

Chapter 1

BASIC INFORMATION THE PEDIATRIST SHOULD KNOW ABOUT CONTRAST AGENTS IN RADIOLOGICAL IMAGING

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INTRODUCTION

With the increase in the use of medical imaging in recent years, the use of radiological contrast material has increased significantly, although more limitedly in children. Therefore, clinicians involved in radiological practice as well as radiologists need to be familiar with the basic physical properties of radiological contrast agents, the adverse effects of their usage, and the treatment of prolonged reactions. Radiologic contrast agents should be injected and eliminated from the body without additional effects on the patient. The contrast agents used are not completely safe to use. Undesirable effects range from simple physiological and mild allergic reactions to serious and life-threatening events. In all age groups, identification of patients likely to experience adverse effects with contrast agents should occur before approval of radiologic examinations. The principles regarding the use of contrast agents and associated adverse events are similar in children to adults. Predicting the incidence of reactions to contrast media in children is impossible because of the lack of controlled prospective studies. There are also many conflicting opinions as to why a true allergic reaction develops. Allergic reaction with the use of iodinated contrast media in children is more common than in adults. The incidence of acute allergic-like reactions due to intravenous administration of low-osmolality nonionic iodinated contrast material has been reported as 0.18% (1). Guidelines for prevention and treatment of allergic reactions in children are similar to those for adults (2). In children, radiological contrast media should be used when necessary due to renal immaturity and low glomerular filtration rate. Gadolinium-based contrast agents may therefore rarely cause nephrogenic systemic fibrosis (NSF) (3). It was first described in 1997 with

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CONCLUSION:

The increasing use of radiological imaging and contrast agents in children requires knowing the physical and chemical properties of these agents and being familiar with the treatment of their adverse-allergic effects. Although these responsibilities rest with radiologists, it is necessary for pediatricians to have knowledge of these agents as they are involved in imaging method and planning. In addition, clinicians may have to recognize and treat recurrent and late allergic reactions that develop with the use of contrast agents. The pediatrician who has acquired this information becomes more competent in the follow-up and treatment of pediatric patients who are more affected by adverse effects and allergic reactions and their consequences.

REFERENCES:

1. Dillman JR, Strouse PJ, Ellis JH, et al. Incidence and severity of acute allergic-like reactions to i.v. nonionic iodinated contrast material in children. *AJR Am J Roentgenol.* 2007 Jun;188(6):1643-7. doi: 10.2214/AJR.06.1328. Erratum in: *AJR Am J Roentgenol.* 2007 Sep;189(3):512. PMID: 17515388.
2. ACR Committee on Drugs and Contrast Media. ACR manual on contrast media: version 9. American College of Radiology Web site. <http://www.acr.org/quality-safety/resources/?/media/37D84428BF1D4E1B9A3A2918DA9E27A3.pdf/>. Published 2013. Accessed February 17, 2015.
3. Penfield JG. Nephrogenic systemic fibrosis and the use of gadolinium-based contrast agents. *Pediatr Nephrol* 2008;23(12):2121-2129
4. Deo A, Fogel M, Cowper SE. Nephrogenic systemic fibrosis: a population study examining the relationship of disease development to gadolinium exposure. *Clin J Am Soc Nephrol.* 2007 Mar;2(2):264-7. doi: 10.2215/CJN.03921106. Epub 2007 Feb 7. PMID: 17699423.
5. Beckett KR, Moriarity AK, Langer JM. Safe Use of Contrast Media: What the Radiologist Needs to Know. *Radiographics.* 2015 Oct;35(6):1738-50. doi: 10.1148/rg.2015150033. PMID: 26466182.
6. ACR Manual on Contrast Media. ACR Committee on Drugs and Contrast Media. 2021, ISBN: 978-1-55903-012-0.
7. Standen JR, Nogrady MB, Dunbar JS, et al. The Osmotic Effects of Methylglucamine Diatrizoate (Renografin 60) in Intravenous Urography in Infants. *Am J Roentgenol Radium Ther Nucl Med.* 1965; 93:473-479.
8. Morris TW HP, Reece K, Katzberg RW. Tissue fluid shifts during renal arteriography with conventional and low osmolality agents. *Invest Radiol.* 1983; 18:335-340.
9. Vergara M, Seguel S. Adverse reactions to contrast media in CT: effects of temperature and ionic property. *Radiology.* 1996;199(8668779):363-366.
10. Davenport MS, Wang CL, Bashir MR, et al. Rate of contrast material extravasations and allergic-like reactions: effect of extrinsic warming of low-osmolality iodinated CT contrast material to 37 degrees C. *Radiology.* 2012;262(22106356):475-484.

11. Trout AT, Dillman JR, Ellis JH, et al. Patterns of intravenous contrast material use and corticosteroid premedication in children--a survey of Society of Chairs of Radiology in Children's Hospitals (SCORCH) member institutions. *Pediatr Radiol.* 2011;41(21594547):1272-1283.
12. Amaral JG, Traubici J, BenDavid G, et al. Safety of power injector use in children as measured by incidence of extravasation. *AJR Am J Roentgenol.* 2006;187(16861567):580-583.
13. Cohen MD, Herman E, Herron D, et al. Comparison of intravenous contrast agents for CT studies in children. *Acta Radiol.* 1992;33(1449887):592-595.
14. Abu-Alfa AK. Nephrogenic systemic fibrosis and gadolinium-based contrast agents. *Adv Chronic Kidney Dis.* 2011 May;18(3):188-98. doi: 10.1053/j.ackd.2011.03.001. PMID: 21531325.
15. Barrett BJ, Carlisle EJ. Metaanalysis of the relative nephrotoxicity of high- and low-osmolality iodinated contrast media. *Radiology* 1993;188:171-8.
16. Navaneethan SD, Singh S, Appasamy S, et al. Sodium bicarbonate therapy for prevention of contrast-induced nephropathy: a systematic review and meta-analysis. *American journal of kidney diseases : the official journal of the National Kidney Foundation* 2009;53:617-27.
17. Taylor AJ, Hotchkiss D, Morse RW, et al. PREPARED: Preparation for Angiography in Renal Dysfunction: a randomized trial of inpatient vs outpatient hydration protocols for cardiac catheterization in mild-to-moderate renal dysfunction. *Chest* 1998;114:1570-4.
18. Zoungas S, Ninomiya T, Huxley R, et al. Systematic review: sodium bicarbonate treatment regimens for the prevention of contrast-induced nephropathy. *Annals of internal medicine* 2009;151:631-8.
19. Brar SS, Aharonian V, Mansukhani P, et al. Haemodynamic-guided fluid administration for the prevention of contrast-induced acute kidney injury: the POSEIDON randomised controlled trial. *Lancet (London, England)* 2014;383:1814-23.
20. Weisbord SD, Gallagher M, Jneid H, et al. Outcomes after Angiography with Sodium Bicarbonate and Acetylcysteine. *The New England journal of medicine* 2018;378:603-14.
21. Solomon R, Werner C, Mann D, et al. Effects of saline, mannitol, and furosemide on acute decreases in renal function induced by radiocontrast agents. *The New England journal of medicine* 1994;331:1416-20.
22. Kallen AJ, Jhung MA, Cheng S, et al. Gadolinium-containing magnetic resonance imaging contrast and nephrogenic systemic fibrosis: a case-control study. *American journal of kidney diseases : the official journal of the National Kidney Foundation* 2008;51:966-75.
23. Abraham JL, Thakral C, Skov L, et al. Dermal inorganic gadolinium concentrations: evidence for in vivo transmetallation and long-term persistence in nephrogenic systemic fibrosis. *The British journal of dermatology* 2008;158:273-80.
24. Auron A, Shao L, Warady BA. Nephrogenic fibrosing dermopathy in children. *Pediatr Nephrol.* 2006;21(16821025):1307- 1311.
25. Dharnidharka VR, Wesson SK, Fennell RS. Gadolinium and nephrogenic fibrosing dermopathy in pediatric patients. *Pediatr Nephrol.* 2007;22(17180360):1395-1395.

26. DiCarlo JB, Gupta EA, Solomon AR. A pediatric case of nephrogenic fibrosing dermopathy: improvement after combination therapy. *J Am Acad Dermatol.* 2006;54(16635686):914-916.
27. Jain SM, Wesson S, Hassanein A, et al. Nephrogenic fibrosing dermopathy in pediatric patients. *Pediatr Nephrol.* 2004;19(14872332):467-470.
28. Jan F, Segal JM, Dyer J, et al. Nephrogenic fibrosing dermopathy: two pediatric cases. *J Pediatr.* 2003;143(14615747):678-681.
29. Harris PD NE, Gerth R. The osmotic effect of water soluble contrast media on circulating plasma volume. *AJR Am J Roentgenol.* 1964; 91:694-698.
30. Poole CA, Rowe MI. Clinical evidence of intestinal absorption of Gastrografin. *Radiology.* 1976;118(1244649):151-153.
31. Frech RS, Davie JM, Adatepe M, et al. Comparison of barium sulfate and oral 40 per cent diatrizoate injected into the trachea of dogs. *Radiology.* 1970;95(5439432):299-303.
32. Friedman BI, Hartenberg MA, Mulroy JJ, et al. Gastrografin aspiration in a 3 3/4-year-old girl. *Pediatr Radiol.* 1986;16(3774397):506-507.
33. McAlister WH, Siegel MJ. Fatal aspirations in infancy during gastrointestinal series. *Pediatr Radiol.* 1984;14(6728539):81- 83.
34. Reich SB. Production of pulmonary edema by aspiration of water-soluble nonabsorbable contrast media. *Radiology.* 1969;92(5765945):367-370.
35. McAlister WH, Siegel MJ. Fatal aspirations in infancy during gastrointestinal series. *Pediatric radiology.* 1984;14(2):81.