Alcohol Biomarkers

Glynnis B. Ingall, MD, PhD

KEYWORDS

- Carbohydrate-deficient transferrin • Acetaldehyde adducts
- Ethyl glucuronide • Ethyl sulfate • Phosphatidylethanol • Fatty acid ethyl esters

KEY POINTS

- Excessive alcohol consumption poses a wide variety of significant immediate and long-term health risks.
- Ethanol biomarkers have clinical utility for detection, diagnosis, and treatment of alcohol use disorders and for screening for fetal alcohol exposure.
- Indirect biomarkers are those that reflect the toxic effects of ethanol on organs, tissues, or body biochemistry, whereas direct biomarkers are products of ethanol metabolism.
- Indirect biomarkers include liver enzymes (aspartate aminotransferase, alanine aminotransferase, and γ-glutamyltransferase), carbohydrate-deficient transferrin, and mean corpuscular volume.
- Direct biomarkers include acetaldehyde adducts, ethyl glucuronide, ethyl sulfate, phosphatidylethanol, and the fatty acid ethyl esters.

INTRODUCTION

Excessive alcohol consumption poses significant immediate and long-term health risks. The search for sensitive and specific laboratory tests suitable for screening, diagnosis, and risk/severity assessment of patients with alcohol use disorders and for monitoring and motivating patients undergoing rehabilitation treatment for alcohol abuse is an active area of clinical research. The other growing use of these biomarkers is for maternal and neonatal screening. These markers can potentially be applied to the management of pregnant women with alcohol use disorders and may allow for earlier identification and treatment of infants at risk for fetal alcohol syndrome and related disorders. A number of promising alcohol biomarkers are being investigated for their potential applications in these settings. These biomarkers fall into two categories, indirect and direct. Indirect markers are those that reflect the toxic effects of ethanol on organs, tissues, or body biochemistry. Direct biomarkers are products

The author has nothing to disclose.
Department of Pathology, MSC08 4640, 1 University of New Mexico Health Sciences Center, Albuquerque, NM 87131, USA
E-mail address: gingall@salud.unm.edu

Clin Lab Med 32 (2012) 391–406
http://dx.doi.org/10.1016/j.cll.2012.06.003 **labmed.theclinics.com**

of ethanol metabolism. The most promising of these direct markers are the longer-lived, nonoxidative products of ethanol metabolism.[1–4]

EPIDEMIOLOGY OF ALCOHOL USE DISORDERS

A significant proportion of the U.S. population is current alcohol consumers, and some of these individuals use it to excess. The 2010 National Survey on Drug Use and Health found that about one half of the population (older than 12 years old) drinks alcohol. Furthermore, about one quarter of drinkers reported that they had experienced binge drinking and 6.7% were identified as heavy drinkers. Many youths aged 12 to 17 years also report that they use alcohol with rates for drinking of 13.7%, binge drinking, 7.8%; and heavy drinking, 1.7%. About 10% of pregnant women aged 15 to 44 years reported binge drinking during the first trimester of pregnancy.[5] U.S. Centers for Disease Control and Prevention (CDC) studies have indicated that from 0.2 to 1.5 cases of fetal alcohol syndrome (FAS) occur per 1000 births. Individuals exhibiting some but not all the diagnostic features of FAS are defined as having fetal alcohol spectrum disorders (FASD). It is estimated that there may be three times as many cases of FASD as FAS.[6]

The CDC has estimated that about 80,000 deaths annually in the United States are attributable to alcohol use disorders, which translates to 2.3 million years of potential life lost per year (2001–2005). In 2005, more than 1.6 million hospitalizations and at least 4 million emergency department (ED) visits were related to excessive alcohol consumption.[7]

PHYSIOLOGIC EFFECTS AND TOXICITY OF ETHANOL

Acute Consumption of Ethanol

The primary acute manifestation of ethanol consumption is central nervous system (CNS) depression. Ethanol affects many neurochemical processes, resulting in an imbalance of excitatory and inhibitory pathways. Signs of intoxication are seen in most individuals after two to three drinks. Initially the individual may show stimulatory effects and behavior related to loss of inhibitions. As the blood ethanol concentrations rise, the depressant effects predominate. Blood ethanol concentrations above 300 mg/dL may lead to coma and death. Other acute effects of ethanol are depression of central temperature regulatory functions, diuresis due to suppression of antidiuretic hormone, and acute pancreatitis and gastritis.[8]

Chronic Use of Ethanol

Chronic ethanol use has untoward effects on many organ systems. Brain disorders associated with chronic excessive ethanol consumption include alcoholic dementia and cognitive deficits, brain atrophy, Wernicke–Korsakoff syndrome and cerebellar degeneration, among others. Chronic heavy ethanol use increases the risk for a number of cardiovascular disorders including myocardial infarction, hypertension, cardiac arrhythmias, congestive heart failure, and hemorrhagic strokes. An alcohol use disorder should be considered as a possible causative factor in patients presenting with gastrointestinal complaints such as chronic gastritis and pancreatitis, esophageal disorders, chronic diarrhea, malabsorption, hepatitis, and hepatic cirrhosis. Alcoholics are also prone to nutritional disorders, macrocytic anemia, thrombocytopenia, and immune system depression.[8]

Tolerance and Dependence

Tolerance is defined as diminished psychological and physiologic response to the same dose. Ethanol is associated with both acute and chronic tolerance to its effects.