Review Article

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Anaesthesia Section

Impact of Alcohol Consumption on Regional and General Anaesthesia: A Narrative Review

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ABSTRACT

Alcohol use has a profound impact on the anaesthesiology practice, affecting the safety and efficacy of general and regional anaesthesia. Ethanol is a Central Nervous System (CNS) depressant that modifies the pharmacokinetics and pharmacodynamics of anaesthetic drugs through multiple drug interactions. Chronic alcohol consumption stimulates hepatic enzymes like cytochrome P450, enhancing the metabolism of anaesthetic agents. This can make them less effective, necessitating increased doses to produce the desired effect, and increase the risk of toxicity as a result of the formation of toxic metabolites. On the other hand, acute alcohol consumption can depress hepatic enzyme activity, leading to delayed drug elimination, prolonged anaesthetic action, and increased risk of adverse effects like respiratory depression and delayed recovery from anaesthesia. These drug-related changes require judicious perioperative planning and personalised anaesthetic management. The extent of this review is to analyse the effect of ethanol upon the clinical use of anaesthesia, with emphasis on regional versus general techniques. It will discuss how alcohol influences preoperative evaluation, such as liver function and risk of withdrawal, intraoperative medication dosing, haemodynamic stability, and selection of anaesthetic drugs. In addition, it takes postoperative considerations into account, including prolonged sedation, changed pain response, and alcohol withdrawal complications. Comparing regional and general anaesthesia in alcohol consumers with different patterns of alcohol consumption, this review seeks to accentuate optimal practices for maximising anaesthetic care. It is vital to understand these interactions in order to minimise perioperative complications as well as to enhance patient outcomes. In conclusion, increased awareness and individualised strategies for anaesthetic care in alcohol-impaired patients are necessary parts of safe and successful surgery.

Keywords: Anaesthesia recovery, Drug interactions, Ethanol pharmacokinetics, Hepatic enzymes, Perioperative care, Substance withdrawal syndrome

INTRODUCTION

Alcohol intake has significant effects on all medical and anaesthetic care. Being a CNS depressant, its interaction with anaesthetic agents should concern the measurement of both its efficacy and safety. The interaction between ethanol and anaesthesia is relevant to effects that may invite surgical procedures for a patient's outcome. Such interactions should be understood in the optimisation of anaesthetic care for a patient's safety [1,2].

Chronic alcohol consumption alters the pharmacokinetics and pharmacodynamics of anaesthetic drugs since ethanol may alter their absorption, distribution, metabolism, and elimination, thus affecting drug efficacy and risk profile. Ethanol induces liver enzymes responsible for the metabolism of anaesthetic drugs, and altered drug levels may exist in the organism. This can lead to a decrease in drug efficacy or an increase in drug toxicity for anaesthetic drugs. As a depressant, alcohol will enhance CNS depression, possibly increasing the sedative and respiratory depressive effects of anaesthetics, thereby complicating the delivery of both regional and general anaesthesia [3,4]. These effects of alcohol on anaesthesia apply not only to regional anaesthesia but also to general anaesthesia. Regional anaesthesia might be affected by alcohol in some ways, such as changes in drug metabolism and altered perception of pain. In contrast to general anaesthesia, such as the induction of unconsciousness accompanied by analgesia, there might be more complications in this case because ethyl alcohol has more generalised systemic effects [5].

The clinical interaction of ethanol with anaesthesia is fraught with significant challenges in general. The proper management of these interactions is achieved through the consideration of differences in the mechanisms by which ethanol affects anaesthetic agents and how patient responses are observed with modifications of anaesthetic techniques for the reduction of risk. Consideration of these facts will go a long way toward safer and more effective management of anaesthesia in patients consuming ethanol and lead to better surgical outcomes with negligible possible complications. This review seeks to examine and contrast the effects of alcohol drinking on general and regional anaesthesia, with an emphasis on the manner in which ethanol modifies the pharmacologic and clinical behaviour of anaesthetic drugs. It discusses how both acute and chronic alcohol consumption affect the pharmacokinetics and pharmacodynamics of most often utilised anaesthetic medications, with relevance to perioperative care planning, intraoperative care, and postoperative recovery. The review also explores the ways in which alcohol impacts patient responses under regional compared with general anaesthesia, particularly in relation to drug metabolism, pain perception, depth of sedation, and risk of complications. By considering clinical evidence and mechanistic insight, this review aims to guide safer anaesthetic practice, aid effective risk stratification, and provide recommendations for anaesthetic technique modification in alcohol-using patients to enhance surgical outcomes and patient safety.

Interactions of Alcohol with Anaesthetic Drugs

Alcohol has a significant influence on the effectiveness and safety of any form of anaesthetic agent. Alcohol in the body will alter the process of absorption, distribution, metabolism, and excretion of anaesthetic drugs, thereby altering their efficiency and safety. Mechanisms by which ethanol may interact with anaesthetic drugs are many and complex. The CNS is the area where the principal

action of ethanol occurs. The drug acts directly or indirectly on modifying neurotransmitter systems, on which the actions of anaesthetic drugs are based. Ethanol increases the activity of γ-Aminobutyric acid (GABA) receptors. mediating the sedative and hypnotic actions of many anaesthetics. Acting on GABA receptors, anaesthetic drugs could add their efforts to this and lead to overdose or respiratory depression. The effects of ethanol on other neurotransmitter systems can also oppose the actions of anaesthetic agents, which are dependent upon them and diminish their efficacy [6-8].

It can also affect the metabolism of anaesthetic drugs, which may have a profound impact on their safety and effectiveness. Continuous ethanol consumption increases the induction of liver enzymes responsible for metabolising numerous drugs, including anaesthetics. Such an induction can increase the clearance of an anaesthetic drug, and a larger dose is needed to achieve the required anaesthetic effect. Acute alcohol intake may actually postpone the metabolism of anaesthetic drugs, hence prolonging the action of drugs and elevating the risk of drug toxicity. Alcohol-induced liver damage may potentially result in the impairment of the metabolism of anaesthetic drugs through altered pharmacokinetics and related complications in and after surgery [9,10]. These interactions are summarised in [Table/Fig-1] [8,9,11-14].

Anaesthetic drug/class	Enzyme metabolism	Effect of acute alcohol	Effect of chronic alcohol	Clinical interaction and risk
Volatile agents (sevoflurane, halothane, enflurane, isoflurane) [9,11]	CYP2E1	Inhibits metabolism → slower elimination	Induces CYP2E1 → faster metabolism, increased MAC	Chronic alcohol use may require higher concentrations; risk of hepatotoxicity, especially with halothane
Propofol [8,12]	CYP3A4 (also, CYP2B6, CYP2E1)	Little change acutely; possible delayed clearance	Increased clearance → higher induction dose may be needed	Tolerance in chronic users; may require higher doses; risk of accumulation in liver dysfunction
Opioids (fentanyl, remifentanil, codeine) [8,13]	CYP3A4, CYP2D6	Additive CNS/ respiratory depression; delayed metabolism	Increased clearance; altered receptor response	Risk of oversedation acutely; chronic use may reduce effect; dose adjustment often required
Benzodiazepines (midazolam, diazepam) [8]	CYP3A4	Enhanced sedative effects due to GABA synergy	Variable clearance; some tolerance	Risk of profound sedation or respiratory depression when combined with alcohol
Local anaesthetics (lidocaine, bupivacaine) [10,14]	CYP1A2, CYP3A4, CYP2E1	Minimal impact acutely	May increase metabolism slightly	Modest clinical effects; local toxicity risk may increase with liver dysfunction

[Table/Fig-1]: Interaction of alcohol with specific anaesthetic drugs [8,9,11-14].

Effects of Alcohol on Regional Anaesthesia

Long-term alcohol intake is regarded as a factor in the development of peripheral neuropathy that disrupts the structure and function of the peripheral nerves. This affects the reactivity to local anaesthetics, meaning that the efficiency of the anaesthetic is reduced either because the binding efficiency of the local anaesthetic drug is diminished within the nerve receptors or because the penetration to the nerve tissues is not adequate. This will compromise changes that are required to ensure that the necessary level of analgesia is not sufficient during procedures, and other methods or additional anaesthetic doses should be given to maintain the essential level of analgesia [6,15].

Acute alcoholic use can also compromise the effectiveness of regional anaesthesia. Alcohol interacts with the pharmacokinetics of the local anaesthetic at all stages. A pH change in body fluids caused by alcohol may influence the ionisation of local anaesthetics and, thereby, the passage of the anaesthetics through nerve membranes. Another factor relates to the impact of alcohol in the distribution of anaesthetics, including the effects of blood perfusion and tissue perfusion. Such alterations in the flow of blood would also change the uptake and distribution of the local anaesthetics in the intended area, leading to differential effects of the anaesthetic [15,16].

The success of regional anaesthesia techniques could be influenced by the impact of alcohol on nerve sensitivity and local tissue characteristics. It might mean that nerve sensitivity changes by alcohol or even changes in vascularity may disturb the spread and diffusion property of the local anaesthetics, which may even alter success rates with these techniques. A patient history of alcohol use may also increase variability associated with alcohol use, creating unpredictable outcomes, hence requiring active observation and possible adjustments to the anaesthesia plan [16,17].

Alcohol consumption is capable of affecting compliance and the patient's response to the anaesthetic. It would be expected that patients who drink alcohol will likely exhibit a modified threshold to pain or even differ in pain response from that observed in non-drinkers. This is likely to affect the reaction to the local anaesthetic administered and the general management of the anaesthetic plan. Alcohol exacerbates the healing process as it may impede the ability to respond well to analgesia as well as the ability to maintain detailed aftercare service instructions [18,19].

Effects of Alcohol on General Anaesthesia

Anaesthesia management has become a concern over alcohol because it has a potential effect on clinical efficacy and safety in anaesthetic practices. General anaesthesia requires a combination of intravenous and inhaled anaesthetics to achieve the goal of general unconsciousness and analgesia [20].

The pharmacokinetics of anaesthetics and the actions of alcohol are complex. Ethyl alcohol can influence the absorption, distribution, metabolism, and elimination mechanisms of general anaesthetics. Ethanol alters enzyme activity in the liver, particularly in the cytochrome P450 system, which is the mechanism of action for the majority of anaesthetics. Chronic alcohol consumption increases these enzymes so that the metabolism of anaesthetic medications can improve, and increased doses need to be given in order for the desired anaesthetic effect to be achieved. This would eventually result in slow drug metabolism and delay the onset of the action of anaesthetic drugs. In such variations in drug metabolism, dosing strategies might become more complicated, and the risks would increase for either inadequate anaesthesia or prolonged sedation [21].

The history of ethanol intake is not only the reason for concerns in process safety but also raises doubts about the success of the procedure and its possible complications under general anaesthesia. Alcohol can provoke respiratory depression, one of the main risks of general anaesthesia. Both depress respiratory function. The combined effect could result in severe respiratory compromise during surgery. It also affects cardiovascular stability and increases the risks of some cardiovascular complications, such as arrhythmias or hypotension, among others, during anaesthesia. Another risk associated with this includes alcohol-induced impairment in liver function, which may further complicate the metabolism of anaesthetic agents, increasing the risk of drug toxicity and delaying recovery [22,23]. It may affect the cognitive and psychomotor functions of the patient, leading to a sort of impairment in following post operative instructions and, as a result, increasing the risk of undesirable outcomes [24].

Comparative Analysis of Regional vs. General Anaesthesia in Alcoholics

The consideration of the effect of alcohol on anaesthesia includes laborious differentiation in comparison between regional and general anaesthesia among alcohol users, and the final analysis demonstrates apparent differences in challenges and implications for clinical practice. There is a profound effect of alcohol on the two forms of anaesthesia, although the nature and degree of the impact on efficacy and safety differ.

Efficacy

Alcohol intake may affect the pharmacological response to local anaesthetics. Chronic intake of alcohol may influence the sensitivity of the nerve receptors, reducing the potential for regional anaesthesia. A good example would be that patients who are alcohol-dependent may require a higher dose of local anaesthetics to achieve similar levels of anaesthesia compared to non-consumers of alcohol. This increased dosage increases the risk of local anaesthetic toxicity and may further complicate the management of the patient's pain during the procedure [11,25,26].

General anaesthesia creates a much broader array of dangers and complications for alcohol users. Chronic alcoholism may cause the pharmacokinetic and pharmacodynamic disorders of general anaesthetics to change. Dysfunction of the liver resulting from alcohol, including the decreased potential for anaesthetic metabolism, can lead to prolongation of sedation and an increase in potential drug accumulation and toxicity. This creates a complex situation in dosing and recovery. With poor metabolism, anaesthetics residing for more extended periods in the organism may keep a patient sedated for a more extended period, thereby increasing the potential risks [15,26,27].

Preoperative Considerations in Anaesthesia for Alcohol-Using Patients

Preoperative considerations markedly influence anaesthetic management in patients with alcohol use. Every good preoperative evaluation should include the assessment of alcohol use Assessment usually consists of a detailed history to determine the extent and pattern of alcohol consumption. Knowing the amount and frequency of ethanol consumption by a patient provides insight into its possible effect on anaesthetic agents and perioperative risks [28].

Specific issues necessitate individualised care when addressing alcohol-related risks related to anaesthesia. Interventions may involve optimisation of liver functions, management of concurrent co-morbidities, and development of contingency plans if complications of drug metabolism are to be expected. Dosages of anaesthetic drugs, alternative medications, and advanced monitoring may have to be modified. There may be a reason to advise total abstinence from alcohol preoperatively to avoid the effects of alcohol on anaesthetic management and recovery [17,21].

Intraoperative Considerations in Anaesthesia for Alcohol-Using Patients

The need for increased intraoperative monitoring for a patient addicted to alcohol should be initiated to confront and manage complications. Increased risks include cardiovascular instability, respiratory depression, and delayed awakening. Continuous monitoring of vital signs, blood gas, and hemodynamic parameters is of paramount importance to eliminate any problem instantly. The depth of anaesthesia, fluid management, and pharmacological intervention may require changes to maintain stability and for the safety of a managed patient for a surgical procedure [29,30].

Postoperative Considerations in Anaesthesia for Alcohol-Using Patients

Events that unfold both in the preoperative and intraoperative periods of people who use alcohol may significantly impact postoperative outcomes. Alcohol may lead to increased action of sedatives, the impairment of cognitive function, and a greater likelihood of postoperative complications. The possibility of an ethanol impact on recovery after surgery necessitates that much attention be focused on pain management and patient observation during the recovery phase. The choice between regional and general anaesthesia also affects postoperative outcomes. Although regional anaesthesia might have a more uneventful recovery with less systemic effect, general anaesthesia in alcohol users is usually associated with more extended recovery periods and a higher rate of complications [26,31].

For an alcohol abuser, a relative assessment of the comparative use of regional versus general anaesthesia would find that regional anaesthesia probably provides better results related to recovery and fewer systemic effects. General anaesthesia can be more successful in specific surgical practices but with a high likelihood of the occurrence of complications due to the effects of alcohol on the levels of drug metabolism and stability at the systemic level. Both need to be particularly acute to the risks related to alcohol to optimally apply anaesthesia for the best patient outcomes [26,32].

Recommendations for Anaesthetic Practice

The 2025 consensus statement of Jenkins MJA et al., emphasises that first, adequate preoperative evaluation is necessary, including routine screening for harmful alcohol intake using tools like AUDIT-C, along with thorough history taking of ethanol intake, which might have significant effects on the metabolism of anaesthetic drugs and their reactions in response to the drugs [33,34].

The practical approaches to handling possible alcohol-related complications in the perioperative period, including preventive measures such as alcohol detoxification or medical stabilisation, should be done where necessary. Lane O et al., stresses that this may even involve prevention in the form of alcohol detoxification or medical stabilisation, which is essential to alleviate the potential withdrawal symptoms and other risks. Postoperative care must also be tailored to the patient who is drinking through close monitoring of pain therapy for a late return of recovery or complications due to alcohol intake. By following these principles and recommendations, anaesthesiologists will be better placed for the continued management of ethanol-ingestion-related complications and ensure the safety and efficacy of anaesthesia delivery across a broad span of surgical care [17,31,35].

Clinical Algorithm for Anaesthetic Management in Alcoholics

Managing surgical patients with a history of alcohol use requires a structured step-by-step clinical approach to minimise perioperative risks and complications. Preoperatively, all patients should be systematically screened for alcohol use disorders using validated questionnaires combined with clinical assessment and relevant laboratory investigations to detect underlying liver dysfunction, nutritional deficiencies, and electrolyte imbalances. Patients identified as high-risk should be counseled about the increased likelihood of postoperative infections, cardiopulmonary complications, bleeding tendencies, and prolonged hospital stays. Whenever feasible, a period of abstinence for at least six to eight weeks before elective surgery should be advised to reduce these risks, and elective procedures may need to be postponed for stabilisation and brief interventions in severe cases. Intraoperatively, the anesthetic plan should be tailored to the patient's physiological status, avoiding long-acting sedatives in favor of short-acting agents, and prioritising regional anaesthesia or multimodal analgesia to minimise opioid requirements. Special attention must be given to airway management due to the heightened aspiration risk. Postoperatively,

vigilant monitoring for alcohol withdrawal symptoms is crucial during the first 72 hours, using objective scales to guide symptom-triggered benzodiazepine therapy, with adjunctive agents employed when necessary. Thiamine supplementation and correction of electrolyte imbalances should be initiated early to prevent neurological complications. Pain management should emphasise non-opioid and regional techniques, especially in patients with hepatic impairment or those previously on opioid antagonists like naltrexone. Finally, discharge planning must include coordination with addiction services for continuation of relapse prevention strategies, cautious reintroduction of maintenance medications, and ensuring appropriate psychosocial support to sustain long-term abstinence and recovery [16,17,19,28].

Future Directions and Research Needs

An area for future research is the search for personified methods of anaesthesia in alcohol-using patients. This would also involve research in the area of the effects of alcohol on new anaesthetic agents and techniques, which may yield insights into the rationalisation of drug dosages to ensure that the side-effects are at a minimum. In this setting, standard protocols in the assessment and management of alcohol-related risks in the perioperative setting have to be developed. A good example is when standard protocols guide the operator on how to adapt their anaesthesia practice as most applicable to an alcohol-dependent patient population, which ultimately leads to better patient outcome measurement [36].

Equally important are clinical trials. Further studies should also be conducted to establish the efficacy of the various preoperative interventions, including alcohol detoxification strategies, in attenuating the anaesthesia risks. Studies looking into the long-term outcomes of varying ways in which ethanol is managed in alcohol-ingesting patients will establish vital information in fine-tuning anaesthetic practices to enhance the safety of patients. Further research has to be directed toward the development of pharmacological interventions targeted at reversing or attenuating ethanol's adverse effects on anaesthesia [37].

CONCLUSION(S)

The complexity of the issues of alcohol-anaesthesia interactions is rather severe. Such interactions require careful management in order to provide protection for the patients and assure optimal outcomes in surgery. Continuous alcohol intoxication results in vital changes in the pharmacokinetics and pharmacodynamics of the anaesthetic drug molecules and affects regional and general anaesthesia. The overall landscape of regional anaesthesia is less effective and more variable with the presence of alcohol. General anaesthesia carries broader risks, such as prolonged sedation and distinctly higher risks with complications in respiration and circulation. An overall preoperative evaluation and customised anaesthetic procedures become need-of-hour specifications. Future research in this direction will help fill in the gaps in the present knowledge, namely, the interaction of modern anaesthetic agents with ethanol and the elucidation of an individual strategy for managing anaesthesia. Attention to these aspects might further help improve the safety and effectiveness of anaesthesia care offered to patients with disorders linked to alcohol use and, therefore, surgical outcomes.

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