AN APPRAISAL OF CONTINUOUS TEMPERATURE MONITORS

Our body temperature is not static but is rather a dynamic phenomenon. Measurement at a particular point in time often times cannot reflect on the health status of the body. The dynamic nature of the human body is not only diurnal but can be monthly, as in the basal body temperature (BBT) pattern of women, or even quarterly as in the case of depression. A pattern may unfold by connecting multiple points taken at various times. This is not only tedious and impractical but one may also miss the changes in between the points of measurement, such as in the detection of the lowest point in the middle of a monthly BBT. A device that can provide a continuous monitoring of the body temperature thus has its significant merit and is in urgent demand.

Besides functionality and accuracy which are the paramount prerequisites of an ideal device it should also be user-friendly. Being non-invasive and sufficiently miniaturized to carry comfortably as well as relatively inexpensive are factors to encourage user compliance.

Functions:

The WD continuous monitor, not only can measure temperature, it can also quantify supracutaneous humidity. The latter is useful in detecting the onset of sweating which is important in following the response to antipyretics. It is especially useful in the monitoring of the effectiveness of medication in the treatment of fever, especially in children.

Supracutaneous humidity can also be an indicator of proper skin application, a feature crucial for the interpretation of the accuracy of the temperature measurements such as in the case of the detection of mammary dysplasia and malignancy. Temperature elevation of diseased breast tissue is due to a general increase in angiogenesis usually associated with malignant formation. An increase in blood flow will be accompanied by an increase of heat in the region. Proper skin attachment is a must for the interpretation of the data with confidence.

The monitor:

The temperature of the skin of a breast with cancer is higher than the normal one. This was demonstrated by attaching multiple probes on the skin of the breasts to record the temperatures, as early as in the 1950's. This temperature differential was repeatedly verified using infrared cameras in a temperature controlled room. Infrared imaging of the breasts, also known as thermal mammography, has the advantage that it is non-invasive, has no radiation and imparts no physical discomfort. Its sensitivity and specificity are the subjects of increasing research recently. There was even claim that a temperature differential was detected years before the changes were found by x-ray mammography and ultrasonagraphy. Despite all the advantages, thermal mammography has the disadvantage of the lack of convenient yet accurate instrumentation until the TM' Holter monitor is available.

The TM' Holter consists of three components:

(1) A continuous temperature monitor system (a battery driven, highly precise temperature and humidity detecting probe, and a Bluetooth transmitter),

(2) a continuous temperature monitoring software (a mobile phone APP software) and
(3) a Cloud operating "body temperature module" with a large database and analysis system.

The probe that is attached to the skin is a small and light-weight almond shape flat disc (36x53x7.5mm, weighing 10g) which houses a button-shaped light weight battery, a sensor for temperature and one for humidity.

The probe is placed onto the skin with a non-allergic adhesive at designated sites, e.g. under the axilla of small children for fever and sweating, around the umbilicus of women for BBT, and attached to the bra at 4 o'clock and 8 o' clock positions for thermal mammography. Temperature is monitored every 10 seconds with a margin of variation of 0.1**°C** .

Applications:

The system can be used for clinical as well as research purposes. It can be used for the study of body temperature patterns in health and in various diseases, both physical as well as mental. For example, there are recent data that demonstrate persistent lower body temperature in cases of depression. The response to treatment can be monitored and showed a recovery of body temperature along with the improvement of symptoms. This finding can be applied to women to alert the obstetrician of postpartum depression which is so often missed.

One area of application is in the monitor of the basal body temperature of women. The continuous tracing can reveal the nadir when ovulation is imminent. This information is extremely useful in planning conception. Subsequent behaviour of the body temperature sheds light on the condition of the corpus luteum such as corpus luteal insufficiency. It can also indicate early pregnancy, as well as the danger of abortion. Should a miscarriage occurred, the body temperature may indicate retained products of conception that may require curettage. The BBT can also be used for contraceptive purposes four days after ovulation took place. A monophasic BBT indicates anovulation leading to infertility. It can aide the physician in the explanation of some cased of menstrual disorder. It may also alert the presence of an unopposed estrogen state which may predispose to the risk of cancer, notably that of the endometrium and the breasts. The BBT can reflect conditions which conventionally require multiple blood sampling for endocrine determinations. The advantage is obvious.

Fever in the neonate and children is common and can be very distressing to the family and parents. A continuous tracing of the child's body temperature and the effectiveness of medication in reducing fever coinciding with sweating will be a welcome relief for the parents as well as the health care takers. This spares them the frequent trips to take the child's temperature as well as checking on sweating.

The most significant application to date is the use of the device for the detection of malignancy, specifically that of the breast. As discussed earlier, the pathophysiologic basis of thermal mammography has been well established. The use of thermography for breast cancer assessment has been approved by the FDA since 1982. Its use has been limited by the lack of appropriate instrumentation. The TM' Holter can now fill this gap. It is accurate, light weight,

non-invasive, no radiation, convenient and not expensive. It is suitable for clinics, hospitals, research institutions as well personal use.

On a broader scale, the TM' Holter can be used not only for obstetrics & gynecology, paediatrics, oncology, and even in the operating theatres, medical and surgical wards as well as ICU and CCU, it is also an excellent tool to explore our body temperature patterns in health and disease. Its potential is only beginning to be realized.

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