A Pennsylvania healthcare facility identified a neurological adverse event in a few patients within 8 hours of receiving an intravenous (IV) contrast agent for a radiologic study. This facility, which used low osmolar, nonionic, monomer, and nonionic iso-osmolar dimer contrast in the studies, contacted the Pennsylvania Patient Safety Authority to inquire whether similar events were reported elsewhere in Pennsylvania. Analysts addressed the request through a focused analysis of radiology contrast events in hospitals of a similar size to the requesting hospital (i.e., hospitals with 300 beds or more).

Contrast media is used as an advanced imaging technique to improve diagnosis, and it is generally safe and effective.¹ It is estimated that contrast media is used in millions of radiological studies annually.² Imaging studies that may require iodinated contrast media include x-ray studies, computed tomography (CT) scans, arteriograms, and interventional radiologic procedures.³ Iodinated contrast media is the most commonly used IV contrast agent.⁴ An estimated 2% to 17% of patients receiving contrast media experience an adverse effect, regardless of the contrast type.⁴,⁵ Adverse reactions mostly occur with IV administration; however, they also occur with intra-arterial and nonvascular injections.⁶ Knowledge of adverse reactions, prevention, preparation, and adequate response when a reaction occurs are essential to providing safe care to patients undergoing imaging studies with contrast agents.²

**METHODS**

In response to the request, Authority analysts queried the Pennsylvania Patient Safety Reporting System (PA-PSRS) to identify radiology contrast–related events in hospitals with 300 beds or more over a 2-year period, from January 2014 through December 2015. The following search terms and word roots were used to identify applicable events: procedu, omni, visip, power inject, contrast, mri, and mra. The query identified more than 4,600 event reports. Analysts reviewed individual free text fields, such as the event narratives, using key terms including the following: MRI, contrast, power injection, study, procedure, infiltration, extravasation, allergic reactions, adverse events, Omnipaque®, and Visipaque™. Of the 4,609 events, 544 were excluded because they had no relevance to contrast administration (e.g., contrast was not given, or was mentioned incidentally). The remaining 4,065 event reports addressed IV, oral, and enteral routes of contrast administration.

Analysts conducted an extensive review of the literature and an Internet search to obtain epidemiological data on the use of radiologic contrast media, adverse reactions, and treatments. A medical librarian assisted with a search for published articles indexed through July 31, 2016, in AccessMedicine, EBSCO Biomedical Reference, Embase, Google, Google Scholar, PubMed, Cochrane, Scopus, and UpToDate databases and search engines. Searches included terms such as radiocontrast agents, media, contaminate, neurological, microemboli, and stroke.

**RESULTS**

**Harm and patient age.** The majority of the event reports were Incidents (i.e., near miss event or events that reached the patient but did not result in harm or require additional interventions): 99.2% (n = 4,034 of 4,065). The remaining 0.8% (n = 31) events were Serious Events, in which an event reached the patient and resulted in harm—including severe extravasations, nephrotoxicity, and cardiac events—and required additional intervention.
Patients in the age group 50 to 59 years had the largest number of reported events (19.8%, n = 805) and patients 60 years or older accounted for 46.5% (n = 1,889) of reported events; these findings parallel findings in the study by Ha, Kim, and Sohn.6 Patients in the age group newborn to 18 years had the fewest number of events reported (2.1%, n = 87).

Radiology contrast route. Administration of IV radiology contrast was noted in 89.9% (n = 3,653 of 4,065) event reports. Oral or enteral routes were noted in 2.8% (n = 112) of the event reports, and the remaining events lacked a description of the route of contrast administration (7.4%; n = 300).

Adverse effect conditions. Not all patients experienced an adverse event and not all conditions caused or explained the adverse event. Almost two-thirds of the event reports (63.4%; n = 2,577 of 4,065) were related to IV contrast infiltrations or extravasations. Another 22.1% (n = 897) were related to allergic reactions. Analysts identified eight types of adverse effects associated with contrast media–related event reports (see Figure). Although less frequently reported, complications of oral contrast included vomiting (n = 8), with the potential for aspiration.

The most frequently reported body system affected was the integumentary system, due to the infiltrations and extravasations as noted above, followed by the renal system at 1.3% (n = 51 of 4,065). There were no reports of neurological adverse effect conditions in this period.

DISCUSSION

Adverse reactions. Acute reactions to contrast media, including allergic and allergic-like reactions, can be divided into three categories: mild, moderate, and severe.3,5,6 Mild symptoms typically include erythema, nausea, vomiting, pruritus, headache, and mild urticaria.4,6 Patients who experience mild reactions require little intervention beyond routine patient care and monitoring and will typically recover in a few hours. Patients with moderate reactions may have any or all of the mild symptoms and additionally might exhibit bronchospasm, moderate urticaria, chest pain, dyspnea, hypotension or hypertension, tachycardia or bradycardia, and other vasovagal responses. Patients with moderate reactions may require therapeutic intervention and monitoring, but most do not require admission. Severe reactions occurred in fewer than 1% of patients who received contrast and happen quickly after administration of contrast, usually within 20 to 30 minutes.4 Immediate intervention is required because severe reactions can be life-threatening. Severe reactions may include laryngeal edema, severe bronchospasm, seizure, convulsion, unresponsiveness, and death.4,6 Delayed reactions, those appearing more than 30 minutes or within 7 days of receiving contrast, occur in 8% to 30% of patients, and the percentage depends on the molecular structure of the iodinated contrast given (e.g., ionic versus non-ionic monomers).3 Delayed reactions include rash, urticaria, flu-like symptoms, and polyarthropathy.1,5 Treating patients who have known contrast allergies or patients at risk for an allergic reaction, such as those with prior sensitivity to contrast, includes preventative interventions such as administering corticosteroids.2,5

An extensive literature search specifically addressing neurological adverse reactions was performed to address the initial inquiry into this topic. This search identified no studies directly linking radiologic contrast media alone to neurological adverse reactions. Neurologic complications, such as stroke and myocardial
infarction, can be associated with air embolism, and “clinically significant air emboli are potentially fatal”; they are most commonly associated with the use of power injectors.2,4

The literature search returned two older studies linking particulate matter with the risk of emboli formation and the possibility of cardiac and neurologic adverse events.3,8 Winding studied angiographic contrast media in ampules and vials. Particles were found in all brands tested and the author recommended “contrast media be passed through a filter during administration.”9

Hirakawa and coauthors studied radiographic contrast media administered intravenously through an automatic injector and noted that “particulate contamination of the radiographic contrast media occurs as a result of the interaction with silicone and sulfur on the surface of the disposable syringe components. High speed injection increases the risk of contrast media contamination from the particulate matter after transfer from the vial to a disposable syringe.”9 A sampling of two package inserts for radiographic contrast media includes a standard recommendation to “visually inspect the product for discoloration and particulate matter prior to administration.”9,10

Extravasation. These events occur when vascular access is compromised and the contrast media enters the surrounding tissue. Contrast media is toxic to surrounding tissues, especially skin, with a local inflammatory response that can peak in 24 to 48 hours.2 Pain (e.g., burning or stinging) or swelling or tightness are the main patient complaints when extravasation occurs; however, some patients experience little or no discomfort.2 Physical examination may uncover a site that is edematous, erythematous, and tender in mild cases and painful or blistering in moderate cases.2,4 Treatment for a contrast-media extravasation is aimed at the clinical manifestations present and may include elevation of the affected extremity above the heart to promote reabsorption, application of either warm or cold compresses, and monitoring of the limb for several hours.2,4 Compartment syndrome is a severe injury that is more likely to occur after extravasation of larger volumes of contrast media.2 Physical assessment may uncover progressive swelling, increasing or severe pain, change in sensation, and decreased circulation.2,4 Medical follow up is recommended and surgical consultation may be warranted.2,4 The American College of Radiologists recommends “close clinical follow up for several hours for all patients experiencing an extravasation.”

Risk factors. The following risk factors can predispose a patient to an adverse event: previous severe reaction to a contrast agent, history of multiple allergies, asthma, dehydration, diabetes, renal disease, sickle cell anemia, polycythemia, myeloma, cardiac disease, thyroid disease (e.g., hyperthyroidism, carcinoma), anxiety, age older than 60 years, concomitant use of certain intra-arterial injections such as papaverine, and certain medications such as beta blockers and metformin.2,5,6

As noted in the PA-PSRS data, patients age 60 years or older accounted for 46.5% of the event reports. Incidentally, the administration of metformin was reported in 26 of the event reports. Staff education on all risk factors including screening for patient age may help reduce the risk of an adverse event or reaction. Likewise, education on the importance of timing the administration of metformin relative to the administration of radiologic contrast media may help reduce likelihood of a delay in obtaining the contrast study and the risk of nephrology complications.

For a list of evidence-based resources on the safe use of radiologic contrast media, see “Safe Use of Radiologic Contrast Media.”

CONCLUSION

Although the administration of radiologic contrast media is generally safe, it is not without risks. As seen in the PA-PSRS data and literature, most adverse events are mild and do not result in permanent patient harm. Knowledge, prevention,
recognition, and prompt management of adverse reactions to radiologic contrast media can all contribute to providing safe care to patients undergoing contrast-related studies. Additionally, knowing the types and severity of radiology contrast events that occur in a facility can guide staff in proactive prevention and screening strategies and in implementing the appropriate responsive actions to mitigate patient harm.

ACKNOWLEDGEMENTS
Timothy Horine, RN BSN, Staff Nurse, Neuro Cardiac ICU, Bryn Mawr Hospital, contributed to the data analysis for this article.

NOTES