ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11,S Iss 3 Dec 2022

OXIDATIVE STRESS IN INBORN ERRORS OF METABOLISM

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ABSTRACT

Oxidative stress has been demonstrated to be an underlying patho-physiologic process in various inborn errors of metabolism. Metabolic profiling of oxidative stress may provide a nonspecific measure of disease activity that may further enable physicians to monitor disease. In this study, we try to find the correlation between the oxidative stress and inborn. Quantifying oxidative stress offers a unique perspective to IEM. Certain measures may provide a means of addressing mitochondrial function in IEM and aid in the development of therapeutic targets and clinical monitoring in this diverse set of disorders.

Key words

Oxidative stress; free radicals; reactive oxygen species (ROS), inborn error of metabolism (IEM)

INTRODUCTION

A wide variety of diseases known as inborn errors of metabolism (IEM) can be inherited or emerge from spontaneous mutation. In these diseases, the metabolic processes that digest or store proteins, fatty acids, and carbohydrate are broken down improperly. Individual inborn metabolic mistakes are exceedingly rare, but overall, inborn faults are quite common, affecting 1 in every 2500 births. The emergency practitioner must have a thorough awareness of these conditions, their symptoms, and how to evaluate them because they can appear at any age.[1-4]

The incidence of IEMs, collectively, is estimated to be as high as 1 in 800 live births, [5] but it varies greatly and depends on the population. Phenylketonuria (PKU) and medium-chain acyl-CoA dehydrogenase (MCAD) deficiency with respective incidences of 1 in 10,000 and 1 in 20,000 are among the most prevalent.[6]

Oxidative stress is a phenomena brought on by an imbalance between a biological system's capacity to detoxify these reactive byproducts and the creation and buildup of reactive oxygen species (ROS) in cells and tissues. Although ROS are normally produced as by-products of oxygen metabolism and can play a variety of physiological roles, including cell signalling, environmental stressors like UV, ionising radiation, pollutants, and heavy metals, as well as, xenobiotics such antiblastic medications and other factors dramatically boost the formation of

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ROS, which results in the imbalance that damages cells and tissues (oxidative stress). Although oxidative stress is frequently associated with being bad for the body, it is also true that it can be employed therapeutically to treat a number of diseases. The most recent research on oxidative stress and its impact on inborn errors metabolism will be discussed in this review.[7]

As previously mentioned, free radicals and oxidants can cause oxidative stress if they are present in excess. This damaging process can disrupt various cellular structures, including membranes, lipids, proteins, lipoproteins, and deoxyribonucleic acid (DNA). [8-13] When there is an imbalance between the production of free radicals and cells' capacity to eliminate them, oxidative stress results.[14] Proteins may also be harmed by oxidative stress, going through structural changes that could lead to a reduction in or loss of their enzymatic activity. [12,14]

Numerous inborn errors of metabolism (IEM) have been linked to oxidative stress, including organic aciduria, phenylketonuria, maple syrup urine illness, tyrosinemia, urea cycle defects, and homocystinuria[15-22]. Numerous studies on oxidative stress in IEM have so far been published in the literature. In an effort to enhance the number of human inborn disorders for which oxidative stress may be patho-physiologic, we collected earlier research. Additionally, the accumulation of dangerous metabolites may change the way genes are expressed or cause the body to use other metabolic pathways, both of which may encourage the growth of cancer.

In this review, we will describe the most recent findings in the oxidative stress field, and its effect on inborn errors metabolism.

Discussion

Three factors—which are interconnected and frequently overlap—are involved in the pathophysiology of various IEM: 1) toxicity brought on by an accumulation of hazardous byproducts; 2) a lack of a crucial metabolic intermediate; and 3) diminished mitochondrial activity. It has been suggested that oxidative stress, which frequently originates from mitochondrial malfunction, is the main cause of the cellular damage that manifests in various IEM.[23]

Oxidative stress seems to play a role in the pathophysiology of several inborn errors of metabolism, such as phenylketonuria, (PKU) i.e. The results of study by Sirtori et.al, 2005 showed a decrease of erythrocyte GSH-Px activity. Therefore, it is presumed that oxidative stress is involved in the pathophysiology of the tissue damage found in PKU.[24]

Gabriele Pizzino et.al, 2017 reviewed in their study that, Oxidative stress and free radicals are generally known to be detrimental to human health. A large amount of studies demonstrates that in fact free radicals contribute to initiation and progression of several pathologies, ranging from CVD to cancer.[7]

ISSN PRINT 2319 1775 Online 2320 7876

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A study by e.ristoff and Larson 2002 stated that the role of oxidative stress in pathogenesis of inborn error of metabolism is discussed in the light of inborn error in the metabolism of glutathione.[25]

In 2009 Peter J. Mc Guire, Aditya Parikh, and George A. Diaz explained in their theory that, quantifying oxidative stress offers a unique perspective to IEM. These measures may provide a means of addressing mitochondrial function in IEM and aid in the development of therapeutic targets and clinical monitoring in this diverse set of disorders.

Study by Cam, Veysel, et al in 2022 Metabolic control status and compliance with treatment are related to oxidative stress level, showing thiol/disulfide balance in urea cycle defects, phenylketonuria, and galactosemia patients.[26] A study by e.ristoff and Larson 2002 stated that the role of oxidative stress in pathogenisis of inborn error of metabolism is discussed in the light of inborn error in the metabolism of glutathione.

Although the idea of reducing oxidative stress has been around for a while, more research is needed to demonstrate its effectiveness in promoting health and lessening the burden of disease. There may be a role for antioxidant therapy in various forms of IEM, according to several research,[27-32]. With the use of tocopherol, ascorbate, melatonin, and glutathione, oxidative stress has been reduced and harmful effects have been avoided in a number of animal models, including organic acidemias, PKU60, tyrosinemia type I64, and MSUD. The efficacy of this strategy may be increased by addressing respiratory chain malfunction particularly with more recent mitochondrial-targeted antioxidants.[33]

CONCLUSION

Management of many IEM is complicated by the fact that the currently available biomarkers may not reliably reflect the patient's current clinical status or disease progression and have limited prognostic value. Evaluating mitochondrial activity in IEM and developing treatment targets and clinical monitoring in this varied range of illnesses may be made possible by quantifying oxidative stress.

We also have come to the conclusion that although oxidative stress is a phenomenon that significantly hurts individual's wellness and health, it may also be used as a treatment tool when and if we are able to fine-tune this process within the human organism.

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