Conflict of Interest Declaration

No conflicts of interest
Overview

- Introduction: definitions in balneology
- Research areas in balneology
- Basic research: examples
- Translational aspects: examples
- Outlook: research priorities
Definitions in balneology
Use of terms

• The term “Hydrotherapy” is not defined consistently all over the world, e.g.
  • UK: exercise in pools
  • Germany: treatments according to Kneipp and related applications of water

• Related terms are:
  • balneotherapy, crénotherapy
  • physiotherapy
  • naturopathy

• The lack of consistent definition is a significant barrier for research especially for meta-analyses in the field of hydrotherapy and balneotherapy
Proposal for definitions

A proposal for a worldwide definition of health resort medicine, balneology, medical hydrology and climatology

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Abstract Health Resort Medicine, Balneology, Medical Hydrology and Climatology are not fully recognised as independent medical specialties at a global international level. Analysing the reasons, we can identify both external (from outside the field) and internal (from inside the field) factors. External arguments include, e.g. the lack of scientific evidence, the fact that Balneotherapy and Climatotherapy is not used in all countries, and the fact that Health Resort Medicine, Balneology, Medical Hydrology and Climatology focus only on single methods and do not have a comprehensive concept. Implicit barriers are the lack of international accepted terms in the field, the restriction of being allowed to practice the activities only in specific settings, and the trend to use Balneotherapy mainly for wellness concepts. Especially the implicit barriers should be subject to intense discussions among scientists and special-promotion, prevention, treatment, and rehabilitation. The use of natural mineral waters, gases and peloids in many countries is called balneotherapy, but other (equivalent) terms exist. Substances used for balneotherapy are medical mineral waters, medical peloids, and natural gases (bathing, drinking, inhalation, etc.). The use of plain water (tap water) for therapy is called hydrotherapy, and the use of climatic factors for therapy is called climatotherapy. Reflecting the effects of health resort medicine, it is important to take other environmental factors into account. These can be classified within the framework of the ICF (International Classification of Functioning, Disability and Health). Examples include receiving health care by specialised doctors, being well educated (ICF-domain: e355), having an environment supporting social contacts (family, peer groups) (cf. ICF-domains: d740, d760),...
Health resort medicine

The field

- Medicine (diagnostic and treatment) in health resorts (health promotion, prevention, therapy, rehabilitation)

Core elements

- Use of (natural) mineral waters, gases and peloids
- Use of (plain) water
- Use of climatic factors
- Use of other therapeutic factors
- Use of environmental factors

Modalities (methods)

- Bathing
- Drinking
- Inhalation
- Head-out immersion
- Application to body parts

Agents (substances, factors)

- CO₂, H₂S, Brine, and others
- HCO₃, SO₄, and others
- NaHCO₃, NaCl, and others
- Under water Exercise
- Thermotherapy
- Hydrogalvanic baths
- Others

..to be continued
Definitions

- **Hydrotherapy**: use of (plain) water for prevention, therapy and rehabilitation including
  - immersion
  - exercise in pools
  - water jets (thermotherapy, pressure)
  - and others

- **Balneotherapy**: use of mineral waters, gases and peloids for prevention therapy and rehabilitation including
  - bathing
  - drinking
  - inhalation
  - and others

Definitions

- **Health resort medicine**: performance of comprehensive medical concepts for prevention, therapy and rehabilitation including
  - change of environment
  - medical examination
  - balneotherapy
  - hydrotherapy
  - physiotherapy
  - climate
  - diet
  - psychotherapy
  - education
  - cultural factors
  - and others

Thresholds for acting substances (examples\(^1\))

- **Mineral water bathing\(^1\):**
  - Carbon Dioxide (> 500 mg CO\(_2\)/l)
  - Sulphur (> 1.0 mg S/l)
  - Brine (> 240 meq NaCl/l)

- **Mineral water drinking\(^2\):**
  - Hydrogen Carbonate (> 1,200 mg HCO\(_3\)-/l)
  - Sulphate (> 1,300 mg SO\(_4\)-/-l)
  - Calcium (> 500 mg Ca\(^{++}\)/d)
  - Magnesium (> 300 mg Mg\(^{++}\)/d)
  - Fluoride (> 1 mg F\(^-\)/d)

\(^1\)“Begriffbestimmungen” des Deutschen Heilbäderverband
\(^2\)Gutenbrunner & Hildebrandt 1994; 1998
Research areas in balneology
Hypothesis

Causality:
event (cause) is regularly followed by second event (effect)

Methods: measurement, evaluation

Source: www.wikipedia.org
Types of studies in Balneology

• **Studies on modalities in balneology:**
  - physiological effects (healthy subjects)
    - acute effects
    - long-term effects (adaptation)
  - clinical effects (patients with defined health conditions; ICD)
    - acute effects
    - long-term effects (efficacy)

• **Studies on combined health resort treatments** (patients with defined functional deficits; ICF):
  - short-term effects (before vs. after treatment)
  - long-term effects (e.g. 6, 12, 24 month after the treatment)
  - cost-effectiveness (e.g. one year after the treatment)
Basic research: examples
Effects on skin microcirculation: CO$_2$

Skin blood flow (Laser-Doppler)

- with CO$_2$-gas:
  - 30°C; 75% r. hum.
  - 30°C; 100% r. hum.
  - 35°C; 75% r. hum.
  - 35°C; 100% r. hum.
  - n=17 each

- without CO$_2$-gas:
  - 30°C; 100% r. hum.
  - n=10

Physiological effects: \( \text{H}_2\text{S} \) & pain perception

ANOVA:
- \( p=0.000 \) (modalities)
- \( p=0.001 \) (sides)

ipsilateral [*]
contralateral [*]

n=17 each

*** bzw. °°°=p<0.001

Effects of H$_2$S: Interleukin expression

**Figure 3** Short-term exposure of FLSs to low concentrations of NaHS diminishes IL-6 expression for up to 12 h
BN09 and BN18 cells were left untreated or were preincubated for 1 h with 0.125 mM (A and B) or 1.0 mM NaHS (C and D). At the indicated time points, IL-6 release was quantified by ELISA. FLSs preincubated with different dilutions of thermal water taken from the sulfur spring in Vienna-Oberlaa showed also reduced levels of IL-6 (E and F).

**Figure 5** Long-term exposure of FLSs to H$_2$S leads to elevated IL-6 expression and reinforced activation of p38 MAPK and ERK1/2
BN09 (A) and BN18 (B) cells were treated for 6 h with 0.125 mM NaHS. At the indicated time points, IL-6 in cell culture supernatants was quantified by ELISA. Activation of p38 MAPK, MEK1/2 and ERK1/2, respectively, was confirmed by Western blot experiments (D). Activation of MAPKs is not linked to an activation of NF-$\kappa$B. As shown in (D), ixBx, the inhibitor of NF-$\kappa$B, was not degraded during incubation of FLSs with NaHS.
Translational aspects: examples
Translational aspects

• Use results from basic research for clinical application (in particular for those diseases where we do not have effective standard protocols)

• Relevant mechanisms (examples):
  ◦ Effects on circulatory functions
  ◦ Effects on pain mechanisms
  ◦ Effects on immune system
  ◦ Effects on autonomous and mental functions (e.g. sleep, depression)

• Priority fields (examples):
  ◦ Chronic widespread pain syndromes (and fatigue)
  ◦ Complex regional pain syndrome
  ◦ Arterial occlusive disorders, venous insufficiency, ulcers
  ◦ Wound healing problems
  ◦ Inflammatory and allergic skin disease
Clinical trials: CO₂ & arterial occlusive disorder

Clinical trials: CO₂ & CRPS

Pain intensity in patients with CRPS during 8 weeks of CO₂ bathing (5 times per week) (Group A; n=20) and controls (Group B; n=20) (from Mucha C, Phys Rehab Kur Med 1992; 2: 173-178)
Clinical trials: CO\textsubscript{2} & wound healing (case reports)

48 years old patient after burn injury. Before and two weeks after CO\textsubscript{2} bathing (2 times per day) (from Werner et al., Z Phys Med Baln Med Klim 1990; 19: 52-56)
H$_2$S bathing in rheumatoid arthritis

![Graph showing pain intensity in rheumatoid arthritis patients with H$_2$S bathing compared to tap water baths.](image)

- **Sulphur baths**
- **Tap water baths**

Pain intensity (VAS)
Patients with R.A.

* = p<0.05
** = p<0.01

Clinical trials: H₂S & fibromyalgia

Clinical trial: H$_2$S & hand osteoarthritis

**Table 4** Comparison of data of the two groups (GLM repeated measures analysis)

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<thead>
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<th>Measures</th>
<th>$F$</th>
<th>p value</th>
<th>Effect size</th>
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<tr>
<td>Pain</td>
<td>7.421</td>
<td>&lt;0.001</td>
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<td>MJS</td>
<td>1.458</td>
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<td>Grip strength/right hand</td>
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<td>HAQ</td>
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<td>EQVAS</td>
<td>4.073</td>
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Research priorities
Outlook: research priorities

• Research on mechanisms of acting substances in mineral waters, gases and peloids, e.g.
  ◦ pain mechanism
  ◦ immune functions
  ◦ wound healing

• Clinical trials on the use of mineral waters, gases and peloids with specific actions, e.g.
  ◦ ulcers
  ◦ pain syndromes
  ◦ skin disease

• Defining minimum thresholds of effective concentrations (*based on dose-effect relations*)
Research, Basic and Translational Sciences in Balneology

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Thank you for your attention!