Forensic Sci Rev 37:117–135
July 2025

Breath-Alcohol Analysis as a Surrogate for Blood-Alcohol Concentration Depends on Assuming a Constant Blood/Breath Ratio of Alcohol

A. W. Jones

Division of Clinical Chemistry and Pharmacology
Department of Biomedical and Clinical Sciences
Faculty of Medicine
Linköping University
Linköping
Sweden

TABLE OF CONTENTS

* Contact information: Dr. A. Wayne Jones, Department of Biomedical and Clinical Sciences, Linköping University, 582 25 Linköping, Sweden; wayne.jones@liu.se.

Breath-Alcohol Analysis as a Surrogate for Blood-Alcohol Concentration Depends on Assuming a Constant Blood/Breath Ratio of Alcohol

REFERENCE: Jones AW: Breath-alcohol analysis as a surrogate for blood-alcohol concentration depends on assuming a constant blood/breath ratio of alcohol; *Forensic Sci Rev* 37:117; 2025.

ABSTRACT: The ratio of blood-alcohol concentration (BAC) to breath-alcohol concentration (BrAC), which is commonly referred to as the blood/breath ratio (BBR), is an important concept in forensic science and legal medicine. For example, the BBR serves as the calibration factor used when a breath-alcohol test result is converted into the coexisting BAC for clinical, research, and forensic purposes. Furthermore, when legislative bodies established statutory BrAC limits for driving, they divided the statutory BAC limit by an assumed population average BBR, hence BrAC = BAC/BBR. However, jurisdictions opted to use different BBRs when calculating statutory BrAC limits for driving, and values of 2000:1, 2100:1, 2300:1, and 2400:1 were used in different countries.

Under *in vitro* conditions, the blood/air partition ratio of ethanol can be determined with high precision (coefficient of variation CV ~2%), whereas *in vivo* the BBR of alcohol depends on numerous physiological factors, such as lung physiology, breathing pattern, and other biological variables; BBRs *in vivo* have CVs ranging from 8–12%, depending on the type of breath analyzer used. BrAC increases during a prolonged exhalation into an evidential breath-alcohol analyzer and the BBR therefore decreases as a person reaches a vital capacity exhalation. The BBR of alcohol also depends on whether arterial (A) or venous (V) blood samples were used for ethanol analysis, because A-V differences are continuously changing during the absorption, distribution, and elimination stages of the blood-alcohol curve.

This article reviews the historical background and wisdom of assuming a constant BBR of alcohol for legal purposes when breath test results are used as a proxy for venous BAC. Discussion and debate about a person's BBR should be irrelevant in those jurisdictions that enforce a statutory BrAC limit for driving.

KEYWORDS: Alcohol, blood analysis, blood-breath ratio, breath testing, Breathalyzer, drunk driving laws.

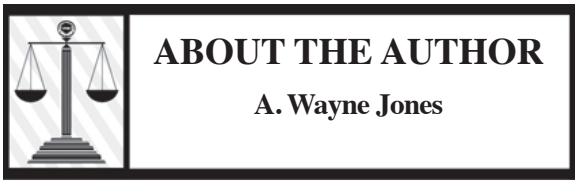
INTRODUCTION

Accurate, precise, and specific analytical methods are a prerequisite if and when the results are used as evidence in a criminal prosecution, such as when a person is charged with driving under the influence of alcohol [41,45,46]. Most nations enforce statutory concentration limits of alcohol in samples of a driver's blood, breath, or urine above which it is an offense to drive [77,130]. Sanctions imposed for a drunk driving offense vary between countries and might include an appreciable monetary fine, revocation of the driving permit for 6–24 months, and in some jurisdictions a mandatory term of imprisonment [32,50].

The first statutory BAC limits for driving were introduced in Norway in 1936, followed by Sweden in 1941, because the dangers of driving after excessive drinking to traffic safety were recognized early in these Nordic countries [91]. Prior to establishing threshold BAC limits for driving, the evidence used for prosecution of traffic offenders included testimony from the arresting police officer, eyewitness statements, and a medical examination of the driver [59]. About 1–2 hours after arrest, a physician was instructed to interview the suspect about recent consumption of alcohol and/or drugs and to document any clinical signs and symptoms of drunkenness using a standardized protocol and questionnaire [3,116].

Besides the person's general appearance and demeanor, things like the smell of alcohol on the breath, ability to stand upright, disturbances in gait while walking and turning, appearance of the eyes (shining, dull, blurred), as well as various cognitive and psychomotor tests, were noted [3]. Taken together, the physician then had to decide whether the person was under the influence of alcohol and if so to what degree, whether mild, moderate, or severe. This type of forensic evidence is necessarily subjective and when a case went to court the physician's conclusions were challenged in cross-examination. Different physicians were known to reach different conclusions about degree of alcohol influence at the same BAC, which tended to undermine the reliability of clinical test results alone [104]. Much seemed to depend on the physician's skill and training in detecting alcohol influence as well as the suspect's habituation to alcohol and the development of tolerance [64].

Clinical evidence of drunkenness was strengthened if laboratory analysis showed a high concentration of ethanol in the suspect's blood or urine [4]. Although initially used as supporting evidence of drunkenness, nowadays a driver's BAC and/or BrAC are afforded much more evidential weight when traffic offenders are prosecuted. This eventually led to the creation of alcohol concentration per se laws, a legal framework such that proof of impairement



ABOUT THE AUTHOR

A. Wayne Jones

A. Wayne Jones was born in Wales (UK), although he has spent most of his career living and working in Sweden, both at government laboratories and in academia. He retired in 2013 as senior scientist at Sweden's National Laboratory of Forensic Genetics and Forensic Toxicology (Linköping). However, he continues to write and publish scientific papers as guest professor at the University of Linköping, Department of Biomedical and Clinical Sciences.

Since his first publication in 1974, Dr. Jones's bibliography now lists 520 items, including journal articles, review papers, book chapters, and letters to the editor. His name appears as sole author on more than half of these contributions and he is the first and/or corresponding author on most of the others. Dr. AW Jones has published papers in more than 100 peer-reviewed journals, including *Journal of Analytical Toxicology* (1983–2024, $n = 49$ items), *Forensic Science International* (1978–2025, $n = 48$), *Journal of Forensic Science* (1978–2024, $n = 24$), and *Clinical Chemistry* (1979–2001, $n = 14$). According to Google Scholar, Dr. Jones's current H-index is 69 and his papers have been cited over 15,000 times. His composite citation score (up to the end of 2023) was 3.978, placing him in fifth position as the most cited scientist worldwide in the discipline of legal and forensic medicine.

Dr. Jones has belonged to editorial boards of about a dozen journals specializing in forensic science, legal medicine, substance abuse, and forensic toxicology. He has peer reviewed manuscripts submitted for publication to over 90 academic journals. Dr. Jones's contributions to the field of alcohol, drugs and traffic safety and forensic toxicology have been recognized by several awards for distinguished service and career-long contributions. Besides hundreds of appearances as an expert witness in Sweden when alcohol-related crimes are prosecuted, Dr. Jones has testified as a toxicology expert, for both defense and prosecution parties, in several countries worldwide.