Mechanisms of acetaminophen toxicity unraveled

Researchers add new insight to acute liver failure caused by overdose of commonly used pain reliever, acetaminophen.

PUTNAM VALLEY, NEW YORK, USA, December 12, 2017 /EINPresswire.com/ -- In the U.S. and around the world, the most common cause of acute liver failure is acetaminophen (APAP) over dose. This commonly used pain reliever is safe and effective when used at recommended doses, but if taken at toxic levels, either by accident or purposefully, acetaminophen overdose lead to liver cell damage, acute liver failure, and death.

A significant public health problem, APAP hepatotoxicity accounts for about half of all acetaminophen-related acute liver failure cases and contributes to around 70,000 hospitalizations in the U.S. every year. APAP overdose is responsible for 46 percent of all cases of acute liver failure in the U.S.

In an effort to better understand the mechanisms of APAP toxicity, and to apply that increased understanding to provide better interventions than currently available, researchers at the University of Kansas Medical Center (UKMC) studied a broad range of cellular toxicity mechanisms that could lead to APAP-induced acute liver failure and liver cell (hepatocyte) death.

The authors note that decades of investigations into the mechanisms of APAP-induced liver injury “have provided significant insight into the role of APAP metabolism” into the cascade of events that can lead to liver injury. However, more insight is needed.

“Although acetaminophen is safe and effective when taken at therapeutic doses, the therapeutic window for treating acetaminophen overdoses is quite narrow and an APAP overdose is highly toxic to the liver.” said Dr. Hartmut Jaeschke of the Department of Pharmacology, Toxicology and Therapeutics at UKMC. “Our research is aimed at gaining a better understanding the mechanisms involved in APAP-induced liver injury so that more effective therapeutic interventions can be developed.”

According to Dr. Jaeschhke and co-researcher Dr. Anup Ramachandran, also of the UKMC Department of Pharmacology, Toxicology and Therapeutics, when consumed at therapeutic doses, the majority of APAP is excreted through the kidneys. However, after an overdose of APAP the body’s metabolic pathways are saturated and a variety of subsequent reactions lead the body form “APAP-protein adducts.” Adducts are products of a direct addition of two or more distinct molecules, resulting in a single “reaction product” containing all atoms of the components.

The initial oxidative stress caused by APAP-protein adducts occurs in the cells’ mitochondria, the site of cellular energy generation. According to the researchers, mitochondria can also play significant roles in cellular signaling and mitochondrial stress has emerged as a key factor in the cell signaling mechanism involved in APAP-induced liver cell death. This stress, however, has cellular ramifications, including mitochondrial failure.

“A better understanding of APAP-protein adduct formation and their relationship to liver cell death is

very important," explained Ramachandran. "Their formation on mitochondrial proteins is most relevant for understanding how APAP toxicity can lead to hepatocyte death."

With APAP toxicity and mitochondrial APAP-protein adduct formation comes oxidative stress and the induction of "mitochondrial permeability transition pore" (MPTP), which ultimately compromises the mitochondrial membrane and shuts down mitochondrial function. Thus, MPTP is central to understanding APAP-induced liver injury, said the authors, who also note that it is now evident that the mitochondrial organelle also plays a significant role in the recovery and regeneration process after toxic injury.

On the positive side, the formation of APAP-protein adducts and their release into the circulatory system might be useful "biomarkers" for diagnosing APAP overdose. Too, they suggested that APAP overdose is a "clinically relevant model" for studying other causes of liver cell death and livery injury and is a model that can be used to study and test potential therapeutic intervention strategies.

What does their work mean for improving clinical interventions to save the lives of those with acute liver failure due to APAP toxicity?

"It is critical to connect these newly-discovered mediators and pathways of APAP metabolism to the already established mechanisms," concluded the authors. "Although more can be learned about various aspects of these mechanisms, it is important to keep in mind potential effects of intervention strategies on drug metabolism, which can lead to misinterpretations. The relevance of these studies will, therefore, depend on the solid understanding of the various toxicity mechanisms."

Their paper appears in the current issue of Gene Expression: The Journal of Liver Research. It is freely available on-line as an unedited, early epub at: http://www.ingentaconnect.com/content/cog/ge/

Funding: Work in the authors' laboratory was supported by the National Institutes of Health grants R01 DK070195 and R01 AA12916, and by grants from the National Institute of General Medical Sciences (P20 GM103549 and P30 GM118247) of the National Institutes of Health. The authors declare no conflicts of interest.

Contact: Hartmut Jaeschke, PhD, Department of Pharmacology, Toxicology & Therapeutics, University of Kansas Medical Center, 3901 Rainbow Blvd. MS 1018, Kansas City, Kansas 66160, USA.
Email: hjaeschke@kumc.edu
Tel: 913-588-7969
Fax: 913-588-7501
##

News release by Florida Science Communications www.sciencescribe.net

###

Hartmut Jaeschke, PhD
University of Kansas Medical Center
913-588-7969
email us here
