

Survey of Radiologists' Knowledge Regarding the Management of Severe Contrast Material–induced Allergic Reactions¹

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Purpose:

To evaluate radiologists' knowledge of the appropriate management of severe contrast material–induced allergic reactions by means of a telephone survey.

Materials and Methods:

Institutional research ethics board approval was obtained. Following verbal consent, a telephone survey of radiologists working in Canada's 13 English-speaking and 13 U.S. university–affiliated radiology departments was performed. Participants were selected by using a multistage sampling scheme and simple random sampling within departments. Given a severe contrast material–induced allergic reaction case scenario, radiologists were first asked their initial medication of choice, then questioned specifically on the use of epinephrine. The Canadian and U.S. cohorts were compared by using the χ^2 and Fisher exact tests, as appropriate, and proportions and 95% confidence intervals (CIs) were computed.

Results:

A total of 253 (81%) of 311 radiologists from a 30% target population were surveyed. Ninety-one percent (231 of 253; 95% CI: 88%, 94%) of radiologists chose epinephrine as the most important initial medication. No radiologist gave the ideal response, but 41% (94 of 231; 95% CI: 35%, 47%) provided an acceptable administration route, concentration, and dose; 17% ($n = 39$; 95% CI: 12%, 22%) of radiologists provided an overdose. Only 11% (27 of 253; 95% CI: 7%, 15%) of radiologists knew what concentration of epinephrine was available in their drug kit and/or crash cart and what equipment would be required to administer it to a patient.

Conclusion:

Radiologists' knowledge of epinephrine for the management of severe contrast material–induced allergic reactions is deficient.

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Few clinical situations arise in the radiology department that require immediate medical intervention from radiologists. A contrast material–induced allergic reaction is one situation that has substantial morbidity and mortality (1). The incidence of severe life-threatening reactions to iodinated contrast material is thought to be approximately one of every 1000 uses for high-osmolar contrast media and approximately five times less frequent for low-osmolar contrast media, with both types having similar mortality rates of around one of every 100 000 uses (1).

There is a steadily increasing reliance on diagnostic imaging in medicine, which increases the use of intravenous contrast agents (2–5). Despite the increasing use of these agents, many physicians have unsatisfactory knowledge of adverse reactions to contrast material (6). Because radiologists are supervising contrast material administration in patients, they should not only have a commanding knowledge of adverse contrast material reactions but be adeptly able to manage them in the acute setting.

Rapid administration of epinephrine is the treatment of choice for severe contrast material–induced allergic reactions (7). Current guidelines strongly recommend assessment and management of airway, breathing, and circulation, as in all critically ill patients, and 0.01 mg per

kilogram of body weight to a maximum of 0.5 mg of 1:1000 concentrated epinephrine to be injected intramuscularly in the lateral aspect of the thigh, as a first-line treatment (7–9). There are few side effects with this approach and it is often life saving (10,11). Subcutaneous injection of epinephrine is less efficacious and may only attain circulatory epinephrine levels comparable to the endogenous stress response from placebo saline injections (8,12,13). Intravenous injection of epinephrine may be required for a life-threatening reaction that is unresponsive to intramuscular doses; however, it must be dilute, given slowly, and titrated against its therapeutic effect in a continuously monitored patient and carries the extremely rare risk of fatal adverse reaction (8,14,15). We sought to evaluate radiologists' knowledge of the appropriate management of severe contrast material–induced allergic reactions by means of a telephone survey instrument.

Materials and Methods

One author (S.K.) was previously involved in the design of continuing medical education for King Pharmaceuticals (Mississauga, Ontario, Canada). King Pharmaceuticals has no involvement in and no knowledge of this study. No industry financial support has been obtained for this study and none of the authors have financial interests in King Pharmaceuticals.

Institutional research ethics board approval was obtained. Following verbal consent, we performed a telephone survey of radiologists working in Canada's 13

English-speaking and 13 U.S. university-affiliated radiology departments. The U.S. institutions were randomly selected from a listing of the American Medical Association Fellowship and Residency Electronic Interactive Database Access System (Chicago, Ill) in 2007. In an effort to increase our response rate, the Canadian radiology department chairpersons were contacted in advance at an annual meeting through distribution of a written document that did not disclose the study subject matter. The chairpersons were asked to inform their staff that we may be calling with a short series of questions.

Faculty lists were obtained from department Web sites and through administrative staff. Radiologists were randomly called with a goal of enrolling 30% from each department to ensure a constant proportionate representation from each center. Radiologists working solely in pediatric imaging were excluded in an effort to focus on a more homogeneous subject population and to avoid the more complex weight-based epinephrine dosing parameters within the constraints of this short telephone survey. If a radiologist was not available at their office number or by their direct paging system, they were excluded. If a radiologist indicated that they were not able to answer the survey immediately and the survey topic had not been disclosed, a second telephone contact was attempted to complete the survey. Site-specific enrollment was finished within 1 day in an attempt to limit

Advances in Knowledge

- The majority of radiologists (59%, 137 of 231) do not have an appropriate working knowledge of epinephrine dosing for severe contrast material–induced allergic reactions.
- When radiologists provided an incorrect dose of epinephrine, they were more likely to overdose (17%, 39 of 231) than underdose (0.4%, $n = 1$).
- Most radiologists (89%, 226 of 253) do not know what type of epinephrine is available on their emergency cart and/or drug kit and what equipment is required to administer it.

Implications for Patient Care

- Because radiologists have a poor working knowledge of epinephrine administration for severe contrast material–induced allergic reactions, patients may not be receiving appropriate or timely treatment.
- The use of an epinephrine autoinjector has the potential to improve and simplify patient care in these emergency situations, at least until support staff arrives.

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Abbreviation:

CI = confidence interval

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Guarantors of integrity of entire study, C.B.L., R.J.A.; study concepts/study design or data acquisition or data analysis/interpretation, all authors; manuscript drafting or manuscript revision for important intellectual content, all authors; approval of final version of submitted manuscript, all authors; literature research, C.B.L., T.M., S.K., R.J.A.; clinical studies, C.B.L., R.J.A., T.M., R.J.A.; statistical analysis, C.B.L., M.A.; and manuscript editing, C.B.L., T.M., M.A., S.K., R.J.A.

See Materials and Methods for pertinent disclosures.

discussion among colleagues at each institution.

The survey was designed on the basis of a case scenario of a severe contrast material–induced allergic reaction. Radiologists were asked their initial medication of choice, then questioned on the use of epinephrine for severe contrast material–induced allergic reactions. They were also asked questions on the logistics of administering epinephrine at their respective institutions (Figure). Following complete enrollment of an institution, computed tomographic (CT) technologists on duty at each hospital were contacted by telephone to verify radiologists' responses to the questions with site-specific answers. Specifically, technologists were asked to confirm what concentration of epinephrine was available in their emergency cart and/or drug kit and whether or not it was kept in the CT scanner rooms. The Canadian surveys were conducted by one author (C.B.L.) with the exception of his own institution (Dalhousie University, Halifax, Nova Scotia, Canada), which was performed by T.M., who at the time of the survey had no affiliation. The U.S. surveys were conducted by two authors (C.B.L. and R.J.A.; C.B.L. supervised a number of the surveys performed by R.J.A. to ensure consistency of the interviews).

The ideal dose of epinephrine was defined as an intramuscular injection of 0.5 mg of 1:1000 concentration. The acceptable dose ranges in this study were defined as 0.1–0.5 mg of 1:1000 concentrated epinephrine for subcutaneous and intramuscular injections and 5 µg to 0.5 mg of 1:10 000 concentrated epinephrine for intravenous injections. These generous adult dosing parameters were selected by combining the widest range of doses in multiple guidelines, including those from the American College of Radiology (16), European Society of Urogenital Radiology (9), and a Joint Task Force on Practice Parameters (7).

Statistical computing software (R; R Foundation for Statistical Computing, Vienna, Austria) (17) was used to generate the random numbers to identify U.S. academic radiology departments

and individual radiologists in both U.S. and Canadian academic radiology departments. Data were collated in a spreadsheet (Excel; Microsoft, Redmond, Wash). Comparisons of the Canadian and U.S. cohorts were made with the χ^2 and Fisher exact tests, as appropriate. Proportions and 95% confidence intervals (CIs) were computed for survey responses (M.A. and C.B.L.).

Results

Three hundred eleven radiologists were contacted directly by telephone. Of those, 20 declined enrollment without knowledge of the survey topic and

38 withdrew from the study during the survey. A total of 253 radiologists were enrolled: 27% (148 of 548) of Canada's 13 English-speaking university-affiliated radiologists and 19% (105 of 552) of radiologists from the U.S. institutions (Table). Our target population was 30% of faculty at each institution; we achieved an 81% (253 of 311) response rate of those contacted. There were no statistical differences in the response rates or survey answers between the Canadian and U.S. cohorts.

Ninety-one percent (231 of 253; 95% CI: 88%, 94%) of radiologists chose epinephrine, 4% ($n = 10$; 95% CI: 2%, 6%) chose an antihistamine,

You have a patient that has just received intravenous contrast material for an imaging study and is now stridorous, in severe respiratory distress with angioedema and diffuse urticaria, consistent with a severe allergic reaction.

1. What is the most important medication to be immediately administered to this patient?
 - a. What is the preferred route of administration of this medication?
 - b. What is the concentration of this medication?
 - c. What is the dose of this medication?

Note: If the subject did not choose epinephrine, we suggested that the patient subsequently deteriorated clinically to the point of requiring epinephrine and continued with the remaining questions on epinephrine administration.

2. For the subcutaneous injection route, what is the dose and concentration of epinephrine?
3. For the intramuscular injection route, what is the dose and concentration of epinephrine?
4. For the intravenous injection route, what is the dose and concentration of epinephrine?
5. How is the 1:1000 concentrated epinephrine supplied?
6. How is the 1:10000 concentrated epinephrine supplied?
7. What concentration of epinephrine is on your emergency cart and/or drug kit?
8. At your institution, what equipment (such as syringe, needle, needleless adapter, etc) is needed to administer the epinephrine supplied on your emergency cart and/or drug kit?
9. Is epinephrine in the same room as your CT scanners?

Survey to evaluate radiologists' knowledge of appropriate management of severe contrast material–induced allergic reactions. Following verbal consent, each radiologist was given case scenario and asked questions listed.

2% ($n = 6$; 95% CI: 0%, 4%) chose a steroid, and 2% ($n = 6$; 95% CI: 0%, 4%) chose a different drug as the most important initial medication for treatment. No radiologist provided the ideal response, but 41% (94 of 231; 95% CI: 35%, 47%) provided an acceptable administration route, concentration, and dose of epinephrine; 17% (39 of 231; 95% CI: 12%, 22%) of radiologists provided an overdose.

Radiologists were asked specifically about subcutaneous, intramuscular, and intravenous administration of epinephrine. Twenty-eight percent (71 of 253; 95% CI: 22%, 34%) provided an acceptable subcutaneous dose and 25% ($n = 62$; 95% CI: 20%, 30%) provided a subcutaneous overdose. Intramuscular injection of epinephrine was the route most often cited as inappropriate by 21% ($n = 54$; 95% CI: 16%, 26%) of radiologists. Sixteen percent ($n = 40$; 95% CI: 13%, 19%) of radiologists provided an acceptable intramuscular dose and 13% ($n = 33$; 95% CI: 9%, 17%) provided an intramuscular overdose. Thirty-nine percent ($n = 99$; 95% CI: 33%, 45%) of radiologists provided an acceptable dose of intravenous epinephrine and 9% ($n = 23$; 95% CI: 5%, 13%) provided an intravenous overdose.

Fifty-four percent (136 of 253; 95% CI: 48%, 60%) of radiologists knew that 1:1000 concentrated epinephrine is supplied in 1-mL glass ampules and 31% ($n = 78$; 95% CI: 25%, 37%) knew

that 1:10 000 concentrated epinephrine is supplied in 10-mL preloaded syringes. Sixty-two percent ($n = 157$; 95% CI: 68%, 56%) knew whether or not epinephrine is kept in the same room as their CT scanners. Only 11% ($n = 27$; 95% CI: 7%, 15%) of radiologists knew which concentration of epinephrine was available in their drug kit and/or crash cart and what equipment would be required to administer it to a patient.

Discussion

No radiologist gave the ideal dose and administration route of epinephrine (defined as a 0.5-mg intramuscular injection [1:1000]) for the management of the severe contrast material-induced adult allergic reaction scenario. Intramuscular is the preferred route of administration and was the route most often cited as inappropriate. When radiologists provided an incorrect dose of epinephrine, they were more likely to overdose than underdose.

Bartlett et al (18) have investigated the knowledge level of radiologists and trainees (in four teaching hospitals in a major Australian city) for the management of allergic reactions to contrast material. They found that radiologists' and trainees' knowledge of immediately life-threatening contrast material reaction management was low. Forty-three percent knew an acceptable adrenaline dose (defined as ≤ 0.75 mg) and an incorrect

dose was more likely to be an overdose. They suggested that regular, compulsory training of radiologists be instituted. Furthermore, Sadler et al (19) in the United Kingdom established through a postal survey that knowledge for managing severe contrast material reactions was higher in junior radiologists when compared with their more senior counterparts, but juniors were more likely to use inappropriate pharmacologic agents. They stated that most radiologists manage severe and potentially fatal contrast material reactions poorly overall. They suggested that it may be unrealistic to expect medical staff who no longer practice acute clinical medicine to manage infrequent medical emergencies with efficiency and confidence. They also called for a simplified treatment approach.

To our knowledge, no study has evaluated North American radiologists' knowledge for the management of severe contrast material-induced allergic reactions. Our study population is a Canadian and U.S. national subset of academic radiologists, in contrast to the localized Australian study (18). In comparison with the United Kingdom postal survey (19), our direct telephone questionnaire decreases the possibility of subjects using reference materials when answering questions. Our high response rate (81%; 95% CI: 77%, 85%) suggests a low chance of selection bias.

Our results indicate that radiologists in daily practice do not maintain a working knowledge of epinephrine dosing parameters. Many studies have found deficiencies in the knowledge and delivery of proper treatment of anaphylactic reactions by others, including family physician, pediatricians, internal medicine specialists and even emergency room physicians (20–26). It is possible that radiologists who are removed from regular patient care may be hesitant in instituting treatment and may choose to wait for acute care support staff to administer epinephrine, causing an unnecessary delay with potential adverse patient outcomes (27,28).

Having ready access to a preloaded epinephrine autoinjector, similar to that prescribed to adult and child laypersons, is a simple solution that could dra-

Radiologists' Responses for Epinephrine Dosing for Management of Severe Contrast Material–Induced Allergic Reactions

Medication of Choice	Epinephrine (%)	Acceptable Dose (%)	Overdose (%)
Total sample	91 (231/253) [88, 94]	41 (94/231) [35, 47]	17 (39/231) [12, 22]
Epinephrine administration route of choice			
Subcutaneous	26 (61/231) [20, 32]	38 (23/61) [26, 40]	34 (21/61) [24, 44]
Intramuscular	6 (15/231) [3, 9]	53 (8/15) [28, 78]	13 (2/15) [0, 30]
Intravenous	61 (141/231) [53, 67]	45 (63/141) [37, 53]	11 (16/141) [6, 16]
When asked specifically about routes of epinephrine administration			
Subcutaneous	100 (253/253)	28 (71/253) [22, 34]	25 (62/253) [20, 30]
Intramuscular	100 (253/253)	16 (40/253) [13, 19]	13 (33/253) [9, 17]
Intravenous	100 (253/253)	39 (99/253) [33, 45]	9 (23/253) [5, 13]

Note.—Numbers in parentheses were used to calculate percentages; numbers in square brackets are the 95% CIs.

matically improve patient care. There are limited side effects with the use of intramuscular epinephrine (10,11) and fewer specific to the use of an autoinjector (27,28). These devices are easy to use and eliminate uncertainty regarding dose administration route. We strongly recommend the combination of education and placing epinephrine autoinjectors in all departments or clinics administering intravenous contrast agents will help save lives. We suggest that these devices be readily visible and within easy reach, wall- or gantry-mounted, for use when the need arises.

In addition to epinephrine autoinjectors, other beneficial options might include posted treatment algorithms in rooms where contrast material is being administered and having appropriate quick-reaction drug kits that are easily visible and accessible. These should contain 1:1000 and 1:10 000 concentrated epinephrine with appropriate materials for administration, such as needles, syringes, and needleless adapters, if required at each institution. Other medications may also be useful (7,9), but their administration is often not as time sensitive as that of epinephrine.

O'Neill and McBride (31) found low retention of knowledge for cardiopulmonary resuscitation and contrast media reactions with additional low levels of retraining in their radiology department. However, a concerted effort for regular updating made a significant difference over the 28-month study period. We also strongly advocate frequent continuing medical education and believe that radiologists should maintain basic and advanced life-support certification.

Our study had limitations in that we chose to survey only radiologists in university-based departments and our results may not generalize to those working in community practices. Although it is difficult to know with certainty the reasons why 38 radiologists withdrew from the survey, many seemed uncomfortable with the questions and their knowledge level, and therefore our results may reflect a slight, falsely elevated level of knowledge for our target population. Individuals may have had access to reference materials

during the survey; however, we attempted to minimize this by requiring an immediate response through our telephone survey methods. Colleagues within institutions could have discussed the survey; we tried to curtail this by single-day institution enrollment. If present, these potential biases should have also resulted in a mild false increase in the assessed level of knowledge of our subjects. Multi-stage random sampling and unequal sample sizes within each academic radiology department led to lower accuracy (32).

In conclusion, radiologists' knowledge of the use of epinephrine for the management of severe contrast material-induced allergic reactions is deficient.

References

- Idee JM, Pines E, Pringent P, Corot C. Allergy-like reactions to iodinated contrast agents: a critical analysis. *Fundam Clin Pharmacol* 2005;19(3):263-281.
- Christiansen C. Late-onset allergy-like reactions to X-ray contrast media. *Curr Opin Allergy Clin Immunol* 2002;2(4):333-339.
- Persson PB. Contrast medium-induced nephropathy. [editorial]. *Nephrol Dial Transplant* 2005;20(suppl 1):i1.
- Katzberg RW, Haller C. Contrast-induced nephrotoxicity: clinical landscape. *Kidney Int Suppl* 2006;100:S3-S7.
- Kalra MK, Maher MM, D'Souza R, Saini S. Multidetector computed tomography technology: current status and emerging developments. *J Comput Assist Tomogr* 2004;28(suppl 1):S2-S6.
- Confino-Cohen R, Goldberg A. Safe administration of contrast media: what do physicians know? *Ann Allergy Asthma Immunol* 2004;93(2):166-170.
- Joint Task Force on Practice Parameters; American Academy of Allergy, Asthma and Immunology; American College of Allergy, Asthma and Immunology; Joint Council of Allergy, Asthma and Immunology. The diagnosis and management of anaphylaxis: an updated practice parameter. *J Allergy Clin Immunol* 2005;115(3 suppl 2):S483-S523.
- Sampson HA, Munoz-Furlong A, Campbell RL, et al. Second symposium on the definition and management of anaphylaxis: summary report—second National Institute of Allergy and Infectious Disease/Food Allergy and Anaphylaxis Network symposium. *J Allergy Clin Immunol* 2006;117(2):391-397.
- ESUR Contrast Media Safety Committee. ESUR guidelines on contrast media, version 6.0. European Society of Urogenital Radiology. http://www.esur.org/ESUR_Guidelines_NEW.6.0.html. Published February 2007. Accessed February 10, 2008.
- Douglass JA, O'Hehir RE. Adrenaline and non-life threatening allergic reactions: intramuscular adrenaline is safe. *BMJ* 2003;327(7408):226-227.
- Posner L. Epinephrine is safe for anaphylaxis treatment in most patients. *Medscape Medical News*. <http://www.medscape.com/viewarticle/493877>. Published November 15, 2004; Accessed February 10, 2008.
- Simons FE, Gu X, Simons KJ. Epinephrine absorption in adults: intramuscular versus subcutaneous injection. *J Allergy Clin Immunol* 2001;108(5):871-873.
- Simons FE, Roberts JR, Gu X, Simons KJ. Epinephrine absorption in children with a history of anaphylaxis. *J Allergy Clin Immunol* 1998;101(1):33-37.
- Pumphrey RS. Lessons for management of anaphylaxis from a study of fatal reactions. *Clin Exp Allergy* 2000;30(8):1144-1150.
- Chamberlain D. Project team of the Resuscitation Council (UK): emergency medical treatment of anaphylactic reactions. *J Accid Emerg Med* 1999;16(4):243-247.
- Committee on Drugs and Contrast Media of the American College of Radiology. Manual on contrast media, version 5.0 http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx. Published 2004. Accessed February 10, 2008.
- R Development Core Team. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, <http://www.R-project.org>. Published October 20, 2008. Accessed February 10, 2008.
- Bartlett MJ, Bynevelt M. Acute contrast reaction management by radiologists: a local audit study. *Australas Radiol* 2003;47(4):363-367.
- Sadler DJ, Parrish F, Coulthard A. Intravenous contrast media reactions: how do radiologists react? *Clin Radiol* 1994;49(12):879-882.
- Mehl A, Wahn U, Niggemann B. Anaphylactic reactions in children: a questionnaire-based survey in Germany. *Allergy* 2005;60(11):1440-1445.
- Ferreira MB, Alves RR. Are general practitioners alert to anaphylaxis diagnosis and treatment? *Eur Ann Allergy Clin Immunol* 2006;38(3):83-86.

22. Krugman SD, Chiaramonte DR, Matsui EC. Diagnosis and management of food-induced anaphylaxis: a national survey of pediatricians. *Pediatrics* 2006;118(3):e554–e560.
23. Wang J, Sicherer SH, Nowak-Wegrzyn A. Primary care physicians' approach to food-induced anaphylaxis: a survey. *J Allergy Clin Immunol* 2004;114(3):689–691.
24. Gompels LL, Bethune C, Johnston SL, Gompels MM. Proposed use of adrenaline (epinephrine) in anaphylaxis and related conditions: a study of senior house officers starting accident and emergency posts. *Postgrad Med J* 2002;78(921):416–418.
25. Clark S, Bock SA, Gaeta TJ, et al. Multicenter study of emergency department visits for food allergies. *J Allergy Clin Immunol* 2004;113(2):347–352.
26. Clark S, Long AA, Gaeta TJ, Camargo CA Jr. Multicenter study of emergency department visits for insect sting allergies. *J Allergy Clin Immunol* 2005;116(3):643–649.
27. Mrvos R, Anderson BD, Krenzelok EP. Accidental injection of epinephrine from an autoinjector: invasive treatment not always required. *South Med J* 2002;95(3):318–320.
28. McGovern SJ. Treatment of accidental digital injection of adrenaline from an auto-injector device. *J Accid Emerg Med* 1997;14(6):379–380.
29. Bock SA, Muñoz-Furlong A, Sampson HA. Fatalities due to anaphylactic reactions to foods. *J Allergy Clin Immunol* 2001;107(1):191–193.
30. Sampson HA, Mendelson L, Rosen JP. Fatal and near-fatal anaphylactic reactions to food in children and adolescents. *N Engl J Med* 1992;327(6):380–384.
31. O'Neill JM, McBride KD. Cardiopulmonary resuscitation and contrast media reactions in a radiology department. *Clin Radiol* 2001;56(4):321–325.
32. Scheuren F. What is a survey? The American Statistical Association. <http://www.whatisasurvey.info>. Published June 2004; Accessed February 10, 2008.

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13-16	\$587	\$710	\$1,201	\$1,748	\$2,297	\$2,843
17-20	\$738	\$858	\$1,474	\$2,167	\$2,846	\$3,532
21-24	\$888	\$1,005	\$1,750	\$2,575	\$3,400	\$4,230
25-28	\$1,035	\$1,164	\$2,034	\$2,986	\$3,957	\$4,912
29-32	\$1,186	\$1,311	\$2,302	\$3,402	\$4,509	\$5,612
Covers	\$149	\$164	\$219	\$275	\$335	\$393

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# of Pages	50	100	200	300	400	500
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5-8	\$387	\$517	\$816	\$1,154	\$1,498	\$1,844
9-12	\$574	\$689	\$1,157	\$1,686	\$2,190	\$2,717
13-16	\$754	\$874	\$1,506	\$2,193	\$2,883	\$3,570
17-20	\$710	\$1,063	\$1,852	\$2,722	\$3,572	\$4,428
21-24	\$1,124	\$1,242	\$2,195	\$3,231	\$4,267	\$5,300
25-28	\$1,320	\$1,440	\$2,541	\$3,738	\$4,957	\$6,153
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