AJNR

The Iodinated Contrast Crisis of 2022: A Near Miss or a Missed Opportunity?

S.A. Amukotuwa and R. Bammer

AJNR Am J Neuroradiol 2023, 44 (8) 908-909
doi: https://doi.org/10.3174/ajnr.A7940
http://www.ajnr.org/content/44/8/908

The Iodinated Contrast Crisis of 2022: A Near Miss or a Missed Opportunity?

The unprecedented global shortage of iodinated contrast media (ICM), commencing in late April 2022, was a direct result of excessive global reliance on one manufacturer, GE Healthcare, which produced much of its most widely used ICM, iohexol (Omnipaque), at a facility in Shanghai, China.[1,2] When Shanghai was plunged into a coronavirus disease 2019 (COVID-19) lockdown, production ceased abruptly. Just-in-time inventory management and production strategies, aimed at reducing costs, left the world with no stockpile to turn to, while GE Healthcare's other factory in Ireland and other ICM vendors did not have the capacity to scale up production at such short notice to meet the global demand. Fortunately, because Shanghai came out of lockdown and GE Healthcare's factory returned to full operating capacity in June, the period of critical ICM scarcity lasted just a few months. However, this near miss taught us some important lessons when it comes to critical medical supplies: Diversification is essential, even if it is costly, and health care services must consider self-sufficiency in the face of vulnerable global supply chains, whether it be through local production or amassing sufficient stockpiles.

Early in the crisis, professional interest groups and journals, including the American College of Radiology and the *American Journal of Roentgenology*, issued guidance to affected health care services on how to rationalize ICM usage and conserve supplies for indications essential to patient care.[2,3] One of these critical indications is acute ischemic stroke (AIS). ICM is required for guiding endovascular thrombectomy and also for diagnosis because most centers in North America rely on multimodal CT, with CTA and CTP, to triage patients presenting with suspected ischemic stroke to treatment. We provided guidance, published in this journal, on how to both reduce and avoid ICM usage in AIS imaging.[1] Approaches included the following: modifying CT scan protocols to allow CTA and CTP to be performed with smaller volumes of ICM; improving triage to multimodal stroke CT by mandating that stroke neurologists, rather than trainees or emergency physicians, assess patients; and using MR imaging instead of CT. Individual institutions were advised to tailor their strategy, depending on their ICM supplies, availability of local expertise, and access to emergent MR imaging.

Now that the crisis is over, we are presented with a unique opportunity to review and study the impact of these interventions. What did we learn? Can we get away with doing fewer multimodal stroke CT scans? Is diversion to MR imaging feasible, and should we be using this technique instead?

The study by Qureshi et al[4] in this issue of the *American Journal of Neuroradiology* sheds some light on the subject. The authors provide a quantitative estimate of the effect of the ICM shortage on the use of multimodal stroke CT by reviewing processing logs of the 399 hospital install-base of the Viz.ai (https://www.viz.ai/) software in the United States. There was a significant reduction in the volume of CTAs and CTPs performed, of 9.6% and 25.9%, respectively, compared with the period before the crisis. There was a disproportionately high reduction in the number of CTPs yielding either no perfusion lesion or a small one, suggesting that multimodal stroke CT was avoided in patients with mild deficits and transient symptoms. Instead, only those patients with more severe symptoms, suggesting a larger volume of eloquent tissue at risk and thus a higher likelihood of a large-vessel occlusion (LVO), were triaged to CTA and CTP.

This practice aligns with the original purpose of CTP, to select patients for endovascular treatment. However, patients with LVOs can present with mild symptoms, due to involvement of the nondominant hemisphere or good collaterals.[5] Furthermore, medium-vessel occlusions, which typically present with milder deficits, are increasingly considered for thrombectomy because even mild deficits can cause severe disability in individual patients.[6] Thus, this strategy may have resulted in worse outcomes for some patients. An audit of stroke clinic data, including follow-up imaging, is needed to ascertain whether treatable strokes, including those due to LVOs, were missed by scanning fewer patients. In addition, multimodal CT is used increasingly in patients with milder symptoms to exclude a vascular cause for presentation. Reassurance provided by normal scan findings may allow patients to be discharged home from the emergency department with early outpatient follow-up. This is, therefore, a valuable opportunity to review our practice and examine the impact of more stringent criteria for triage to multimodal CT on stroke care, including hospitalization rates.

The crisis also provided health care systems with a golden opportunity to revisit using emergent MR imaging for triage of AIS

patients to treatment. While CT is easier to access in the emergent setting, MR imaging with DWI is the criterion standard for identifying infarcted brain tissue.[7-9] It is, therefore, the standard-of-care first-line imaging technique for assessing patients with AIS in Europe and some centers in North America. DSC PWI was the method used for delineating the ischemic penumbra in early thrombectomy studies, and MR imaging diffusion-perfusion mismatch to select patients for thrombectomy has been well-validated.[10] MR imaging also has the advantage of offering an entirely noninvasive technique, which requires no contrast agent injection, for assessing the penumbra: arterial spin-labeling perfusion.[11]

Because our institution, a comprehensive stroke center, had access to a software that is FDA-cleared for performing MR imaging–based mismatch analysis, RapidAI (https://www.rapidai.com/), we seized the opportunity to implement a fast (around 5 minutes) acute stroke MR imaging protocol. While we were able to divert some patients to MR imaging, we encountered several obstacles: First, access to emergent MR imaging was more challenging than anticipated. Due to the high demand for MR imaging examinations, both our inpatient and outpatient scanners were heavily overbooked, making it challenging even to fit in a short scan. We also found that our MR imaging technologists are less accustomed to emergent workflows and fast scan turnaround than our CT technologists. We learned, therefore, that while emergent MR imaging for triage to thrombectomy is feasible, it requires a streamlined workflow with staggered bookings and sufficient time to "squeeze in" patients with stroke. Plenty of practice is also needed to embed these fast workflows and bring MR imaging technologists up to speed. Audits from institutions that switched to predominantly or exclusively MR imaging, including the effect on door-to-needle times, would therefore be needed "to identify effective strategies to reduce reliance on contrast media-based studies, such as CTAs/CTPs, without compromising patient outcomes," as suggested by the authors.

Unfortunately, because Viz.ai does not have FDA clearance for LVO detection and mismatch analysis on MR imaging, the authors did not have access to data on MR imaging scan numbers to determine whether diversion occurred in their installed bases and, if so, to what extent. In addition, the impact of using MR imaging instead of CT on door-to-needle time could not be assessed because the software was not used for care co-ordination of these patients, leading to a loss of valuable data on workflow on which health care systems may rely.

In conclusion, the study from Qureshi et al[4] provides us with a glimpse of the effect of the ICM crisis on acute stroke imaging in the United States. However, it also raises many important questions that must be answered through audits of individual health care services in order to not miss a valuable opportunity to gain insights that can improve stroke care.

REFERENCES

1. Bammer R, Amukotuwa SA. **Navigating supply chain disruptions of iodinated contrast agent for neuroimaging and how business intelligence can drive decisions.** *AJNR Am J Neuroradiol* 2022;43:944–50 CrossRef Medline
2. Cavallo J, Pahade J. **Practice management strategies for imaging facilities facing an acute iodinated contrast media shortage.** *AJR Am J Roentgenol* 2022;219:666–70 CrossRef Medline
3. **ACR Committee on Drugs and Contrast Media Brief Statement on Nomenclature for Symptoms Associated with Gadolinium-Based Contrast Agent Exposure (SAGE).** https://www.acr.org/-/media/ACR/Files/Clinical-Resources/SAGE-Paragraph-_-FINAL.pdf. Accessed May 13, 2022
4. Qureshi AI, Grintal A, DeGaetano AC, et al. **Effect of radiographic contrast media shortage on stroke evaluation in the United States.** *AJNR Am J Neuroradiol* 2023;44:901–07 CrossRef Medline
5. Maas MB, Furie KL, Lev MH, et al. **National Institutes of Health Stroke Scale score is poorly predictive of proximal occlusion in acute cerebral ischemia.** *Stroke* 2009;40:2988–93 CrossRef Medline
6. Saver JL, Chapot R, Agid R, et al; Distal Thrombectomy Summit Group. **Thrombectomy for distal, medium vessel occlusions: a consensus statement on present knowledge and promising directions.** *Stroke* 2020;51:2872–84 CrossRef Medline
7. Campbell BC, Purushotham A, Christensen S, et al; EPITHET–DEFUSE Investigators. **The infarct core is well represented by the acute diffusion lesion: sustained reversal is infrequent**. *J Cereb Blood Flow Metab* 2012;32:50–56 CrossRef Medline
8. Gill R, Sibson NR, Hatfield RH, et al. **A comparison of the early development of ischaemic damage following permanent middle cerebral artery occlusion in rats as assessed using magnetic resonance imaging and histology.** *J Cereb Blood Flow Metab* 1995;15:1–11 CrossRef Medline
9. Gonzalez RG, Schaefer PW, Buonanno FS, et al. **Diffusion-weighted MR imaging: diagnostic accuracy in patients imaged within 6 hours of stroke symptom onset.** *Radiology* 1999;210:155–62 CrossRef Medline
10. Lansberg MG, Straka M, Kemp S, et al; DEFUSE 2 Study Investigators. **MRI profile and response to endovascular reperfusion after stroke (DEFUSE 2): a prospective cohort study.** *Lancet Neurol* 2012;11:860–67 CrossRef Medline
11. Zaharchuk G, El Mogy IS, Fischbein NJ, et al. **Comparison of arterial spin labeling and bolus perfusion-weighted imaging for detecting mismatch in acute stroke.** *Stroke* 2012;43:1843–48 CrossRef Medline

S.A. Amukotuwa
R. Bammer
Department of Diagnostic Imaging
Department of Radiology
Monash University, Melbourne, Australia

http://dx.doi.org/10.3174/ajnr.A7940