DRUGS IN CONTEXT
RIGOROUS • RAPID • RESPONSIVE

A continuous publication, open access, peer-reviewed journal

ACCESS ONLINE

REVIEW

An overview of exposure to ethanol-containing substances and ethanol intoxication in children based on three illustrated cases

Kam Lun Hon[1], Alexander KC Leung[2], Eddie Cheung[3], Bryan Lee[4], Michelle MC Tsang[5], Alcy R Torres[6]

[1]Department of Pediatrics, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong; [2]Department of Pediatrics, University of Calgary, Calgary, Alberta, Canada; [3]Hong Kong Adventist Hospital, Hong Kong; [4]Department of Anaesthesia, Princess Margaret Hospital, Hong Kong; [5]Department of Paediatrics and Adolescent Medicine, Queen Mary Hospital, Hong Kong; [6]Department of Neurology, Boston Medical Center, Boston University School of Medicine, Boston, MA, USA

Abstract

Alcohol addiction and intoxication are major health problems worldwide. Acute alcohol intoxication is well reported in adults and adolescents but less frequently reported in children of younger ages. We report three anonymized cases of pediatric ethanol exposure and illustrate the different mechanisms of intoxication. In all cases, a focused history is the key to prompt diagnosis and timely management. Physicians should be aware of this potential poison in children presented with acute confusional or encephalopathic state. In contrast, neonates with ethanol intoxication may present with nonspecific gastrointestinal symptomatology. Urgent exclusion of sepsis, electrolyte imbalance, drug intoxication, and surgical abdominal condition is critical. Using these illustrated cases, we performed a narrative literature review on issues of exposure to ethanol-containing substances and ethanol intoxication in children. In conclusion, a high level of suspicion and interrogation on ethanol or substance use are essential particularly in the lactating mother for an accurate and timely diagnosis of ethanol intoxication to be made.

Keywords: alcohol, child, ethanol, intoxication, neonate.

Citation

Hon KL, Leung AKC, Cheung E, Lee B, Tsang MMC, Torres AR. An overview of exposure to ethanol-containing substances and ethanol intoxication in children based on three illustrated cases. Drugs in Context 2018; 7: 212512.
DOI: 10.7573/dic.212512

Introduction

Poisoning is a common cause of mortality and morbidity in children [1,2]. Young children are at risk of unintentional poisoning because of their curious disposition and the careless placement of medication by adults. In adolescents, intentional poisoning occurs frequently as a result of suicidal attempts. Occasionally, a neonate may be intoxicated. However, the mechanism through which this happens is completely different, depending if the infant is breastfed or bottlefed. Ethanol intoxication is well reported in adolescents. However, it is uncommon in young children and rare in infants [3–5]. We report three pediatric cases of ethanol exposure and intoxication and illustrate the different mechanisms of intoxication in these children. In all cases, a focused history is the key to its prompt diagnosis and timely management. Patient consent was not obtained from these anonymized archived cases; however, it was felt that the information is important for medical education, and all measures have been taken to ensure patient confidentiality. Approval for reviewing morbidity of pediatric admissions by the internal review board of the principal author's hospital was obtained.

Case 1

An exclusively breastfed male infant presented at 3 weeks of age with abdominal distension for 6 days, which was associated with reduced frequency of passage of stools. There was no history of vomiting. The infant was feeding well and thriving. Physical examination showed a well-appearing infant with a distended abdomen. Vitals were normal: mean blood pressure was 45 mmHg, heart rate 130/minute, respiratory rate 40/minute, temperature 37°C, and oxygen saturation of 97%. There was no 'gush of air' on rectal examination. Serum electrolytes, glucose level, and liver function were normal. Abdominal radiograph showed multiple distended bowel loops, which resolved within 4 hours on repeated radiography (Figure 1). The mother denied consumption of any medication but subsequent

Figure 1. Abdominal radiograph at the emergency department showing gaseous distension, which subsequently resolved following special care baby unit admission.

interrogation revealed that she had been taking one bowl of chicken cooked in Chinese 'yellow wine' and some herbs twice per day for 1 week. The history of chicken wine consumption was retrospectively obtained, and hence alcohol level was not timely measured. The mother was not aware that this practice could affect the lactating neonate but reported that she felt 'drunk' after consuming the chicken wine herself. The mother stopped consuming chicken wine, and breastfeeding was subsequently resumed. The abdominal distension spontaneously resolved. As no other causes for the abdominal symptoms were identified, alcohol exposure was considered to be the possible etiology.

Case 2

A previously healthy 4-year-old girl presented with abdominal pain, vomiting, unsteady gait, and confusion of acute onset while attending a kindergarten. Physical examination reviewed Glasgow Coma Scale of 13 (E3M6V4). However, her vitals were normal. She was afebrile. Neurological examination showed cerebellar ataxia and evidence of disorientation. Interrogation revealed that she had been licking and eating hand sanitizer jelly (75% ethanol) at the kindergarten while momentarily left unsupervised. Urine toxicology screen was negative. Her blood ethyl alcohol level was 224.7 mg/dL (toxic concentration: 50–100 mg/dL, depression of central nervous system >100 mg/dL). Blood glucose and liver function tests were normal. She was admitted to the hospital for observation and management. The child's condition improved with intravenous hydration. She was discharged the next day with due health care education prescribed.

Case 3

A previously healthy 10-year-old boy was noted to have an unsteady gait, vomiting, and increasing drowsiness at home. He was taken to the emergency department and admitted to the pediatric ward. On admission, the Glasgow Coma Scale was 8 (E2V2M4). He had stable vital signs. Physical examination revealed generalized limb weakness, but otherwise the examination was unremarkable. His blood glucose, blood gas, liver function, and renal function tests were unremarkable. His blood ethanol level was 281 mg/dL. Urine toxicology was negative. Computed tomography (CT) of the brain showed no intracranial pathology. As the child's consciousness improved, he admitted that he had taken sips from a bottle of spirit (40% alcohol) from his parents' wine cabinet. He was provided intravenous fluid overnight and discharged the next day. Parents were counseled on home safety measures.

Discussion

Pediatric ethanol intoxication is a worldwide health issue [5]. Adolescents are prone to expose themselves in drug experimentation. Very often, ethanol may be consumed with various psychotropic drugs of abuse, compounding the central nervous effects of these poisons.

Tonisson et al. analyzed data from 256 children aged 8.4–17.9 years [6]. The investigators concluded the most correctly described signs in children in different serum alcohol concentration (SAC) groups were consciousness and speech. The severity of alteration of consciousness and degrees of disturbance in balance and speech were positively correlated with SAC. Infants and young children are prone to profound hypoglycemia, coma, and hypothermia despite ingesting relatively small amounts of ethanol [3].

Children

Ethanol is found in beverages, mouthwashes, perfumes, and topic antiseptics. The case of the 4-year-old girl illustrates that young children may be exposed to ethanol via ethanol-containing sanitizers with high alcohol concentrations. The hygiene conscientious parents, caregivers, and school teachers may mediate this mechanism of intoxication. Rayar et al. reviewed pediatric ingestions of household products containing ethanol [3]. Many household products such as perfumes, colognes, mouthwash, medicinals, and ethanol-based hand sanitizers contain quantities of ethanol that are sufficiently significant to induce intoxication and hypoglycemia. Serious adverse events included hypoglycemia, seizures, and death. Child-resistant closures appear to have reduced the incidence of ingestion of ethanol-based products, including mouthwashes, and may be applicable to other products such as hand sanitizers [7]. Leung reported 27 children (mean age: 8.1 years, range: 1–13 years) with documented ethanol ingestion admitted to the Alberta Children's Hospital over a

15-year period [8]. Four patients (aged 2, 2, 4, and 12 years, respectively) had ethanol intoxication because of ingestion of mouthwashes, and the reminder 23 patients because of ingestion of beer, rye, whisky, or vodka) [7,8].

Infants

The mechanism of intoxication in neonates is different when compared to children and deserves in-depth discussion. Medications or toxic substances present in breast milk may intoxicate breastfed neonates, whereas formula-fed neonates may be intoxicated by medications or toxic substances added to the formula milk. Either way, neonates exposed to such chemicals may become intoxicated and seriously ill. Ethanol exposure or intoxication in the neonates has only been reported in a few case reports including the ones reported by us [9–14]. We have noted the local maternal 'chicken yellow wine' consumption during the neonatal period as a cause of unexplained gross abdominal distention in the absence of sepsis, electrolyte imbalance, drug intoxication, and surgical abdominal condition in breastfed infants [14]. Cases of neonatal ethanol intoxication are rare in the literature, possibly because babies are not ambulatory. Clinical manifestations of ethanol intoxication include vomiting, impaired level of consciousness, hypotonia, ataxia, irregular respirations, apnea, metabolic acidosis, and electrolyte imbalance. Neonates are significantly more prone to hypoglycemia and hypothermia [9–13]. The increased risk of hypoglycemia is due to the lack of sufficient glycogen stores in the neonate, microcirculation redirection in the pancreas leading to increased insulin release, as well as the gluconeogenic inhibiting effects of ethanol. Neonates are also more susceptible to hypothermia owing to low body mass. Clinical manifestations may not correlate with the blood ethanol level. The few cases that we managed shared similar clinical features in that they presented with abdominal distension and gastrointestinal symptoms (such as vomiting, poor appetite, or constipation). They were afebrile, and cardiorespiratory and hemodynamically stable. Abdominal radiography showed gross gaseous distension that resolved spontaneously. Diagnosis was only made by exclusion of sepsis, electrolyte imbalance, drug intoxication, and surgical abdominal condition, followed by subsequent interrogation about the consumption of 'chicken wine' by the lactating mothers. Cases could have been missed if the history of maternal ethanol intake was missed and blood ethanol levels were not measured. Many of the cases that we managed were at best presumed to be due to the effects of ethanol when other diagnoses were excluded.

Breastfeeding is globally advocated owing to the suitability of breast milk to the nutritional needs of infants and its immunological properties [15,16]. However, healthcare providers frequently fail to adequately advise mothers to be cautious about their diet, as traces of what they consume may pass into breast milk. Moreover, food advocated in complementary and alternative medicine (CAM) is often believed to be a good supplement to the health of the lactating mother and her child.

In traditional Chinese culture, 'chicken wine' is considered to have rejuvenating properties, and is widely consumed by post-partum mothers. Essentially, it is a type of chicken soup made with the addition of rice wine. Depending on the composition of the specific soup and the method of cooking, the soup may contain varying amounts of ethanol. Considering that traces of maternally consumed ethanol are found in breast milk, consumption of soup with high ethanol content on a regular basis may adversely affect the nursing infant. Haastrup et al. commented that even maternal consumption of four standard units of pure ethanol (48 g ethanol total) and subsequent breastfeeding at the peak of maternal blood ethanol concentration is unlikely to produce clinically significant effects on the nursing infant [17]. They opined that occasional drinking while breastfeeding has not been convincingly shown to adversely affect nursing infants, and special recommendations aimed at lactating women are not warranted. Consumption of an alcoholic soup (chicken soup flavored with sesame oil and rice wine) during the postpartum 'doing-the-month' ritual has been extensively studied by Taiwan investigators [13]. This practice affects not only the ethanol composition of maternal blood and milk, but also lactation performance. The investigators suggest that an alcoholic diet should be avoided during lactation [18]. The acute health risks for infants exposed to ethanol through their mothers' milk under the usual exposure scenario are low. The authors advised that nursing infants at least 3 hours after ingesting a diet containing alcohol would further reduce potential health risks [19].

There is evidence to suggest that the ethanol metabolism mechanisms in neonates and adults are quite different. In adults, the enzyme alcohol dehydrogenase (ADH) is responsible for most of the oxidative conversion of ethanol into acetaldehyde, with catalase playing only a minor role in the conversion process [20]. On the contrary, the reverse seems to be true in neonates. Catalase appears to play a major role in ethanol metabolism; it has been suggested that neonatal ADH concentrations are at around one-tenth of that in an adult, whereas catalase concentrations are equal if not higher than that of an adult [21]. In addition, Idanpaan-Heikkila et al. found that the rate of ethanol elimination in neonates was approximately half of that observed in adults [22]. Conversely, one report suggests that neonates may in fact eliminate ethanol at a faster rate compared to adults. By analyzing two cases of acute neonatal ethanol poisoning researchers, McCormick et al. put forward the idea that ethanol elimination in neonates follows first-order kinetics up to approximately 225 mg/dL, after which it transitions to zero-order. This is significantly higher than the transition point of an adult (approximately 20 mg/dL) [9]. Leung found that the rate of ethanol elimination was greater than 6.2 mmol/L/h (28.4 mg/dL/h), which was approximately twice the rate

of ethanol elimination in adults [8]. Literature on alcohol metabolism in infants may be contradicting and confound the interpretation of clinical observations in these young patients.

In formula-fed infants, exposure is frequently accidental. Minera et al. described a grandmother accidentally used approximately 90 mL of vodka to prepare baby formula and fed her 2-month-old grandchild [4]. The authors performed a literature review and found ethanol poisoning in very young children is not rare. They cautioned emergency physicians should be prepared for the management of infants with alcohol poisoning.

Chen et al. studied potential causes and clinical characteristics of abdominal distention in early newborns [23]. Medical records of 201 newborns were analyzed. Congenital malformations may be the major cause of abdominal distension in early newborns. Sepsis and congenital megacolon are the single disease most frequently associated with abdominal distention in preterm and full-term newborns, respectively. Vomiting is a main accompanying symptom in early newborns with abdominal distention. X-ray manifestations seem to be more severe in preterm newborns than in full term newborns. Ethanol exposure was not listed as a potential cause in their series.

Conclusion

Diagnosis of ethanol intoxication in children is based on detailed history of exposure, including the lactating mother. Physicians should be aware of the danger of ethanol intoxication in childhood. Specific treatment for ethanol intoxication is typically not necessary. Supportive measures include intravenous fluids, dextrose, and mechanical ventilation, which should be used when necessary.

Disclosure and potential conflicts of interest: The authors declare that there is no conflict of interest regarding the publication. The international Committee of Medical Journal Editors (ICMJE) Potential Conflicts of Interest form for the authors is available for download at: http://www.drugsincontext.com/wp-content/uploads/2017/11/dic.212512-COI.pdf

Funding declaration: No financial support was received.

Article URL: http://www.drugsincontext.com/an-overview-of-exposure-to-ethanol-containing-substances-and-ethanol-intoxication-in-children-based-on-three-illustrated-cases

Correspondence: Kam Lun Hon, Department of Paediatrics, 6/F Prince of Wales Hospital, Shatin, NT, Hong Kong. ehon@hotmail.com

Provenance: invited; externally peer reviewed.

Submitted: 29 October 2017; **Peer review comments to author:** 6 November 2017; **Revised manuscript received:** 15 November 2017; **Accepted:** 15 November 2017; **Publication date:** 9 January 2018.

Drugs in Context is published by BioExcel Publishing Ltd. Registered office: Plaza Building, Lee High Road, London, England, SE13 5PT.

BioExcel Publishing Limited is registered in England Number 10038393. VAT GB 252772009.

For all manuscript and submissions enquiries, contact the Editorial office dic.editorial@bioexcelpublishing.com

For all permissions, rights and reprints, contact David Hughes david.hughes@bioexcelpublishing.com

References

1. Hon KL, Leung AK. Childhood accidents: injuries and poisoning. Adv Pediatr. 2010;57:33–62. http://dx.doi.org/10.1016/j.yapd.2009.08.010
2. Hon KL, Ho JK, Leung TF, Wong Y, Nelson EA, Fok TF. Review of children hospitalised for ingestion and poisoning at a tertiary centre. Ann Acad Med Singapore. 2005 Jun;34(5):356–61. PMID: 16021225.
3. Rayar P, Ratnapalan S. Pediatric ingestions of house hold products containing ethanol: a review. Clin Pediatr (Phila). 2013;52: 203–9. http://dx.doi.org/10.1177/0009922812470970
4. Minera G, Robinson E. Accidental acute alcohol intoxication in infants: review and case report. J Emerg Med. 2014;47:524–6. http://dx.doi.org/10.1016/j.jemermed.2014.06.032
5. Lamminpaa A. Alcohol intoxication in childhood and adolescence. Alcohol Alcohol. 1995;30:5–12. PMID: 7748276.
6. Tonisson M, Tillmann V, Kuudeberg A, Lepik D, Vali M. Acute alcohol intoxication characteristics in children. Alcohol Alcohol. 2013;48:390–5. http://dx.doi.org/10.1093/alcalc/agt036
7. Leung AK. Ethanol-induced hypoglycemia from mouthwash. Drug Intell Clin Pharm. 1985 Jun;19(6):480–1. PMID: 4006744.

8. Leung AK. Ethyl alcohol ingestion in children. A 15-year review. Clin Pediatr (Phila). 1986 Dec;25(12):617–9. http://dx.doi.org/10.1177/000992288602501207
9. McCormick T, Levine M, Knox O, Claudius I. Ethanol ingestion in two infants under 2 months old: a previously unreported cause of ALTE. Pediatrics. 2013;131:e604–7. http://dx.doi.org/10.1542/peds.2012-1652
10. Zaitsu M, Inada Y, Tashiro K, Hayashi C, Doi H, Hamasaki Y, Matsuo M. Acute alcohol intoxication in a 15-day-old neonate. Pediatr Int. 2013;55:792–4. http://dx.doi.org/10.1111/ped.12134
11. Yamagishi M, Iwasaki T. Acute alcohol intoxication in a two-month-old baby. J UOEH. 1987;9:53–9. PMID: 3576010.
12. Palano GM, Pratico AD, Pratico ER, D'Agata A, Carpinato C, Sottile F, Distefano G. [Accidental ethyl alcohol intoxication in a 30-day-old infant. Clinical findings and neurological follow-up]. Minerva Pediatr. 2007;59:275–9. PMID: 17519873.
13. Dalt LD, Dall'Amico R, Laverda AM, Chemollo C, Chiandetti L. Percutaneous ethyl alcohol intoxication in a one-month-old infant. Pediatr Emerg Care. 1991;7:343–4. PMID: 1788121.
14. Hon KL, Wong YC, Chau IK, Chau MK, Cheung KL, Wong W. Alcohol exposure in breastfed neonates associated with Chinese chicken wine. Indian J Pediatr. 2016;83:1495–6. http://dx.doi.org/10.1007/s12098-016-2181-4
15. Mason JB, Shrimpton R, Saldanha LS, Ramakrishnan U, Victora CG, Girard AW, McFarland DA, Martorell R. The first 500 days of life: policies to support maternal nutrition. Glob Health Action. 2014;7:23623. http://dx.doi.org/10.3402/gha.v7.23623
16. Leung AK, Sauve RS. Breast is best for babies. J Natl Med Assoc. 2005;97:1010–19. PMID: 16080672.
17. Haastrup MB, Pottegard A, Damkier P. Alcohol and breastfeeding. Basic Clin Pharmacol Toxicol. 2014;114:168–73. http://dx.doi.org/10.1111/bcpt.12149
18. Chien YC, Huang YJ, Hsu CS, Chao JC, Liu JF. Maternal lactation characteristics after consumption of an alcoholic soup during the postpartum "doing-the-month" ritual. Public Health Nutr. 2009;12:382–8. http://dx.doi.org/10.1017/S1368980008002152
19. Chien YC, Liu JF, Huang YJ, Hsu CS, Chao JC. Alcohol levels in Chinese lactating mothers after consumption of alcoholic diet during postpartum "doing-the-month" ritual. Alcohol. 2005;37:143–50.
20. Cederbaum AI. Alcohol metabolism. Clin Liver Dis. 2012;16:667–85. http://dx.doi.org/10.1016/j.cld.2012.08.002
21. Tran MN, Wu AH, Hill DW. Alcohol dehydrogenase and catalase content in perinatal infant and adult livers: potential influence on neonatal alcohol metabolism. Toxicol Lett. 2007;169:245–52. http://dx.doi.org/10.1016/j.toxlet.2007.01.012
22. Idanpaan-Heikkila J, Jouppila P, Akerblom HK, Isoaho R, Kauppila E, Koivisto M. Elimination and metabolic effects of ethanol in mother, fetus, and newborn infant. Am J Obstet Gynecol. 1972;112:387–93. PMID: 5060384.
23. Chen A, Du J, Du LZ. [Clinical characteristics of abdominal distention in early newborns]. Zhongguo Dang Dai Er Ke Za Zhi. 2013;15:1074–8. PMID: 24342199.