91 - ANALYSIS OF DISPOSABLE METHODS OF MEASURE OF BODY TEMPERATURE: AN APPLICATION IN THE PHYSIOLOGY OF EXERCISE

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Introduction

The present study if it proposes to discuss the methods of evaluation of the accessible corporal temperature. Since 1871, when more than 40 reasons to prove the importance of the measure of corporal temperature they were mentioned by the teacher Carl Wunderlich of Leipzeig in your study (MORAN and MEDAL, 2002), several studies were led in this area, however with a lot of clinical emphasis and recently in the physiology of the exercise. They are intended with this study to supply a tool that allows the choice of a method of evaluation of the body yemperature in athletes, especially in the study of the determination of the point of fatigue.

The perfected monitoring of the central body temperature is of extreme importance in some clinical cases, in the athletic acting and in some cases you work specific as in industries and rural works that request the use of protection vestiment. The central corporal temperature is the temperature detected by the hipotalamus to regulate the corporal temperature, with variation of just few degree tenth that it provokes change in the termoregulatory answer (EASTON and col., 2006, mentioning SAWAKA and WENGER, 1998).

Now several methods of gauging of the corporal temperature exist, among which can be considered two types: invasives and non invasives. In the available literature, he/she is citation of three considered methods, depending on the author, as "gold standard ". THE first is the measure of the sanguine temperature in the lung artery. This method of measurement of the corporal temperature is invasive and practical, soon your viability is limited to events of surgical nature. The second method is the measure of the esofageous temperature, that is of the three the one of faster answer, however with smaller acuracy than the measure of the lung artery (EASTON and col, 2006). THE third measure and more used in scientific studies it is the rectal measure.

Habitually, for the access easiness and manipulation, the axillary measurement is used. This is not the most necessary measurement, however it is the more cockroach. For validation of other methods, in most of the studies he/she is considered as "gold standard " the rectal measurement. In this case the possibilities of application of the method are restricted due to cultural aspects. It is had the need of development of a method then relatively of low cost and at the same time I need, perfected and of fast answer.

The choice of the method of gauging of the corporal temperature will influence deeply in the study, because the organism answers to small variations in the corporal temperature, besides the variation of central corporal temperature compatible with the human life also to be very small. In Brazil the axillary temperature is quite used, while countries of Europe and in the United States the oral temperature is used more frequently. In both countries the substitution of the methods is happening in function of the use of the tympanic temperature, that is relatively of easy application and good precision.

All the used methods try to esteem the central corporal temperature, in other words, starting from an approach he/she hopes to obtain a possible closer value of the central corporal temperature real. Any estimate should take in consideration the environmental conditions and the inherent characteristics to each corporal area, as for instance, the sanguine irrigation and the fabric type.

Physiologic considerations

The production of heat for the body during the effort could elevate the corporal temperature at dangerous levels in few minutes case there was not an efficient system of balance of the temperature. The center of the human body stays inside in constant levels of a variation strip considered by Guyton (2006) between 36,5° and 37°C, when mensured orally, and approximately higher 0,6°C, when mensured for rectal road. The second method mentioned above it is considered in many studies in the scientific way as " Padrão Ouro ". The humans are considered homeotermic because they generate heat internally to regulate the temperature for a swinging of production of heat, absorption and loss (LIM and col., 2008). A corporal function completes and appropriate it depends on the maintenance of the central corporal temperature between 36,5 and 38,5°C (MORAN and MENDAL, 2002). A deviation of + 3,5°C in the central corporal temperature can result in physiologic damage and fatality (LIM and col., 2008).

The maintenance of the constant corporal temperature feels for the balance between the production and the loss of heat for the atmosphere. When the production exceeds the capacity of dissipation of the heat the temperature he/she rises and it increases the chances of damages to the human health. The production of heat is one of the principal final products of the metabolism (GUYTON, 2006) and it can be worsened if the atmosphere is not favorable to the mechanisms of termoregulation responsible for the dissipation of the heat. The speed of loss of heat is determined by the speed of transport of the heat from where it is produced (I center corporal) until the corporal surface and the speed of transfer of heat between the skin and the environment (GUYTON, 2006).

The effects of the body termoregulation are a process of physiologic answer to a suffered aggression and it happens outside of the center of the body. The external aggressive factor, the heat, is not disrespected however the organic answer is a potential risk the worker's health. When the termoregulation is ineffective, some imminent effects can appear, among them, the thermal shock.

The thermal shock (or heatstroke) it affects the individuals' life seemingly healthy in a tragic way, as athletes, military (CARTER and CHEUVRONT 2007 mentioning BERGERON and col., 2005 and CARTER and col., 2005) and industrial workers (CARTER and CHEUVRONT, 2007) and rural. The thermal stress can happen in function of a predominant factor or for the combination of some factors as environmental processes, I make an effort physical and vestiment.

Mechanisms of change of heat

The human body throws hand of your more important cooler mechanism when he/she is in a state of great accumulation of heat: the evaporation through the sweating. Of all the forms of heat, this is definitively the most important for the organism. However other forms of transfer of heat also happen, therefore actually a combination of mechanisms of change of heat happens simultaneously.

The simultaneity of the mechanisms of change of heat turns more difficult an evaluation of the thermal stress. In practice, when necessary, that evaluation depends a lot on the individuals' subjective information.

Table 1. Forms of Transfer of Heat according to McArdle and al. (2003)

Radiation The objects emit waves thermal eletromagnéticas continually. The radiation is a form of heat that doesn't request molecular contact among the bodies. The coldest bodies absorb thermal energy of the hottest bodies.

Conduction THE exchange of heat for conduction involves the direct transfer of the heat of a molecule for other through a liquid, solid or gas.

Convection The effectiveness of the loss of heat for conduction depends on the speed with that the air (or the water) adjacent to the body it is exchanged after it being warm.

Evaporation The evaporation provides to main defense against the superaquecimento. The water that vaporizes starting from the aerial roads and of the cutaneous surface it transfers heat continually for the environment.

The principal accessible methods analysis

Several methods of gauging of the corporal temperature exist, however the one that the literature shows is that most of them is not to evaluate the elevation of the temperature in individuals accomplishing activity in external and hot environment. Initially the precision of each method will be analyzed for subsequent discussion of the possibility of use more methods in a protocol of evaluation of the thermal stress.

It is considered a valid method that that allows a reading the closest possible of the criterion considered "pattern gold ". Second Marry and col. (2007), a valid method should allow a reading of the temperature with + 0,27°C (+ 0,5) of the standard criterion in your study, in this case, the rectal measure. Lim and col. (2008) they mention El Radhi and col. and Rupp and col. to determine the measure of the temperature in the lung artery as standard method, however your use just limits to surgical procedures.

Casa and col. (2007) they consider that the rectal measure and the intestinal are only valid methods for to gauging of the increase of the corporal temperature during exercises accomplished outdoors in the heat. This case approaches a lot of the reality found by the rural workers in the tomato farming. To weigh of that, Lim and col. (2008) they consider the late rectal measure in relation to the temperature of the lung artery, in other words, the variation in the rectal temperature happens some instants after the variation of the lung arterial temperature.

Pulmonary artery measure

It is the considered measure more perfected (MORAN and MENDAL, 2002). Your gauging feels starting from the insert of a catheter in the lung artery. That artery is responsible for bringing the veined blood of the circulation sistêmica and it comes directly from the center of the body, soon it is the method that best reflects the central corporal temperature. This measured it is considered what best represents central corporal temperature because it is a mixture of the blood that comes from several areas of the center of the body (BYRNE and LIM, 2007).

Esofageous measure

The esofageous measure is used in many studies to obtain the central corporal temperature because of your deep location and proximity with the left ventrículo, responsible for the sanguine flow that is going to the hipotálamo (MORAN and MENDAL, 2002). it is measured interfering a termistor for the passage oral or nasal until the esophagus and the adjustment of the positioning is made in function of the reading of the largest observed temperature (LIM and col., 2008). Your answer is fast, but your application promotes a very big discomfort and it requests a very specialized positioning in the introduction of the thermometer. For your reason use in field researches is not advised.

Rectal measure

This measured it is the more used for research ends and it possesses excellent precision. The place of the measure is considered the most practical and perfected to measure the body core temperature (MORAN and MENDAL, 2002), very away your use in the field has not been told in the consulted literature, just in controlled atmosphere. It is confronted by the introduction of a thermometer he/she saw rectal that penetrates eight centimeters beyond anal esfincter (LIM and col., 2008). the use of this method in field becomes unviable in function of your nature invasiva, one of the reasons for the which the volunteers of a research if they refuse to participate, in addition Easton and col. (2007) they call social stigma. The rectal measure is considered standard criterion for evaluation of the corporal temperature in rest or during the effort (it MARRIES and col., 2007), however in the cases of abrupt elevation of the corporal temperature the reading of this measured it can supply a smaller value than the central corporal temperature (MORAN and MENDAL, 2002). Byrne and Lim (2007) they consider that this measured it is only considered acceptable in conditions of physiologic balance.

Oral measure

It is a practical plenty measure, however it possesses a lot of limitations to be used in a study. It takes around 5 minutes to allow a stable reading (LIM and col., 2008), it depends on the position with relationship to the different parts of the buccal cavity (MORAN and MENDAL, 2002) and it can be influenced by environmental and behaviorments factors (LIM and col., 2008). A difficulty in this method is in the influence of the temperature it adapts in the head's temperature or of the face, that can decrease and to supply a smaller measure if compared to the central temperature (MORAN and MENDAL, 2002). in spite of this measured to be constantly smaller than the central corporal temperature (it MARRIES and col. 2007 mentioning TOGAWA, 1985), the correction through pré-certain algorithms doesn't present representative results of the rectal measure (it MARRIES and col., 2007).

Axillary measure

In spite of practice, non invasive and quite it holds, the axillary measure presents little precision and he/she is considered a poor option for use in research (LIM and col., 2008). This measured it can be influenced by the temperature it adapts, perspiration, humidity, density of the hair in the armpits (LIM and col., 2008), temperature of the skin, subcutaneous sanguine flow and the continuous sweating in the axillary area (it MARRIES and col., 2007). besides, it is a measure related with the corporal temperature of the skin, in other words, in the more superficial corporal layers, soon it is little sensitive to modifications in the central corporal temperature. Moran and Mendal (2002) mentioning Cattaneo and col. (2000) they show that this measured it is less perfected if compared to the rectal measure, oral and tympanic.

Measure of the intestinal temperature

This measured it is obtained through the ingestion of a termistor. The termistor sends a sign for an external receiver that registers the corporal temperature while the termistor stays in the intestinal treatment. This measured he/she answers faster than the rectal measure when it happens variation of the corporal temperature (LIM and col., 2008 mentioning BYRNE and LIM, 2007). on the other hand the answer is slower if compared to the esofageous measure (BYRNE and LIM, 2007).

The great advantage of this method is the absence of the discomfort provoked during to gauging and the possibility of maintenance of the monitoring in a constant way while the termistor to stay in the intestinal treatment. The disadvantage of the method is the need of location of the termistor along the intestinal treatment. The termistor should meet in a specific point of the gastrointestinal treatment where the ingestion of food or fluids don't commit the acuracy of the method (it MARRIES and col., 2007). This procedure is possible through a finder supplied by one of the manufacturing companies. The whole apparatus for the use of this method is available, however at high costs. This is the most expensive method in comparison with the others.

Tympanic measure

It is the measure electric outlet on the surface of the membrane timpânica. This method is more convenient compared to the previous ones and it is less influenced by thermal workmanships and you adapt, besides usually supplying the measure in less than five seconds (MORAN and MENDAL, 2002). in spite of being non invasiva, it is probably a measure that presents larger association with the corporal temperature (LIM and col., 2008). he/she Bases on the measurement of the temperature of the blood that arrives to the hipotálamo and the adjacent fabrics, since in the hipotálamo he/she is the center termorregulador (GUYTON, 2006). the membrane timpânica receives blood of branches of the artery carotid it interns that supplies the center termorregulador in the hipotálamo (MORAN and MENDAL, 2002). A negative point is that this measured it is taken in an instant, on time, what makes unfeasible your use for a continuous measurement of the corporal temperature. He/she/you marries and col. they don't consider this a valid measure why the equipment he/she doesn't play the tympanic membrane and it can suffer interference in function of the amount of air in the channel of the ear it interns. Easton and col. (2006) they consider that this measured it underestimates the central corporal temperature during the exercise.

Given the previous information, he/she is considered for study ends in human beings during labor activity the rectal measure as standard criterion for validation of another method of evaluation of the corporal temperature. In general the analyzed measures presented in studies previous lower values when compared with the rectal measure (it MARRIES and col., 2007).

All the forms of measurement of the corporal temperature are through thermometers. Moran and Mendal (2002) they suggest some parameters that should be followed for the choice of a best equipment. Firstly, the acuracy level should be of $\pm$ 0,1°C. THE thermometer cannot be sensitive to external changes as the temperature of the air or non important areas of the body. It should be stable in the precision and calibration. The thermometer type should be in agreement with the area of the body that will be used. The area where will be placed should not interfere in the precision of the thermometer.

Discussion

This study analyzed some methods of measure of the corporal temperature that they can be used for an evaluation of the thermal stress of an exposed individual to an unfavorable atmosphere the body termoregulation, considering your practicity, accessibility (I cost) and acuracy. Besides an unfavorable atmosphere, the accomplishment of a labor activity that requests great effort it is an important added difficulty in this analysis. In the revision of the methods considered " Pattern gold " a larger citation was observed in the literature of the rectal measure as to measured principal used to validate other methods of gauging of the corporal temperature. The use of the esofageous measure and of the measure of the lung artery it is limited to specific cases. The esofageous measure becomes dangerous if it be not used in an atmosphere controlled and it depends on a technical practice to avoid accidents that can affect the individual's physical integrity. Your use is quite efficient, however little effective. The measure of the lung artery, according to the bibliographical revision portrays in the best possible way the central corporal temperature, but the application technique is surgical, soon your application should limit to you research with medical apparatus and it is out of the reality of a field research.

The axillary measure and the measure oral are quite simple and of easy use, however the quality of the measure is very low (LIM and col., 2008). the use of those measured in research it would be mistaken and the imprecise results, soon are disable methods for this end. The other two methods analyzed in this study they seem to present larger quality in your measure, soon they will be approached with more details starting from now.

The measure of the intestinal temperature has been plenty cited in previous studies in function of your aplicability relatively easy and capacity to supply a very close value of the central corporal temperature, in spite of being a quite onerous method, especially if it is necessary to accomplish several measures. Easton and col (2006) in your study they showed a good approach of the obtained values of intestinal temperature for the first time in relation to the rectal temperature.

The use of an intestinal termistor is of easy application, it doesn't cause discomfort and it can supply a trustworthy measure with analysis possibility in degree tenth. Each termistor is gauged individually and that that to vary your measure more of 0,1°C is put back for calibration and in case it turns to vary more of 0,1°C this it is discarded (EASTON and col., 2006). besides the termistor and of the receiver of the sign that will be turned into degrees, it is also necessary a specific apparel of location of the termistor in the organism, because in case this he/she is out in an area of the certain for measurement the measure it can suffer interference and the result will be invalidated. That fact can be a limitation in the use of this method if the objective will monitor the temperature during a period of some hours, because the termistor will proceed along the intestinal treatment in function of the peristaltics movements and it can, during the monitoring period, to leave of the area standardized for validation of the result. That whole apparatus technological demand a high cost for your use.

The last analyzed method was it of the tymppanic measure. This method has a great use in the pediatrics in function of your practicity, speed in supplying the measure, low cost and relative precision. The tympanic measure allows to esteem the rectal temperature during the rest and in the initial phases of the effort, however you differentiate among the measures they begin to happen when the corporal temperature exceeds 37,5°C (EASTON and col., 2006). in general, previous studies mentioned by Easton and col. (2006), they show that after 30 (thirty) minutes of physical exercise the tympanic measure begins to underestimate the rectal measure. This measured he/she bases on the measure of the temperature of the blood and fabrics enclosures to the hipotalamus that are responsible for giving beginning to the necessary nervous excitement for a termoregulatory answer. Staaij and col (2003) they verified in your study with children that the tympanic measure reflected the rectal temperature and it allowed to detect the presence of fever.

The subestimation of the tympanic measure compared with the rectal measure with that Easton and col. (2006) they suggested the existence of a mechanism of selective brain cooling in the human beings. That same author places that the mechanism is present in several species of mammals and your function is to reduce the cerebral temperature with more speed through the evaporation for the superior aerial roads and for the head, since that area is the one that it presents the largest sweating in the human body [EASTON and col. (2006) mentioning CABANAC and BRINNEL (1988)].

The use of the tympanic measure could be used for events in that the corporal temperature doesn't surpass the 37,5°C or then a relationship between this and other measure considered " pattern gold " should be established in order to allow an estimate of the central corporal temperature. A disadvantage exists in this method that is the need to accomplish otoscopic maneuvers (MORAN and MENDAL, 2002). THE technique of application of the method is of fundamental importance for the quality of the measure. Other studies should be led to determine the acuracy of the method better. It is not still very clear if this method of gauging of the temperature has enough acuracy (STAAIJ and col, 2003)

Conclusion

The analysis of the methods allowed an evaluation of the quality of each method and the possibility of a possible use in research. Except for the measure of the lung artery, it can be considered mediated esofageous and the rectal measure as pattern for validation of other methods. In first analysis the tympanic measure is shown as an alternative for a fast use, practice, holds and with acuracy relatively good. The correct application of the gauging technique is decisive for obtaining of trustworthy results. The

methodology for gauging of the corporal temperature in rest is very defined. During the exercise the intestinal measure is very efficient and effective, however at high costs.

It is necessary the development of a method that is capable to reflect the central corporal temperature, the athlete's thermal sensation and the direct consequences in the health and in the acting. That method should be developed in a simple way and at costs not very high, this way it can be applied in studies in a wider way and to supply capable results be used her/it by the physiology of the exercise.

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ANALYSIS OF DISPOSABLE METHODS OF MEASURE OF BODY TEMPERATURE: AN APPLICATION IN THE PHYSIOLOGY OF EXERCISE

Abstract

The study of the central corporal temperature is study object of the physiology at a long time and it has been showing if decisive in the point of emergence of the fatigue intra-effort. Several studies are led with different methodologies, however the use of a method little perfected and I need it interferes in the obtained results and it limits the conclusions. The present study analyzed some of the different methods used in research, relating the readiness and efficiency of each one. It is intended with the study to determine which method is the perfected and starting from this method to supply a tool for development of a necessary method, perfected and of cost relatively low and this way to enlarge the studies in this research area.

Key words: Body termoregulation, body core temperature, physiology of exercise.

ANALYSE DES MÉTHODES JETABLES DE MESURE DE TEMPÉRATURE CORPORELLE : UNE APPLICATION EN PHYSIOLOGIE D'EXERCICE

Résumé

L'étude de la température corporelle centrale est objet d'étude de la physiologie le beaucoup de temps et si a montré déterminant au point d'aspect de la fatigue intra-esforço. De diverses études sont conduites avec de différentes méthodologies, néanmoins l'utilisation d'une méthode peu d'acurado et précise intervient dans les résultats obtenus et limite les conclusions. Présente étude il a analysé certaines des différentes méthodes utilisées dans recherche, en rapportant la disponibilité et l'efficacité de chacun. Il se prétend avec l'étude déterminer quelle méthode est plus l'acurado et à partir de cette méthode de fournir un outil pour développement d'une méthode précise, acurado et de coût relativement bas et de cette forme élargir les études dans ce secteur de recherche.

Mots de la clef : Termorregulação corporel, température corporelle centrale, physiologie de l'exercice.

ANÁLISIS DE LOS MÉTODOS DISPONIBLES DE MEDIDA DE TEMPERATURA CORPORAL: UNA APLICACIÓN EN FISIOLOGÍA D' EJERCICIO

Resumen

L' estudio de la temperatura corporal central es objeto d' estudio de la fisiología él mucho tiempo y si mostró determinando en el punto d' aspecto del cansancio intraesforço. Se conducen distintos estudios con distintas metodologías, sin embargo l' utilización d' un método poco d' acurado y precisa se produce en los resultados obtenidos y limita las conclusiones. Presente estudio analizó algunas de los distintos métodos utilizados en investigación, informando de la disponibilidad y l' eficacia de cada uno. Se pretende con l' estudio determinar qué método es más l' acurado y a partir de este método de proporcionar una herramienta para desarrollo d' un método preciso, acurado y de coste relativamente bajo y de esta forma ampliar los estudios en este sector de investigación.

Palavras clave: Termorregulação corporal, temperatura corporal central, fisiología del ejercicio.

ANÁLISE DOS MÉTODOS DE MEDIDA DA TEMPERATURA CORPORAL: UMA APLICAÇÃO NA FISIOLOGIA DO EXERCÍCIO

Resumo

O estudo da temperatura corporal central é objeto de estudo da fisiologia a muito tempo e tem se mostrado determinante no ponto de aparecimento da fadiga intra-esforço. Diversos estudos são conduzidos com diferentes metodologias, porém a utilização de um método pouco acurado e preciso interfere nos resultados obtidos e limita as conclusões. O presente estudo analisou alguns dos diferentes métodos utilizados em pesquisa, relacionando a disponibilidade e eficiência de cada um. Pretende-se com o estudo determinar qual método é o mais acurado e a partir deste método fornecer uma ferramenta para desenvolvimento de um método preciso, acurado e de custo relativamente baixo e desta forma ampliar os estudos nesta área de pesquisa.

Palavras-chave: Termorregulação corporal, temperatura corporal central, fisiologia do exercício.