Well-being through work

Finnish Institute of
Occupational Health

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Fluid infusion and oxygen administration in cold conditions

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Leverage from the EU 2007–2013

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Introduction

- tourists and hikers trek in remote wilderness
- in the case of accident medical treatments may take place on site in the cold
- intravenous fluids are administered to trauma patients as treatment for hypovolemia, hypotension, shock, dehydration or hypothermia
- supplemental oxygen is of great benefit to a patient with severe trauma and/or hypothermia

Do medical treatments cool the patient in cold?

Patients may be treated with substances colder than core temperature in the pre-hospital settings

- infusion of cold fluids
  - decrease in body heat content - risk of hypothermia?
    - 1 liter of 20 ° C fluid decreases core temperature by 0,3 ° C
  - local cooling → pain and/or vasoconstriction
  - ventricular fibrillation
  - inhibition of blood clotting
- cold oxygen administration
  - decrease in body heat content?
  - local cooling → bronchoconstriction?
- Need of protection or warming?

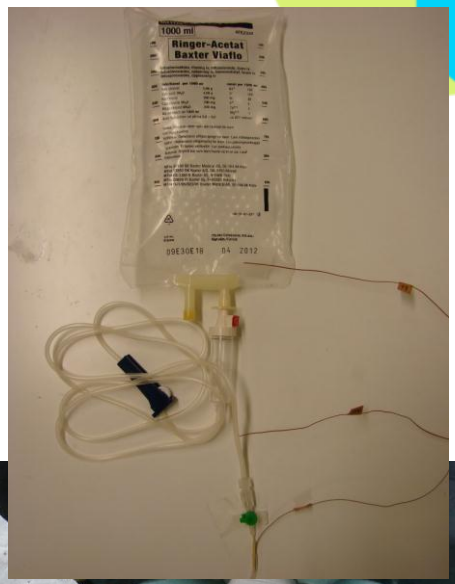
Aims

to examine the effects of cold environment on

1. infusion fluid temperature when different infusion line protective covers are used
2. upper respiratory track temperature when supplemental oxygen is administered

Warm IV fluid is recommended in cold

- recommendations
  - warmed 37 – 41° C IV fluids in the treatment of trauma patients
- however, at the accident site in the cold
  - cooling of the IV fluid during infusion is presumed



Example 1 of preventive methods

Traditional hanging type

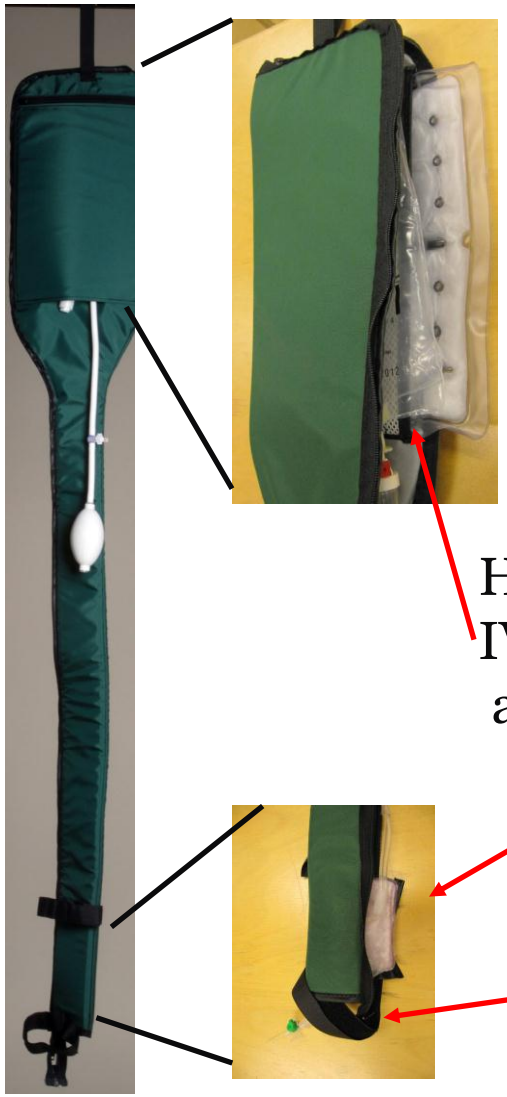
Protection of the infusion line

- Help&Rescue
- padded insulation around the bag and line

Distal end can be wrapped around the cannulated hand

Example 2 of preventive methods

Traditional hanging type



Protection and external heating

- IM-Medico

Heat packs for
IV bag and
at the distal end

No cover
for the hand

Example 3 of preventive methods

Protection and external heating

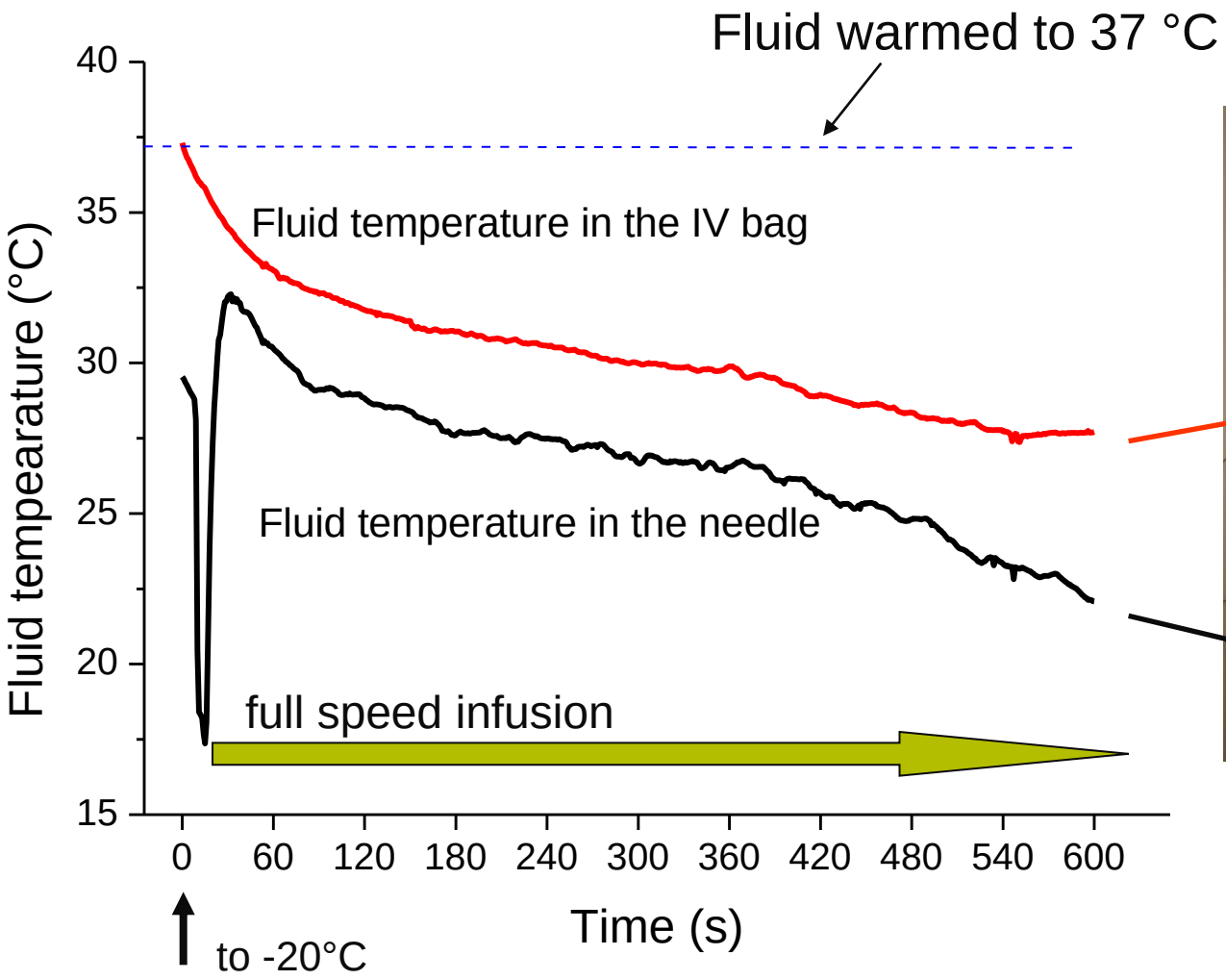
- Heat-it

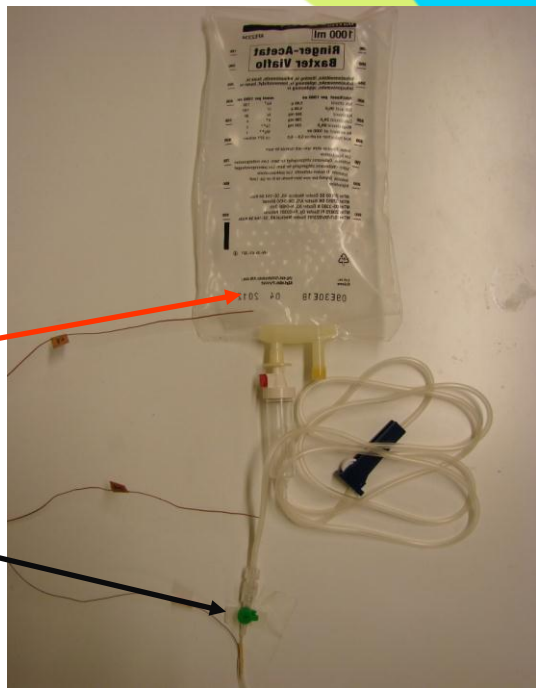
Pressure pouch for the IV bag

Heat pack under the arm, not beside the IV bag

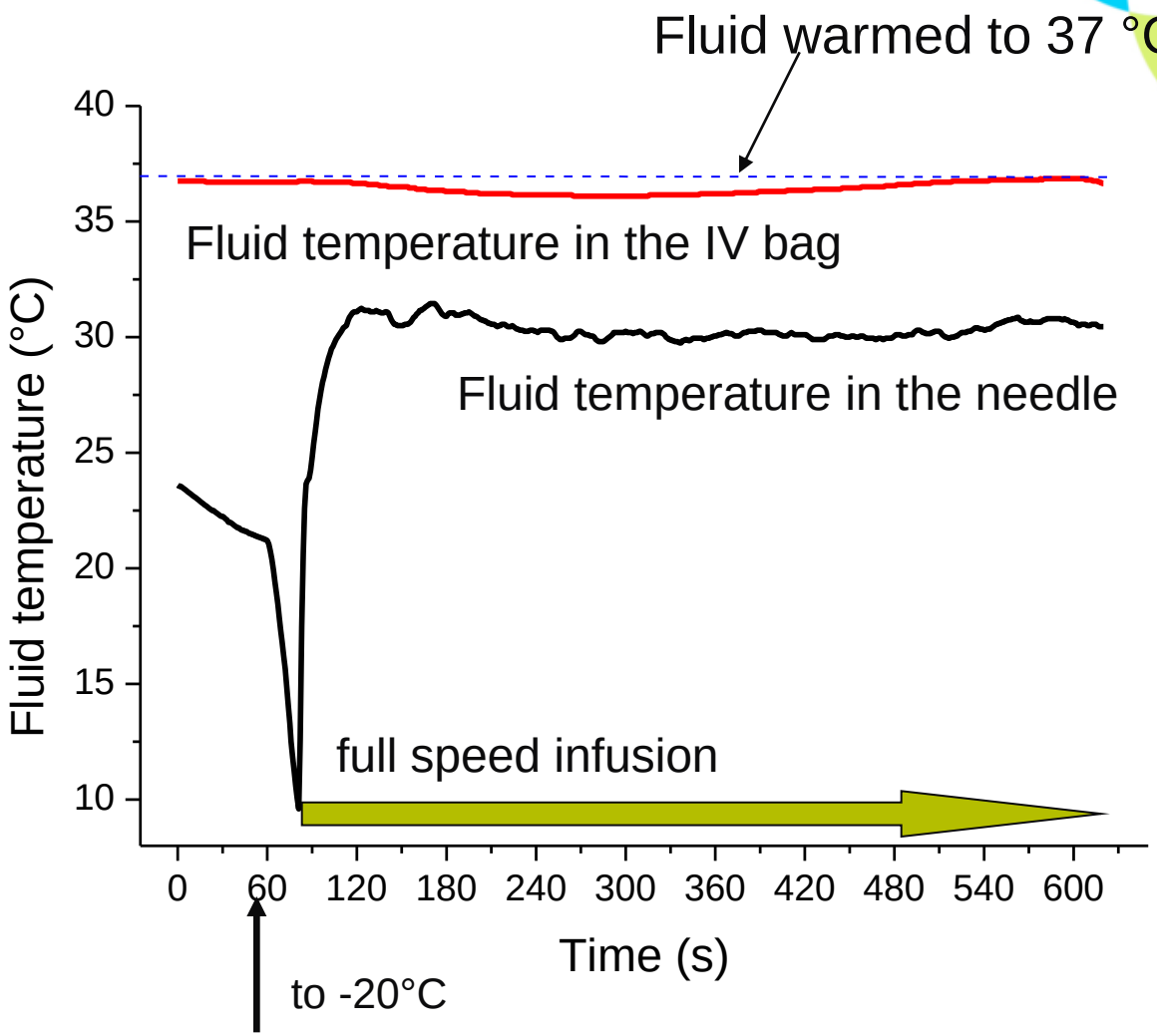
Arm is wrapped inside

Rapid cooling without protection at -20° C





Cooling rate slower with protection at -20° C



Summary

Fluid temperature, warmed to 37°C, after 10 min infusion at -20, 0 and 20°C,

-20° C		0° C		20° C	
bag	needle	bag	needle	bag	needle
37	31	38	33	40	36
35	33	35	34	37	37
30	31	33	34	37,5	35
27	22	32	28	34	34

Summary

Fluid temperature, 22°C, after 10 min infusion at -20, 0 and 20°C,

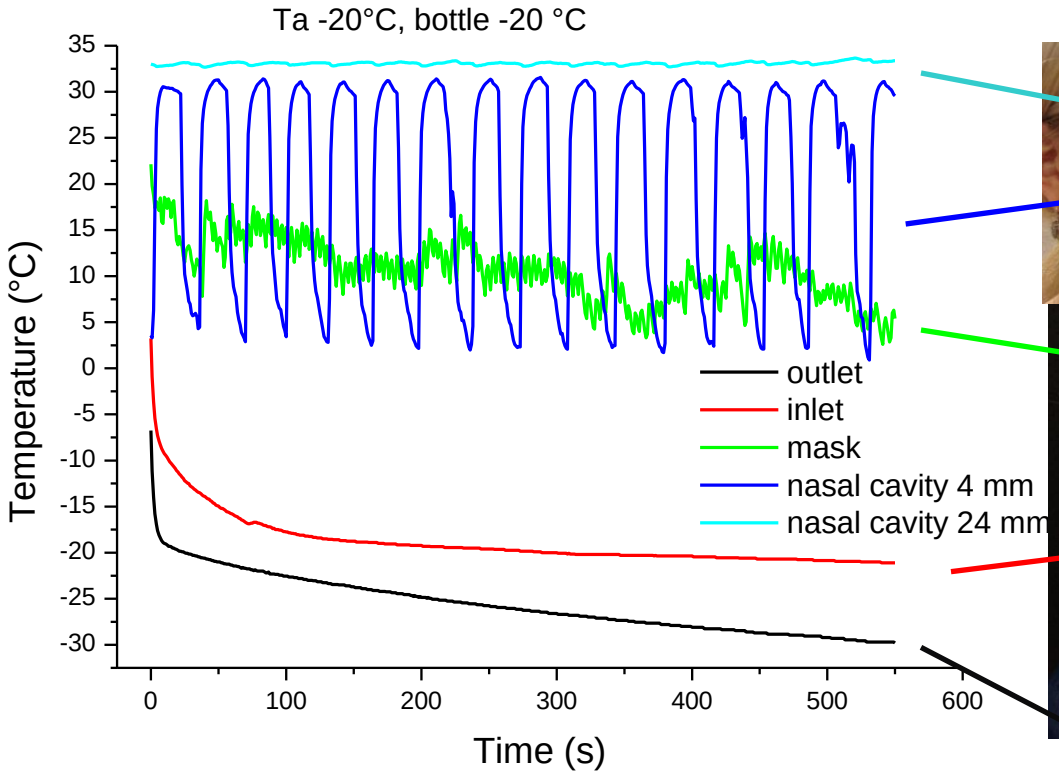
-20° C		0° C		20° C	
bag	needle	bag	needle	bag	needle
24	16	25,5	22	28	27,5
20	18	20	20	22	22
19,5	14,5	20	17,5	31	23
17	8	18,5	17	22	22

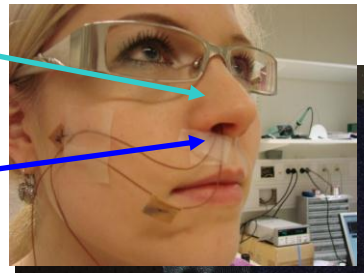
Oxygen administration in the cold was tested

- Methods
  - 7 subjects
  - ambient temperatures: -20, 0 and 20 ° C
  - oxygen bottle and the regulator stored at the exposure temperatures
    - in addition: warm bottle and the regulator at -20 ° C
  - breathing through the nose
  - gas flow 15 l/min

Air temperature was measured at 5 sites

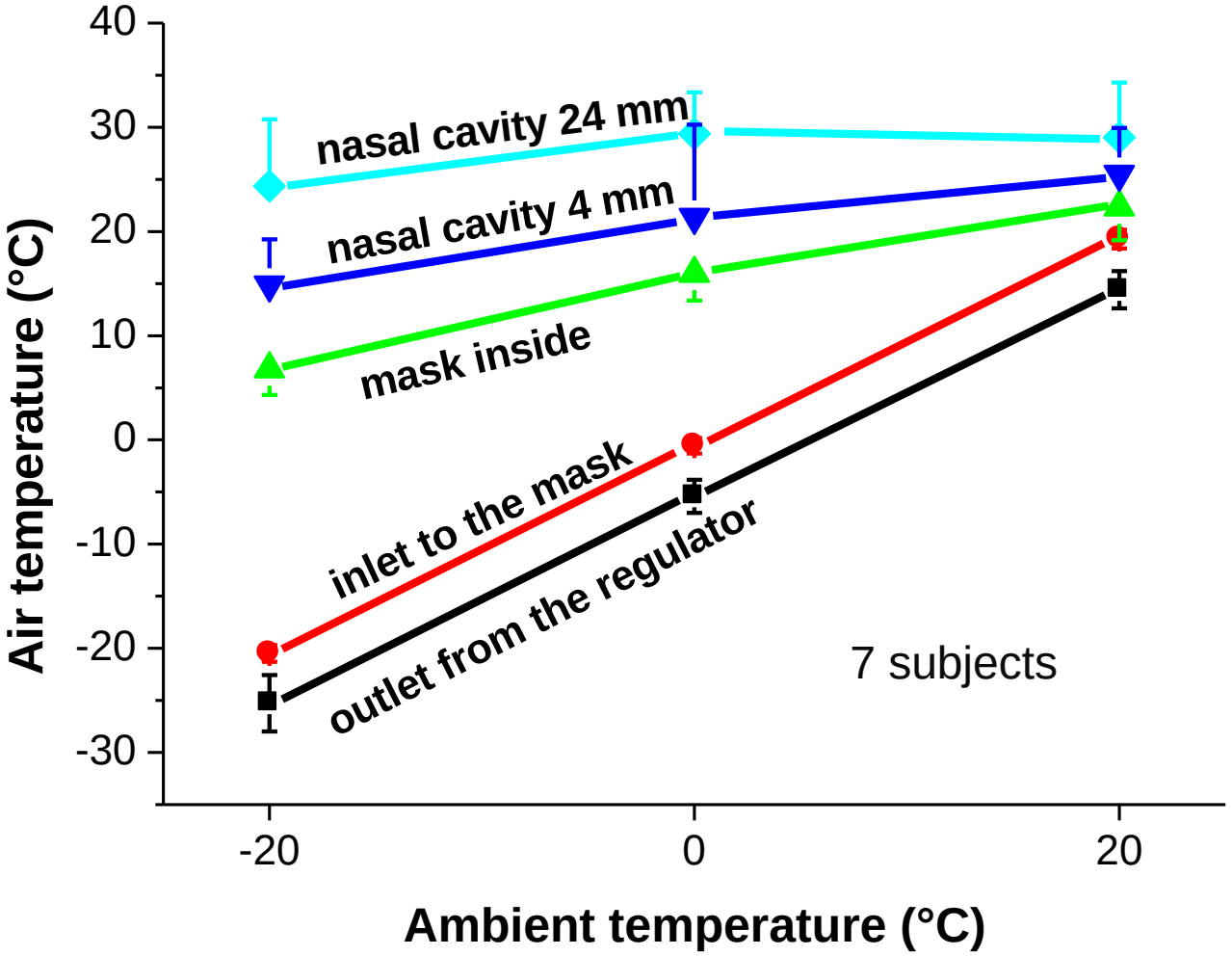
Cold oxygen does not cool the air temperature in the nasal cavity at the depth of 24 mm





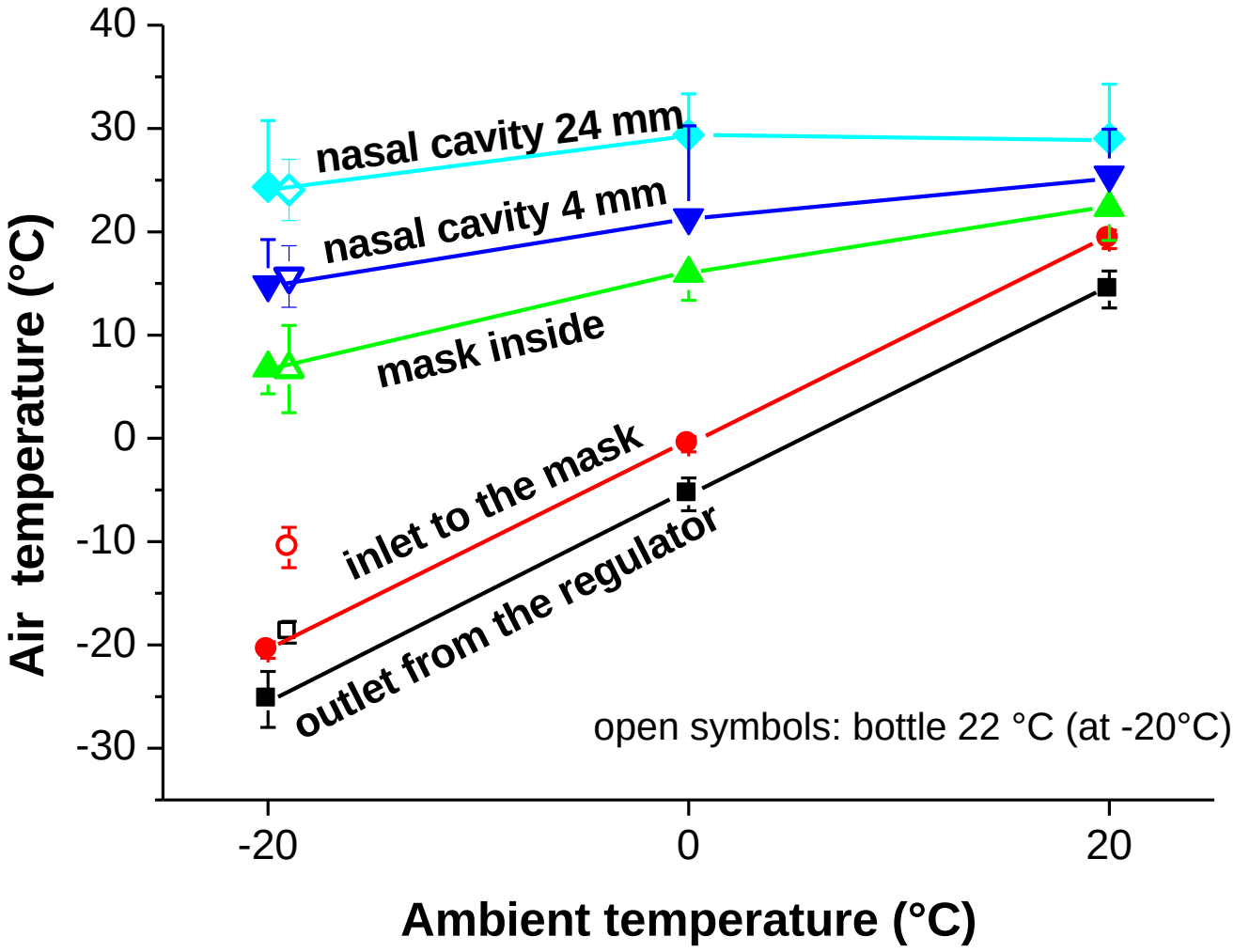
Cold oxygen bottle in the cold

Mask is a heat and moisture exchanger - air temperature increases to the safe level



Warm oxygen bottle in cold

Warm oxygen bottle does not provide any benefit in the cold



General conclusions

- Thermal protection of the IV fluid is important in pre-hospital trauma care in the remote wilderness in cold conditions
- Oxygen administration is safe in the cold conditions

Thank you!

This study is part of EU funded project: CoSafe – The Cooperation for safety in sparsely populated areas

www.cosafe.eu

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www.ttl.fi/matkasutu

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Centre for Economic Development, Transport and the Environment

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Conclusions

- Fluid with high heat capacity is a risk for trauma patient in the cold
  - Heat capacity of water is ca. 4.2 $J \cdot cm^{-3} \cdot K^{-1}$
  - with 20° C fluid temperature, the "cold load" of 1000 ml infusion would be 7100 J, core temperature decreases by ca. 0.3 ° C
- Gas has low heat capacity and therefore low temperature of oxygen is not a thermal risk for a patient
  - Heat capacity of air is ca. 0.0013 $J \cdot cm^{-3} \cdot K^{-1}$
  - with -20° C gas temperature, the theoretical "cold load" of 150 l of gas (given in 10 min) would be 800 J, compared to breathing air at 20° C
  - due to the low heat capacity, the gas temperature may quickly change in tubes → no effects on inhaled gas temperature