Simulation Education in Anesthesia Training: A Case Report of Successful Resuscitation of Bupivacaine-Induced Cardiac Arrest Linked to Recent Simulation Training

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Simulation training is rapidly becoming an integral element of the education curriculum of anesthesia residency programs. We report a case of successful resuscitation of bupivacaine-induced cardiac arrest treated with IV lipid emulsion by providers who had recently participated in simulation training involving a scenario nearly identical to this case. Upon debriefing, it was determined that the previous training influenced execution of the following steps: rapid problem recognition, prompt initiation of specific therapy in the setting of supportive advanced cardiac life support measures, and coordinated team efforts. Although the true cause of efficient resuscitation and ultimate recovery cannot be proven, the efficiency of the resuscitation process, including timely administration of lipid emulsion, is evidence that simulation may be useful for training providers to manage rare emergencies.

Several studies have shown improved performance in simulated crises after simulation training. However, evidence documenting the transfer of skills rehearsed during simulated emergencies into actual clinical decision-making is limited. In this report, we describe a case of successful resuscitation of bupivacaine-induced asystolic cardiac arrest treated with IV lipid emulsion. Two anesthesia providers involved in the resuscitation had recently completed simulation training involving the management of local anesthetic-induced cardiac toxicity.

CASE DESCRIPTION

An 83-yr-old, ASA 3, 75 kg man was scheduled for total knee arthroplasty under general anesthesia with preoperative continuous femoral and single-injection sciatic nerve blocks for postoperative pain management. After placement of standard monitors and patient positioning, the patient was sedated using fentanyl 50 μg and midazolam 2 mg. A subgluteal approach to the sciatic nerve was performed using a 4-inch Braun stimulating needle that was advanced until foot plantar flexion was obtained and titrated down to a current of 0.5 mA. An attending physician and CA-3 resident performed the block, and sciatic nerve stimulation was achieved on the first needle pass. After negative aspiration, a 5-mL test dose of bupivacaine 0.5% with epinephrine 1:400,000 was given with no adverse events. Bupivacaine 0.5% with epinephrine 1:400,000 and 100 μg clonidine was slowly and incrementally injected with repeat aspiration at 5-mL intervals. After 26 mL of local anesthetic injection, the patient abruptly lost consciousness and experienced a tonic-clonic seizure. The injection was stopped and the patient was immediately positioned supine and respirations were assisted with 100% oxygen by facemask ventilation. Midazolam 2 mg was given for treatment of the seizure. Upon termination of the seizure, the electrocardiogram showed asystole and the patient was determined to be pulseless (Fig. 1).

Chest compressions were performed by the nurse while the patient was tracheally intubated and ventilated by the attending anesthesiologist. At this point, an ad hoc resuscitation team assembled that consisted of the anesthesiology attending, CA-3 anesthesia resident, and sedation nurse, and two anesthesia fellows (provider 1 and 2) who were nearby at the time. Upon arriving at the scene, provider 1 assessed the etiology of the problem and retrieved a 250 mL (3 mL/kg) dose of 20% lipid emulsion, which he administered over approximately 2 min. After receiving the code cart, provider 2 applied the patches of a Zoll biphasic defibrillator and asked for brief chest compression cessation to assess the rhythm, which was asystole (Fig. 2).
Compressions were resumed, and epinephrine 1 mg and atropine 1 mg were immediately given with subsequent circulation by chest compression. Provider 2 reinspected the rhythm after 2 min, which revealed irregular, wide-complex tachycardia with palpable femoral pulse (Fig. 2). Provider 1 instituted an infusion of 20% lipid emulsion bolus after the initial bolus. The irregular, wide-complex tachycardia became regular within 2 min with palpable femoral pulse throughout. Regular, wide-complex tachycardia evolved into regular, narrow-complex tachycardia and eventually sinus rhythm (Fig. 2). No cardioversion was necessary. He was transferred to the intensive care unit in stable condition and within 90 min was awake and responsive. The patient underwent uneventful total knee arthroplasty 6 wk later.

As part of a multimodal approach to resident education at our institution, trainees undergo simulation-based training during their regional anesthesia rotation. Scenarios are designed to be as realistic...
as possible, and involve potential emergencies (high spinal, seizures, cardiotoxicity, etc.) associated with both single-injection and continuous regional anesthetic procedures. One scenario completed by the residents involved a patient who developed local anesthetic cardiac toxicity while loading bupivacaine through a peripheral nerve catheter. The patient lost consciousness, seized, and developed full cardiac arrest as the monitor displayed deterioration of the electrocardiogram and loss of arterial blood pressure and pulse oximetry. Trainees are expected to recognize the pattern, allocate roles, determine the etiology, and use standard advanced cardiac life support (ACLS) techniques as well as a 20% lipid emulsion (Intralipid™) in the simulated resuscitation. Providers 1 and 2 had undergone this simulation based exercise 8 weeks prior the described event.

**DISCUSSION**

Simulation education is increasingly used to provide realistic training opportunities for management of clinical situations. Through experiential learning, trainees can acquire skills used in the management of events rarely encountered in practice, such as local anesthetic-induced cardiac toxicity. Although these events seldom occur, appropriate therapy requires very specific interventions, a high degree of clinical proficiency, and a small margin for error. Advocates of simulation education for rare clinical situations refer to its use in personnel training for disaster medicine, chemical warfare casualties, and for infrequently encountered emergencies in neonatal and pediatric anesthesia. Evidence that simulation-based education allows trainees to transfer learned skills from rehearsal to reality is extremely difficult to acquire, especially in the case of rare emergencies. At present, the best data demonstrate only that measurement of simulation scenario performance is improved by simulation scenario training, a very surprising outcome. The translation of skills learned during simulation training to real clinical situations has not been well documented.

Local anesthetic-induced cardiac arrest is an example of a rare and potentially fatal complication of regional anesthesia. Lipid emulsion infusion has been demonstrated to be effective in reversing such cardiotoxicity in animal models and various mechanisms have been proposed. Recent case reports have reinforced the utility of lipid rescue from local anesthetic toxicity in humans, yet treatment regimens are not well-defined or readily accessible from standard medical and pharmacologic sources.

In an informal postresuscitation debriefing approximately 90 min after the described event, the providers discussed several notable aspects of the case and its management. The cardiovascular consequences and its etiology (local anesthetic toxicity) seemed familiar to providers 1 and 2, who quickly recognized the nature of the problem. Institution of lipid emulsion was initiated as treatment for bupivacaine-induced cardiac toxicity simultaneous with the administration of ACLS drugs. As rehearsed in the recent simulation, the providers were familiar with the dosing and administration of the lipid emulsion and recognized the importance of a large initial volume. Teamwork, with clear division of roles, facilitated smooth coordinated efforts. Examples of coordinated resuscitation efforts included: (1) the attending physician managed the airway while providers 1 and 2 worked from the right and left sides of the patient, (2) provider 1 initiated specific lipid therapy and administered ACLS drugs, and (3) provider 2 operated the Zoll defibrillator, assessed rhythms, and supervised blood gas analysis and the placement of additional vascular access and invasive monitoring.

Both providers, with simulation training in the management of local anesthetic toxicity, noted that their problem recognition and therapeutic approach was strongly influenced by their crisis resource management training. Specifically, the providers commented that their prior training facilitated prompt execution of the following steps: rapid problem recognition, initiation of specific therapy (lipid emulsion) in the setting of supportive ACLS measures, and coordinated team efforts. Both providers described their simulation training as directly contributing to their familiarity and confidence with an infrequently used treatment algorithm and their readiness to manage this potentially fatal regional anesthetic emergency. We cannot be certain that administration of lipid emulsion was responsible for the patient’s recovery, or that the team would not have considered administering lipid emulsion in the absence of a recent simulation experience. Nevertheless, the efficiency and coordinated efforts of providers involved with the resuscitation process, including the initiation of specific therapy, is evidence that simulation training may be helpful in the management of rare emergencies.

**REFERENCES**

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