or strenuous exercise

Olivier Castagna^{1,2}, Sébastien de Maistre³, Bruno Schmid¹, Delphine Caudal⁴, Jacques Regnard⁵

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Immersion Pulmonary Oedema (2 – lungs)

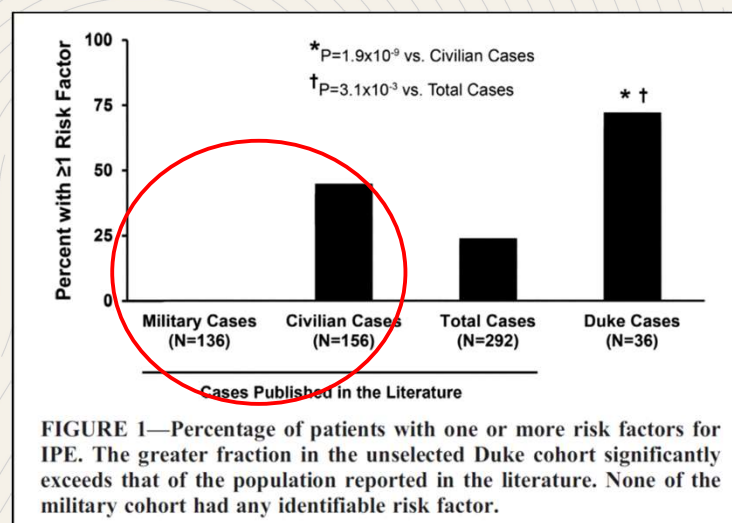
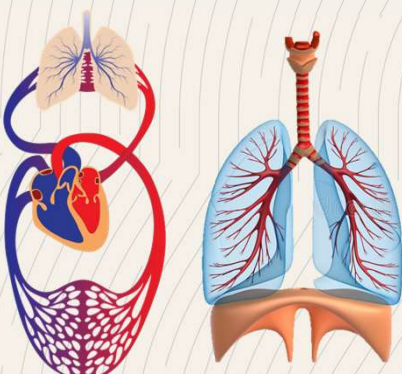


Possible factors during diving:

- Exercise = increased transalveolar fluid pressure
 - “Pulmonary capillary stress failure”
- Negative pressure breathing
 - CCR divers (back-mounted counterlung)
 - Head-up position vs horizontal position
 - Resistance of breathing apparatus (regulator, snorkel)
- Tight suit / equipment
 - Wetsuit
 - (Inflated) BCD

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Immersion Pulmonary Oedema: statistics



Peacher DF et al. 2015

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Immersion Pulmonary Oedema: statistics

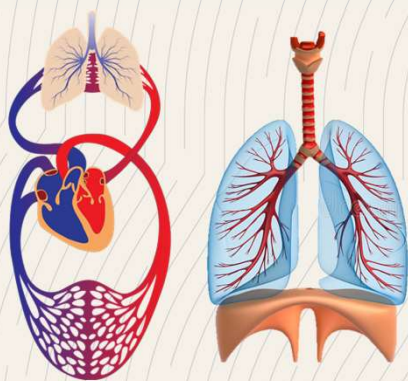


Table 4: Univariate and multivariate analyses

Variable	Univariate analysis OR (95% CI)	Multivariate analysis p*	OR (95% CI)	p†
Age ≥ 50 yr	2.81 (1.74-4.53)	<0.001	3.30 (1.76-6.19)	<0.001
Female	2.10 (1.31-3.37)	0.002	2.20 (1.19-4.08)	0.012
Daily medication intake	3.50 (2.16-5.68)	<0.001	2.79 (1.50-5.21)	0.001
NSAID intake before diving	61.74 (7.91-481.83)	<0.001	24.32 (2.86-206.91)	0.003
Dive depth > 20 m	1.70 (1.04-2.78)	0.035	2.00 (1.07-3.74)	0.031
Physical exertion before and/or during diving	7.08 (4.03-12.42)	<0.001	5.51 (2.69-11.28)	<0.001
Training dive	6.24 (3.64-10.72)	<0.001	5.34 (2.62-10.86)	<0.001
Hypertension	3.88 (2.03-7.39)	<0.001		

Henckes A et al. 2018

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Immersion Pulmonary Oedema: who is at risk ?

- (Older) divers with cardiovascular risk factors
- (Younger) divers during dives with severe exercise
- CCR divers
- Snorkelers
- (Competition) swimmers

<https://www.bsac.com/news-and-blog/the-hidden-killer-immersion-pulmonary-oedema-ipo/>

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The hidden killer: Immersion pulmonary oedema (IPO)

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NIEUWS

Hartfalen wordt duiker fataal



door Redactie DuikeninBeeld op 28 maart 2022

1 reactie



Het incident met dodelijke afloop dat zondag plaatsvond bij Duiklocatie Boschmolenplas, is het gevolg van hartfalen, zo is officieel bevestigd.

Zondag is bij Duiklocatie Boschmolenplas een duiker omgekomen. Door de medische dienst is inmiddels vastgesteld dat de oorzaak hartfalen is.

Een groepje van drie duikers was die middag afgedaald naar het platform op vijf meter. De man, een ervaren duiker, heeft daar nog het OK-teken gegeven en verdween vervolgens uit het zicht. Naar bleek richting de oppervlakte. Daar is hij kort gezien voordat hij weer onder water verdween.

Ook de twee andere duikers zijn opgestegen en hebben alarm geslagen, aldus een woordvoerder van de duiklocatie. Conform protocol zijn reddingswerkers van de duiklocatie met de boot naar de plek gegaan en is de man snel uit het water gehaald. Aan de kant is men direct begonnen met reanimatie tot de hulpdiensten ter plaatse waren en het overnamen. Helaas mocht het -ondanks adequaat handelen van zijn buddies- niet baten.

Wij wensen de nabestaanden, buddies en andere betrokkenen veel sterkte.



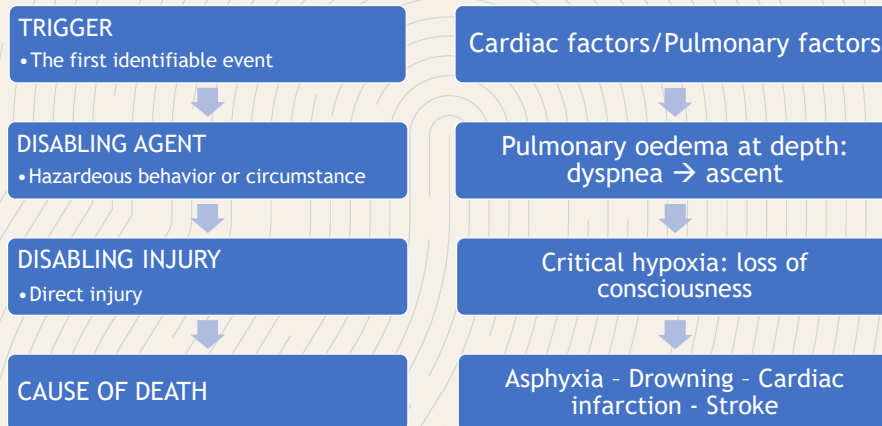
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“Root Cause Analysis” duikongevallen



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“Root Cause Analysis” duikongevallen: IPO



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Immersion Pulmonary Oedema: clinical

- Circumstances: cold; physical effort; stress; older diver
- Often during first phases of dive ! (< 10-15min)
- Dyspnea at depth!
- Ascending: symptoms worse due to falling pO_2 !
- At surface:
 - Pulmonary oedema, profound desaturation, cardiac events
 - Inflating BCD may trigger Loss of Consciousness !
- Possibly fatal
 - Dead on the surface, dive tank full; cause of death : “drowning”
- High risk of recurrence (> 30%) : previous (milder) episodes ?



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Treatment of Immersion Pulmonary Oedema

- Get the diver out of the water !
- Not breathing: CPR with oxygen (**BREATHING** + CARDIAC MASSAGE) !
- Breathing:
 - Sitting position
 - Give oxygen (100%)
 - Alert 112
 - Call for dive medicine advice
DAN Benelux 24/24 Hotline
0800-12382



Société Belge de Médecine Hyperbare et Subaquatique asbl
Belgische Vereniging voor Overdruk- en OnderwaterGeneeskunde vzw

Standpunt van de Belgische Vereniging
voor Overdruk- en Onderwatergeneeskunde
over Eerste Hulp met Zuurstof bij Duikongevallen

15 November 2020

<http://www.bvoog.be/>

- **Diver alive in hospital = survival**

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Immersion Pulmonary Oedema – prevention ?

- Check and control cardiovascular risk factors
 - Hypertension ? LVH ? Medication ? (*Wilmshurst DHMJ 2019*)
- Evaluate need for extreme underwater physical exercise
 - In young, healthy adults : main factor ! (*Boussuges et al. Sports Med Open 2017*)
- Avoid negative pressure breathing
 - > when combined with exercise (*Castagna et al. Sports Med Open 2018*)
- Avoid cold stress (*Hohmann et al BMJ Sports Science 2018*)
- Genetic factors ? (*Cialoni et al UHM 2015*)

Recurrence rate: up to 30% !

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Immersion Pulmonary Oedema – Stop diving ?

- Address at-risk situations
 - Regular cardiovascular checkup – specific dive medical examination
 - Choose diving environment wisely: no current, warm water
 - Avoid stress before/during dive
- Prepare for possible recurrence
 - Awareness and low threshold for aborting dive (note: buddy awareness !)
 - No-decompression dives only
 - Oxygen + furosemide on board
- Medication
 - Stopping beta-blockers for hypertension treatment
 - Sildenafil ? (*Moon et al, 2016*) Nifedipin ? (*Wilmschurst, 1998*)

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Immersie longoedeem – kopje onder ?

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DEFENSIE
 Medische Component



146

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De oudere duiker

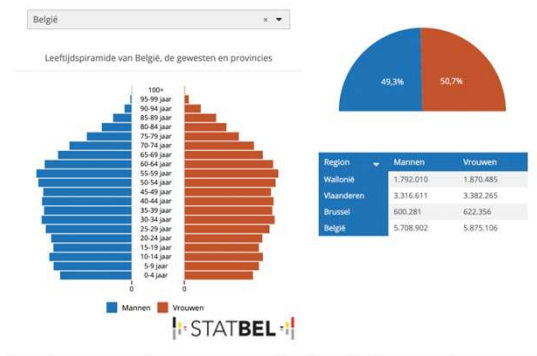
Dr. Catherine De Maeyer – Cardiologisch Centrum Grens



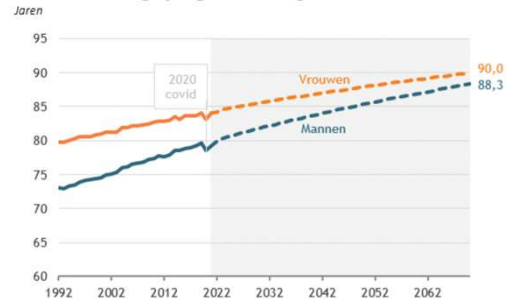
148

De oudere duiker

Huidige situatie in België/Nederland en voorspellingen



Levensverwachting bij de geboorte - België

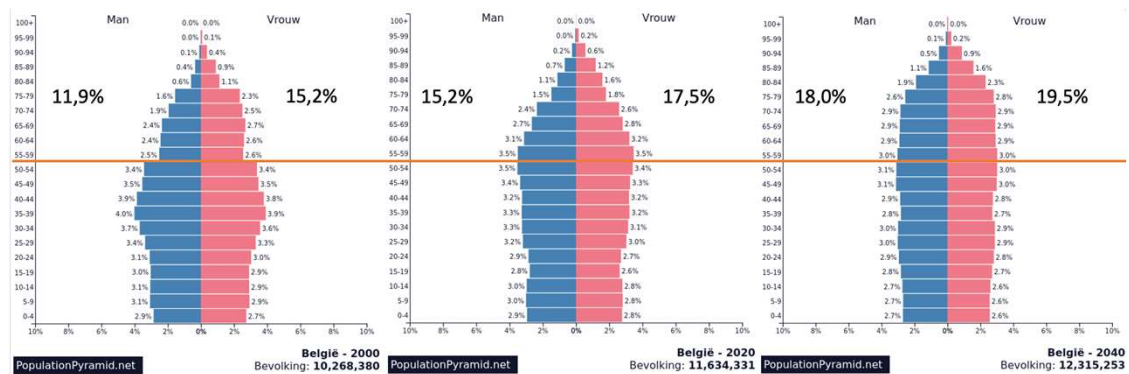


Bron: Demografische vooruitzichten 2022-2070, FPB en Statbel

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De oudere duiker

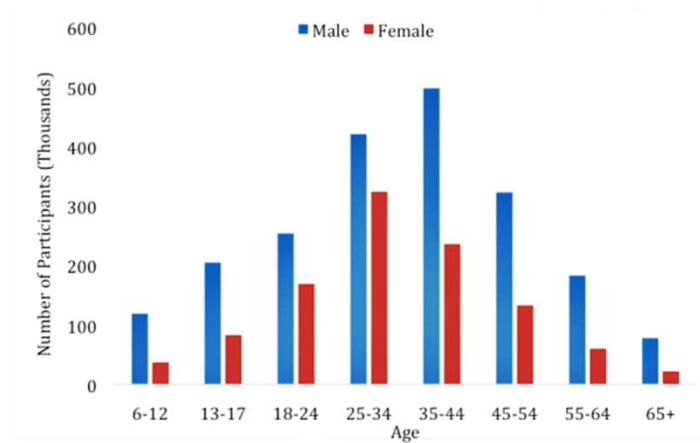
Bevolkingspiramide België in 2000, 2020, 2040



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De oudere duiker

Leeftijdsverdeling recreatieve duikers



Sports and Fitness Industry Association Report 2015

151

De oudere duiker

US & Canada diving fatalities 2015 (n=67)

Gemiddelde leeftijd DAN leden en DAN dodelijke ongevallen

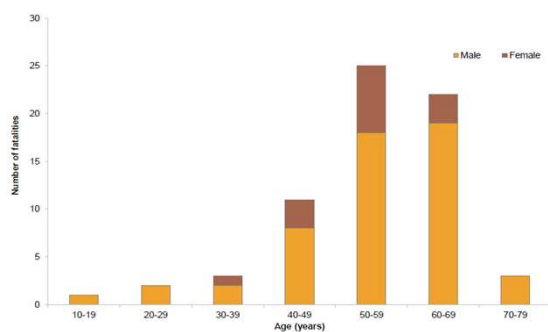
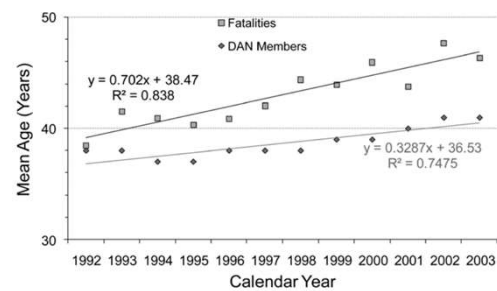


Figure 1.4-1. Distribution by age and sex for U.S. and Canadian scuba fatalities, 2015 (n=67)

Buzocott P. DAN Annual Diving Report 2017



The mean ages of DAN America members and all fatalities from 1992-2003 are shown in Figure 9. The mean age of members increased by one year in every four years, while the mean age of fatalities increased by two years in every four years. Fatalities were about two years older than members in 1992 and five years older in 2003 as a result of greater fatality rates for older divers.

Vann R, Lang M. UHMS 38(4): 257-60

152

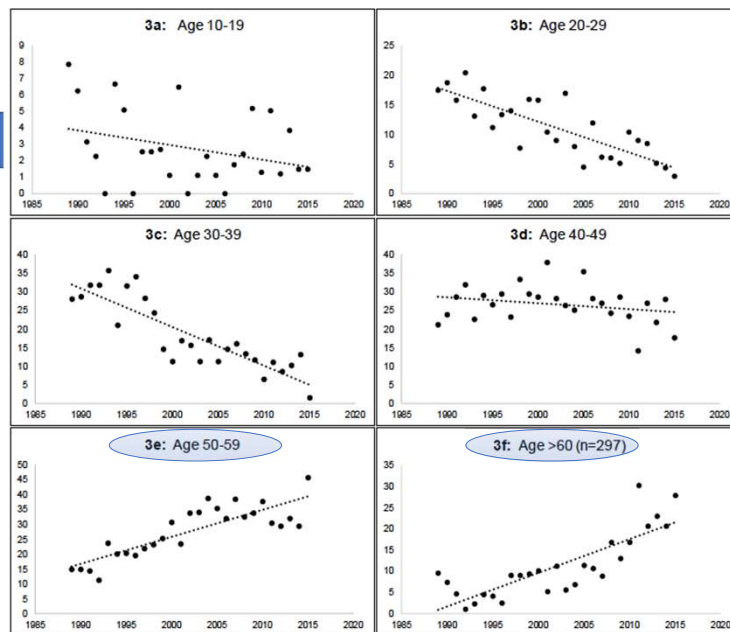


Figure A-3. Percentage of each year's fatalities by age-group, 1989–2015 (n=2,267)

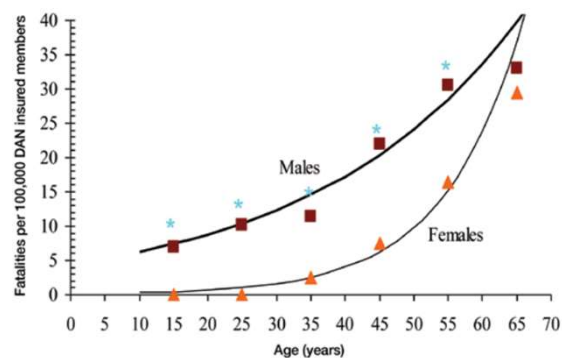
Buzocott P. DAN Annual Diving Report 2017

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De oudere duiker

Dodelijke ongevallen: Geslacht, leeftijd

Figure 7: Gender- and age-specific fatality accident rates
(Denoble, Pollock et al. 2008, with permission)



154

De oudere duiker

US & Canada diving fatalities 2015 (n=67)

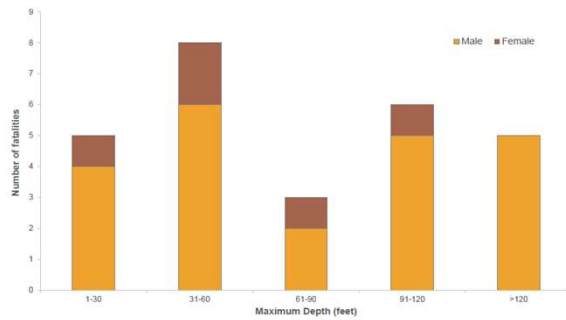


Figure 1.6-3. Maximum depth by sex for U.S. and Canadian scuba fatalities, 2015 (n=26)

Buzocott P. DAN Annual Diving Report 2017

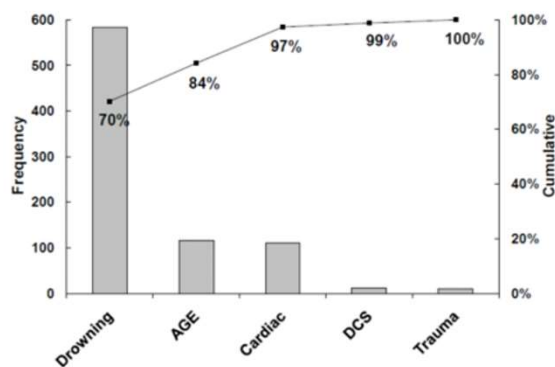
→ Onafhankelijk van de diepte

155

De oudere duiker

Oorzaken van overlijden

Figure 3: Causes of Death identified in 814 of 947 scuba fatalities, 1992-2003
(Denoble et al. 2011)



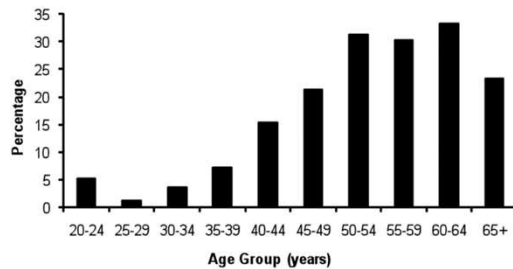
"The problem is there is no systematic collection of data performed to determine exactly how or why scuba divers are dying."

156

De oudere duiker

Oorzaken van overlijden

Figure 6: Percentage of cardiac-related disabling injury among fatalities of various age groups (unpublished DAN fatality data)



% cardiale factor bij ongevallen tijdens het duiken stijgt van 5% op 35 jaar naar 30% vanaf 50-jarige leeftijd

Leeftijd en een daaraan verbonden verhoogd risico op hart-en vaatziekten verhogen het risico op immersie-longoedeem (ILE)

Peacher et al. MMSE 2015

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De oudere duiker

Definitie 'oud'

Oud

1) Afgedragen 2) Afgeleefd 3) Afgetrapt 4) Aftands 5) Antiek 6) Niet meer in de mode 7) Bedaagd 8) Bejaard 9) Bekende architect 10) Belegen 11) Beschimmeld 12) Bouwvallig 13) Drank 14) Ex 15) Gewezen 16) Grijs 17) Kaduuk 18) Klassiek 19) Lang geleden 20) Lang geleden gekocht 21) Lang geleefd 22) Muf
Gevonden op <https://www.mijnwoordenboek.nl/puzzelwoordenboek/Oud/1>

oud

•"(van mensen)" van hoge leeftijd. •"(van voorwerpen)" al lange tijd bestaand, versleten. •de vorige.
Gevonden op <https://nl.wiktionary.org/wiki/oud>

oud

reeds lang bestaand, lang geleefd hebbend
Jaar van herkomst: 893 (Künzel)
Gevonden op https://www.dbnl.org/tekst/sijs002chro01_01/colofon.php

158

De oudere duiker

Veroudering ...

- Structurele (weefsel) en functionele **veranderingen**
- Die aan **verschillende snelheden** in verschillende weefsels/organen optreden
- Verschillend per **persoon**
- ifv **genetica (aanleg), omgevingsfactoren, levensstijl, ...**
- Over het algemeen:
 - 'veroudering' zet in vanaf de derde decade (>30j)
 - Wordt vaak pas opgemerkt vanaf de vijfde decade (>50j) bij gezonde, fitte personen

159

De oudere duiker

Veroudering: **interactie** van verschillende factoren



160

Leeftijd

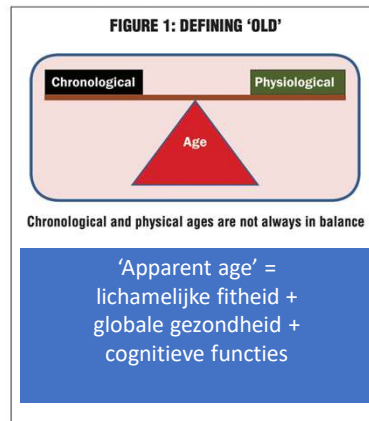
Chronologische versus Fysiologische leeftijd

Chronologische leeftijd

- Actuele leeftijd (geboortedatum)
- Houdt geen rekening met cognitieve functies, comorbiditeiten, ervaring, fitness, beoordelingsvermogen, mobiliteit en kracht.

Fysiologische leeftijd

- Subjectief
- Fysiek en mentaal
- 'Je ziet er jonger/ouder uit dan je bent'



Fysieke en cognitieve veranderingen

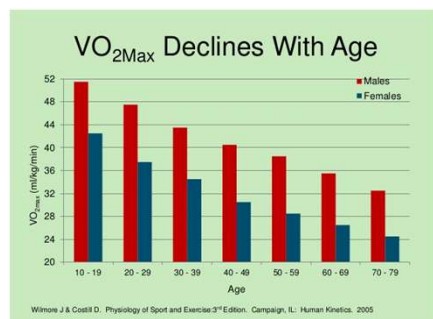
- Grijs haar
- Verziendheid
- Verminderd libido
- Gehoorsverlies
- Trager gedachtengang
- Trager herstel na letsel
- Spierverlies
- Minder eetlust
- Lager activiteitsniveau

Strauss M, et al. UHM 2017, Vol. 44, No. 1

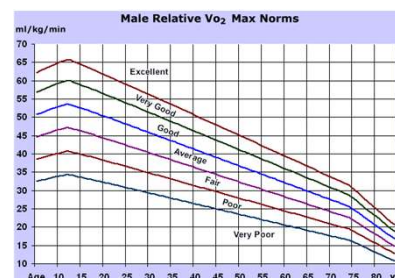
161

De oudere duiker

Enkele vaststellingen ...



Dit wordt vastgesteld bij mannen en vrouwen, elite sporters en recreanten, magere en zwaardere personen, ...



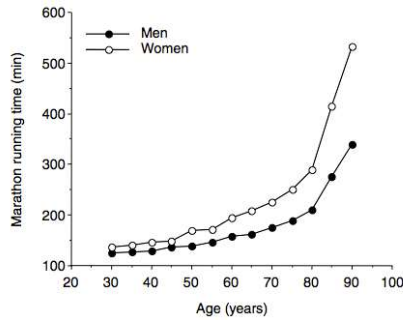
VO₂max = hartslag x slagvolume x O₂verbruik thv spier

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De oudere duiker

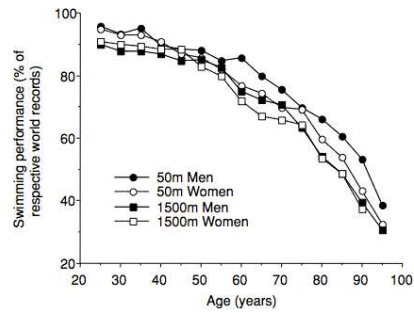
Enkele vaststellingen ...

Looptijd voor marathon voor mannen en vrouwen volgens leeftijd



Tanaka H, Seals DR. J Physiol. 2008(586):55-63

Zwemprestaties (mannen en vrouwen) volgens leeftijd

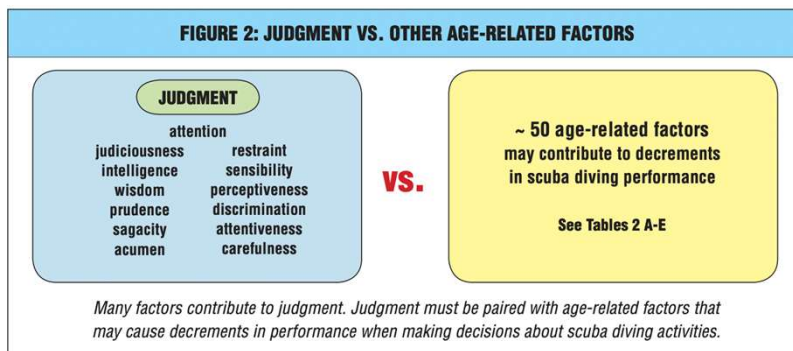


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Leeftijd

- Merendeel van de leeftijdsgebonden veranderingen leidt tot achteruitgang van de prestatantie
- Uitzondering: Beoordelingsvermogen → kan compenseren voor achteruitgang op andere vlakken

FIGURE 2: JUDGMENT VS. OTHER AGE-RELATED FACTORS



Strauss M, et al. UHM 2017, Vol. 44, No. 1

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Veroudering van verschillende orgaansystemen

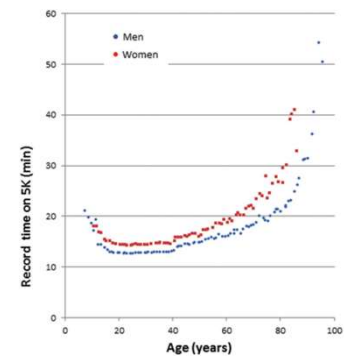
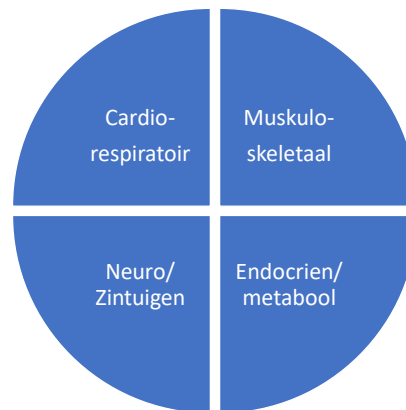


Figure 9 World record times for running 5 km (with permission from Ferrucci et al).¹²

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Muskuloskeetaal

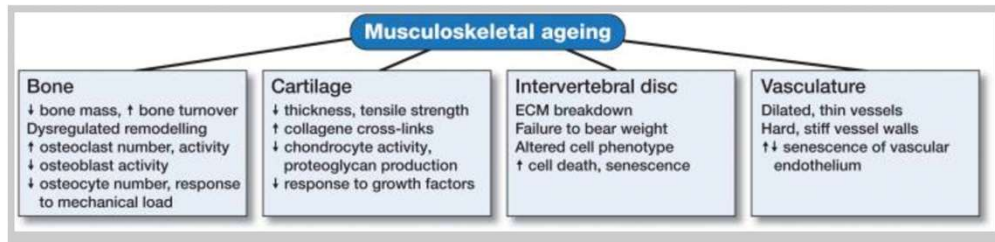
OBSERVATION	COMMENT
Decreased speed and strength	Muscle atrophy with decreased activity coupled with not enough time to workout
Decreased flexibility and joint range of motion	Generalized loss of plasticity of connective tissues with aging
Decreased standing height	Loss of turgidity of intervertebral discs, loss of disc spaces, collapse of discs and co
More susceptibility to and longer recovery time from injury	Decreased strength and injuries; longer healing endocrine/metabolic eff
Increased muscle stiffness after activity	Probably associated with tissues, decreased elasticity of muscles and longer time to carry away metabolic waste products generated by muscle with activity
Loss of bone mass	Multiple contributing factors: hereditary, decreased stresses to maintain bone strength, hormonal changes, nutritional deficiencies, decreased calcium absorption and bone resorption exceeding bone formation with aging

- Doorgaans minst goed gedefinieerd
- Enkel indien zeer uitgesproken CI voor duiken
- Factor die het meest doorweegt in beslissing om te stoppen met duiken

Strauss M, et al. UHM 2017, Vol. 44, No. 1

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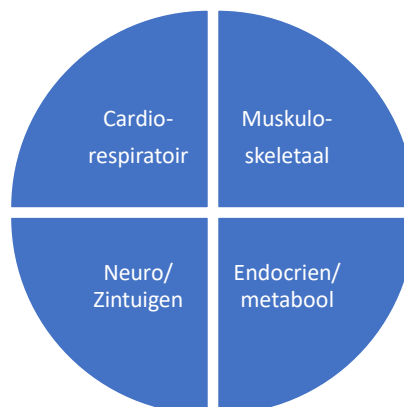
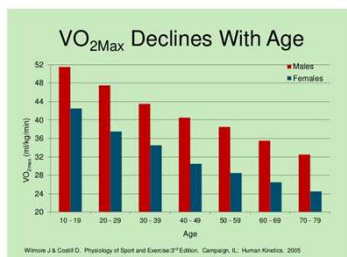
Muskuloskeetaal



Roberts S, et al. *Acta Orthop.* 2016; 87(Suppl 363): 15–25

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Veroudering van verschillende orgaansystemen



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CardioRespiratoir

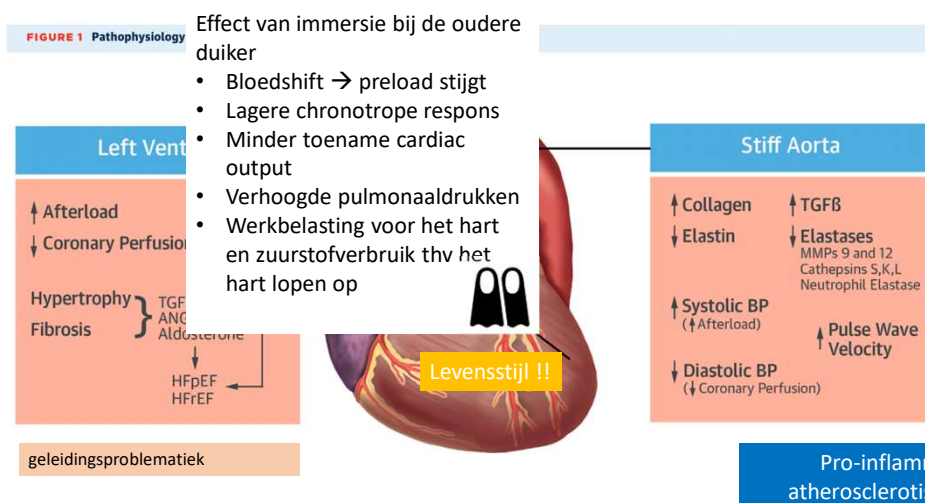
OBSERVATION	COMMENT
Cardiac alterations in heart valves and conduction system	Both decrease efficiency of heart function which, in turn, can interfere with fitness and reserve capacity for the stresses of exercise
Atherosclerosis of coronary arteries	Interferes with oxygen delivery to heart muscles; decreases cardiac output and reserve capacity
Age-related decreases in vital capacity and ventilator capacity	These changes cause more pulmonary effort for the same amount of ventilation, lowered maximal oxygen uptake capacity with maximal exercise and decreased breath-hold times
Adult onset asthma and chronic obstructive pulmonary disease	These interfere with ventilation and can be a source of air-trapping in the lungs during ascent from a scuba dive, a cause of arterial gas embolism
Peripheral artery disease	Interferes with perfusion to muscles during exercise thereby lessening maximal muscle effort and speeding the onset of fatigue
Requirement for anticoagulants and/or antiplatelet agents	Increases susceptibility to bruising and in the event of trauma or a shark bite (uncontrollable bleeding)

Strauss M, et al. UHM 2017, Vol. 44, No. 1

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Cardiovasculaire

Pathofysiologie verouderend CV stelsel



Paneni F, et al. JACC VOL. 69, NO. 15, 2017: 1952-67

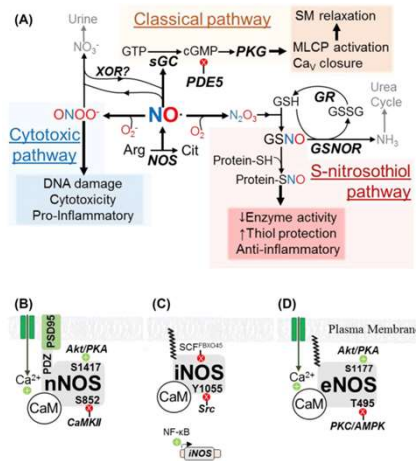
170

Cardiovasculair

Endotheel, NO

Lichaamsbeweging =
bescherming tegen
CVD

Veroudering gaat
gepaard met
achteruitgang
endotheel → pro-
inflammatoir @
atherosclerotisch
fenotype → CIHL



Duiken = extra
bescherming door
gewenning' aan
oxidatieve stress

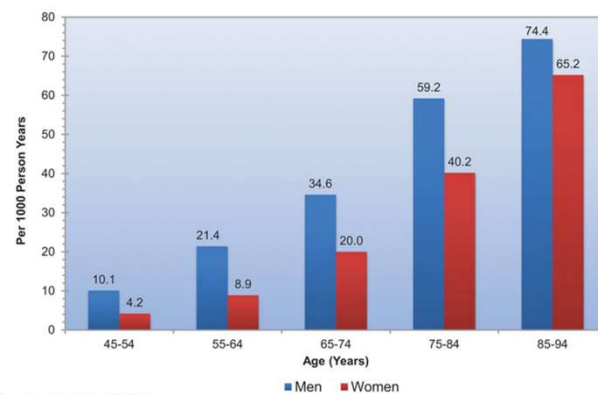
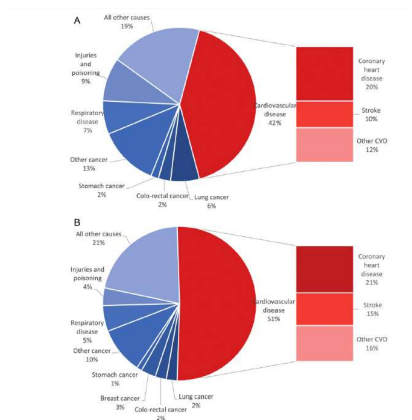
Duiken leidt tot
transiënte
endotheeldysfunctie,
ontstekingsrespons
en release van
micropartikels

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Cardiovasculair

Oorzaken van overlijden volgens geslacht (Europa)

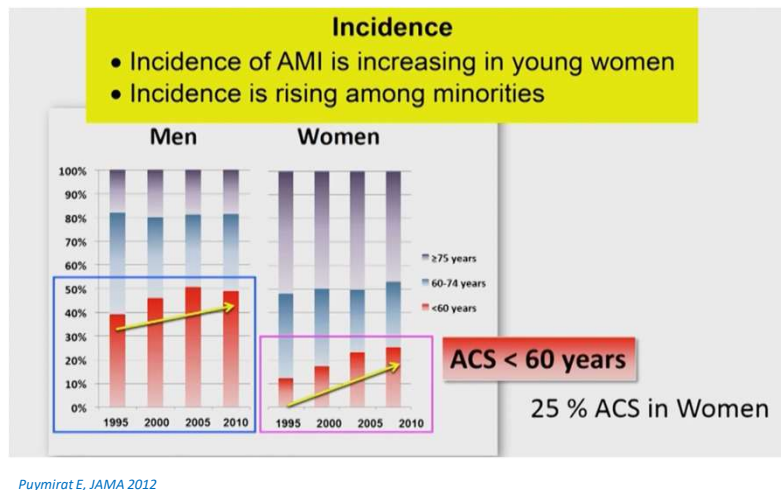
Voorkomen van hart- en vaatziekten volgens leeftijd en geslacht



172

Myocardinfarct bij Jonge Vrouwen

Toename incidentie vooral bij **Jonge Vrouwen**



Aandeel vrouwen <60 j is over 15 jaar verdubbeld !

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Cardiovasculair

Figure 6: Percentage of cardiac-related disabling injury among fatalities of various age groups (unpublished DAN fatality data)

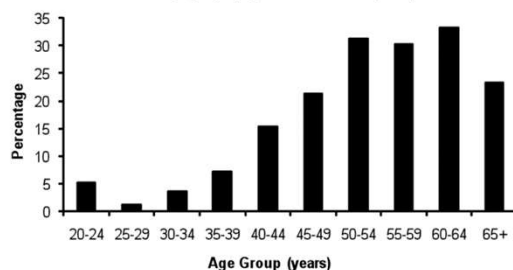
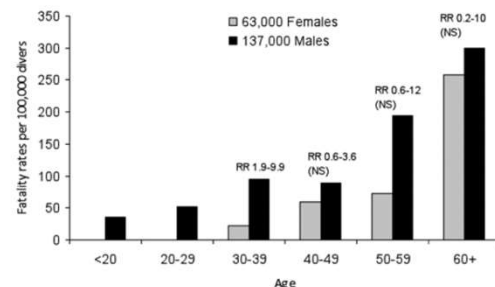


Figure 8: Fatality rates and relative risk of death for males and females in DAN Europe insured members, by age group, for 1996-2008

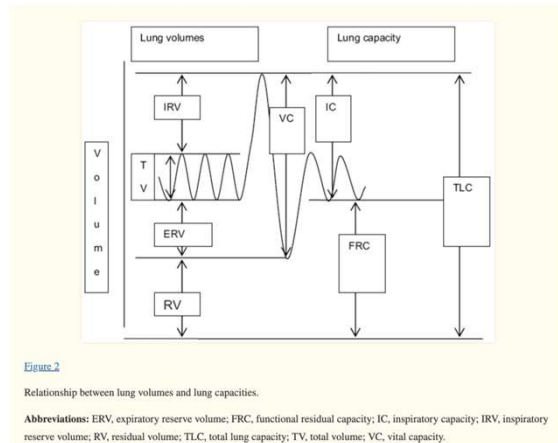


Similar trends with age and sex were observed for cases with cardiac events in the DAN Europe data but with higher rates (Figure 8). Up to age group 30-39, relative risks of fatalities were greater for males. For older age groups, risks were similar for both sexes.

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Respiratoir

Leeftijdsgebonden **respiratoire** veranderingen



Sharma G, et al. *Clin Interv Aging*. 2006 Sep; 1(3): 253-260

Anatomical and physiological changes of respiratory system with aging

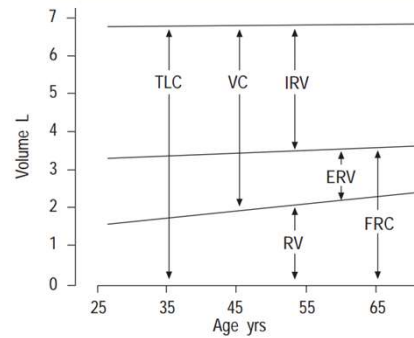


Fig. 1. – Evolution of lung volumes with ageing. TLC: total lung capacity; VC: vital capacity; IRV: inspiratory reserve volume; ERV: expiratory reserve volume; FRC: functional residual capacity; RV: residual volume. (Adapted from CRAPO *et al.*, 1982 [6].)

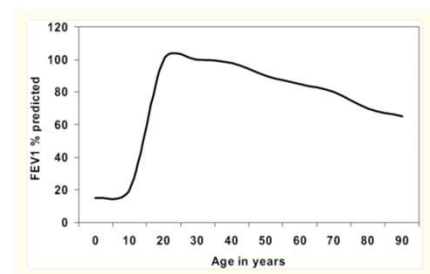
Janssens J, et al. *Eur Respir J* 1999; 13: 197-205

Ratio of CD4 ⁺ /CD8 ⁺ cells	Increased
Epithelial lining fluid antioxidants	Decreased

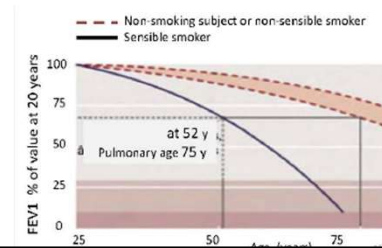
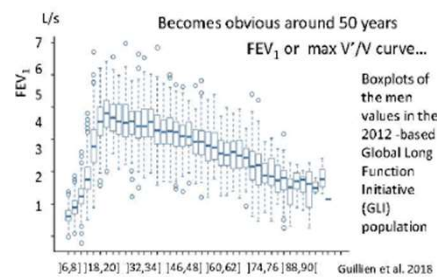
175

Respiratoir

Leeftijdsgebonden **FEV1** daling



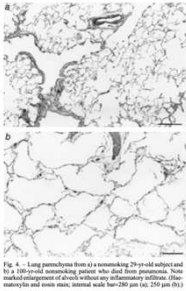
Sharma G, et al. *Clin Interv Aging*. 2006 Sep; 1(3): 253-260



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Respiratoir

Determinanten in leeftijdsgebonden longfunctie veranderingen



- Afname van de long-elasticiteit
- Toenemende stijfheid van de borstkaswand
- Afname van de kracht in de ademhalingspijpen

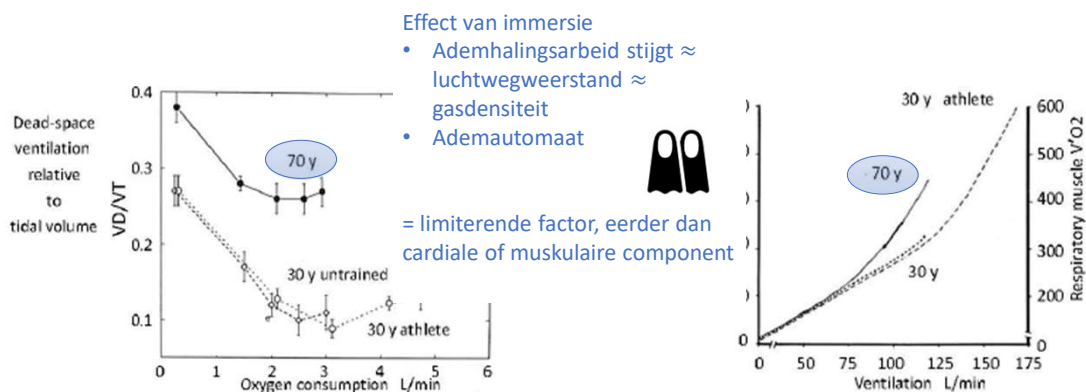
Aging and respiratory muscle strength

Study	Technique	Pdi (cm of H ₂ O)		Reduction	p-value
		Young	Elderly		
Toplep et al 1995	Mueller	171±8	128±9	25%	<0.003
Polkey et al 1997	Sniff	136±17	119±22	13%	0.05

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Respiratoir

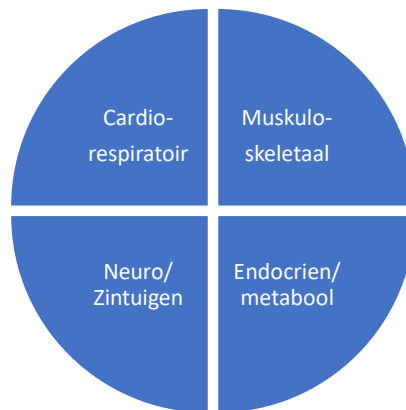
Veroudering leidt tot verlaagde ademhalings efficiëntie en verhoogde ademhalingsarbeid



Johnson BD. Clin Chest Med 1994

178

Veroudering van verschillende orgaansystemen



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Neurologisch

ELEMENT 2C: NERVOUS SYSTEM AND SENSORY ORGAN CHANGES WITH AGING	
OBSERVATION	COMMENT
Improved judgment and reasoning ability	Experience contributes to this one possibly positive change associated with aging
Decreased near object visual acuity (farsightedness)	Lens of the eye stiffens and decreases its ability to accommodate and focus on near objects
Decreased low light and color perception	Decreased opacity of lens and vitreous humor, with cataracts being an end point of lens clouding
Decreased auditory acuity, especially in the high-frequency range	Attributed to age-related changes (arthritis) aggravated by auditory trauma in the sound-conducting system of the ear
Balance, proprioception and coordination decrements	Probably multifactorial and related to aging changes in the musculoskeletal system; however, artists, craftsmen, surgeons, etc., often preserve these skills into older age
Increased reaction time	Probably similar to balance, etc., above, but cognitive function may contribute to the decision of whether to react or not

Strauss M, et al. UHM 2017, Vol. 44, No. 1

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Neurologisch

Veroudering van het cognitief functioneren

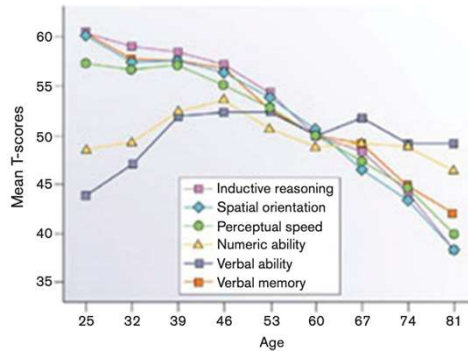


Figure 7 Cognitive changes in different domains across the life course. Cross-sectional data from the Seattle Longitudinal Study (reprinted with permission from Hedden and Gabrieli).¹⁶

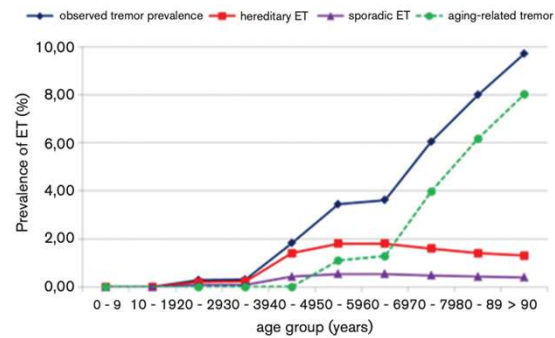


Figure 6 Tremor in older people (reproduced with permission from Deuschl et al).¹⁴

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Neurologisch

Veroudering van het cognitief functioneren

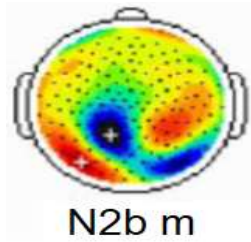
Afname van

- Werk- en korte termijngeheugen
- Vermogen tot multi-tasking
- Fijne motoriek
- Waakzaamheid en concentratievermogen
- Oriëntatievermogen
- Analyse- en oplossingsvermogen

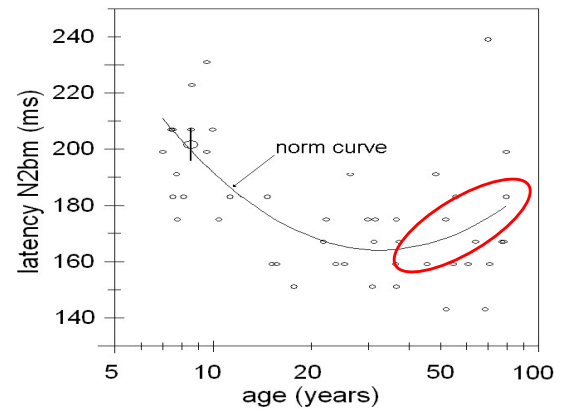
→ *Routine handelingen en complexe beslissingen worden minder evident!*

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Antwoord op bewegende schaakborden
160 channel MEG map
(magneto-encephalography)



n=82



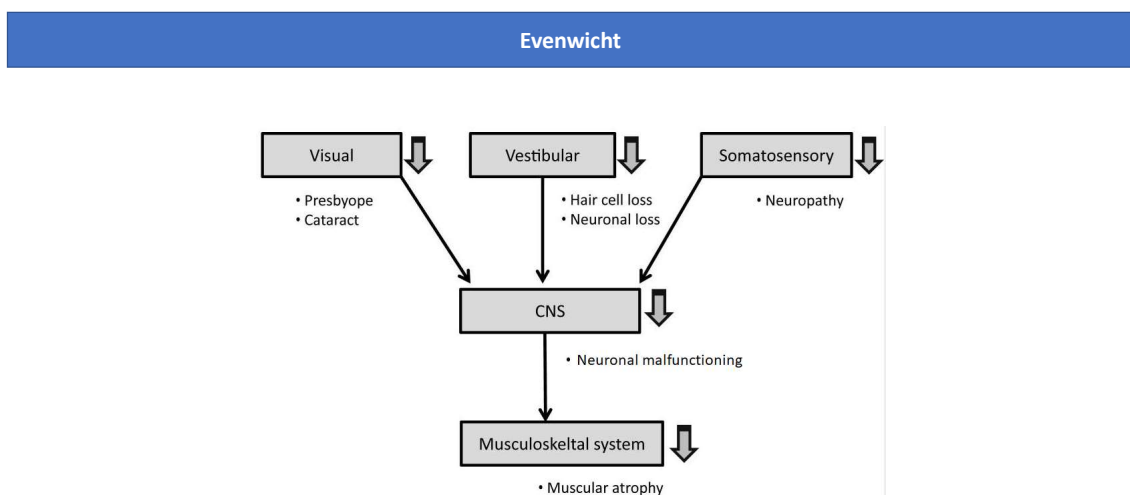
40 → 70 j ca. 7% trager

verwerking trager (latencies) → tijd psychometrisch antwoord ↑

Schellart et al. Vision Res. 2004;44:119-34

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Neurologisch



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Zintuigen

Oog

Table 3 Prevalence of ocular pathology by age

	Age (years)				
	40–49	50–59	60–69	70–79	>80
Blindness (acuity<6/60)	0.1%	0.1%	0.3%	0.8%	7.0%
Low vision (acuity<6/12)	0.2%	0.3%	0.9%	3.0%	16.7%
Myopia	36%	23%	17%	15%	18%
Cataract	3%	7%	20%	43%	68%
Glaucoma	1%	1%	2%	4%	8%

Adapted from data from the US National Eye Institute⁶

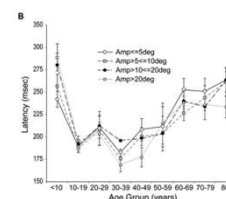
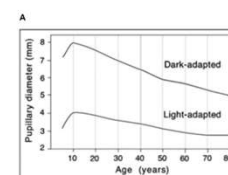
Schott JM. *Pract Neurol* 2017;17:172–182. doi:10.1136/practneurol-2016-001566

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Zintuigen

Oog

- Scherppte: bijna gehalveerd
- Statisch contrast gevoeligheid: 1/3
- Kleur contrast: 25-40% minder
- Helderheid in temporaal gebied: bijna gehalveerd
- Waarneming van beweging:
 - Snelle bewegingen: factor 3
 - Trage bewegingen: factor 2
- Nachtzicht neemt af (10 – 300 x minder gevoelig)
- Aanpassing aan duister gebeurt trager:
 - schemer: 30% trager
 - donker: >30% trager



Schott JM. *Pract Neurol* 2017;17:172–182. doi:10.1136/practneurol-2016-001566

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Zintuigen

Oor

Geluiden onder water

- Fauna (zwak)
- Ademautomaat
- Werktuigen
- Zee (branding)
- Schepen

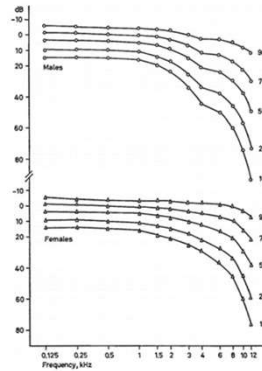
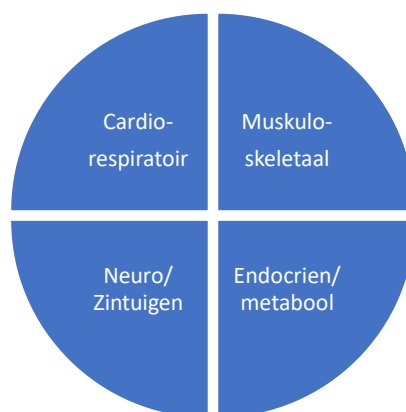


Figure 3 Change in hearing threshold (medians, quartiles, deciles) between 18 and 55 for men (upper panel) and women (lower panel). Reproduced with permission from Robinson and Sutton.¹⁰

Schott JM. *Pract Neurol* 2017;17:172–182. doi:10.1136/practneurol-2016-001566

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Veroudering van verschillende orgaansystemen



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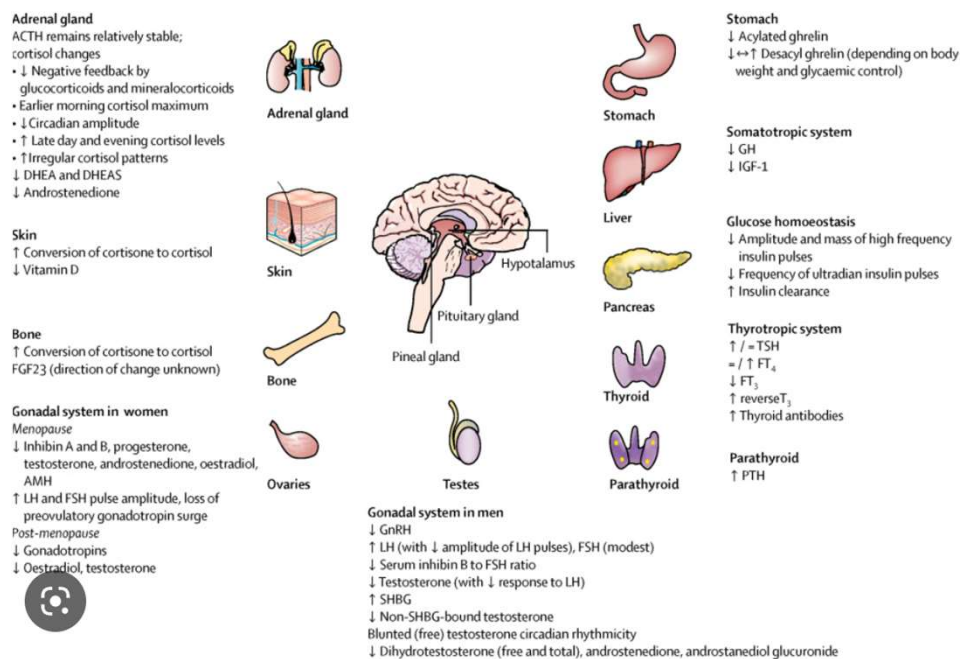
Endocrien - metabool

ELEMENT 2D: ENDOCRINE, METABOLIC AND SKIN CHANGES WITH AGING

OBSERVATION	COMMENT
Lowered metabolism rate	Poorer tolerance to cold water; weight gain without changes in amount of food intake, body fat redistribution and/or accumulation
Decrements in libido and sexual activity	Attributed to decreased sex-related hormone production, but other factors such as perfusion (Leriche's syndrome), neuropathy and psychological factors may contribute
Decreased stress (approach/avoidance) response	Probably related to adrenalin production by the adrenal glands
Altered drug metabolism	Attributed to age-related changes of liver and kidneys, but diseases, chemicals and injuries may be contributing factors
Decreased bone mass	Multiple contributing factors: hereditary, decreased stresses to maintain bone strength, hormonal changes, nutritional deficiencies, decreased calcium absorption and bone resorption exceeding bone formation with aging
Skin atrophy/decreased tolerance to insults	Contributing factors include loss of elasticity, wasting of subcutaneous fat, impaired moisturization, malnutrition, decreased turnover time, underlying deformities, and medications (e.g., warfarin)
Obesity	Increased susceptibility to decompression sickness due to the affinity of fatty tissue (5 times that of lean tissue) for nitrogen; fitting of thermal protection suits can be challenging, increased weights needed to achieve neutral buoyancy

Strauss M, et al. UHM 2017, Vol. 44, No. 1

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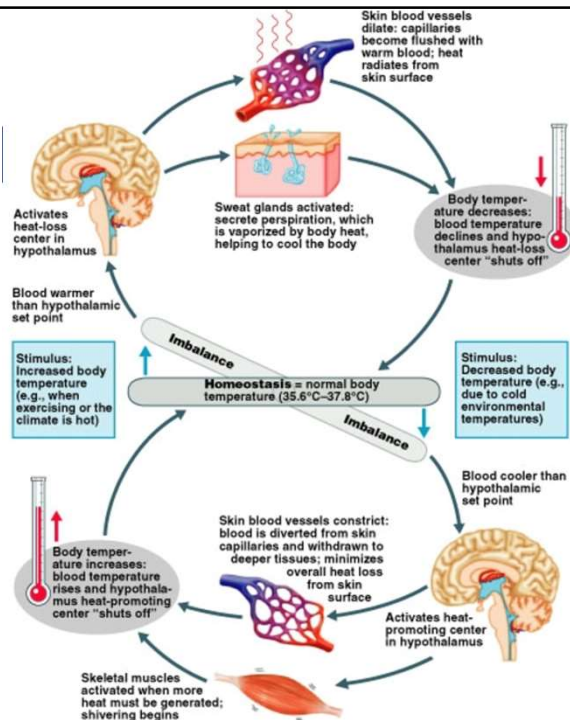


Van den Beld A, et al. AGEING AND ENDOCRINOLOGY 6(8), 647-658

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Thermoregulatie

Smolander J. Int J Sports Med 2002 Feb;23(2):86-92



- Older persons, particularly men over ca. 60 years, are less able to maintain core temperature during a given cold challenge compared to younger individuals. Older persons have a reduced cutaneous thermal sensitivity, and a reduced subjective thermal perception during cooling. Thus, older people may require a more intense stimulus to perform protective actions against cold stress.
- Older persons' skin vasoconstrictive response to cold is diminished compared to younger persons, which seems partly related to a reduced skin vasomotor sensitivity to sympathoneuronal stimuli.
- The cold-induced rise in metabolic rate is attenuated in older persons, but the mechanism is unknown. Both central and peripheral components seem to be involved in the age-related changes in regulatory effector functions.

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Fit do dive?

Individuele beoordeling



Lichamelijke
fitheid



Comorbiditeiten



Kracht,
mobiliteit

Absolute CI's

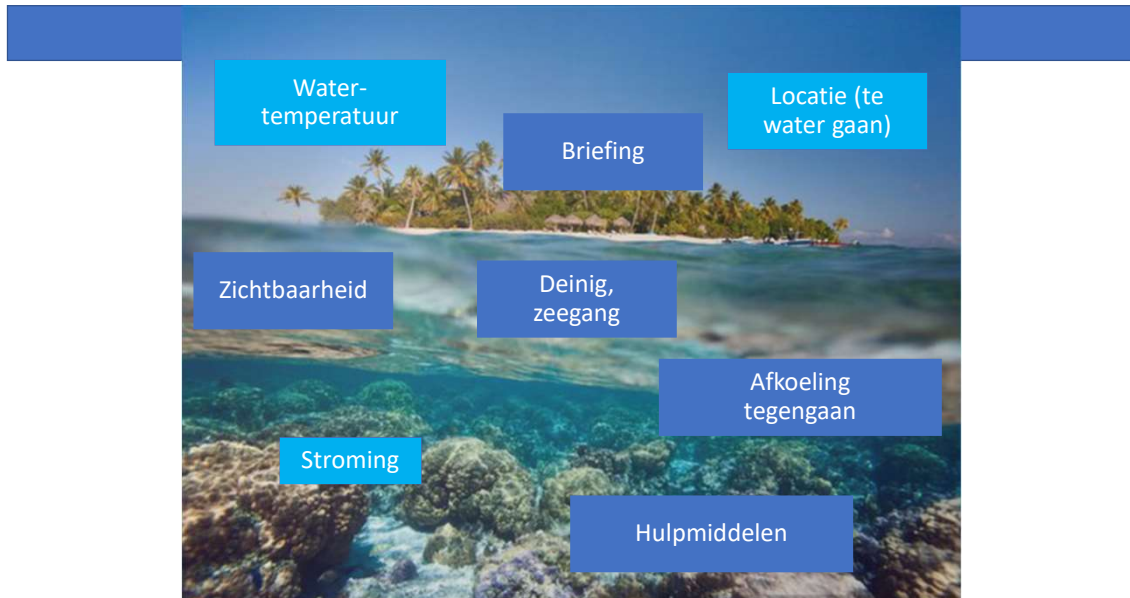
Relatieve CI's

'Veroudering'

"Safety usually means that the risks are judged acceptable in the context of the expected benefits."

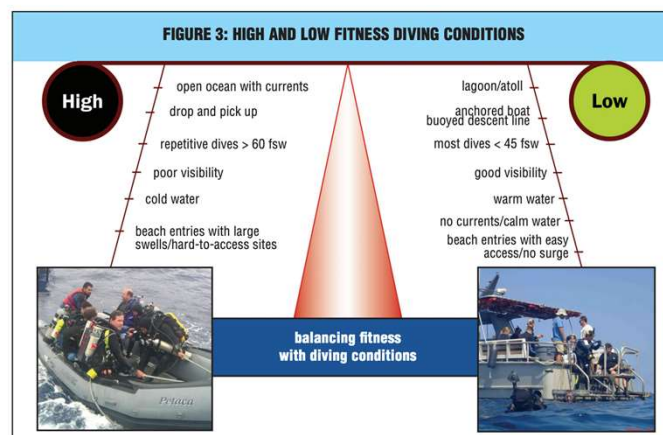
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Adviezen



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Adviezen



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Adviezen

TABLE 1: THE WELLNESS SCORE				
	assessment	2 points	1 point	0 points
		use half points if mixed or intermediate between 2 grades		
summate 5 assessments grade each from 2 (best) to 0 (worst)	activities of daily living	full	some	none
	ambulation	community	household	none
	comorbidities	no significant	impaired	decompensated
	smoke/steroid (whichever gives the lower score)	none	past	current
	neurological deficits	none	some	severe
interpretations applicable to scuba divers				
8 to 10 points = HEALTHY		OK to scuba dive		
4 to 7 points = IMPAIRED		possible diving		
0 to 3 points = DECOMPENSATED		no diving		

Strauss M, et al. UHM 2017, Vol. 44, No. 1

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Take home messages

- Veroudering thv alle orgaansystemen, individueel verloop, invloed van comorbiditeiten en levensstijl
- Leidt tot afname van
 - het prestatievermogen
 - de aanpassingsmogelijkheden voor de duikgebonden uitdagingen en beperkingen
- Uitzondering: Beoordelingsvermogen → kan compenseren voor achteruitgang op andere vlakken
- Fitt to dive:
 - geen zwart – wit beslissing
 - veiligheid primeert
 - fysieke ipv chronologische leeftijd
 - individuele beoordeling met aanpassingen
 - responsabiliseren
 - levensstijlmaatregelen (bewegen, voeding)
- Beschermd effect van duiken?

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**EEN DIEPERE DIJK IN DE
DIJKWERELD**

**25
MAART**

SPREKERS

- Prof. Dr. K. Tournay**
Is COVID nog een issue voor de duiksport?
- Prof. Dr. C. Mathieu & M. Roden**
Duiken en diabetes, don't en don'ts!
- Dr. H. van Bogaert**
Decompressiestress, wat moet je ermee?
- Dr. P. Germonpré**
Immersie/afkouding, kopje onder?
- Dr. C. De Maeyer**
De oudste duiken, een RASCO?

INSCHRIJVEN: WWW.DUIKARTS.BE/SYMPOSIUM_HTML



Vrije Universiteit Brussel
Human Physiology Research Group (MFYS)
WWW.BLITS.ORG




SPORT + KEURINGSARTSEN



**Dank aan
sprekers, sponsors, cateraars!
Prettig weekend en veilig
thuis!
Tot de volgende maal!**