AIDMED ONE TEMPERATURE MEASUREMENT VALIDATION

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Abstract

Aim. The aim of this work is to validate the temperature measurement method of the Aidmed One device.
Materials and methods. In this work, we perform measurements on the metal plate with a heating mat and on the human chest skin. We also use reference temperature sensors to measure the temperature distribution on the surfaces.
Results. In each measurement, the original surface temperature is reached in less than 10 minutes. However, Aidmed One acts as a thermal isolation on a given surface. It reduces heat loss, thus, increasing the temperature under the device.
Conclusion. Aidmed One properly measures human skin temperature, with ±0.2°C accuracy. However, as time passes, the measured temperature increases and shifts more towards the core temperature.

1 Introduction

The measurement of human body temperature is one of the basic elements of a medical examination. Classical temperature measurement is performed by a glass mercury thermometer, which gives us only one sample of temperature data per measurement time and can be dangerous in the case of breaking the thermometer. Recently, electronic ones replaced glass thermometers. They are safer and reduce the measurement time. Additionally, most of them enable measurement once in a while, which complicates sampling data in the continuous mode. However, some wearable devices have been developed that can constantly measure temperature. One of them is Aidmed One, which enables the measurement of chest skin temperature in the continuous mode.

Body and skin temperature

Body temperature is one of the main parameters used to describe health conditions and diagnose many diseases. It can be divided into two compartments - core and shell. Core temperature is the temperature of human internal organs - the main determinant is the temperature of the hypothalamus, which is the thermoregulatory center of the brain. The typical core temperature varies from 36.5°C to 37.5°C and depends on age, sex, time of day and health status. It is maintained relatively stable thanks to the homeostasis. The heat is transferred from the core to the external parts of the body by the circulatory system. On the other hand, shell temperature is the temperature of external tissues and is lower than core temperature depending on the ambient temperature [1][2][3]. The core and shell compartments are shown in Fig. 1.1.

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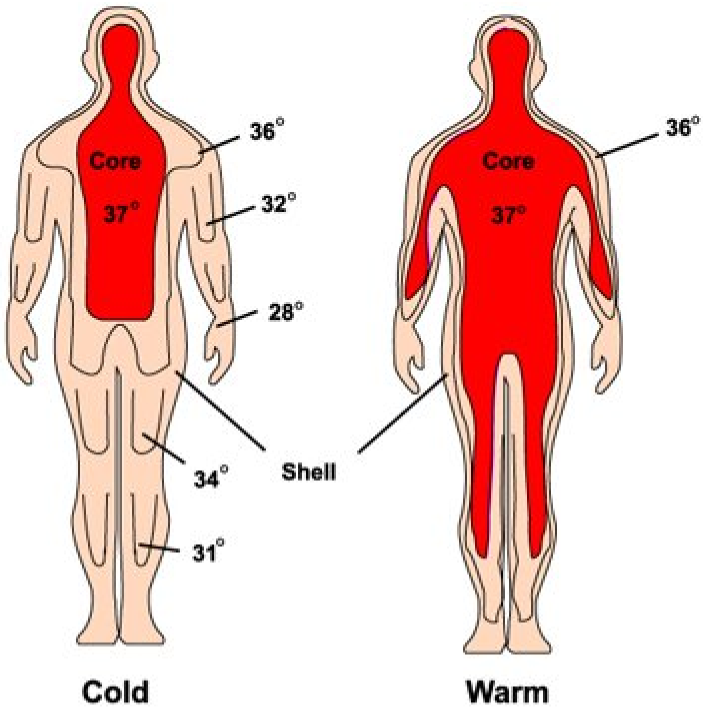

Fig. 1.1. Illustration of temperature distribution in the human body. Core temperature is the temperature of internal organs and is close to 37°C. Shell temperature is the temperature of external tissues and is lower than core temperature depending on the thermal environment. In the cold environment, the core area is limited to the trunk and head; blood vessels in the external parts of the body constrict (vasoconstriction) to protect the organism from heat loss. In the warm environment, the core temperature is expanded on the wider area; metabolism tries to dispose of heat excess by dilating the blood vessels (vasodilation) and sweating [2].

Skin temperature is the temperature measured on the surface of the human skin. It is an important physiological parameter that is related to the state of heat exchange between the human body and an environment. This parameter provides useful information for many research and clinical applications such as assessment of thermal comfort or thermoregulation. Human skin temperature on the trunk varies from 33°C to 36°C and is usually about 1-3°C lower than the body core temperature. The temperature of the skin as the most external human organ is highly dependent on the thermal environment. Also, the presence of the measuring device can affect the temperature of the skin, which makes it hard to measure precisely [1][2][4].

Aidmed One recorder device

Aidmed One is a wearable medical recorder device designed for data acquisition in tele-medical scenarios. Its main purpose is to support the diagnosis of pulmonary or cardiovascular diseases. The device collects bio-signals such as ECG, chest impedance, nasal airflow, patient movements, acoustic signals from the chest and chest skin temperature. The measurement of skin temperature will be the main topic of this work. The temperature sensor of Aidmed One is Si7051, which is designed for medical purposes with an accuracy of ±0.1°C [5]. The construction of the Aidmed One device is shown in the Fig. 1.2 and the placement of it on the human body in the Fig. 1.3 [6].

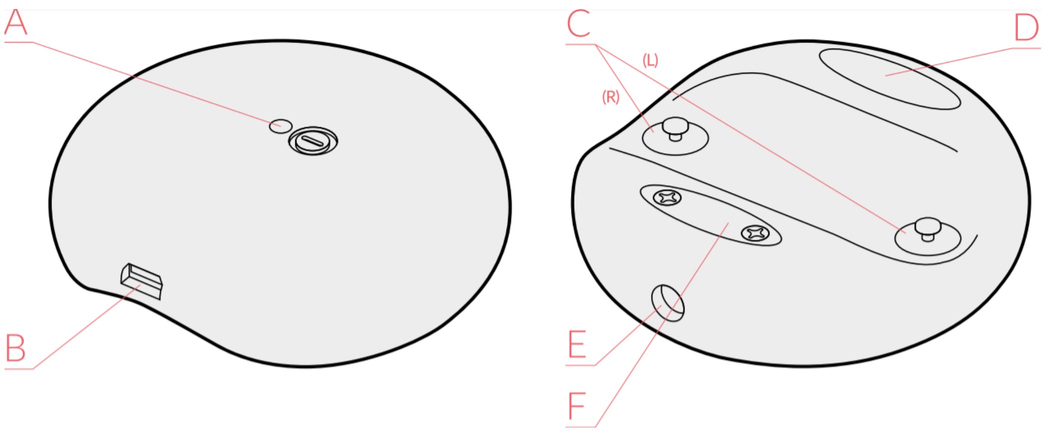

Fig. 1.2. Aidmed One recorder: A – LED diode and multifunctional button, B – micro USB port, C – connectors for chest strap electrodes (L – left electrode, R – right electrode), D – temperature sensor, E – nasal cannula port, F – stabilizing electrode [6].

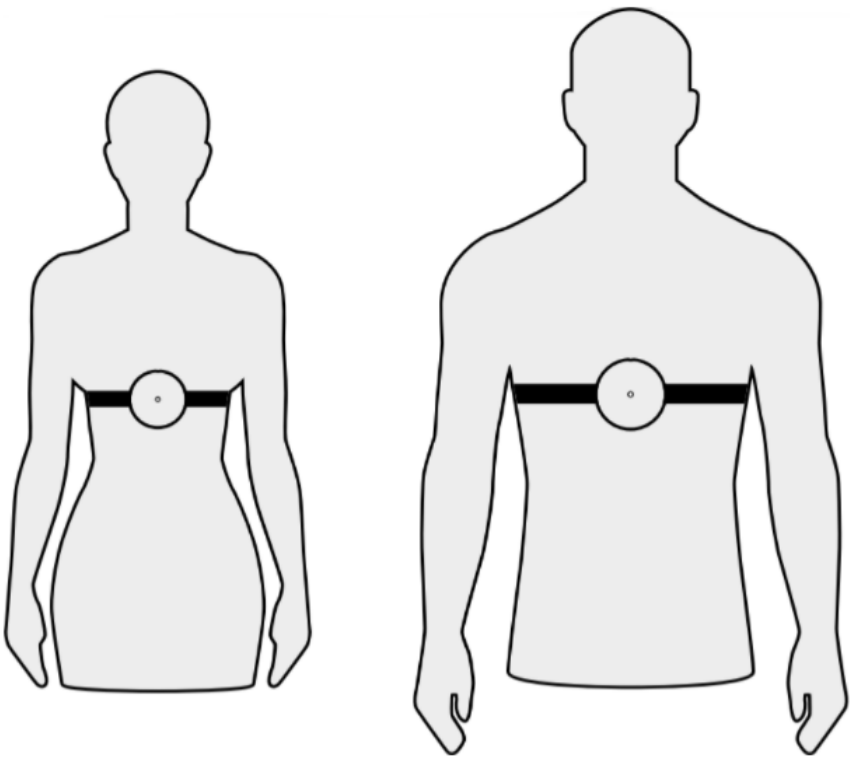

Fig. 1.3. Proper placement of Aidmed One on the human body. The device is fixed to the body by a chest strap [6].

2 Materials and methods

Measurements were performed with Aidmed One and reference temperature sensors. The measurements were performed in two ways. First, we used a model system consisting of a heating mat with a metal plate placed on it. Later, we measured human skin temperature.

Model system with heating mat and metal plate

To perform temperature measurements under comparable conditions, we built a model system consisting of a heating mat, a metal plate and temperature sensors connected to Arduino (Fig. 2.1). A heating mat is a flat device that generates heat and is used to warm up terrariums (up to 40°C). In our system, we used a 5 W power mat [7]; however, the temperature of such mat may not be evenly distributed on the surface and may be unstable over time. To overcome these effects, we covered a heating mat using a thick metal plate (1 cm thick). Through this, the temperature will be distributed more evenly and, thereby be more stable; however, the warm-up time may be longer. To measure the temperature distribution, we used 5 reference temperature sensors (TMP117 BlueDot, ±0.1°C accuracy) [8]. They were stuck to the metal plate by heat transfer tape and connected to the Arduino by an I2C multiplexer (to avoid address conflict). After the temperature stabilization, Aidmed One was placed on the metal plate, over the middle (S4) temperature sensor (Fig. 2.2). This allowed for simultaneous measurement of the temperature from Aidmed One and temperature sensors. Temperature measurements were taken under various conditions (heating mat and Aidmed turned on and off). All of the measurements were performed in a room with approx. 25°C.

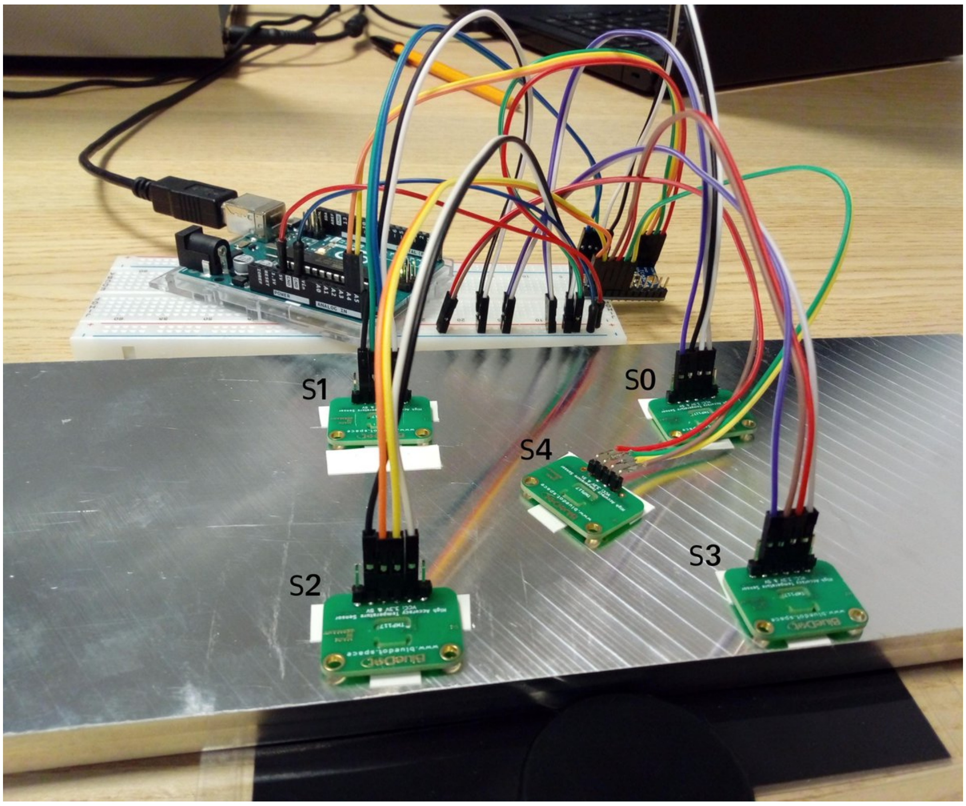

Fig. 2.1. Model system with heating mat and metal plate. A heating mat (black rectangle) was placed on the table. It was covered by a thick metal plate to stabilize the temperature. Temperature sensors S0:S4 connected to Arduino were placed on a metal plate to measure the temperature distribution.

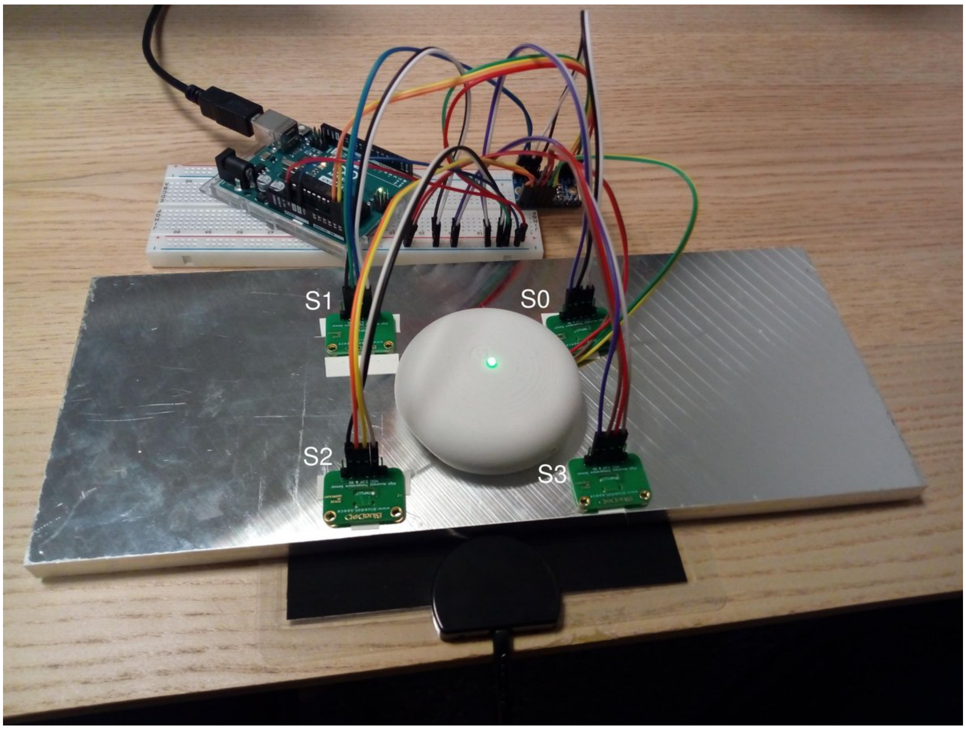

Fig. 2.2. Aidmed One placed on the metal plate with heating mat and reference sensors. Aidmed One was placed over the S4 sensor. The temperature sensor of Aidmed One is located under the device, between S1 and S4 sensors. This system allows measurement of temperature distribution on the metal plate and comparison between readings of Aidmed One and reference sensors.

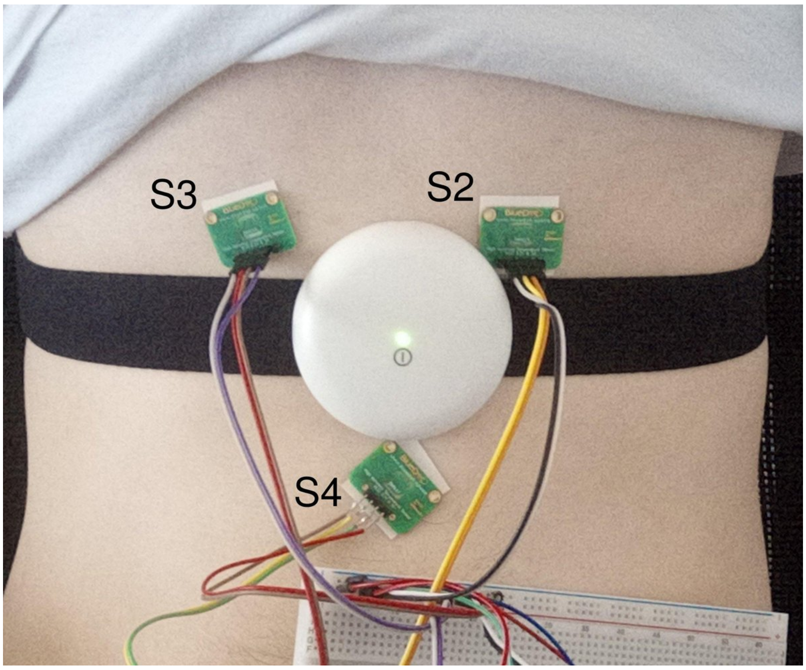

Fig. 2.3. Placement of the reference sensors S2, S3, S4 and Aidmed One on the chest.

Measurements of human skin temperature

Three reference sensors were placed on the chest skin of a male volunteer (healthy 26 years old, 36.0°C armpit temperature). They measured the distribution of the temperature on the chest and its changes over time. After reaching the temperature equilibrium, Aidmed One was placed between the sensors (Fig. 2.3). For the first half of the experiment, the measurements were performed on the naked chest. During the second half, the chest was covered with a T-shirt to reflect typical chest temperature conditions. The ambient temperature during measurements was approx. 28°C.

3 Results

In the model system with metal plate, measurements were first performed with the heating mat turned off (cold metal plate) and later, with the heating mat turned on (hot metal plate). These investigated the ability of Aidmed One to measure temperature and an impact of the device on the surface temperature of the metal plate. When the device was placed on the plate or removed from it, there were temporary signal distortions, which were excluded from the analyses. The following experiments with various conditions were performed:

(a), (b) heating mat turned off, here we check:

- isolation effect (Aidmed One turned off and placed on the plate), estimated increase of temperature of sensor S4: 0.2 ± 0.1°C
- heating effect (Aidmed One turned on and placed on the plate), estimated increase of temperature S4: 0.2 ± 0.1°C

(c), (d), (e) heating mat turned on, here we check:

- isolation and heating effect (Aidmed One turned on and placed on the plate), estimated increase of temperature of sensor S4: 0.7 ± 0.1°C
- time of thermalization of Aidmed One: ~3 min

(f) heating mat turned on with hydrogel - heating mat turned on, hydrogel between metal plate and sensors, here we check:

- isolation and heating effect (Aidmed One turned on and placed on the hydrogel), estimated increase of temperature of sensor S4: 1.3 ± 0.1°C
- time of thermalization of Aidmed One: ~7 min

(g) chest skin temperature measurement:

- time of thermalization of Aidmed One: ~7 min

Measurements of the cold metal plate (a), (b)

There were two performed experiments (a) and (b) of the cold metal plate. During the experiments, the heating mat was turned off. The experiment (a) was divided into 5 stages (Fig. 3.1). In stage Ia of the experiment, on the metal plate, there were reference temperature sensors (S0:S4) only. Their measurements were very consistent because the mean absolute error (MAE) was 0.02°C. In stage IIa, the Aidmed One was turned off and placed on the metal plate over the S4 sensor. After a short time of signal distortions, caused by putting the device on the plate, the measurements become consistent, but the middle sensor S4, which was covered by Aidmed One, resulted in higher temperature readings than the rest of the sensors (S0:S3). The mean difference between S4 and S0:S3 was 0.20±0.10°C. Aidmed One may act as a thermal isolation over the S4 sensor and thus cause a higher temperature around S4. In stage IIIa Aidmed One was turned on. The readings from the sensor S4 were also higher (0.21±0.10°C) than the mean of the rest sensors (S0:S3). Turning on the Aidmed One may have caused heat emission to the environment, because with the progress of time, the difference in temperature readings between S4 and S0:S3 was higher (0.15±0.10°C at the beginning of the stage IIIa and 0.25±0.10°C at the end of this stage). The readings from Aidmed One were slightly lower than those from S0:S3 (-0.13±0.10°C difference) and S4 (-0.34±0.14°C difference). As the temperature sensor of Aidmed One is located between S1 and S4 sensors, the most probable temperature (Sm) under it is a mean of S1 and S4. Then the difference between Aidmed One and Sm is -0.24±0.14°C. In stage Iva, Aidmed One was turned off and removed from the metal plate. Readings from the sensors become very consistent; the difference between S4 and S0:S3 was 0.08±0.10°C. In stage Va, the Aidmed One was turned off and placed once again on the metal plate, over sensor S4. The temperature difference between the sensors S4 and S0:S3 was 0.19±0.10°C. Comparing stages with Aidmed One removed from the plate (Ia, IVa) and stages with Aidmed One placed on the plate over sensor S4 (IIa, IIIa, Va), it can be said that Aidmed One may act as a thermal isolation, preventing local heat loss from the surface. The measurement results are shown in Table 3.1.

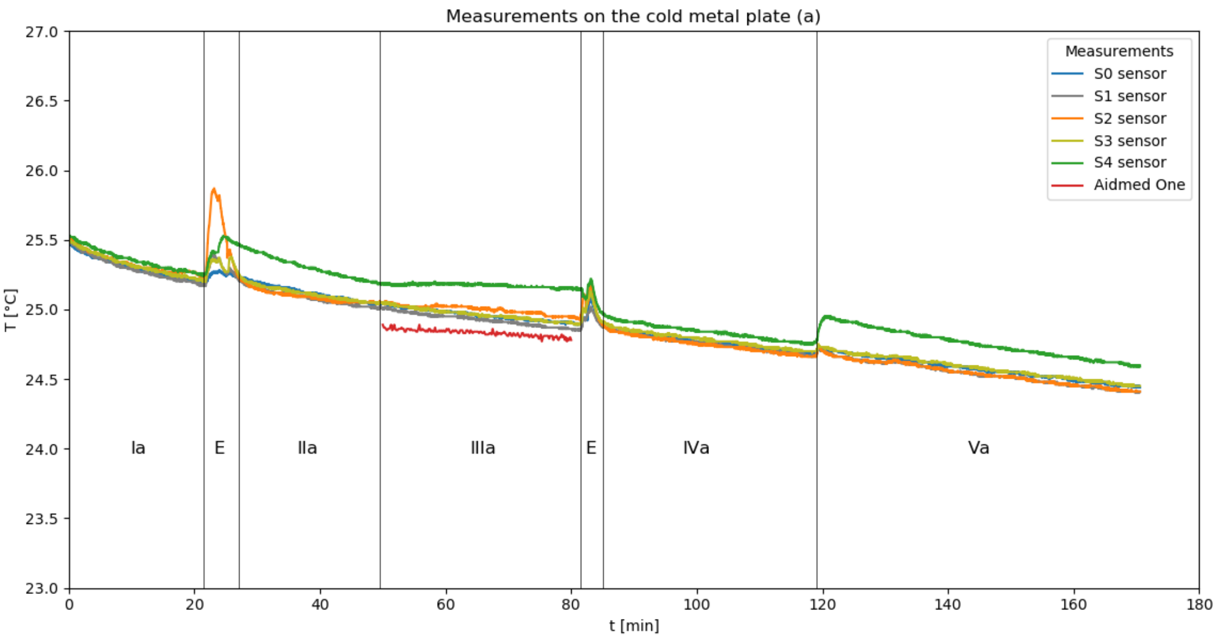

Fig. 3.1. Measurements of the cold metal plate (a). Ia – metal plate with S0:S4 sensors only, IIa – turned off Aidmed One placed on the plate, IIIa – Aidmed One turned on, IVa – Aidmed One removed from the plate, Va – turned off Aidmed One placed on the plate. E – distortions excluded from the analysis. The experiment was carried out for almost 3 hours so there is a general noticeable temperature decline as the ambient temperature dropped.

Table 3.1. Temperature measurements for the cold metal plate (a). For each stage, mean temperature measurements from sensors and the differences between them are shown. Sm is the mean between S4 and S0:S3. The results are given in [°C].

Sensor	Stage of measurement (a)				
	Ia	IIa	IIIa	IVa	Va
S0:S3	25.32 ± 0.02	25.09 ± 0.02	24.96 ± 0.02	24.75 ± 0.02	24.54 ± 0.02
S4	25.37 ± 0.10	25.29 ± 0.10	25.17 ± 0.10	24.83 ± 0.10	24.73 ± 0.10
Sm	25.35 ± 0.10	25.19 ± 0.10	25.07 ± 0.10	24.79 ± 0.10	24.64 ± 0.10
S4 - S0:S3	0.05 ± 0.10	0.20 ± 0.10	0.21 ± 0.10	0.08 ± 0.10	0.19 ± 0.10
Aidmed One	-	-	24.83 ± 0.10	-	-
Aidmed One - S0:S3	-	-	-0.13 ± 0.10	-	-
Aidmed One - S4	-	-	-0.34 ± 0.14	-	-
Aidmed One - Sm	-	-	-0.24 ± 0.14	-	-

The measurement (b) was divided into 3 stages (Fig. 3.2). The stages Ib, IIb and IIIb were performed in the same way as corresponding stages of the measurement (a). The outcome is similar to this from (a) but the differences between S4 and S0:3 are slightly lower (0.09 ± 0.10°C for the stage IIb and 0.16 ± 0.10 for the stage IIIb). In stage IIIb, with the progress of time, the difference in temperature readings between S4 and S0:S3 was higher (0.07±0.10°C at the beginning of the stage IIIb and 0.18±0.10°C at the end of this stage), which could have been caused by heat emission from Aidmed One. The measurements of Aidmed One were very similar to those from (a). The results are shown in the Table 3.2.

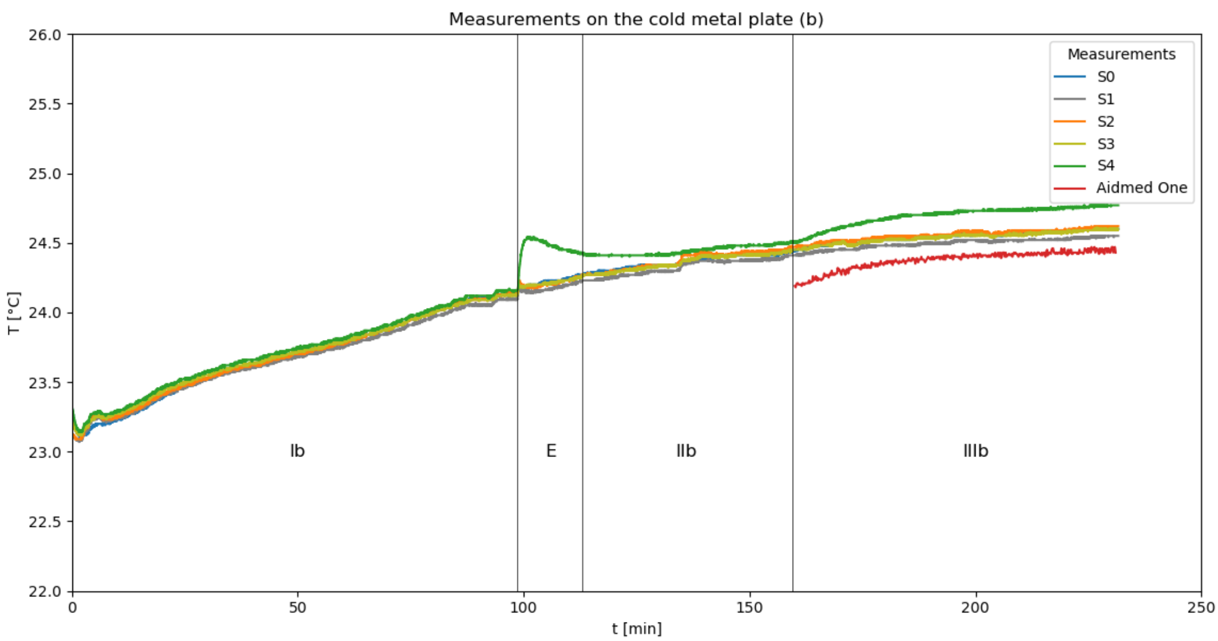

Fig. 3.2. Measurements of the cold metal plate (b). Ib – metal plate with S0:S4 sensors only, IIb – turned off Aidmed One placed on the plate, IIIb – Aidmed One turned on. E – distortions excluded from the analysis. The experiment was carried out for almost 4 hours, so there is a general noticeable temperature rise as the ambient temperature increased.

Table 3.2. Temperature measurements for the cold metal plate (b). For each stage, mean temperature measurements from sensors and the differences between them are shown. Sm is the mean between S4 and S0:S3. The results are given in [°C].

Sensor	Stage of measurement (b)		
	Ib	IIb	IIIb
S0:S3	23.67 ± 0.02	24.35 ± 0.02	24.53 ± 0.02
S4	23.71 ± 0.10	24.44 ± 0.10	24.69 ± 0.10
Sm	23.69 ± 0.10	24.79 ± 0.10	24.61 ± 0.10
S4 - S0:S3	0.04 ± 0.10	0.09 ± 0.10	0.16 ± 0.10
Aidmed One	-	-	24.37 ± 0.10
Aidmed One - S0:S3	-	-	-0.16 ± 0.10
Aidmed One - S4	-	-	-0.32 ± 0.14
Aidmed One - Sm	-	-	-0.24 ± 0.14

In the initial stage of experiments (a) and (b), the mean absolute error (MAE) was 0.02°C, so measurements of all sensors (S0:S4) were very consistent. From both experiments, it can be concluded that Aidmed One may act as a thermal isolation. For the metal plate at room temperature, there could be a temperature rise up to 0.20±0.10°C. However, the differences in (a) were higher than in (b). This could be explained by the fact that while placing Aidmed One on the metal plate, the temperature could have increased locally around S4 (Aidmed One was held in the fingers by a while). During the measurement (a) the temperature of the environment was dropping, so the thermal isolation created by Aidmed One prevented heat loss around sensor S4, which caused a difference in the temperatures. During the measurement (b) the temperature of the environment was rising, so it reached the temperature around sensor S4 and the difference between the temperatures was smaller. After turning Aidmed One on, noticeably, the temperature readings of S4 became higher than S0:S3. The mean difference between the end and beginning of the measurement was 0.11 ± 0.10°C, which is a low value and should not have a significant impact on the temperature measurements. In both experiments (a) and (b), the difference between measurements of Aidmed One and sensors was similar. The mean difference between Aidmed One and S0:S3 was -0.15 ± 0.10°C, whereas the mean difference between Aidmed One and S4 was -0.33 ± 0.14°C. The temperature sensor of Aidmed One is halfway between S4 and S1 sensors, so the most probable difference between Aidmed One measurement and environmental temperature is -0.24 ± 0.17°C. The results are shown in the Table 3.3.

Table 3.3. Comparison of the (a) and (b) experiments for the cold metal plate.

Experiment	Initial MAE	S4 - S0:S3 Aidmed off	S4 - S0:S3 Aidmed on	S4 - S0:S3 end beginning difference Aidmed on	Aidmed - S0:S3	Aidmed - S4
(a)	0.02	0.20 ± 0.10	0.21 ± 0.10	0.10 ± 0.10	-0.13 ± 0.10	-0.34 ± 0.14
(b)	0.02	0.09 ± 0.10	0.16 ± 0.10	0.11 ± 0.10	-0.16 ± 0.10	-0.32 ± 0.14
Mean	0.02	0.15 ± 0.10	0.19 ± 0.10	0.11 ± 0.10	-0.15 ± 0.10	-0.33 ± 0.14

Measurements of the hot metal plate (c), (d), (e), (f)

Four experiments were performed on the hot metal plate. During the experiments, the heating mat was turned on. Unfortunately, the sensor S0 had problems with communication; as a result, it was excluded from the analysis.

The experiment (c) was divided into three stages (Fig. 3.3). In stage Ic, there were only reference sensors S1:S4 on the metal plate and the heating mat was turned off. In stage IIc, the heating mat was turned on. The temperature was rising after 117 minutes and increased from 24.40°C to 34.20°C. During heating, the measurements of the sensors S1:S4 were consistent, but not so much as during the experiments for the cold plate. The mean absolute error (MAE) was 0.07°C. In the stage IIIc, Aidmed One was placed on the plate over sensor S4. The temperature was dropping for a while (80 seconds) and reached 33.50±0.10°C (S4 - S1:3 = -0.69±0.12°C). After 8 minutes, the readings of S4 reached the readings from S1:S4. Then readings from S4 started becoming higher than S1:3 and after 50 minutes; the difference between S4 and S1:S3 was 0.66±0.12°C. From those measurements, it can be concluded, that placing Aidmed One (at room temperature) on the hot metal plate may initially lower the temperature around the S4 sensor. After a few minutes, the S4 temperature will increase, reach the temperature of S1:S3 and then exceed it. It is caused by the thermal isolation created by Aidmed One over the S4 sensor. The end S4 - S1:3 difference (0.66±0.12°C) was higher than for experiments performed for the cold metal plate (0.20±0.10°C) because heat generated by the heating mat was retained by the thermal isolation and thus the difference was bigger.

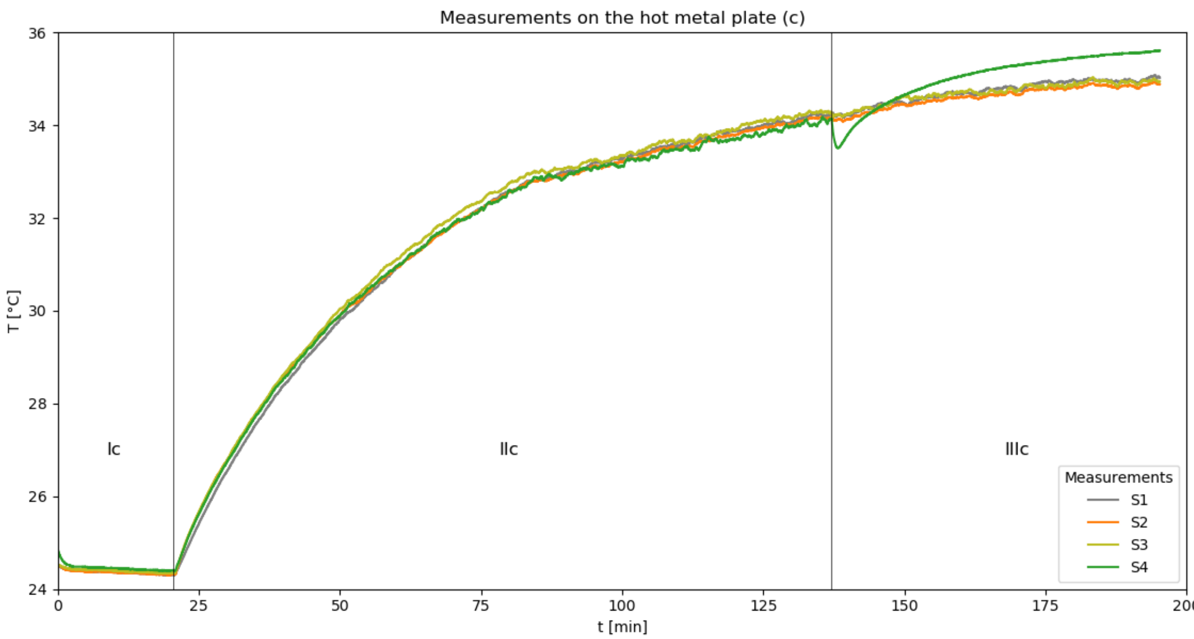

Fig. 3.3. Measurements of the hot metal plate (c). Ic – metal plate with S1:S4 sensors only, IIc – heating mat turned on, IIIc – turned off Aidmed One placed on the plate.

Experiments (d), (e) and (f) were performed with Aidmed One turned on. In experiment (f) we also placed a layer of hydrogel covered by plastic membrane between metal plate and sensors to simulate human skin tissues. Each experiment was divided into two stages - stage I with the stabilization of the heated metal plate temperature and stage II with placement of Aidmed One on the plate and its measurements (Fig. 3.4 - 3.13). In each measurement, after placing Aidmed One on the plate, there was a noticeable increase in temperature readings of S4 in comparison to S1:S3. Aidmed One measurements can be analyzed in two ways - as the time of reaching the temperature not influenced by Aidmed One (S1:S3) or reaching the most probable temperature under the temperature sensor of Aidmed One. In the case of reaching the S1:S3 temperature, for experiments (d) and (e) the temperature difference |Aidmed - S1:S3|<0.1°C was reached in less than 5 minutes, and for experiment (f) in less than 7 minutes, so the result is acceptable from a functional point of view (Table 3.4). However, after this time, temperature readings of Aidmed One became higher than S1:S3 because of heating under Aidmed One caused by thermal isolation. The temperature sensor of Aidmed One is located between S1 and S4 sensors. Thus the most probable temperature under it is a mean temperature of S1:S3 and S4 sensors, defined as Sm. For experiments (d) and (e), the temperature difference |Aidmed - Sm|<0.1°C was reached in less than 5 minutes; however, for experiment (d) it was 34 minutes, so it is much longer. For (d), the differences |Aidmed - Sm|<0.2°C and |Aidmed - Sm|<0.3°C were reached relatively faster, in 19 minutes and 13 minutes respectively (Table 3.5). The longer time taken to reach the target temperature could be explained by poor thermal conductivity of the hydrogel and plastic membrane [9], which better simulates the thermal properties of skin tissues than raw metal plate. Table 3.6 shows a comparison of temperature differences after 15 minutes of measurements in each experiment. The biggest difference between Aidmed One and S1:S3 was 0.5°C, but over time, this difference can increase due to thermal isolation over the temperature sensor of Aidmed One. After 15 minutes, the biggest difference between Aidmed One and Sm was -0.23°C and it was getting smaller over time, so after 15 minutes, the measurement of the error between the most probable temperature under the sensor of Aidmed One and its temperature reading should be ±0.2°C or less.

Table 3.4. Time [s] of reaching S1:S3 temperature by Aidmed One. Se is a temperature of external sensors and is defined as S1:S3 for experiments (d), (e), (f) and S2:S4 for experiment (g).

Experiment	|Aidmed - Se|<0.3°C	|Aidmed - Se|<0.2°C	|Aidmed - Se|<0.1°C
(d)	160 ± 10	210 ± 10	250 ± 10
(e)	100 ± 10	110 ± 10	130 ± 10
(f)	290 ± 10	320 ± 10	400 ± 10
(g)	300 ± 10	360 ± 10	430 ± 10

Table 3.5. Time [s] of reaching Sm temperature by Aidmed One. Sm is defined as a mean between S1:S3 and S4 sensors.

Experiment	|Aidmed - Sm|<0.3°C	|Aidmed - Sm|<0.2°C	|Aidmed - Sm|<0.1°C
(d)	130 ± 10	160 ± 10	240 ± 10
(e)	100 ± 10	110 ± 10	130 ± 10
(f)	770 ± 10	1140 ± 10	2030 ± 10

Table 3.6. Temperature differences after 15 minutes of measurements. Se is a temperature of external sensors and is defined as S1:S3 for experiments (d), (e), (f) and S2:S4 for experiment (g).

Experiment	S4 - Se	Aidmed - Se	Aidmed - S4	Aidmed - Sm
(c)	0.24 ± 0.12	-	-	-
(d)	0.40 ± 0.14	0.20 ± 0.14	-0.2 ± 0.14	0.00 ± 0.14
(e)	0.63 ± 0.18	0.50 ± 0.18	-0.13 ± 0.14	0.18 ± 0.14
(f)	1.21 ± 0.14	0.38 ± 0.14	-0.83 ± 0.14	-0.23 ± 0.14
(g)	-	0.31 ± 0.14	-	-
Mean	0.62 ± 0.19	0.35 ± 0.14	-0.39 ± 0.22	-0.02 ± 0.14

Measurements of the chest skin temperature (g)

The experiment (g) was divided into three stages (Fig 3.14 - 3.16). In the stage Ig, reference sensors S2, S3 and S4 were placed on the naked chest. Their measurements were consistent, the MAE was 0.1°C. In the stage IIg, an Aidmed One was between the reference sensors and turned on. In contrast to previous measurements, none of the reference sensors were placed under Aidmed One, because the chest strap (a strap which holds Aidmed One on the chest) occupied the space under the device. The temperature difference |Aidmed - S2:S4|<0.1°C was reached in approx. 7 minutes, so it was similar to previous experiments. It was not possible measure the most probable temperature (Sm) under the sensor of Aidmed One because of lack of the reference sensor under the device. However, the result seems to be similar to the previous experiments because the readings of Aidmed One exceeded the measurements of S2:S4, so it acts as a thermal isolation and the area under the device was warming up. In stage IIIg, the chest was covered with a T-shirt, so it prevented heat loss. The temperature measurements of S2:S4 significantly increased, from 34.10±0.10°C at the beginning of IIIg to 35.18±0.10°C at the end of IIIg. Also, the difference between Aidmed One readings and S2:S4 was reduced, from 0.66±0.14°C at the beginning of IIIg to 0.41±0.10°C at the end of IIIg. The thermal isolation of clothing has caused the skin temperature to shift more towards the core temperature of the subject.

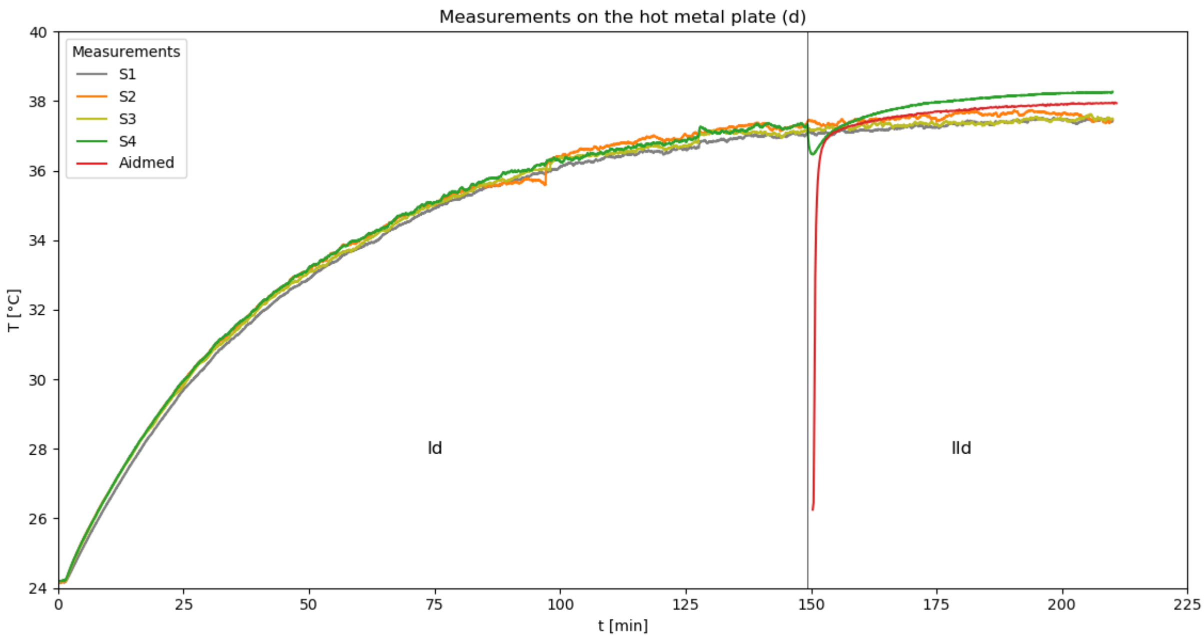

Fig. 3.4. Measurements of the hot metal plate (d). Id – heating up metal plate, IId – turned on Aidmed One placed on the plate.

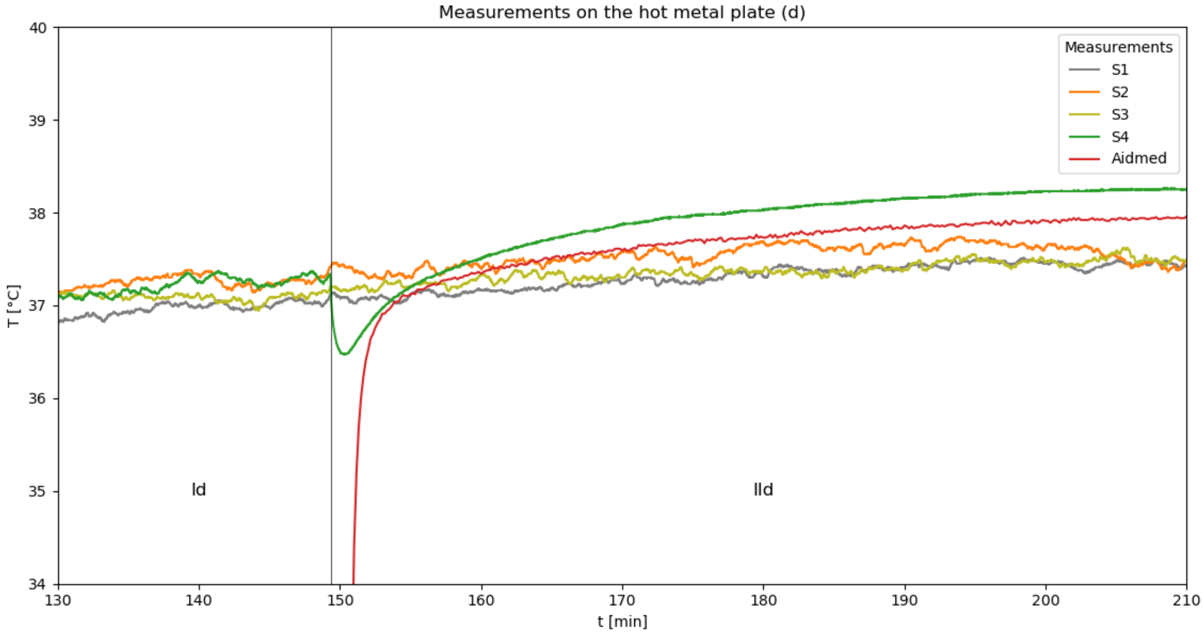

Fig. 3.5. Measurements of the hot metal plate (d). Id – heating up metal plate, IId – turned on Aidmed One placed on the plate.

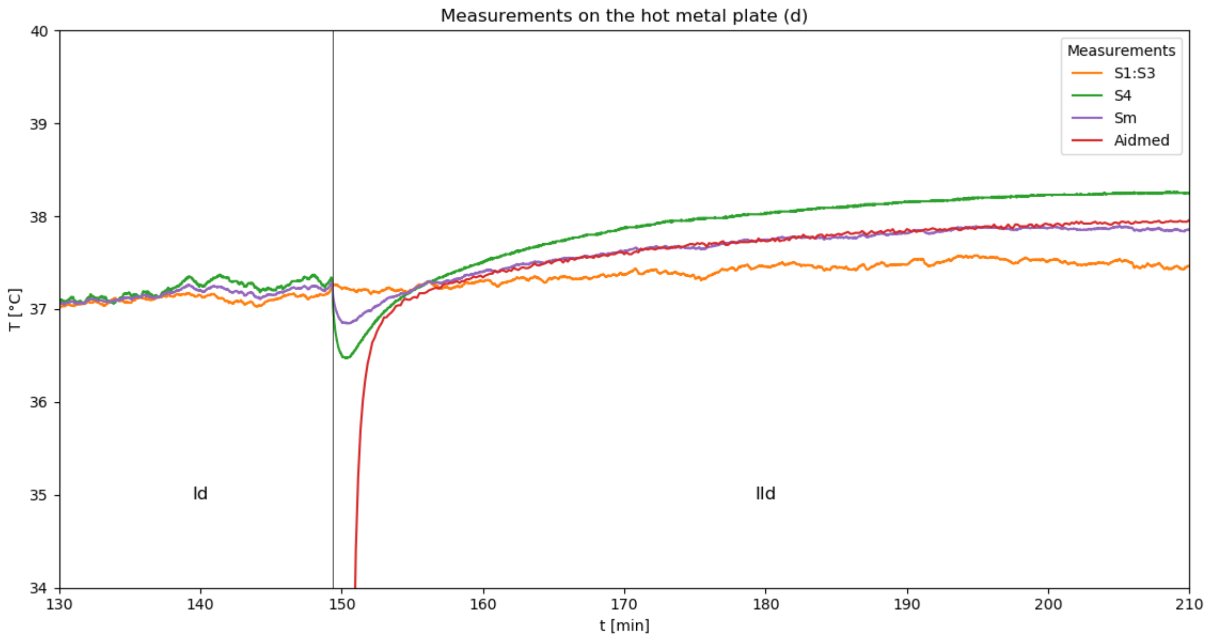

Fig. 3.6. Measurements of the hot metal plate (d). Id – heating up metal plate, IId – turned on Aidmed One placed on the plate.

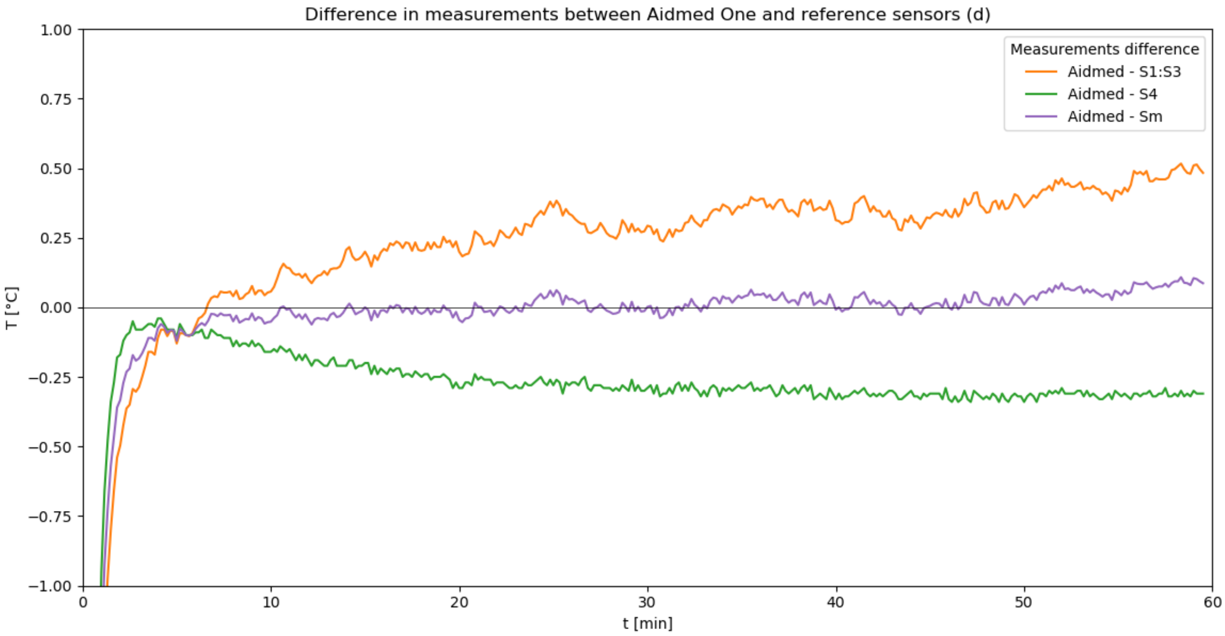

Fig. 3.7. Difference in measurements between Aidmed One and reference sensors (d).

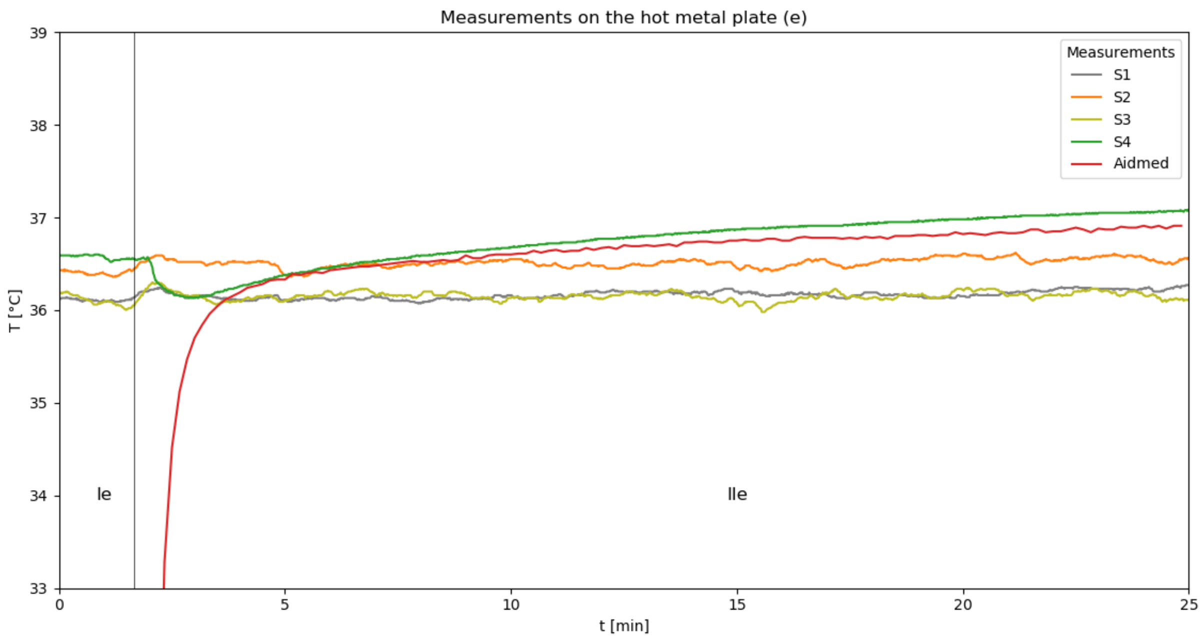

Fig. 3.8. Measurements of the hot metal plate (e). Ie – heating up metal plate, IIe – turned on Aidmed One placed on the plate.

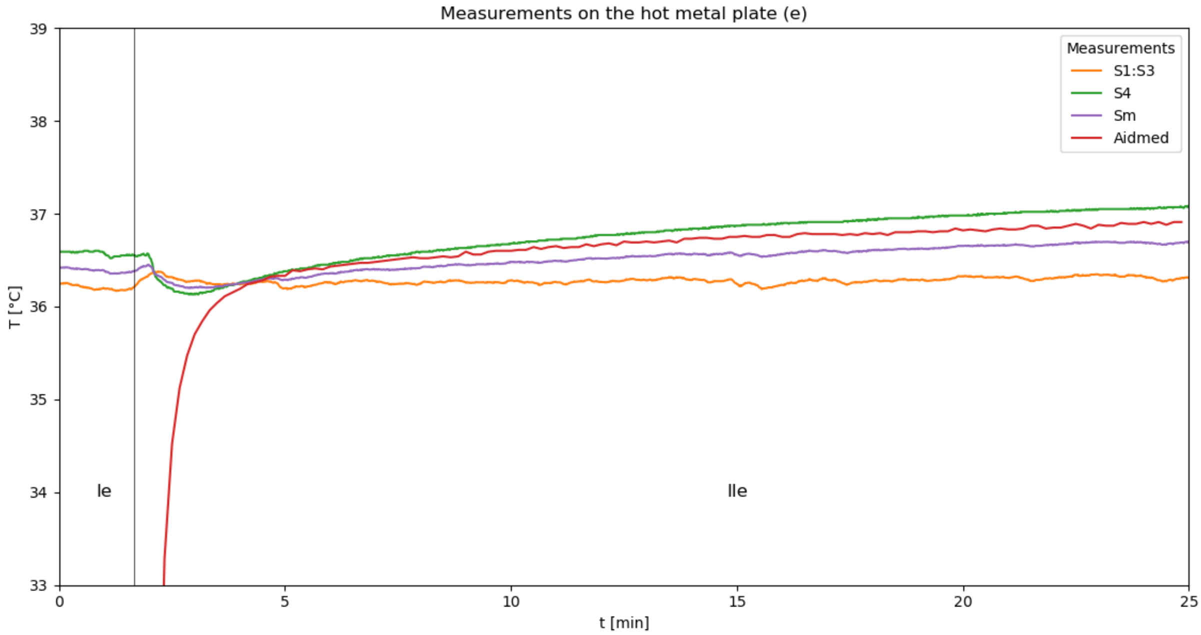

Fig. 3.9. Measurements of the hot metal plate (e). Ie – heating up metal plate, IIe – turned on Aidmed One placed on the plate.

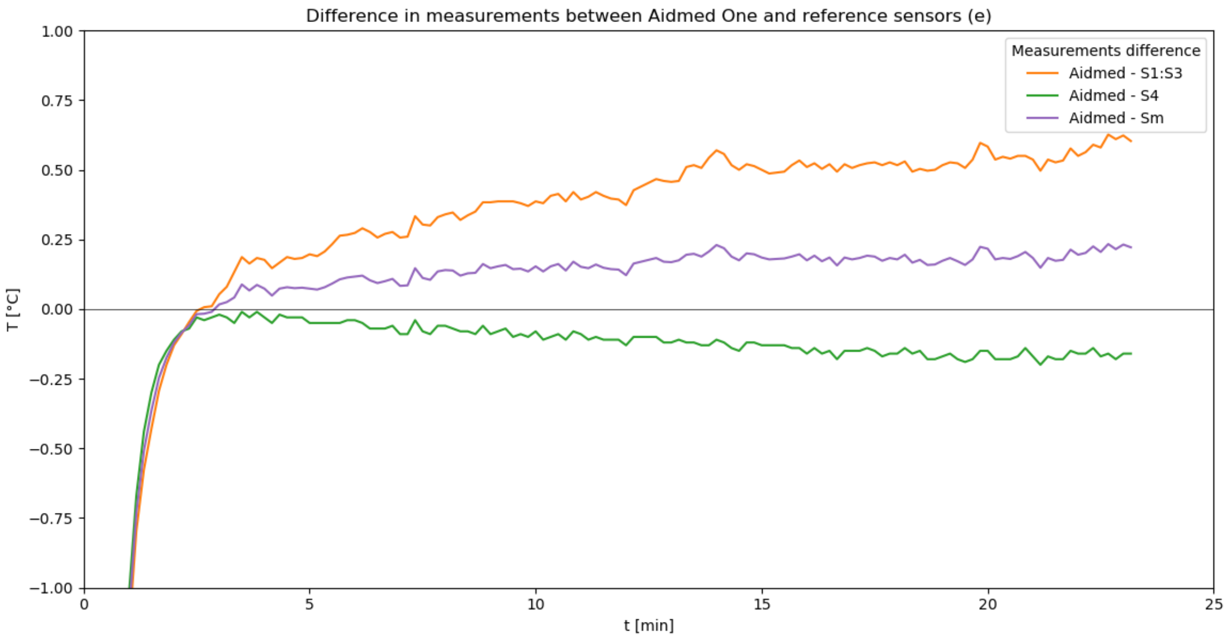

Fig. 3.10. Difference in measurements between Aidmed One and reference sensors (e).

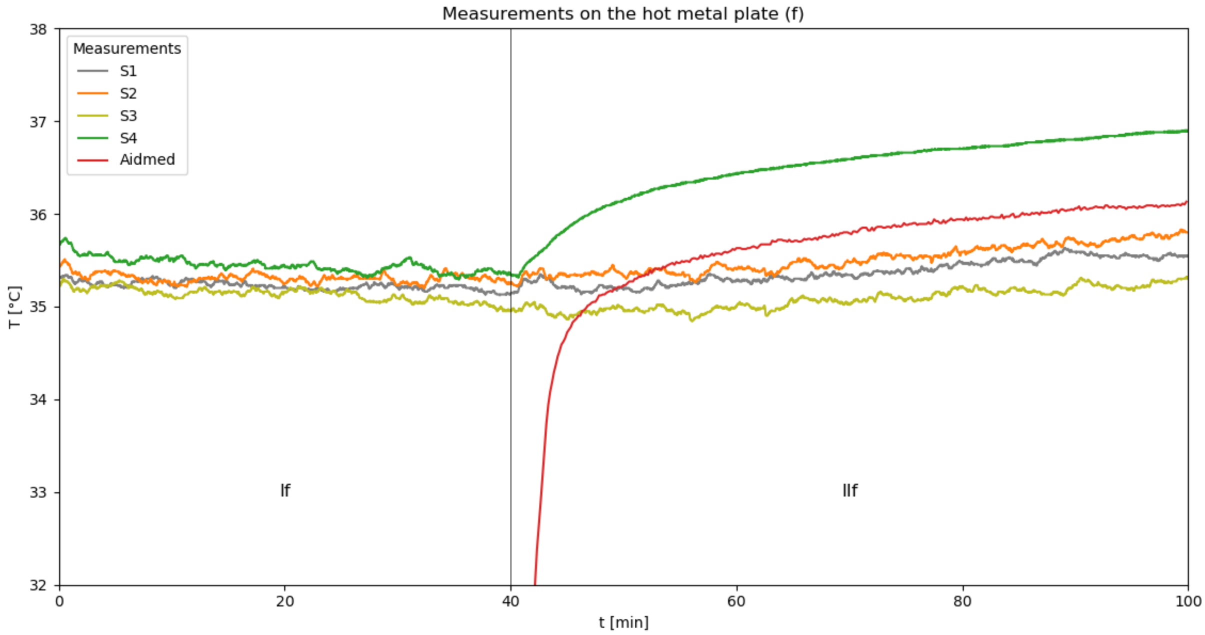

Fig. 3.11. Measurements of the hot metal plate with hydrogel (f). If – heating up metal plate, IIf – turned on Aidmed One placed on the plate.

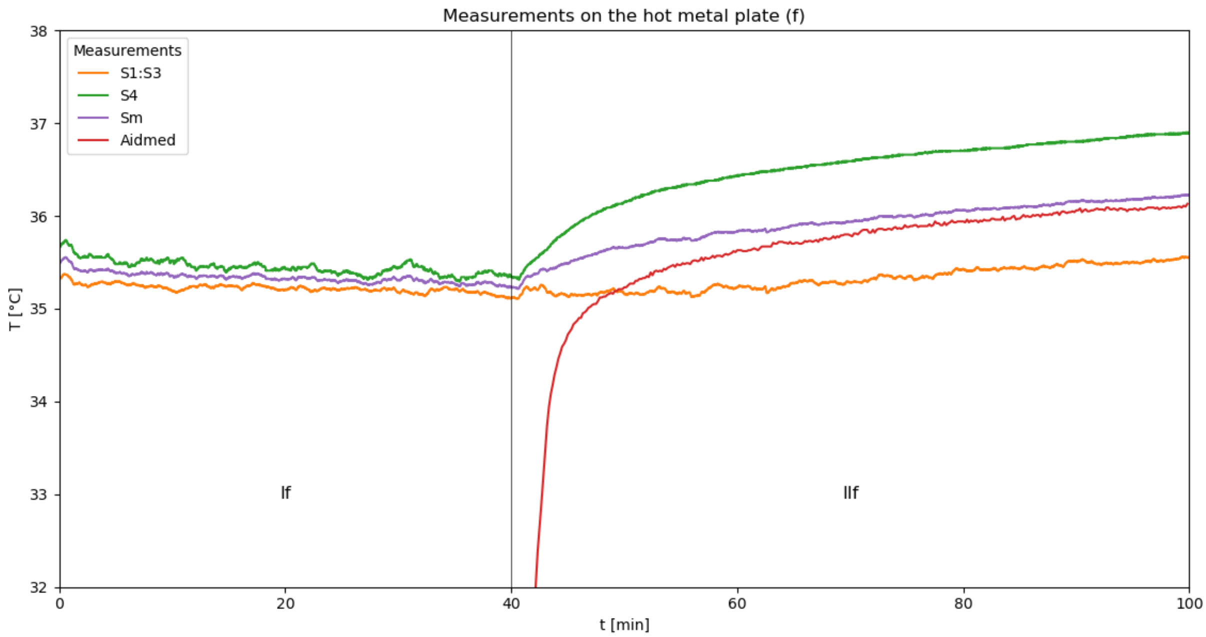

Fig. 3.12. Measurements of the hot metal plate with hydrogel (f). If – heating up metal plate, IIf –turned on Aidmed One placed on the plate.

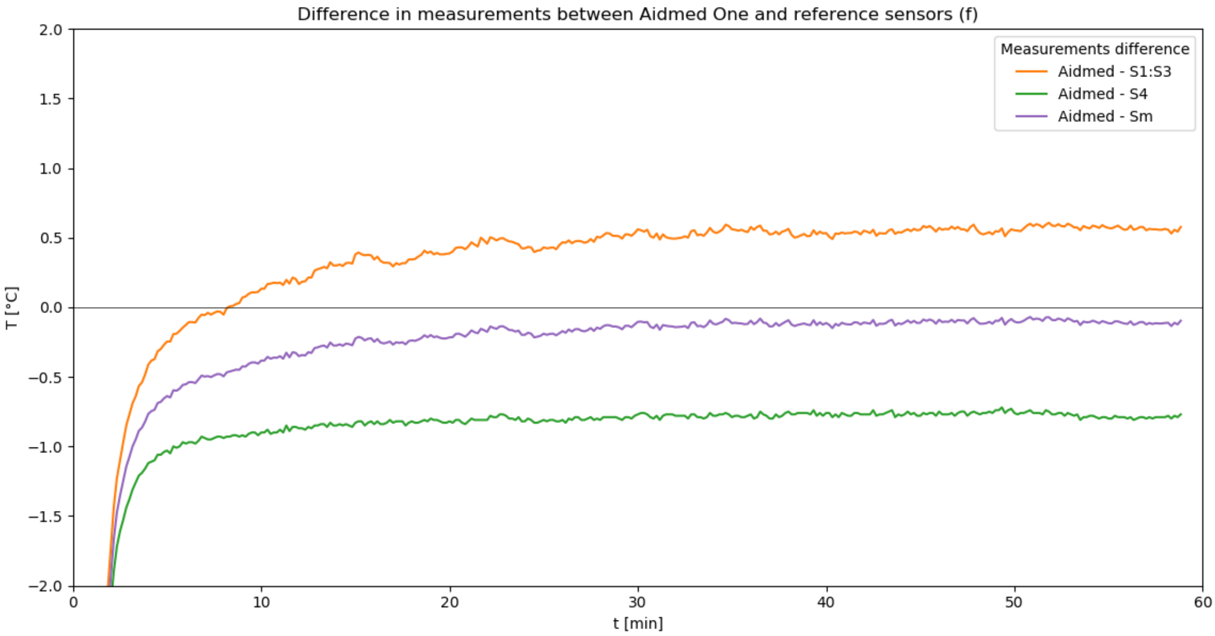

Fig. 3.13. Difference in measurements between Aidmed One and reference sensors (f).

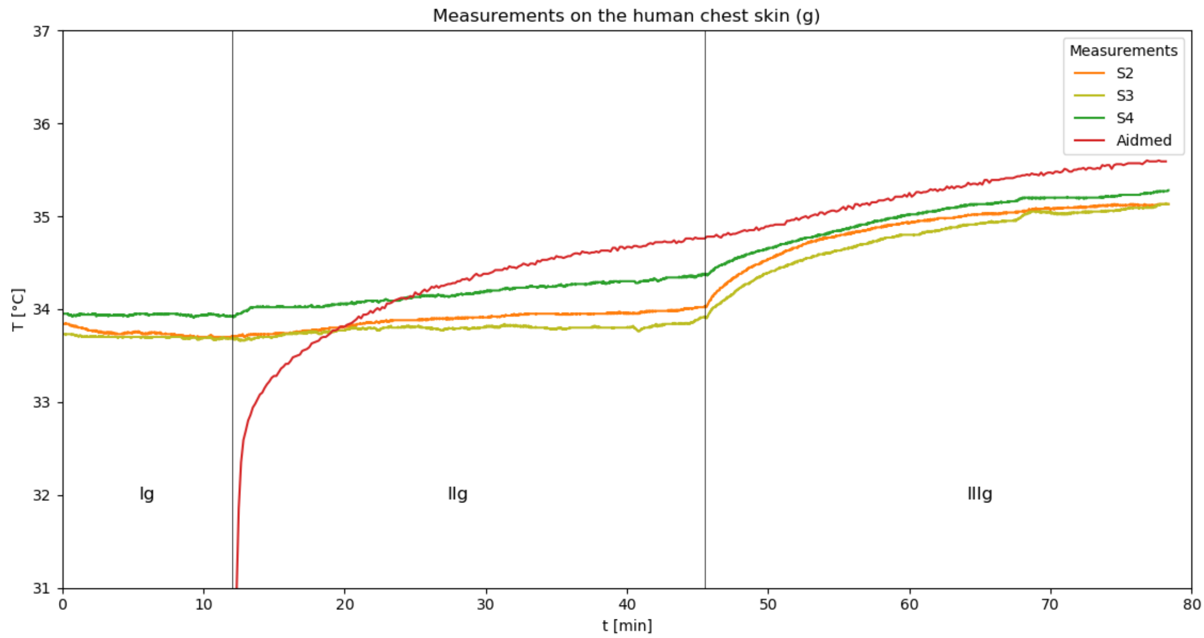

Fig. 3.14. Measurements of the human chest skin (g). Ig – only reference sensors placed on the naked chest, IIg –turned on Aidmed One placed on the naked chest, IIIg – chest covered with a T-shirt.

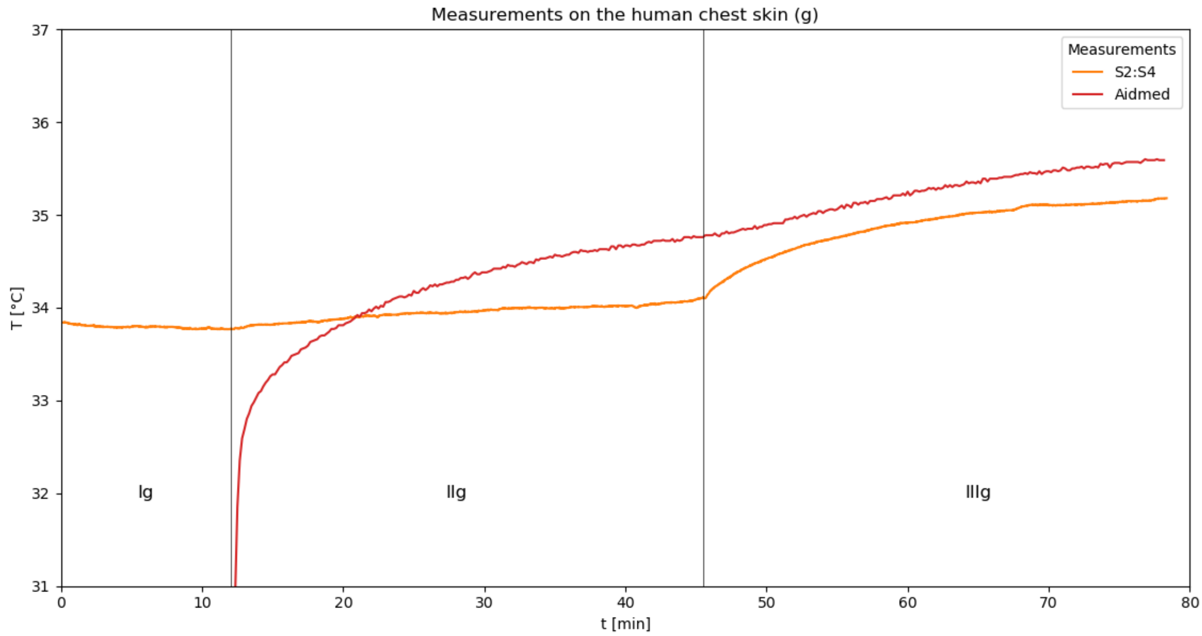

Fig. 3.15. Measurements of the human chest skin (g). Ig – only reference sensors placed on the naked chest, IIg –turned on Aidmed One placed on the naked chest, IIIg – chest covered with a T-shirt.

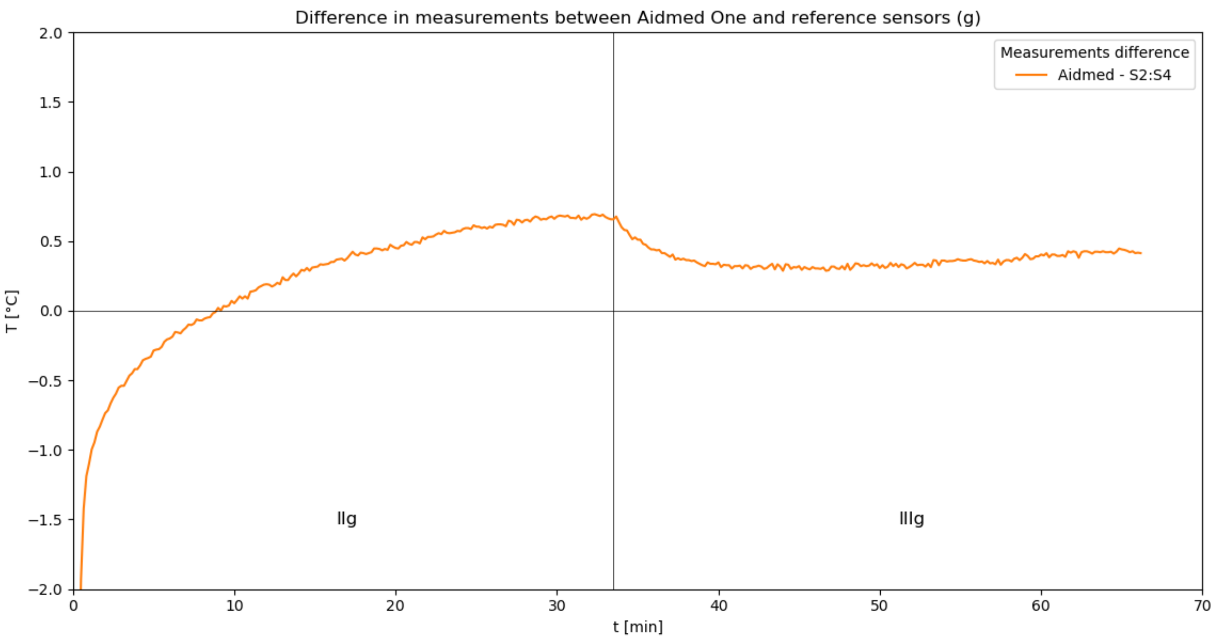

Fig. 3.16. Difference in measurements between Aidmed One and reference sensors (g). IIg – naked chest, IIIg – chest covered with a T-shirt.

4 Conclusion

Aidmed One correctly measures the temperature of human skin, but over time, the measurements shift more towards the core temperature. In each experiment, readings of Aidmed One reached the original surface temperature in less than 10 minutes. The original surface temperature is defined as a temperature not affected by the presence of Aidmed One and is represented as a mean value of measurements of external reference sensors surrounding Aidmed One. However, Aidmed One placed on a given surface creates a thermal isolation, which reduces heat loss from the surface and causes temperature increase under the device. Due to this effect, after reaching the original skin temperature of the chest, the readings of Aidmed One shift more towards the core temperature. For this reason, it is better to wear some clothes on the chest during the measurement than perform it with the naked body. The difference between readings of Aidmed one and the most probable temperature under its sensor was ±0.2°C, so this is the assumed accuracy of temperature measurements of Aidmed One.

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