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Relevance of studies on shock impacts for military routine

German Naval Medical Institute, Kronshagen/Kiel

Dr. med. Kai-Thorsten (KT) Bretschneider
Internal and Occupational Medicine

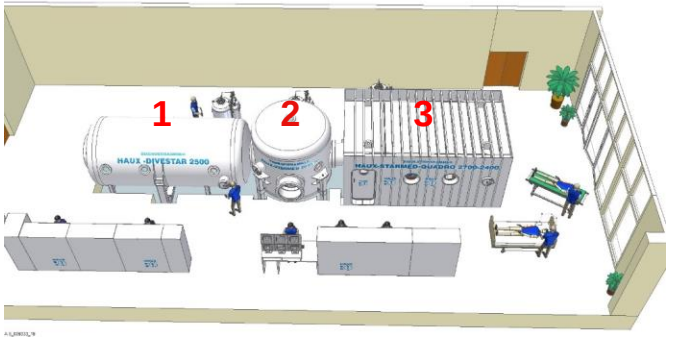
-- NATO unclassified --

BUNDESWEHR

Relevance of studies on shock impacts for military routine

Agenda

- Damages to health of speedboat crew members
- Present data of vibration measurement
- Force on the cervical spine
- Procurement project DEU Navy
- Occupational medicine considerations
- Need for further research



Damages to health of speedboat crew members

Empirical knowledge about acute and chronic health damages of speedboat crew members

- Musculoskeletal system

→herniated discs, vertebral fractures, lumbago, sprains, strains…

- Central nervous system

→hearing and concentration disorders, other mental limitations: tiredness, fatigue, unconsciousness…

- Short term reduction of mental and physical fitness with consequences for military operational capability

Triggering factors

Shock Impacts

- depending on weather and sea conditions, course, speed, driving behavior
- depending on posture, direction of view, individual anatomical conditions
- occur at short notice (“one wrong wave”) and cause acute health damage, reduced physical and mental performance and injuries
- no known limits and acknowledged measurement methods

Vibrations

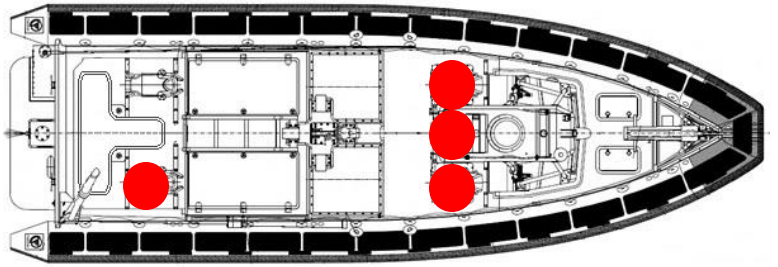
- arise due to the design, the engine, sea conditions, speed and course
- probably less depending on weather conditions and driving behavior
- have long-term exposure health consequences for the crew members
- limits and measurement methods are suitable to control of long-term hazards in a working life

Present data of vibration measurement

RHIB „BUSTER“ class (Fassmer SFB 10.1)
DEU Frigate Class F 125, August 2018, Helgoland

Friendly conditions

- Speed 26 kn
- Wave height 1,5 m 300° → 90°
- Wind speed 3,3 m/s 90°
- Course 315° → not against the wave, not against the wind
- Acceleration Z axis maximum 5,5 m/s²…?



(Acceleration of a car 0→100 km/h in 8 s = 3,5 m/s²)

Force on the cervical spine

Restricted measuring → limited calculations

- More than eight times the daily dose of vibrations

  → 40 years / 8 hours / 5 days a week RHIB…?

  → end of daily mission in relation to conditions after 8 minutes…?

- Limitation of assessability: seat cushion device

  → Reading of the seat, not of the person on it

- Derived from 2. Newton`s law:

  → Force = mass * acceleration (F = m * a)

- Weight of head 5 kg and acceleration 5,5 m/s²…?

  → F = 5 kg * 5,5 m/s² = 27,5 N…? (kg * m/s² = Newton)

Procurement project DEU Navy: Helmet for RHIB crews

Helmets to select

- Helmet 1: Weight 1,64 kg, metallic parts not salt water resistant (attachments, screws)
- Helmet 2 (“Buster”): no ballistic protection, not compatible to radio equipment (headphones)
- Helmet 3: Weight 1,72 kg, metallic parts not salt water resistant, not compatible to radio equipment (headphones)
- Helmet 4: Weight 1,25 kg, compatible to radio equipment, ballistic protection, salt water resistant

➢ Favored by Procurement Agency of Bundeswehr (“BAAInBw”): Helmet 1

➢ Favored by RHIB crews DEU Navy: Helmet 4

Attempt at calculation

- Weight of 2013 planned helmet 4,0 kg
- Weight of actual helmet (use expired) 1,8 kg
- Weight of favored helmet No. 4 1,25 kg
- Weight of additional equipment each helmet 1,65 kg
- Total spine load: weight of person + equipment > 120 kg

Weight of head + helmet + additional equipment	Load on the cervical spine: F = m * a
2013 planned helmet: 5 kg + 4,0 kg + 1,65 kg = 10,65 kg	10,65 kg * 5,5 m/s² = 58,58 N
Actual helmet: 5 kg + 1,8 kg + 1,65 kg = 8,45 kg	8,45 kg * 5,5 m/s² = 46,48 N
Helmet 4: 5 kg + 1,25 kg + 1,65 kg = 7,9 kg	7,9 kg * 5,5 m/s² = 43,45 N

-25,8%

Occupational medicine considerations

Real and felt load on the cervical spine

- Unit of gravity acceleration: G-force (g)
- Simplified calculation of the felt weight of head with helmet during acceleration:

1. The direction of gravity is down (9,81 m/s²), that of acceleration in any direction.
2. The two forces add up to each other according to their angle.
3. Assumed angle through shock impact of 180° (=Z axis).
4. Acceleration through shock impacts with 20 g / 30 g / 40 g* …?

Helmet 2013 in total 10,65 kg	4074,584 N	415,35 kg
Helmet 4 in total 7,9 kg	3022,461 N	308,1 kg

- Lateral force from cornering…?
- Effects by twisted spine…?

*Forces up to 50 g for fractions of a second in the Helgoland campaign 2018 documented

Need for further research

Questions

- What are the real forces on the anatomical structures?
- What are the effects of the position in the boat and the conditions of the trip?
- What are the short, medium and long-term stresses on crews?
- What corresponding effects on their health can be expected in the short, medium and long term?
- What possibilities of prevention exist in the military context?
- Can evidence-based medical recommendations on exercise limits and recovery times be given?
- Are measuring instruments with or without scaling conceivable?

Thank you for your attention