

Vomiting, Diarrhea, and Dehydration in Infants and Children

Stephen B. Freedman

Jennifer Thull-Freedman

REFERENCES

- Liu L, Johnson HL, Cousens S, et al: Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 379: 2151, 2012. [PMID: 22579125]
- Ejemot RI, Ehiri JE, Meremikwu MM, et al: Hand washing for preventing diarrhoea. *Cochrane Database Syst Rev* 1:CD004265, 2008. [PMID: 18254044]
- Sandora TJ, Taveras EM, Shih MC, et al: A randomized, controlled trial of a multifaceted intervention including alcohol-based hand sanitizer and hand-hygiene education to reduce illness transmission in the home. *Pediatrics* 116: 587, 2005. [PMID: 16140697]
- Sandora TJ, Shih MC, Goldmann DA: Reducing absenteeism from gastrointestinal and respiratory illness in elementary school students: a randomized, controlled trial of an infection-control intervention. *Pediatrics* 121: e1555, 2008. [PMID: 18519460]
- Payne DC, Boom JA, Staat MA, et al: Effectiveness of pentavalent and monovalent rotavirus vaccines in concurrent use among US children <5 years of age, 2009–2011. *Clin Infect Dis* 57: 13, 2013. [PMID: 23487388]
- Tate JE, Mutuc JD, Panozzo CA, et al: Sustained decline in rotavirus detections in the United States following the introduction of rotavirus vaccine in 2006. *Pediatr Infect Dis J* 30 (Suppl): S30, 2011. [PMID: 21183838]
- Weintraub ES, Baggs J, Duffy J, et al: Risk of intussusception after monovalent rotavirus vaccination. *N Engl J Med* 370: 513, 2014. [PMID: 24422678]
- Payne DC, Vinje J, Szilagyi PG, et al: Norovirus and medically attended gastroenteritis in U.S. children. *N Engl J Med* 368: 1121, 2013. [PMID: 23514289]
- Malhotra A, Lakkundi A, Carse E: Bilious vomiting in the newborn: 6 years data from a Level III Centre. *J Paediatr Child Health* 46: 259, 2010. [PMID: 20337876]
- Godbole P, Stringer MD: Bilious vomiting in the newborn: how often is it pathologic? *J Pediatr Surg* 37: 909, 2002. [PMID: 12037761]
- Orenstein SR, Whittington PF, Orenstein DM: The infant seat as treatment for gastroesophageal reflux. *N Engl J Med* 309: 760, 1983. [PMID: 6350877]
- Aboagye J, Goldstein SD, Salazar JH, et al: Age at presentation of common pediatric surgical conditions: reexamining dogma. *J Pediatr Surg* 49: 995, 2014. [PMID: 24888850]
- Hickey CA, Beattie TJ, Cowieson J, et al: Early volume expansion during diarrhea and relative nephroprotection during subsequent hemolytic uremic syndrome. *Arch Pediatr Adolesc Med* 165: 884, 2011. [PMID: 21784993]
- Porter SC, Fleisher GR, Kohane IS, et al: The value of parental report for diagnosis and management of dehydration in the emergency department. *Ann Emerg Med* 41: 196, 2003. [PMID: 12548269]
- Steiner MJ, DeWalt DA, Byerley JS: Is this child dehydrated? *JAMA* 291: 2746, 2004. [PMID: 15187057]
- Freedman SB, Vandermeer B, Milne A, Hartling L, Pediatric Emergency Research Canada Gastroenteritis Study Group: Diagnosing clinically significant dehydration in children with acute gastroenteritis using noninvasive methods: a meta-analysis. *J Pediatr* 166: 908, 2015.
- Bailey B, Gravel J, Goldman RD, Friedman JN, Parkin PC: External validation of the clinical dehydration scale for children with acute gastroenteritis. *Acad Emerg Med* 17: 583, 2010. [PMID: 20624137]
- Friedman JN, Goldman RD, Srivastava R, Parkin PC: Development of a clinical dehydration scale for use in children between 1 and 36 months of age. *J Pediatr* 145: 201, 2004. [PMID: 15289767]
- Goldman RD, Friedman JN, Parkin PC: Validation of the clinical dehydration scale for children with acute gastroenteritis. *Pediatrics* 122: 545, 2008. [PMID: 18762524]
- Duggan C, Nurko S: "Feeding the gut": the scientific basis for continued enteral nutrition during acute diarrhea. *J Pediatr* 131: 801, 1997. [PMID: 9427881]
- Meropol SB, Luberti AA, De Jong AR: Yield from stool testing of pediatric inpatients. *Arch Pediatr Adolesc Med* 151: 142, 1997. [PMID: 9041868]
- Borgnolo G, Barbone F, Guidobaldi G, et al: C-reactive protein in viral and bacterial gastroenteritis in childhood. *Acta Paediatr* 85: 670, 1996. [PMID: 8816201]
- Marcus N, Mor M, Amir L, et al: The quick-read C-reactive protein test for the prediction of bacterial gastroenteritis in the pediatric emergency department. *Pediatr Emerg Care* 23: 634, 2007. [PMID: 17876252]
- Reid SR, Losek JD: Hypoglycemia complicating dehydration in children with acute gastroenteritis. *J Emerg Med* 29: 141, 2005. [PMID: 16029822]
- National Collaborating Centre for Women's and Children's Health: *Diarrhoea and Vomiting Caused by Gastroenteritis: Diagnosis, Assessment and Management in Children Younger Than 5 Years*. London: National Institute for Health and Clinical Excellence; 2009.
- King CK, Glass R, Bresee JS, et al: Managing acute gastroenteritis among children: oral rehydration, maintenance, and nutritional therapy. *MMWR Recomm Rep* 52 (RR16): 1, 2003. [PMID: 14627948]
- Wathen JE, MacKenzie T, Bothner JP: Usefulness of the serum electrolyte panel in the management of pediatric dehydration treated with intravenously administered fluids. *Pediatrics* 114: 1227, 2004. [PMID: 15520100]
- Yilmaz K, Karabucoglu M, Citak A, et al: Evaluation of laboratory tests in dehydrated children with acute gastroenteritis. *J Paediatr Child Health* 38: 226, 2002. [PMID: 12047687]
- Steiner MJ, Nager AL, Wang VJ: Urine specific gravity and other urinary indices: inaccurate tests for dehydration. *Pediatr Emerg Care* 23: 298, 2007. [PMID: 17505271]
- Gill CJ, Lau J, Gorbach SL, et al: Diagnostic accuracy of stool assays for inflammatory bacterial gastroenteritis in developed and resource-poor countries. *Clin Infect Dis* 37: 365, 2003. [PMID: 12884161]
- Chen CC, Chang CJ, Lin TY, et al: Usefulness of fecal lactoferrin in predicting and monitoring the clinical severity of infectious diarrhea. *World J Gastroenterol* 17: 4218, 2011. [PMID: 22072854]
- Klein EJ, Boster DR, Stapp JR, et al: Diarrhea etiology in a children's hospital emergency department: a prospective cohort study. *Clin Infect Dis* 43: 807, 2006. [PMID: 16941358]
- Denno DM, Stapp JR, Boster DR, et al: Etiology of diarrhea in pediatric outpatient settings. *Pediatr Infect Dis J* 24: 142, 2005. [PMID: 15702043]
- Liu LJ, Yang YJ, Kuo PH, et al: Diagnostic value of bacterial stool cultures and viral antigen tests based on clinical manifestations of acute gastroenteritis in pediatric patients. *Eur J Clin Microbiol Infect Dis* 24: 559, 2005. [PMID: 16096776]
- Freedman SB, Xie J, Nettel-Aguirre A, et al: Enteropathogen detection in children with diarrhoea, or vomiting, or both, comparing rectal flocked swabs with stool specimens: an outpatient cohort study. *Lancet Gastroenterol Hepatol* 2: 662, 2017. [PMID: 28712662]
- Lilien LD, Srinivasan G, Pyati SP, et al: Green vomiting in the first 72 hours in normal infants. *Am J Dis Child* 140: 662, 1986. [PMID: 3717104]
- Rothrock SG, Green SM, Hummel CB: Plain abdominal radiography in the detection of major disease in children: a prospective analysis. *Ann Emerg Med* 21: 1423, 1992. [PMID: 1443835]
- Freedman SB, Willan AR, Boutis K, et al: Effect of dilute apple juice and preferred fluids vs electrolyte maintenance solution on treatment failure among children with mild gastroenteritis: a randomized clinical trial. *JAMA* 315: 1966, 2016. [PMID: 27131100]
- Hartling L, Bellemare S, Wiebe N, et al: Oral versus intravenous rehydration for treating dehydration due to gastroenteritis in children. *Cochrane Database Syst Rev* 3: CD004390, 2006. [PMID: 16856044]
- Nager AL, Wang VJ: Comparison of nasogastric and intravenous methods of rehydration in pediatric patients with acute dehydration. *Pediatrics* 109: 566, 2002. [PMID: 11927697]
- Freedman SB, Ulerik E, Rumanitir M, et al: Ondansetron and the risk of cardiac arrhythmias: a systematic review and postmarketing analysis. *Ann Emerg Med* 64: 19, 2014. [PMID: 24314899]
- Schnadower D, Finkelstein Y, Freedman SB: Ondansetron and probiotics in the management of pediatric acute gastroenteritis in developed countries. *Curr Opin Gastroenterol* 31: 1, 2015. [PMID: 25333367]
- Freedman SB: Acute infectious pediatric gastroenteritis: beyond oral rehydration therapy. *Expert Opin Pharmacother* 8: 1651, 2007. [PMID: 17685883]
- MacGillivray S, Fahey T, McGuire W: Lactose avoidance for young children with acute diarrhoea. *Cochrane Database Syst Rev* 10: CD005433, 2013. [PMID: 24173771]
- Pickering LK, Feldman S, Ericsson CD, et al: Absorption of salicylate and bismuth from a bismuth subsalicylate-containing compound (Pepto-Bismol). *J Pediatr* 99: 654, 1981. [PMID: 7277115]
- Leher P, Cheron G, Calatayud GA, et al: Racecadotril for childhood gastroenteritis: an individual patient data meta-analysis. *Dig Liver Dis* 43: 707, 2011. [PMID: 21514257]
- What place for racecadotril? *Drug Ther Bull* 51: 54, 2013. [PMID: 23657196]
- Parker MW, Schaffzin JK, Lo Vecchio A, et al: Rapid adoption of *Lactobacillus rhamnosus* GG for acute gastroenteritis. *Pediatrics* 131(suppl 1): S96, 2013. [PMID: 23457156]
- Yi SH, Jernigan JA, McDonald LC: Prevalence of probiotic use among inpatients: a descriptive study of 145 U.S. hospitals. *Am J Infect Control* 44: 548, 2016. [PMID: 26822808]
- Guarino A, Guandalini S, Lo Vecchio A: Probiotics for prevention and treatment of diarrhea. *J Clin Gastroenterol* 49(suppl 1): S37, 2015. [PMID: 26447963]
- Kolacek S, Hojsak I, Berni Canani R, et al: Commercial probiotic products: a call for improved quality control. a position paper by the ESPGHAN Working Group for Probiotics and Prebiotics. *J Pediatr Gastroenterol Nutr* 65: 117, 2017. [PMID: 28644359]
- Nixon AF, Cunningham SJ, Cohen HW, et al: The effect of *Lactobacillus* GG on acute diarrheal illness in the pediatric emergency department. *Pediatr Emerg Care* 28: 1048, 2012. [PMID: 23023475]
- Freedman SB, et al: Multicenter trial of a combination probiotic for children with gastroenteritis. *N Engl J Med* 379: 2015–2026, 2015–2026.
- Schnadower D, et al: *Lactobacillus rhamnosus* GG versus placebo for acute gastroenteritis in children. *N Engl J Med* 379: 2002–2014, 2018.
- Huff BA. Caveat emptor. "Probiotics" might not be what they seem. *Can Fam Physician* 50: 583, 2004. [PMID: 15116804]
- Lazzerini M, Ronfani L: Oral zinc for treating diarrhoea in children. *Cochrane Database Syst Rev* 1: CD005436, 2013. [PMID: 23440801]
- Walker CL, Black RE: Zinc for the treatment of diarrhoea: effect on diarrhoea morbidity, mortality and incidence of future episodes. *Int J Epidemiol* 39 (Suppl 1): i63, 2010. [PMID: 20348128]
- Onwueze IA, Oshun PO, Odigwe CC: Antimicrobials for treating symptomatic nontyphoidal *Salmonella* infection. *Cochrane Database Syst Rev* 11: CD001167, 2012. [PMID: 23152205]
- Ternhag A, Asikainen T, Giesecke J, et al: A meta-analysis on the effects of antibiotic treatment on duration of symptoms caused by infection with *Campylobacter* species. *Clin Infect Dis* 44: 696, 2007. [PMID: 17278062]
- Freedman SB, Xie J, Neufeld MS, et al: Shiga toxin-producing *Escherichia coli* infection, antibiotics, and risk of developing hemolytic uremic syndrome: a meta-analysis. *Clin Infect Dis* 62: 1251, 2016. [PMID: 26917812]

61. Guandalini S, Newland C: Differentiating food allergies from food intolerances. *Curr Gastroenterol Rep* 13: 426, 2011. [PMID: 21792544]
62. Sicherer SH, Sampson HA: Food allergy: a review and update on epidemiology, pathogenesis, diagnosis, prevention, and management. *J Allergy Clin Immunol* 141: 41, 2018. [PMID: 29157945]
63. Sharma HP, Mansoor DK, Mikhail IJ, Nguyen C, Klein BL: Recognition and management of pediatric food allergy in the emergency department. *Pediatr Emerg Care* 29: 527, 2013. [PMID: 23558276]
64. Guandalini S, Assiri A: Celiac disease: a review. *JAMA Pediatr* 168: 272, 2014. [PMID: 24395055]
65. Snell H, Ramos M, Longo S, et al: Performance of the TechLab C. DIFF CHEK-60 enzyme immunoassay (EIA) in combination with the C. difficile Tox A/B II EIA kit, the Triage C. difficile panel immunoassay, and a cytotoxin assay for diagnosis of *Clostridium difficile*-associated diarrhea. *J Clin Microbiol* 42: 4863, 2004. [PMID: 15472364]
66. Zheng L, Keller SF, Lysterly DM, et al: Multicenter evaluation of a new screening test that detects *Clostridium difficile* in fecal specimens. *J Clin Microbiol* 42: 3837, 2004. [PMID: 15297543]
67. Deshpande A, Pasupuleti V, Rolston DD, et al: Diagnostic accuracy of real-time polymerase chain reaction in detection of *Clostridium difficile* in the stool samples of patients with suspected *Clostridium difficile* infection: a meta-analysis. *Clin Infect Dis* 53: e81, 2011. [PMID: 21890762]
68. Stamper PD, Alcabasa R, Aird D, et al: Comparison of a commercial real-time PCR assay for tcdB detection to a cell culture cytotoxicity assay and toxigenic culture for direct detection of toxin-producing *Clostridium difficile* in clinical samples. *J Clin Microbiol* 47: 373, 2009. [PMID: 19073875]