



German

-



Austrian

-



Swiss

# *Guidelines for Diving Accidents*

Wilhelm Welslau

# ***Development***

***created 10/2002***

***update 10/2005***

***update 4/2008***

***update 3/2011***

***next update 2014***

## *Guideline versions*

- **GTÜM (Germany)** - german
- **GTÜM (Germany)** - english
- **ÖGTH (Austria)** - german
- **SUHMS (Switzerland)** - german
- **SUHMS (Switzerland)** - french
- **SUHMS (Switzerland)** - italian

# ***Development of guidelines***

## ***”Guideline for guidelines”***

### ***Levels of evidence***

**Level 1** ***Group of experts*** (representative, independant)

**Level 2** ***Consensus process***

- *Delphi conference*

- *Consensus conference*

- *representative audience*

- *independant steering committee (jury)*

**Level 3** ***Revision according to EBM standards***  
(*definition of study quality...*)

## ***Group of experts***

***Frank HARTIG (ÖGTH)***

***Wolfgang FÖRSTER (BG Bau)***

***Wolfgang HÜHN (VDD)***

***Peter KNESSL (SUHMS)***

***Konrad MEYNE (VDST)***

***Volker WARNINGHOFF (German Navy)***

***Wilhelm WELSLAU (GTÜM)***

## *Jury*

**Ulrich VAN LAAK** (*DAN Europe*)

**Alf O. BRUBAKK** (*DMAC, Norway*)

**Claudio CAMPONOVO** (*SUHMS, Switzerland*)

**Andreas KOCH** (*German Navy*)

**Peter MÜLLER** (*GTÜM, Germany*)

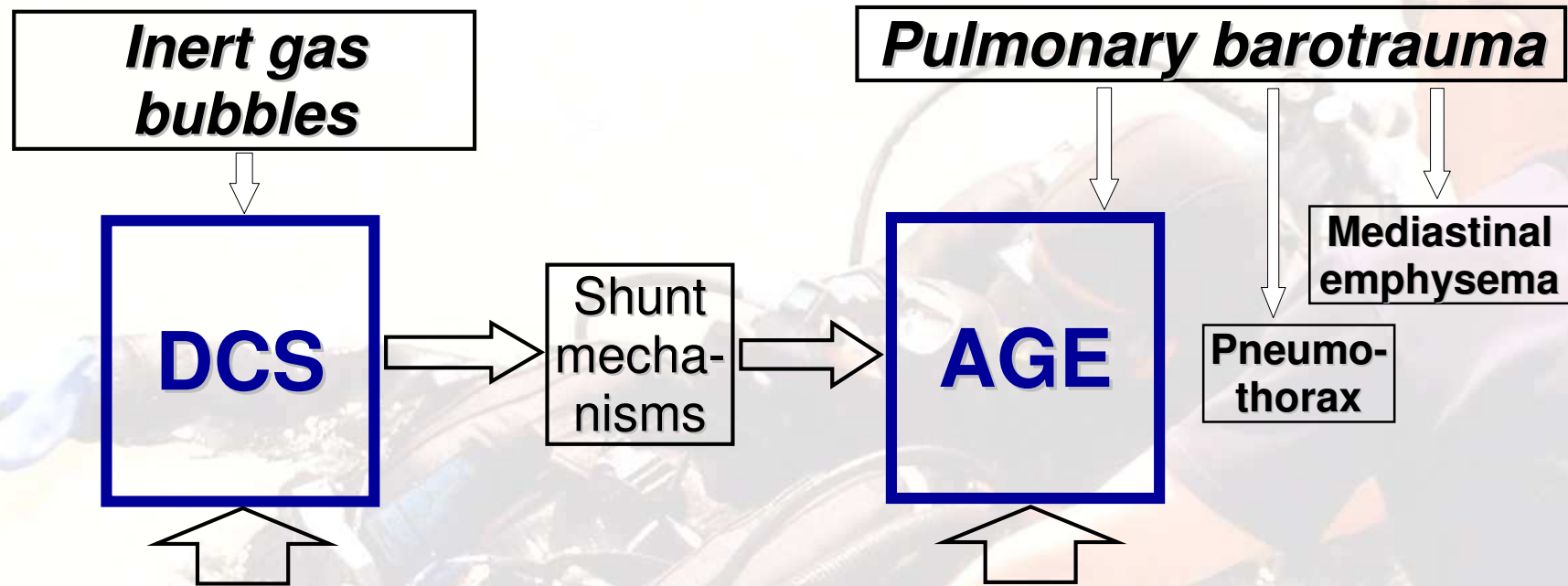
**Roswitha PROHASKA** (*EDTC, Austria*)

**Rob VAN HULST** (*Nederlands Navy*)

**Wilhelm WELSLAU** (*Group of Experts*)

## ***Content***

- ▶ *First Aid*
- ▶ *Transport*
- ▶ *Hyperbaric treatment*
- ▶ *Transport to treatment center*
- ▶ *Further hyperbaric treatments*
- ▶ *Fitness to dive*



**DCI**  
*Decompression Illness - Decompression Injury  
Decompression Incident*



## *Mild symptoms*

- ▶ Unusual tiredness
- ▶ Skin itching

## *Severe symptoms*

- ▶ Discoloration and alteration of skin
- ▶ Pain
- ▶ Tingling
- ▶ Physical weakness
- ▶ Numbness
- ▶ Paralysis
- ▶ Breathing troubles
- ▶ Vision, hearing or speech troubles
- ▶ Vertigo
- ▶ Nausea
- ▶ Impaired consciousness
- ▶ Unconsciousness

## *Mild symptoms*

- ▶ Unusual tiredness
- ▶ Skin itching

## *Severe symptoms*

- ▶ Discoloration and alteration of skin
- ▶ Pain
- ▶ Tingling
- ▶ Physical weakness
- ▶ Numbness
- ▶ Paralysis
- ▶ Breathing troubles
- ▶ Vision, hearing or speech troubles
- ▶ Vertigo
- ▶ Nausea
- ▶ Impaired consciousness
- ▶ Unconsciousness

## ***First aid for mild symptoms***

*(unusual tiredness / skin itching)*

- ▶ **Oxygen** (100%, for **every** breathing gas of divers )
- ▶ **Fluids** (0.5-1.0 ltr / h, no alcohol, no caffeine)
- ▶ **Examination** (,5 minutes neurocheck', DAN)

# ',5 minutes neurocheck' (DAN Europe)

Check No. 1		1. Orientation	Check No. 2	
Time:			Time:	
Yes	No		Yes	No
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver orientated to person (name, age)?	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver orientated to place (present location)?	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver orientated to time (present time, date)?	<input type="checkbox"/>	<input type="checkbox"/>
Yes	No	2. Eyes	Yes	No
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver able to recognize the number of fingers held in front of his face (2-3 tries)? First, test each eye separately, then both eyes together.	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver able to identify an object in the distance?	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver able to follow a finger moving in front of his face with his eyes while holding his head still? The finger should be moved from the right to the left and from the top to the bottom in a distance of approx. 50 cm. Look for a uniform movement of both eyes and for possible jerky movements in the extreme positions.	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	Are the diver's pupils equally wide and round and do they become narrower in the light? Look for left-right differences.	<input type="checkbox"/>	<input type="checkbox"/>

# ',5 minutes neurocheck' (DAN Europe)

<b>Check No. 1</b>		<b>1. Orientation</b>
<b>Time:</b>		
<b>Yes</b>	<b>No</b>	
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver orientated to person (name, age)?
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver orientated to place (present location)?
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver orientated to time (present time, date)?
<b>Yes</b>	<b>No</b>	<b>2. Eyes</b>
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver able to recognize the number of fingers held in front of his face (2-3 tries)? First, test each eye separately, then both eyes together.
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver able to identify an object in the distance?
<input type="checkbox"/>	<input type="checkbox"/>	Is the diver able to follow a finger moving in front of his face with his eyes while holding his head still? The finger should be moved from the right to the left and from the top to the bottom in a distance of approx. 50 cm. Look for a uniform movement of both eyes and for possible jerky movements in the extreme positions.
<input type="checkbox"/>	<input type="checkbox"/>	Are the diver's pupils equally wide and round and do they become narrower in the light? Look for left-right differences.
<b>Yes</b>	<b>No</b>	<b>3. Face</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to whistle. Look for a symmetric movement of both halves of the face and equal muscle tension on both sides.
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to „bare his teeth“. Look for a symmetric movement of both halves of the face and equal muscle tension on both sides.
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to close his eyes. Then touch the left and the right halves of his forehead and his face and ask the diver if the sensation is the same on both sites.
<b>Yes</b>	<b>No</b>	<b>4. Hearing</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to close his eyes. Then rub your index finger against your thumb ca. 50 cm away from the diver's right ear, then next to his left ear and ask the diver whether he perceives the sound in the same way on both sites. Repeat this check several times on both sites. In a noisy environment, the distance may be reduced and the source of noise should be blocked (ask those present for silence, turn off running engines).
<b>Yes</b>	<b>No</b>	<b>5. Swallowing reflex</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to swallow. Observe if his Adam's apple is moving up and down smoothly.

<b>Yes</b>	<b>No</b>	<b>6. Tongue</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to stick out the tongue. Observe if it is located exactly in the centre or somewhat to the right or to the left.
<b>Yes</b>	<b>No</b>	<b>7. Muscle strength</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to lift both shoulders, while applying a gentle pressure onto them with the palm of your hands. By doing this, it should be easy to determine if the diver is able to generate the same force on both sites or if there are left-right differences.
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to bend both arms at the elbow in a 90° angle. Then ask him to move his hands up, down and sideways, while you provide resistance to his movements with your hands. Assess potential left-right differences in strength.
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to lie down flat on his back. Then ask him to lift his knees against the resistance of your hands and to move his ankle joints up and down against your resistance.
<b>Yes</b>	<b>No</b>	<b>8. Sensory perception</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to close his eyes. Then touch the left and right halves of his torso in turn, then the outer and inner sites of his limbs and ask the diver, whether the sensation is the same on both sites. Assess and document the result of this test separately for each body part.
<b>Yes</b>	<b>No</b>	<b>9. Balance and motor coordination</b>
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to stand with his feet together and parallel, extend his arms in front of him, palms facing upwards and close his eyes. The diver should be able to keep his balance if he is not standing on shaky ground. <b>Caution:</b> During this test the diver might lose his balance and fall, you have to be prepared to catch him!
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to close his eyes. Then ask him to extend his arms in front of him and try to touch the tip of his nose alternately with his left and right index fingers. Assess potential left-right differences.
<input type="checkbox"/>	<input type="checkbox"/>	Ask the diver to lie down flat on his back. Ask him to alternately move his left and right heels over the shin of the opposite leg. Assess potential left-right differences.
<b>10. Additional remarks and observations:</b>		

## ***First aid for mild symptoms***

*(unusual tiredness / skin itching)*

- ▶ **Oxygen** (100%, for **every** breathing gas of divers )
  - ▶ **Fluids** (0.5-1.0 ltr/h, no alcohol, no caffeine)
  - ▶ **Examination** (,5 minutes neurocheck', DAN)
  - ▶ **Observation** (24 hrs.)
- 
- ▶ **if not free of symptoms within 30 min.:**  
treat like severe symptoms

## *First aid* for severe symptoms

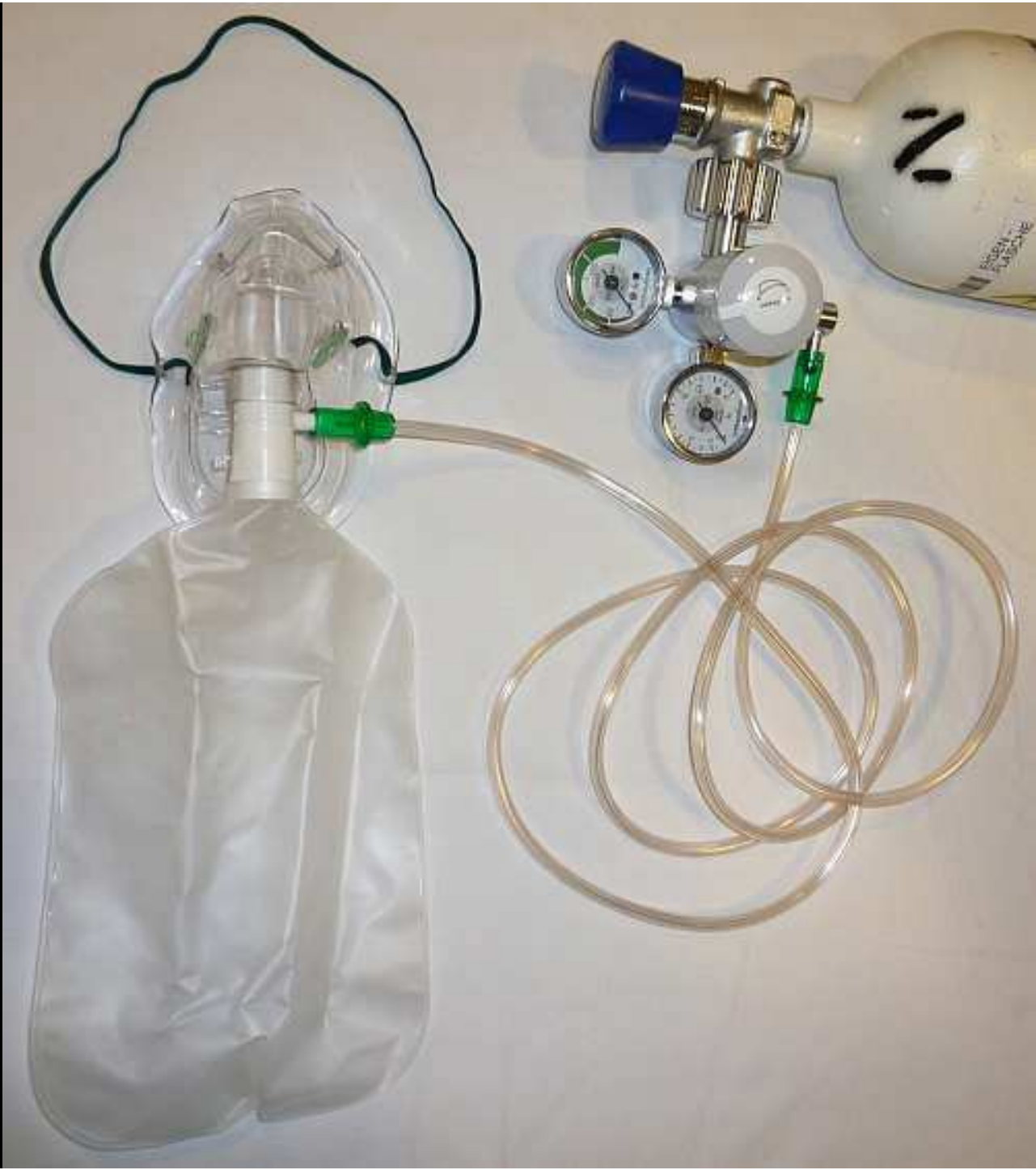
- ▶ **Cardio pulmonary resuscitation**  
following recommendations of  
European Resuscitation Council  
(ERC or AHA)

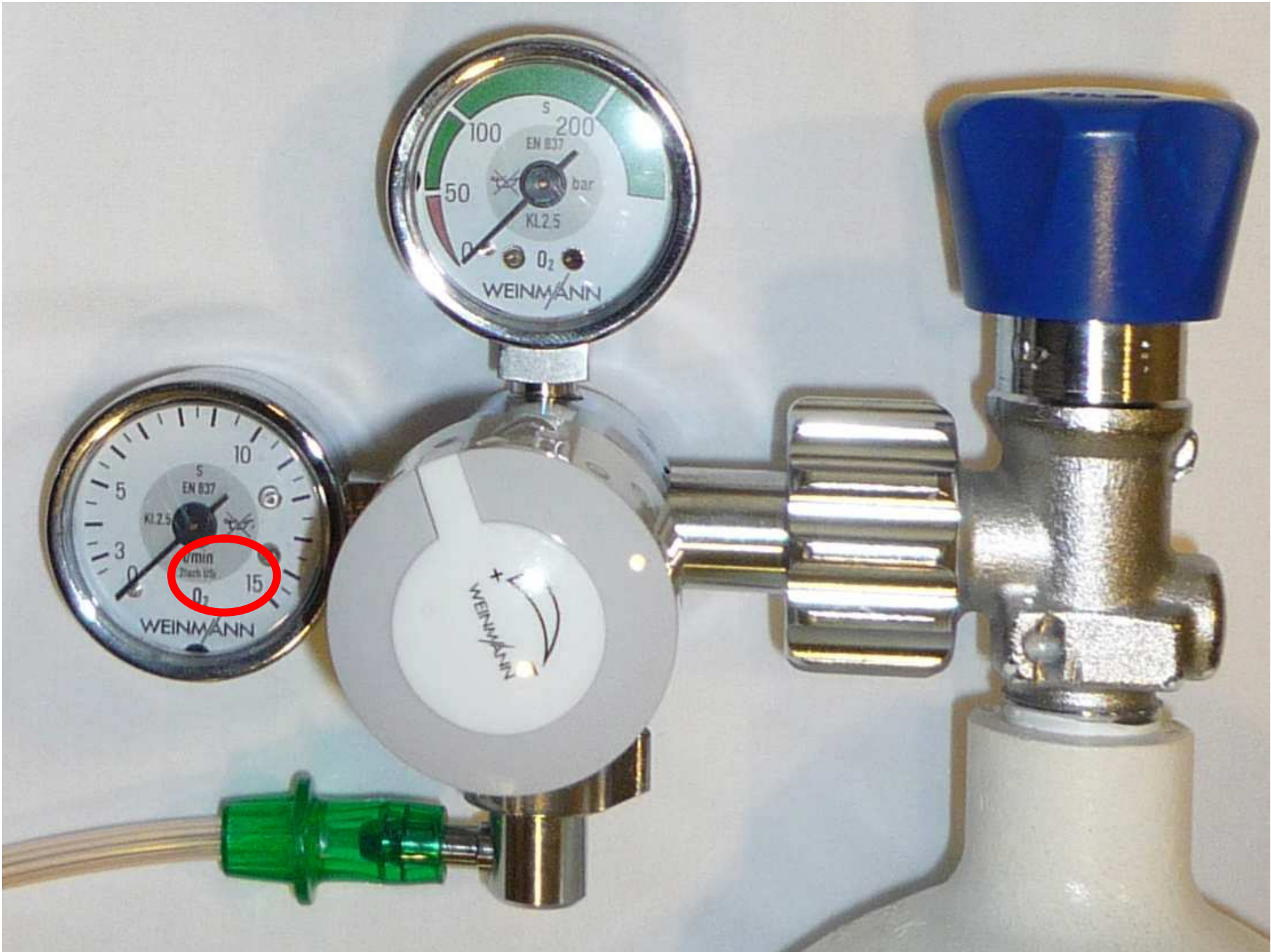
## *First aid for severe symptoms*

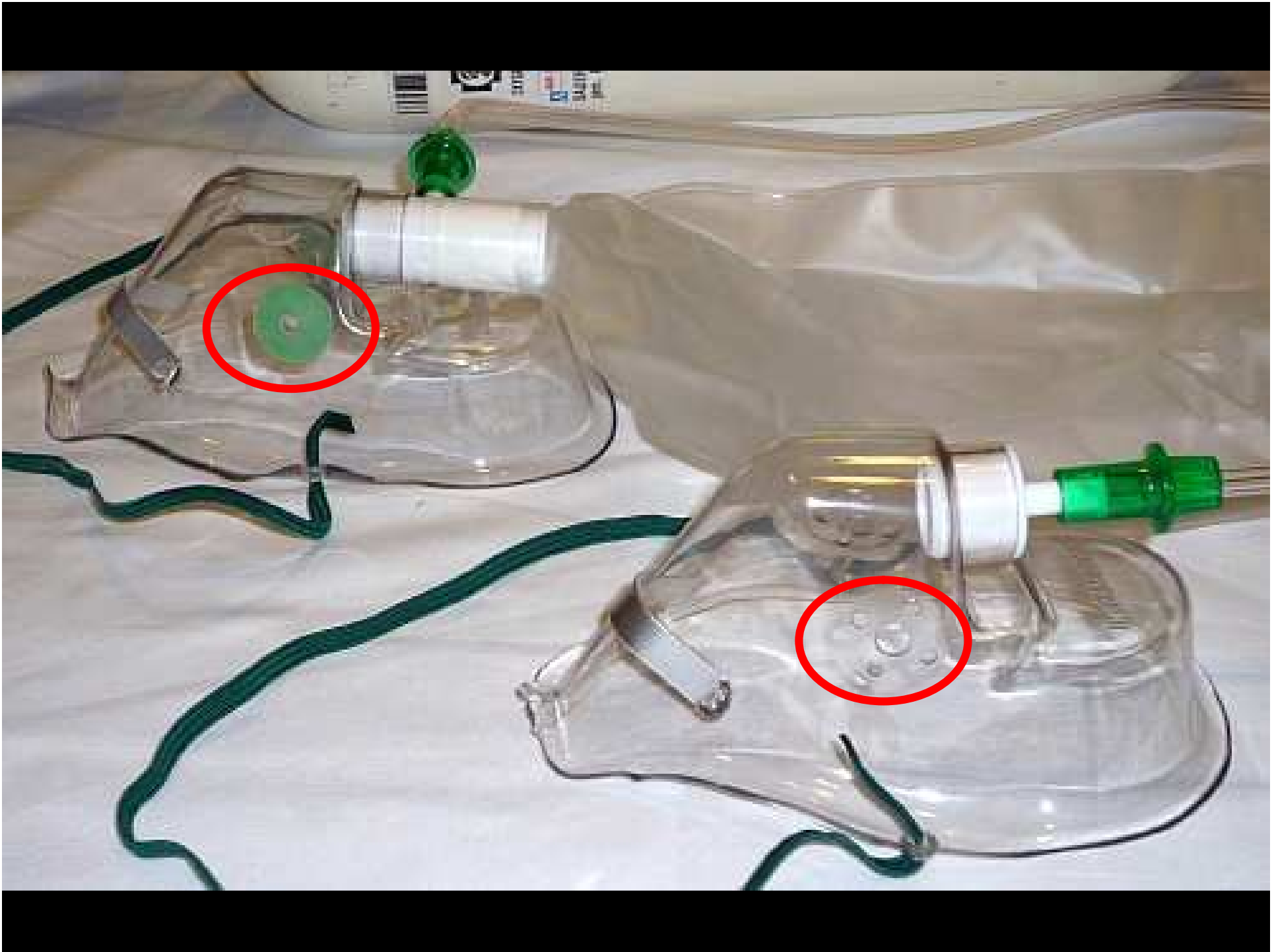
- ▶ **Supine position** (if **unconscious**: recovery position)
- ▶ **Fluids** (0.5-1.0 ltr/h, no alcohol, no caffeine)
  - ▶ **If fully conscious**: give fluids orally
  - ▶ **Impaired consciousness**: fluids only i.v.
- ▶ **Oxygen** (for **every** breathing gas of divers)
  - ▶ **as soon as possible, 100%**
  - ▶ **no breaks - until hyperbaric treatment**
  - ▶ **Demand valve or oxygen rebreather**  
**Only** if not available: 15-25 ltr/min constant flow











**NOT  
suitable**

**Constant flow  
pressure regulator with  
simple mask**

O<sub>2</sub> concentration

**30-50%**

**PROVISORY  
suitable**

**Constant flow  
pressure regulator with  
„high concentration“ mask**

- with reservoir bag
- with expiration valves

O<sub>2</sub> concentration

**60-70%**

**SUITABLE**



**Pressure regulator  
with demand valve  
tight fitting mask  
O<sub>2</sub> concentration  
**90-100%****



**SUITABLE for  
artificial respiration**

**Pressure regulator with demand  
valve and Ambu/Laerdal bag**

O<sub>2</sub> concentration

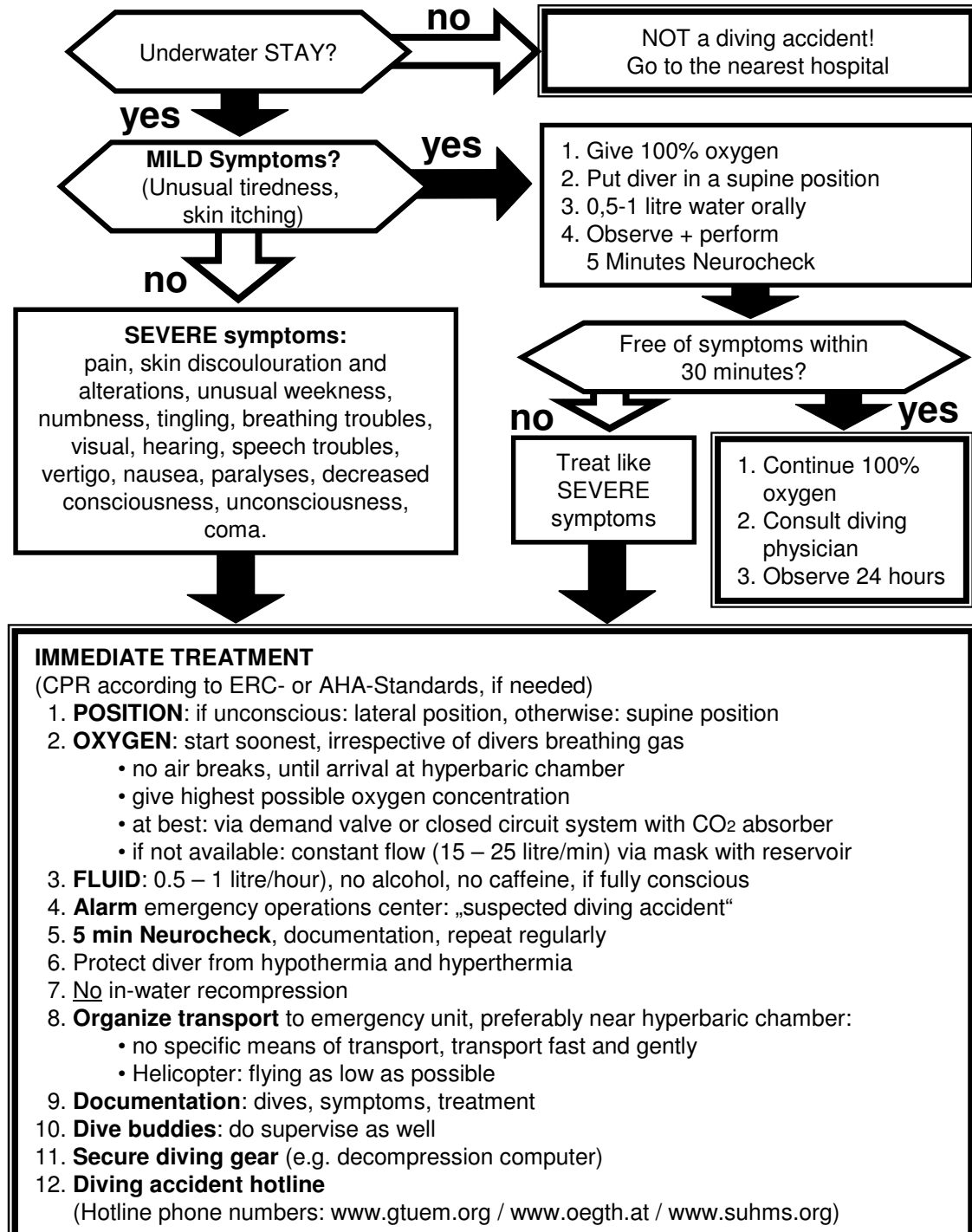
**90-100%**

## *First aid for severe symptoms*

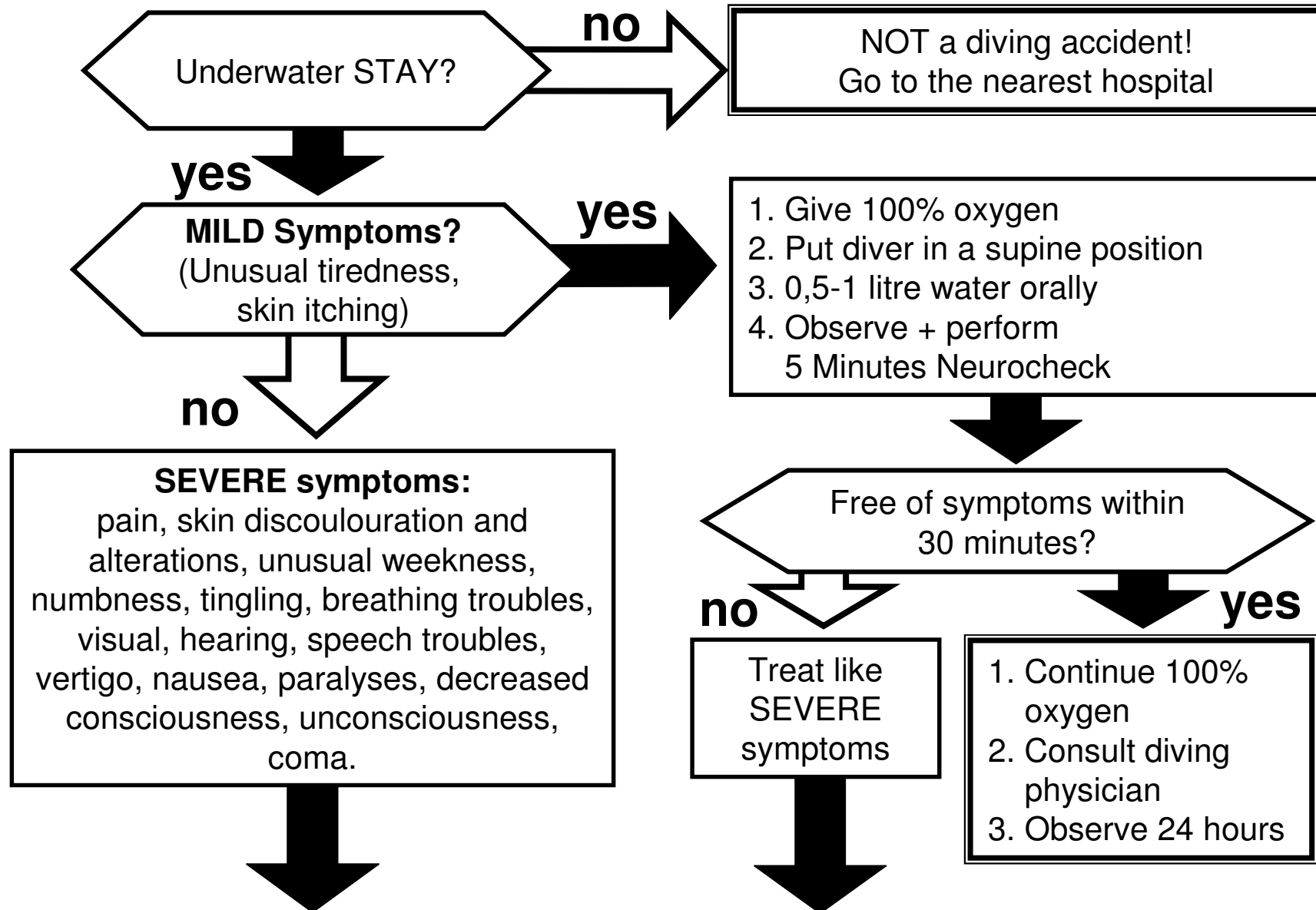
- ▶ **Supine position** (if unconscious: recovery position)
- ▶ **Fluids** (0.5-1.0 ltr/h, no alcohol, no Caffeine)
  - ▶ If fully conscious: give fluids orally
  - ▶ Impaired consciousness: fluids only i.v.
- ▶ **Oxygen** (for every breathing gas of divers)
  - ▶ as soon as possible, 100%
  - ▶ no breaks - until hyperbaric treatment
  - ▶ Demand valve or closed circuit system  
Only if not available: 15-25 ltr/min constant flow



*Flow chart  
modified from  
DAN Europe*



# Flow chart modified from DAN Europe



# *Flow chart modified from DAN Europe*

## **IMMEDIATE TREATMENT**

(CPR according to ERC- or AHA-Standards, if needed)

1. **POSITION:** if unconscious: lateral position, otherwise: supine position
2. **OXYGEN:** start soonest, irrespective of divers breathing gas
  - no air breaks, until arrival at hyperbaric chamber
  - give highest possible oxygen concentration
  - at best: via demand valve or closed circuit system with CO<sub>2</sub> absorber
  - if not available: constant flow (15 – 25 litre/min) via mask with reservoir
3. **FLUID:** 0.5 – 1 litre/hour), no alcohol, no caffeine, if fully conscious
4. **Alarm** emergency operations center: „suspected diving accident“
5. **5 min Neurocheck**, documentation, repeat regularly
6. Protect diver from hypothermia and hyperthermia
7. No in-water recompression
8. **Organize transport** to emergency unit, preferably near hyperbaric chamber:
  - no specific means of transport, transport fast and gently
  - Helicopter: flying as low as possible
9. **Documentation:** dives, symptoms, treatment
10. **Dive buddies:** do supervise as well
11. **Secure diving gear** (e.g. decompression computer)
12. **Diving accident hotline**  
(Hotline phone numbers: [www.gtuem.org](http://www.gtuem.org) / [www.oegth.at](http://www.oegth.at) / [www.suhms.org](http://www.suhms.org))

## *Further measures*

- ▶ **Examination** (,5 minutes neurocheck‘, DAN)
- ▶ **Organization of transport**
  - ▶ Emergency control centre  
( → Emergency unit ,close to a HBOT chamber‘)
- ▶ **Diving physician hotline**

## *Important:*

- ▶ **NO** in-water recompression
- ▶ **NO** direct alerting of hyperbaric chamber
- ▶ **NO** recommendation for specific infusions
- ▶ **NO** recommendation of specific medications
- ▶ **NO** specific medical measures  
besides emergency medicine SOPs

## *Chamber treatment*

### ▶ **Thoracic X-ray or thoracic CT scan**

before hyperbaric chamber treatment

- if pulmonary barotrauma is suspected
- if feasible within reasonable time frame

### ▶ **US Navy Treatment Table 6**

Table 6 is standard for first treatments

- **irrespective** of divers breathing gas







## *Further treatment*

- ▶ **Transport to hyperbaric treatment centre**
  - **soonest** after completion of first hyperbaric treatment
  - **always** case by case decision
- ▶ **Physiotherapy**
  - **max.** 3 days after diving accident
- ▶ **Termination** of hyperbaric treatments
  - **soonest** after standstill of symptoms for 3 to 5 days
- ▶ **Fitness to dive certificate** after diving accident
  - **only** by qualified and experienced physician  
(list of diving physicians at [www.gtuem.org](http://www.gtuem.org))

*Download of guideline at*  
***[www.gtuem.org](http://www.gtuem.org)***  
**→ *downloads***