# HUMIDIFICATION IN HEALTHCARE

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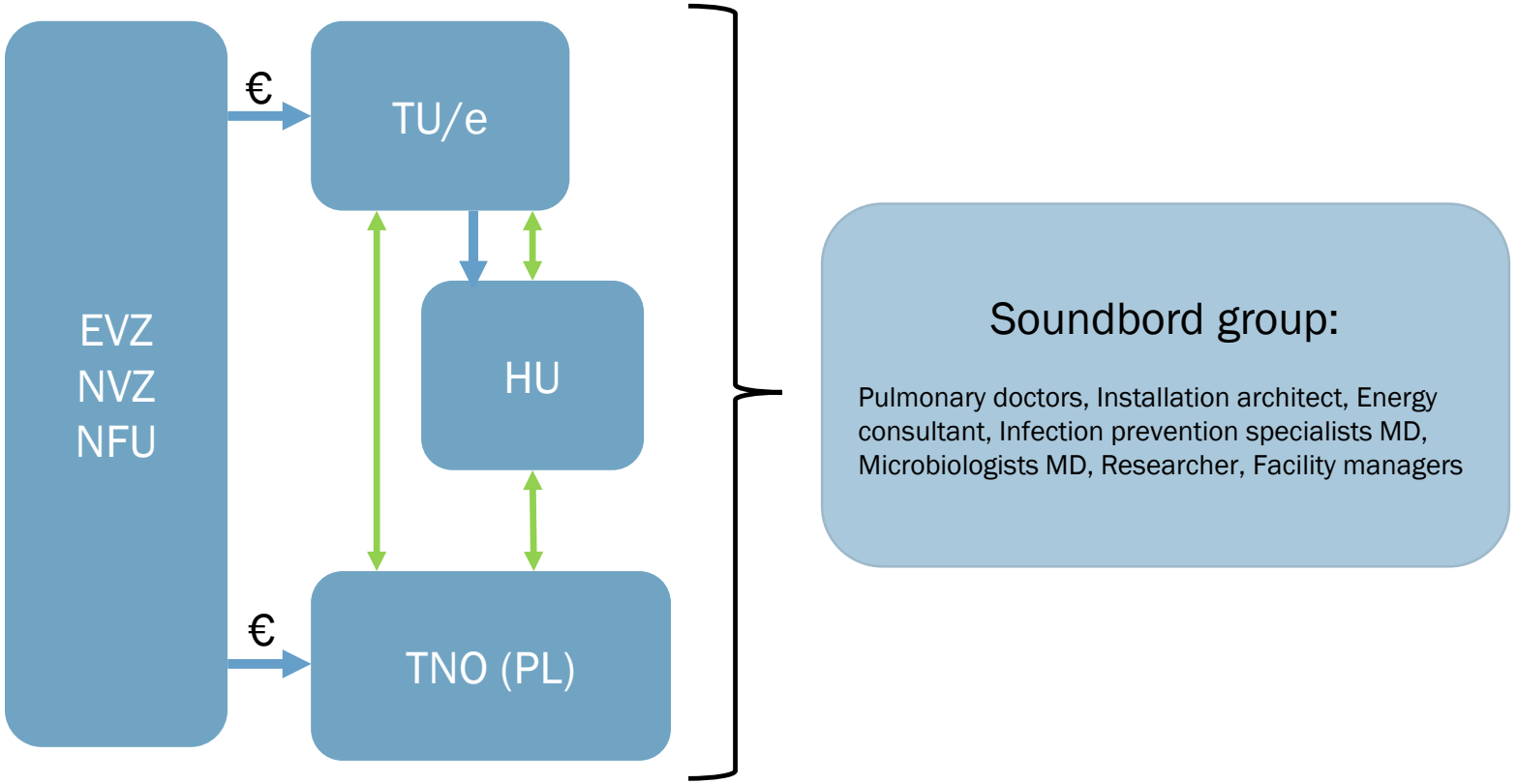
# COLLABORATION

## RESEARCH INITIATED FROM EXPERTISECENTRUM VERDUURZAMING ZORG (EXPERTISE CENTRUM FOR HEALTHCARE SUSTAINABILITY)

- Collaboration between:
  - University of Technology Eindhoven
  - University of Applied Sciences Utrecht
  - TNO (Projectlead)
- Funding
  - EVZ
  - NVZ
  - NFU



# MOTIVE

## HUMIDIFICATION IS ENERGY INTENSIVE

- In general: based on the reduction of natural gas consumption and $CO_2$-emission,
- Humidification is an energy intensive process and natural gas is mainly used for this,
- Limited energy efficient alternatives present,
- Parties involved seem to keep strict boundary conditions for humidification.

# RESEARCH QUESTIONS AND METHOD

A. What is the need for humidification in healthcare from the point of view of safety and comfort of patients and employees and is there a distinction in building functions?

1. Humidification in relation to micro-organisms and viruses
2. Effect of humidification on functioning of medical equipment
3. Effect of humidification on human physiology
4. Effect of relative humidity on well-being and comfort

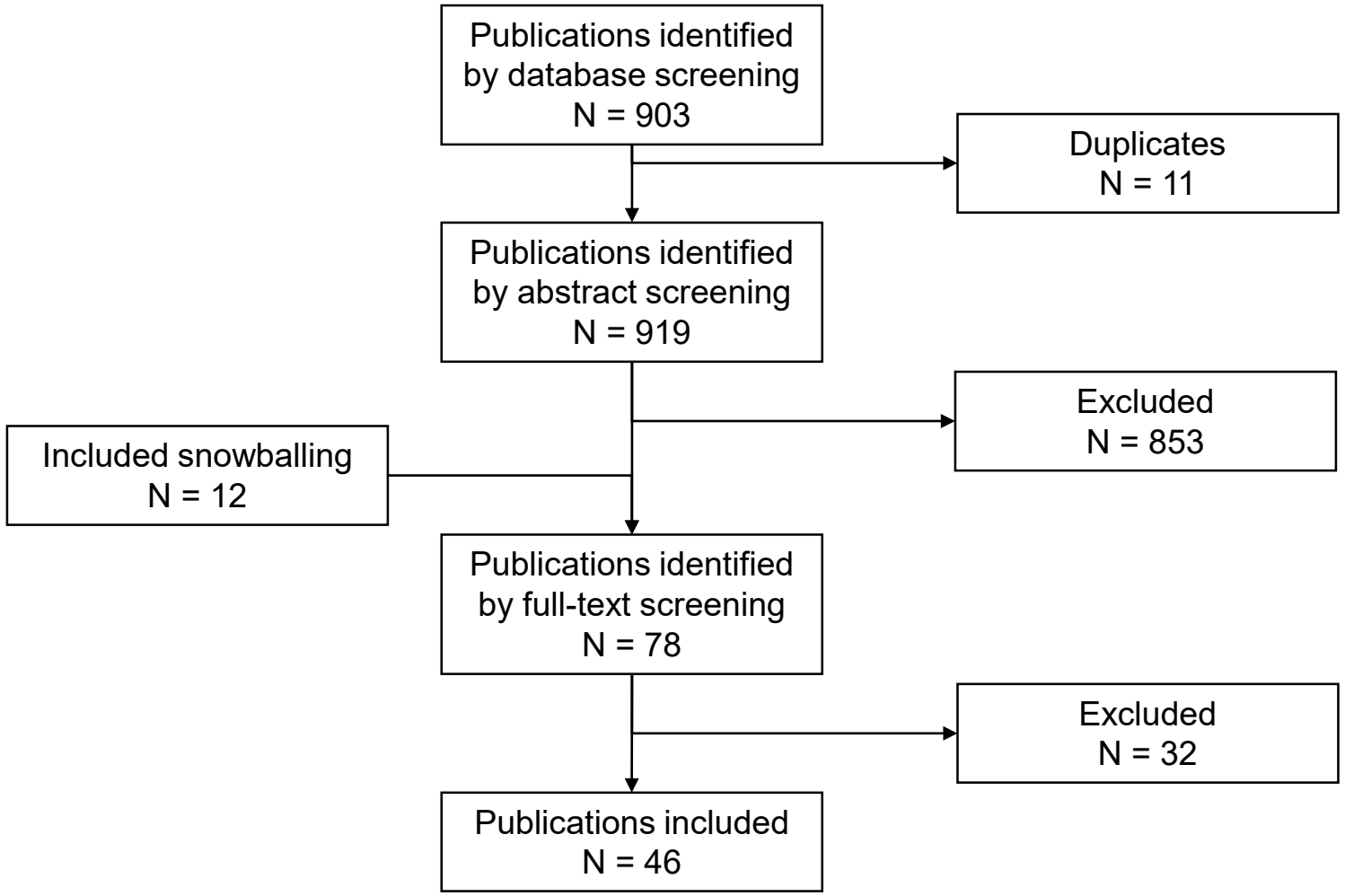
Literature review (knowledge base)

B. Which alternative, energy-friendly method could realise humidification?

1. Practice with regard to humidification: requirements and use of humidification installations (surveys and interviews)
2. Alternatives for steam humidification

Hospital inventory (practice base)

# KNOWLEDGE BASE
## LITERATURE REVIEW




# 1. HUMIDIFICATION IN RELATION TO MICRO-ORGANISMS AND VIRUSES

| Studies included | Hospital environment |
|---|---|
| 22 | 11 |

- Distinction between
  - Molds, bacteria, viruses, mites and allergens

- Temperature and relative humidity (RH) influence microbial growth,
- Survival rate under specific indoor climate conditions differs per organism, not possible to extract general values,
- In general, low and high RH need to be avoided to limit growth of micro-organisms,
- The extent of RH on the development of an infection is not clear.

# 2. EFFECT OF HUMIDIFICATION ON FUNCTIONING OF MEDICAL EQUIPMENT

| Studies included | Hospital environment |
|---|---|
| 4 | - |

- The effect of RH on the performance of medical devices is dependent on the specific device and manufacturer's usage specifications,
- The RH has an effect on the operation of medical equipment due to the potential of electrostatic discharge (ESD) occuring,
- A minimum requirement of 30% RH is usually given. Imaging techniques (MRI) in particular seem to be sensitive to RH. Higher RH levels may be desirable if specifications require this.
- To avoid ESD (shock when touching surfaces and other persons), use appropriate materials, e.g. footwear (conductive) and bedding (cotton). RH can reduce but not completely prevent this form of ESD.

# 3. EFFECT OF HUMIDIFICATION ON HUMAN PHYSIOLOGY

| Studies included | Hospital environment |
|---|---|
| 4 | - |

- Distinction between:
  - General complaints, nose complaints, eye complaints, skin complaints, respiratory symptoms, sneezing and headache

- At RH value < 30%, a significant deterioration of nasal mucosa protection occurs in the **elderly** population,
- The duration of exposure to specific conditions is not explicitly given or limited, this is a limitation of the found studies,
- Long-term exposure (several days, e.g. related to habituation) has not yet been studied,
- Studies based on specific functions within a care building that deal with RH are limited.

# 4. EFFECT OF RELATIVE HUMIDITY ON WELL-BEING AND COMFORT

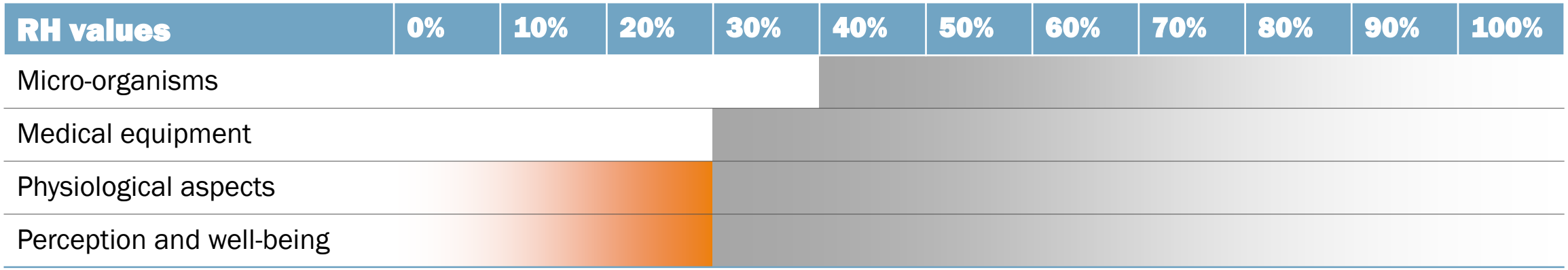
| Studies included | Hospital environment |
|---|---|
| 17 | 5 |

- Distinction between:
  - (Perceived) fatigue, concentration and nausea, stress, performance/productivity, dry air and comfort.

- Effects of relative humidity on perception of dry air appear to be limited,
- Individual sensitivity can affect this perception.

# CONCLUSIONS KNOWLEDGE BASE

- Limited research is available related to healthcare,
- Insufficient quantitative substantiation for values to be used for RH levels,
- An indicative lower limit of 30% RH seems desirable (medical equipment, physiological aspects and well-being and comfort),
- No general relationship has been found between RH and micro-organisms and viruses,
- An upper limit for RH cannot be recommended as there is no unambiguous optimum for all four themes,
- For each room or function, a trade-off must be made between the presence of (medical) equipment, the presence of patients and the perception of comfort with regard to humidity and energy consumption.



# PRACTICE: HUMIDIFICATION DEMANDS IN HEALTHCARE

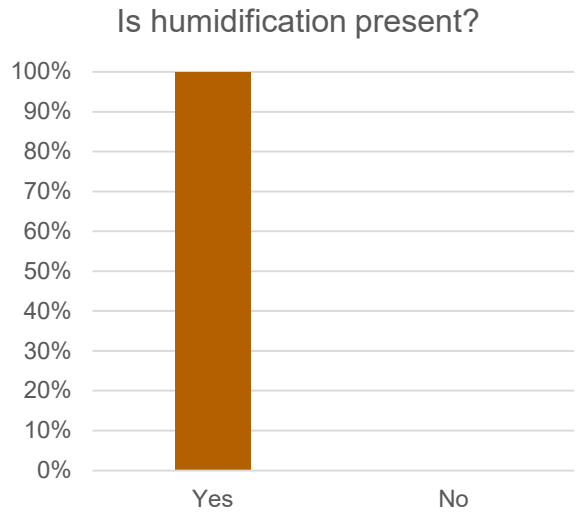
# GUIDELINES

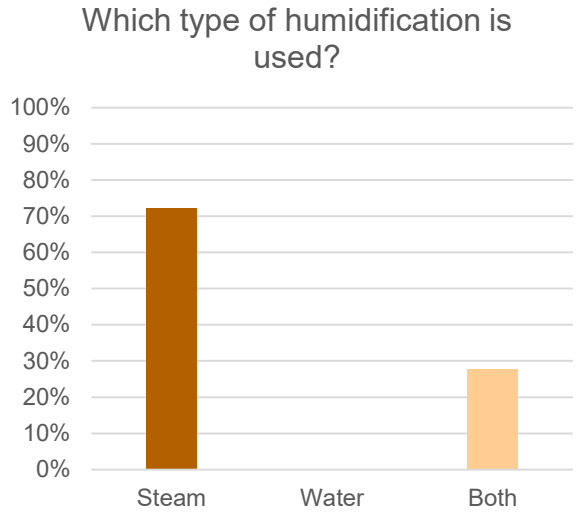
| | RH levels (%) |
|---|---|
| ASHRAE 170-2017 | 20-60 |
| DIN1946-4 | 30-60 |
| ÖNORM H 6020:2007 | 40-60 |
| UNI 11425 | 30-60 |
| College Bouw Ziekenhuisvoorzieningen | 50-75 |
| WIP richtlijn ‘Luchtbehandeling in operatiekamer en opdekruimte in operatieafdeling klasse: 2014’ | 40-65 |
| ARBO portaal | 30-70 |

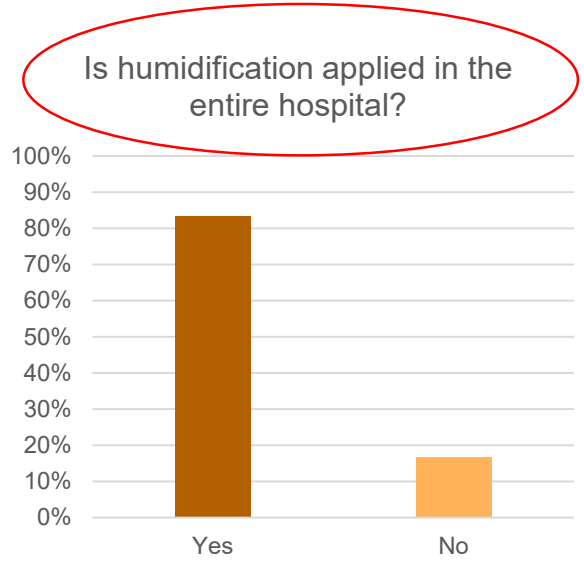
- Unclear which scientific base these guidelines have,
- Large variation between minimum and maximum RH.

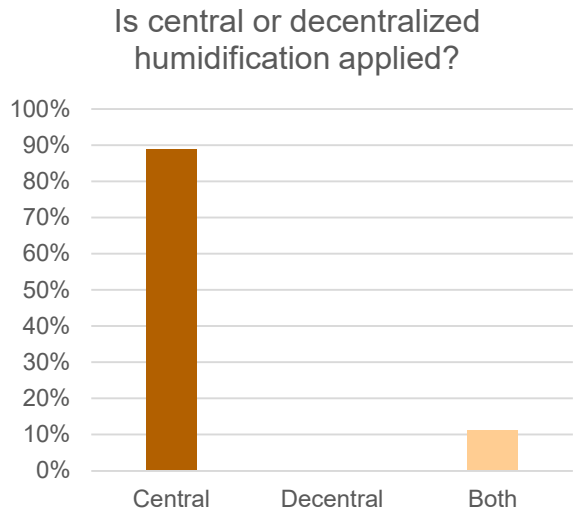
# DUTCH CURRENT PRACTICE

## SURVEY DUTCH HOSPITALS (N = 20)



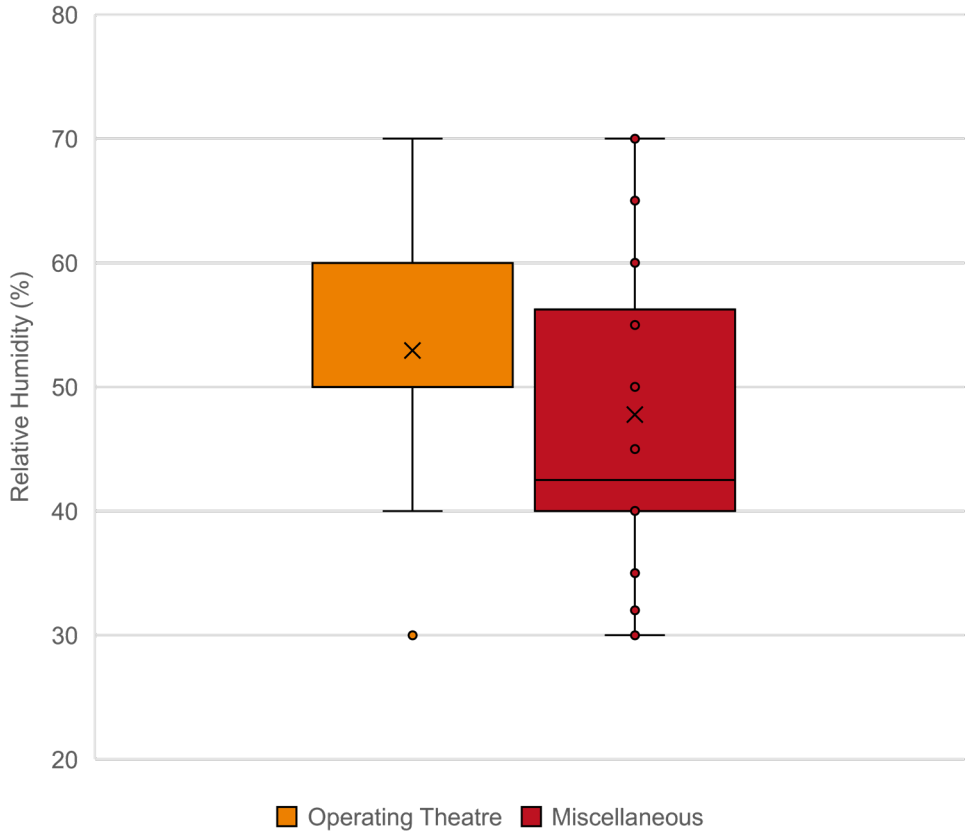




- Distinction between different functions or uses of hospital areas is often not made.

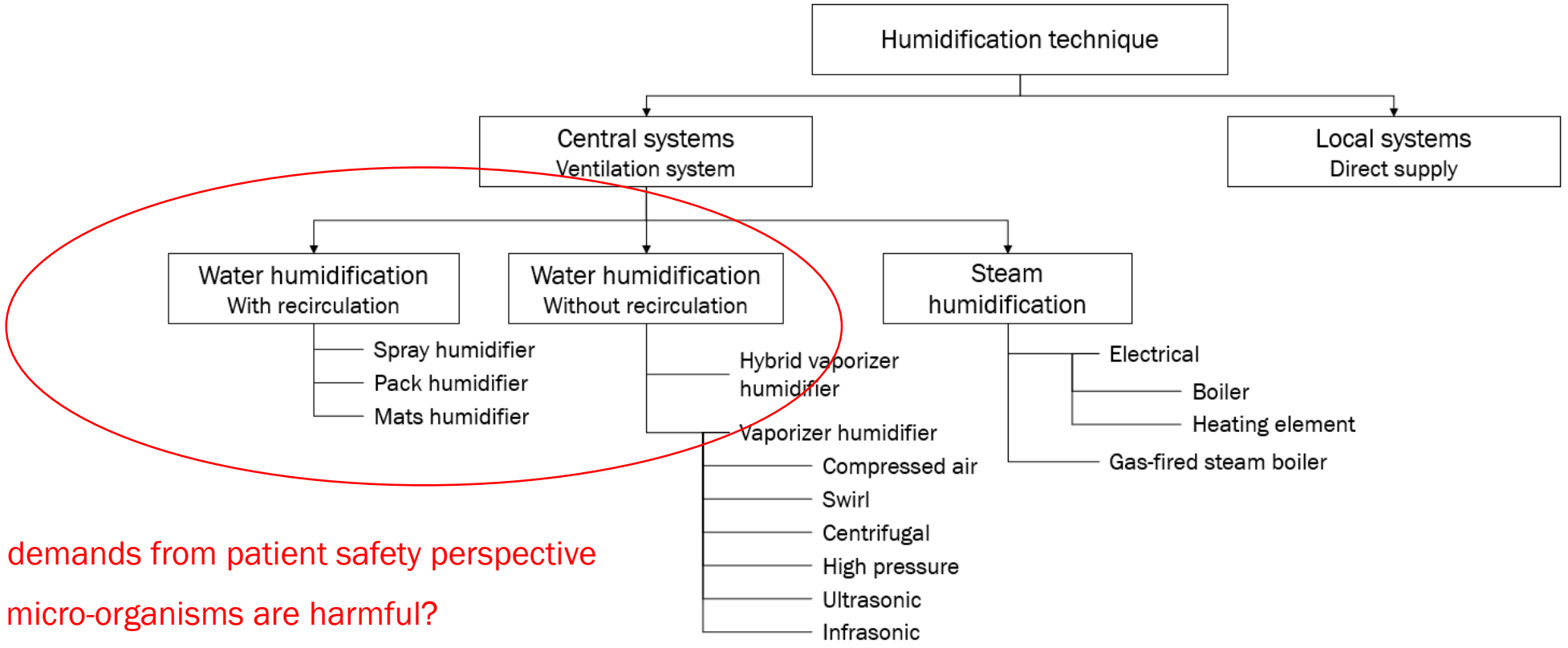
# HUMIDIFICATION SETPOINT RANGE
## DUTCH HOSPITALS (N = 20) AND MEDICAL DEVICES




| | RH (%) | |
|---|---|---|
| | min | max |
| MRI | 20 | 80 |
| IV pumps | 30 | 90 |
| Echo | 35 | 85 |
| EMG | 20 | 80 |
| Laser | 30 | 80 |
| PET/CT | 20 | 75 |
| Surveillance monitor | 15 | 95 |
| Feeding pump | 30 | 75 |
| Diathermia | 15 | 80 |
| Transcutaneous $pO_2/PCO_2$ meter | 20 | 80 |
| Blood pressure monitor | 15 | 90 |
| AED | 10 | 95 |
| CTG | | 95 |
| EKG | 10 | 90 |

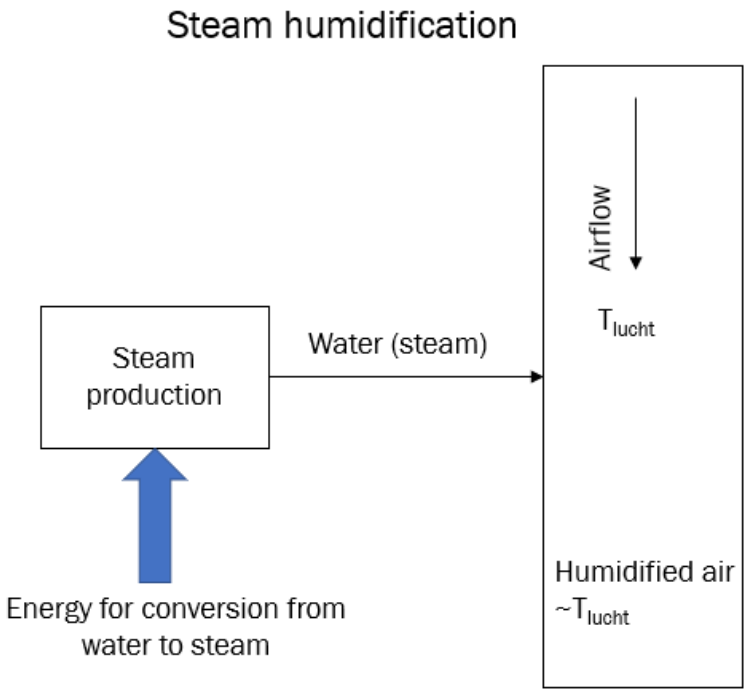
- Do you have to apply humidification in an entire hospital?

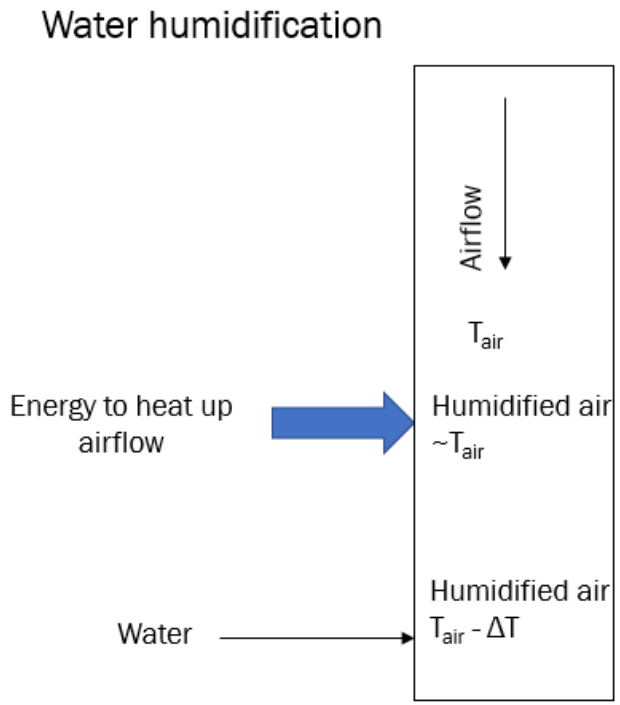
# CLASSIFICATION OF HUMIDIFICATION TECHNIQUES




- No clear demands from patient safety perspective
  - Which micro-organisms are harmful?
  - How to monitor this?

# STEAM VS WATER HUMIDIFICATION




Special attention necessary for prevention of micro-organisms

# CONCLUSIONS CURRENT PRACTICE

- The requirements used in hospitals are strict when it comes to operating wards. This is often extended to other function groups or even the entire hospital,
- From a medical treatment point of view, no relationship has been found with a specific minimum or maximum humidity,
- For the application of specific medical equipment a lower limit can be given from the point of view of liability. This does not mean that problems arise below this limit,
- Steam humidification is currently the most widely used:
  - Producing steam is an energy-intensive process,
  - Hospitals consider alternatives (such as adiabatic humidification),
- Attention is paid to the question of whether air humidification is necessary in the entire hospital.

# CONCLUSIONS CURRENT PRACTICE (2)

- Various forms of humidification techniques are available,
- Steam humidification is recommended by various norms, standards and guidelines,
  - Seems based on theoretical approach that steam is sterile
- An alternative to steam humidification is to use water humidification,
- It is not possible to indicate unambiguously which principle is energetically the most efficient,
- If adiabatic humidification is used, the microbiological safety must be demonstrated.

# THANK YOU FOR
YOUR ATTENTION

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