

Thermal Characteristics of Blood in Early Age Children with Pneumonia

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ABSTRACT

A comparative analysis of thermal properties of the whole blood, erythrocytes and blood plasma of healthy and sick with pneumonia children at the age from three months to five years has been carried out for the first time. It has been shown that 3 endotherms at 60.5°C, 70°C and 80°C are observed in the heating process of healthy child whole blood on the thermogram and in case of pneumonia only one endotherm at 70°C is observed. It has been established that the endotherm at 60.5°C appears due to denaturation of albumin fatless fraction, and the endotherms at 70°C and 80°C - due to denaturation of erythrocytes. It has been also shown that denaturation heat (Q_d) coming on endotherm at 60.5°C in case of plasma denaturation of child with pneumonia is 5 times less than Q_d coming on this endotherm in case of norm. This result directly points that a content of albumine fatless fraction in case of pneumonia in comparison with norm is decreased by 5 times. An observed decrease of endotherm Q_d at 70°C in case of plasma denaturation and an absence of endotherms at 60°C and 80°C in case of whole blood denaturation of child sick with pneumonia is used as a new, quick, reliable and cheap test for diagnostics of the protein disorders in case of pneumonias.

KEYWORDS: severe pneumonia, children, differential scanning microcalorimetry

Pneumonia is the major cause of serious childhood morbidity and mortality globally. Despite antibiotics becoming increasingly available worldwide, mortality from pneumonia remains high, particularly in developing countries. Particular attention requires from physicians severe pneumonia. By WHO classification pneumonia is implied as severe by simple clinical criteria - high respiratory rate and/or chest indrawing [1].

In the series of research [2-4] it was shown that the method of differential scanning microcalorimetry (DSC) gives the possibility to follow up the conformational changes of proteins directly in composition of human blood serum. It has been shown that albumin in composition of donor blood serum has two stages of denaturation with Td at 60.5°C and 81°C, (-globulins - at 70.5°C, and what is important, their denaturation occur independently from each other [2]. It has been established before that denaturation parameters of human blood plasma main proteins differ from the same parameters of proteins with various forms of cancer and leukemia [4]. In the presented research we tried to use this method for study of thermal properties of one of the most complex biological system - the whole blood of children.

The goal of this research was to find out if the changes of main components of thermostability of healthy children's whole blood compare to the patients with pneumonia could be observed.

MATERIALS AND METHODS

The studies were carried out on the computer-operated microcalorimeter with sensitivity 0.1 (W, measuring vessel volume - 0.290 ml, scanning rate - 1.5-0.54°C/min, the exactness of temperature measurements - not less than 0.1°C [5]. The fresh venous blood without anticoagulants was used. Blood plasma and erythrocyte mass was obtained due to centrifugation of fresh venous blood at 10 000 turn/min for 10 minutes on centrifuge "Ependorf 5414". We studied a venous blood and plasma of 48 children with severe pneumonia and 20 healthy children at the age from 3 months to 5 years.

RESULTS AND DISCUSSION

Fig.1 presents a record of heat absorption of venous blood of healthy and children with pneumonia. As it is seen, the profiles of heat absorption curves significantly differ from each other. In case of pneumonia, the peaks about 60.5°C and 80°C are absent, and, what is important, the entire curve is shift down the temperature scale by 2°C.

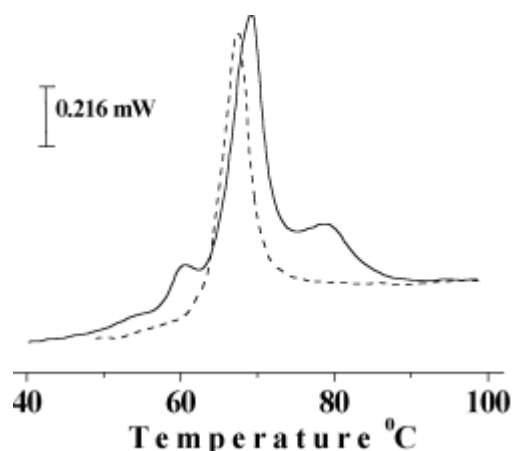


Fig.1 Microcalorimetric records of thermal effect in the process of venous blood heating, in cases of healthy (solid line) and sick child with bronchopneumonia (dash line).

Preparation quantity-0.281 ml; heating rate - 0.56°C/min. Dry biomass quantity - 17,1 mg in case of the norm and 18.2 mg of dry biomass in the case of bronchopneumonia;

We studied thermal characteristics of erythrocyte mass and blood plasma of healthy and sick children to find out to which protein structures correspond the observed heat absorption peaks (endotherms). These data are presented in Fig.2,3.

Fig.2 shows that the endotherm at 70°C corresponds to denaturation of erythrocytes. We mention that in case of donor blood plasma (Fig.3) a clearly expressed shoulder at 55°C and a weak heat absorption with Td=92.5°C

correspond to denaturation of E and D fibrinogen domains [4], and a heat absorption peak at 60.5°C is connected with denaturation of albumin fatless fraction, which makes up 90 % of the total albumin (Fig. 1). As for shoulders at 70°C and 80°C, they are attributed to Y-globulin and fatty fraction of albumin melting accordingly.

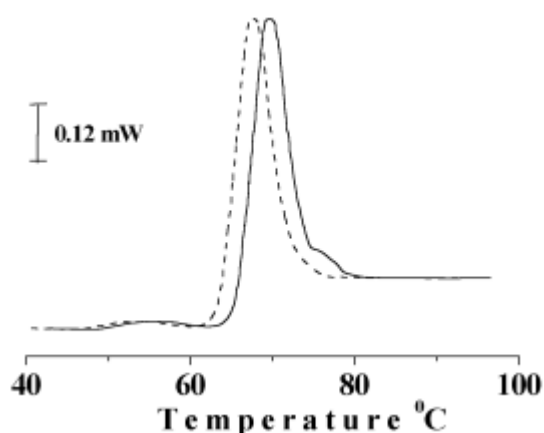


Fig.2 Microcalorimetric records of thermal effect in the process of erythmass heating (conditions as in Fig. 1): norm, $M_{dry}=65.2$ mg, bronchopneumonia, $M_{dry}=71$ mg.

The data of Fig.3 (a,b) show that heat absorption (Q_d) coming on the endotherm at 60.5 °C connecting with denaturation of albumin fatless fraction is 5 times less (curve b) and 3.2 times less (curve c) than Q_d of this endotherm in case of norm (curve a). An observed sharp decrease of endotherm intensity connected with denaturation of albumin fatless fraction (Fig.3 b) is so significant that the endotherm at 60.5°C is absent on calorimetric curve (Fig.1 b).

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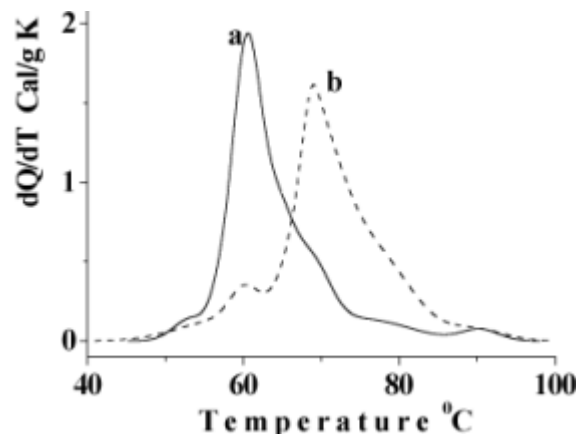


Fig.3 Heat absorption curves as a function of temperature (dQ/dT cal/gK) for blood serum of healthy child (a), sick child (b) calculated per gram of dry biomass (conditions as in Fig.1.)

CONCLUSION

We suppose that the above-mentioned effect and absence of endotherm at 80°C on the thermogram of whole blood of patient with pneumonia relative to the norm may be used as a new test for diagnostics of theseverity of disease on the basis of calorimetric measurements of the whole blood and plasma. For diagnostics may be used also for rutino biochemical analysis of denaturation of albumin fatless fraction in plasma/serum of patient, but it is less reliable as in this case only one parameter is determined - quantitative content of albumin fatless fraction.

Тепловые характеристики крови у детей раннего возраста с бронхопневмонией

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Р Е З Ю М Е

Впервые изучены тепловые свойства цельной крови, плазмы и суспензии эритроцитов крови здоровых и больных бронхопневмонией детей в возрасте от 3 месяцев до 5 лет. При бронхопневмонии на кривой теплопоглощения пики около 60,5°C и 80,0°C отсутствуют и вся кривая сдвинута вниз по температурной шкале на 2°C. Тепло (Qd), переходящее на эндотерму при 60,5°C, которая связана с денатурацией обезжиренной фракции альбумина при бронхопневмонии в 5 раз меньше в сравнении с нормой. Наблюдаемое уменьшение интенсивности эндотермы, связанной с денатурацией обезжиренной фракции альбумина, в случае бронхопневмонии настолько значительно, что при сканировании цельной крови больного при 60,5°C на калориметрической кривой отсутствует эндотерма. По-видимому, уменьшение термостабильности гемоглобина и увеличение теплоты плавления цельной крови больного бронхопневмонией можно использовать как новый дополнительный тест для диагностики тяжести этого заболевания на основе калориметрических измерений цельной крови.

Ключевые слова: *тяжёлая пневмония, дети, микрокалориметрия, параметры тепловой денатурации*