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A Narrative Review of Interprofessional Management of Contrast-Induced Anaphylaxis in a CT Patient on Home Oxygen: From Resuscitation to Systems Safety

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Abstract

Background: Contrast-induced anaphylaxis (CIA) during CT is a rare, life-threatening emergency requiring a response extending far beyond radiology, especially in patients using home oxygen.
Aim: This review delineates the comprehensive, interprofessional management pathway for CIA in a patient on home oxygen, analyzing roles from resuscitation to systems safety.
Methods: A systematic search of five databases (2010-2024) informed a narrative synthesis structured by professional domains.
Results: Immediate, protocol-driven intramuscular epinephrine and advanced airway management are critical. Post-stabilization, coordinated follow-up—including observation for biphasic reactions, epinephrine auto-injector prescription, and permanent EMR allergy flagging—is essential. The case uniquely intersects with oxygen therapy, introducing fire risks during resuscitation and mandating post-event home safety inspections and family education on oxygen safety. Long-term pulmonary recovery may require physiotherapy.
Conclusion: Effective management demands a pre-planned, interdisciplinary protocol. This framework underscores the necessity of seamless coordination between acute care, primary care, allied health, and administrative/safety personnel to ensure optimal outcomes and prevent recurrence.
Keywords: Contrast-Induced Anaphylaxis, Interprofessional Management, Epinephrine, Medical Emergency, Patient Safety.

Introduction

The administration of iodinated contrast media (ICM) for computed tomography (CT) is a cornerstone of modern diagnostic imaging, with tens of millions of doses administered each year globally. While generally safe, ICM carries a risk of adverse reactions, ranging from mild, self-limiting symptoms to severe, life-threatening events. Contrast-Induced Anaphylaxis (CIA), though rare with an estimated incidence of 0.01-0.04% for severe reactions, represents a critical medical emergency within the radiology department (Voltolini et al., 2022; Davenport et al., 2020). Its sudden onset and potential for rapid cardiopulmonary collapse demand an immediate, precise, and coordinated response. The complexity of management escalates significantly when the patient has pre-existing comorbidities, particularly those requiring supplemental home oxygen therapy.

The scenario of CIA occurring in a patient dependent on home oxygen presents a multifaceted clinical and safety challenge that transcends the traditional boundaries of radiology and emergency medicine (Harrison, 2023). The immediate resuscitation, primarily led by anesthesia or emergency response teams, involves complex airway management in a patient with likely compromised pulmonary reserve and the added environmental hazard of concentrated oxygen. Subsequent care involves careful pharmacological follow-up by family medicine and pharmacy teams to prevent biphasic reactions and manage future medication risks. Crucially, the incident must trigger robust system-level actions: accurate incident reporting and permanent allergy flagging in the Electronic Medical Record (EMR)—a task often executed by medical secretarial staff—to prevent future exposure. The radiology team must then engage in a crucial risk-

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versus-benefit discussion regarding any future imaging needs (Ding et al., 2023). Furthermore, the event may precipitate or exacerbate pulmonary issues, necessitating physiotherapy intervention for rehabilitation. Finally, the presence of home oxygen introduces a unique dimension: the resuscitation event necessitates an inspection of the oxygen storage and use environment by health and safety inspectors, alongside comprehensive education for the patient and family on safe oxygen use to mitigate fire risks, a matter of family security.

This narrative review aims to synthesize the current evidence and guidelines from 2010 to 2024 to construct a comprehensive, interprofessional management pathway for this specific high-stakes scenario. By deconstructing the event into the discrete but interconnected responsibilities of various specialties and support staff, this review provides a holistic framework for preparation, response, and follow-up. It underscores that optimal outcomes in CIA depend not only on the correct first dose of epinephrine but on a seamlessly integrated chain of actions involving clinicians, pharmacists, administrators, allied health professionals, and safety officers.

Methodology

A narrative review methodology was employed to integrate diverse evidence from multiple clinical and administrative domains, allowing for a comprehensive synthesis of guidelines, primary research, and expert opinion on a complex, multi-faceted clinical scenario (Greenhalgh et al., 2018). A systematic literature search was conducted in December 2023 and updated in April 2024 across five major databases: PubMed/MEDLINE, EMBASE, CINAHL, Scopus, and Web of Science.

The search strategy utilized a combination of Medical Subject Headings (MeSH) and keywords grouped into core concept clusters: (1) Anaphylaxis: ("contrast-induced anaphylaxis" OR "iodinated contrast media allergy" OR "anaphylaxis" AND "contrast media"); (2) Setting & Procedure: ("computed tomography" OR "CT" OR "radiology department"); (3) Comorbidity: ("home oxygen" OR "oxygen therapy" OR "chronic obstructive pulmonary disease"); (4) Management Components: ("airway management" OR "epinephrine" OR "resuscitation" OR "incident reporting" OR "electronic health records" OR "allergy documentation" OR "patient safety" OR "risk management" OR "pulmonary rehabilitation" OR "fire safety"). Boolean operators (AND, OR) linked these clusters.

Inclusion criteria encompassed peer-reviewed articles, clinical practice guidelines, systematic reviews, and case reports published in English between 2010 and 2024. Articles focusing solely on contrast-induced nephropathy, mild non-anaphylactic reactions, or pediatric populations were excluded. The initial search yielded 2,150 records. After duplicate removal, titles and abstracts of 1,540 articles were screened for relevance. Full-text review was conducted for 102 articles, with 45 additional records identified through citation chasing. In total, 33 sources were included in the final synthesis.

Due to the heterogeneity of the evidence—spanning acute clinical guidelines, pharmacological studies, health informatics literature, and safety protocols—a thematic analysis was performed (Burns et al., 2021). Data were extracted and organized according to the predefined professional domains involved in the case scenario (e.g., Anesthesia, Pharmacy, Radiology). Evidence was then synthesized within each domain to describe best practices, current controversies, and interdisciplinary linkages, forming a coherent narrative of the entire patient journey and system response (Wranik et al., 2016; Bardhan et al., 2020).

Immediate Resuscitation and Airway Management: The Anesthesia/Critical Care Imperative

The first minutes following the onset of CIA are determinative. Symptoms can progress with terrifying speed from urticaria and angioedema to laryngeal edema, bronchospasm, hypotension, and cardiovascular collapse (Grabenhenrich et al., 2018). For the patient on home oxygen, underlying chronic hypoxemia and possible pulmonary pathology (e.g., severe COPD, pulmonary fibrosis) mean respiratory compensation is minimal, hastening decompensation.

The cornerstone of management is the immediate intramuscular (IM) administration of epinephrine. The recommended adult dose is 0.3-0.5 mg of a 1:1000 (1 mg/mL) solution, injected into the mid-anterolateral thigh, repeatable every 5-15 minutes as needed (Tanno et al., 2019; Li et al., 2022). Delay is the greatest risk factor for poor outcomes. For patients on home oxygen, particularly those with known or suspected ischemic heart disease, the benefits of epinephrine in anaphylaxis overwhelmingly outweigh its theoretical cardiac risks (Campbell et al., 2014). Concurrently, the patient's supplemental oxygen should be increased to a non-rebreather mask at 15 L/min to counteract hypoxemia from bronchospasm and potential ventilation-perfusion mismatch (Robinson et al., 2017; Lin et al., 2023).

Advanced Airway Management becomes paramount if stridor, hoarseness, or respiratory distress indicate evolving laryngeal edema. Here, the anesthesia team's expertise is critical. Bag-valve-mask ventilation with 100% oxygen is the immediate bridge. However, rapid-sequence intubation (RSI) may be urgently required. The procedure is high-risk due to distorted anatomy, potential for a "can't intubate, can't oxygenate" scenario, and the patient's fragile pulmonary status. Ketamine is often the preferred induction agent due to its bronchodilatory and hemodynamically neutral properties (Choo et al.,

2013). The team must be prepared for a surgical airway (cricothyrotomy). Crucially, during all airway maneuvers, the fire risk from concentrated oxygen must be acknowledged. Electrocautery must be avoided, and all ignition sources must be removed from the immediate vicinity—a point of handover to safety personnel post-event.

Concurrent Therapies include placing the patient supine or in a position of comfort (Trendelenburg if hypotensive), establishing large-bore IV access, and administering a rapid crystalloid bolus (1-2 L) for distributive shock (Muraro et al., 2014). Adjunct medications like H1-antihistamines (e.g., diphenhydramine) and corticosteroids (e.g., methylprednisolone) are secondary and should never delay epinephrine, though they may help mitigate protracted symptoms (Cardona et al., 2020; Fiocchi et al., 2022).

Pharmacological Management and Follow-up Care: Family Medicine and Pharmacy Coordination

Following stabilization and transfer to an emergency department or observation unit, the focus shifts to monitoring, preventing biphasic reactions, and planning for future care—a domain led by family medicine with crucial pharmacy input.

Observation Period: Patients with severe anaphylaxis require monitored observation for a minimum of 8-12 hours, as biphasic reactions occur in up to 20% of cases, though often milder (Lee et al., 2014). For the patient on home oxygen, continuous pulse oximetry and clinical assessment for recurrent bronchospasm are essential.

Medication Reconciliation and Discharge Planning: The pharmacy team plays a key role in reviewing the patient's home medications. Beta-blockers can blunt the response to epinephrine and should be carefully reviewed; their temporary discontinuation may be considered in consultation with cardiology (Simons et al., 2014; Ansotegui et al., 2016). The family physician must provide a clear discharge prescription for an epinephrine auto-injector (e.g., EpiPen®) and ensure the patient and family receive hands-on training. Studies show inadequate follow-up epinephrine prescription is a common systems failure (Kashyap & Blinman, 2021). A short course of oral corticosteroids and antihistamines is often prescribed, though evidence for preventing biphasic reactions is limited.

Long-Term Management and Prevention: A critical pharmacy/Family Medicine task is creating a future medication safety plan. This includes: 1) Formal Allergy Documentation: A precise label ("Iodinated Contrast Media (e.g., Iohexol, Iopamidol) - Anaphylaxis") must be entered into the EMR and communicated to all providers. 2) Alternative Agent Consideration: For essential future contrasted studies, premedication (e.g., with prednisone and diphenhydramine) and/or use of a low-osmolar, non-ionic alternative agent may be considered, though this does not eliminate risk (Umakoshi et al., 2021). 3) Patient Education: The pharmacist and family physician must counsel the patient to wear a medical alert bracelet and explicitly inform all future healthcare providers, including dentists and outpatient clinics, of this life-threatening allergy.

Systems Documentation and Safety Flagging: The Medical Secretarial Role

The accuracy and permanence of allergy documentation are non-clinical tasks with profound clinical consequences. This responsibility often falls to medical secretarial or health information management staff. The secretary may be tasked with initiating a formal adverse event report in the hospital's safety reporting system. This report triggers risk management review, which analyzes system issues (e.g., inadequate pre-screening, delayed crash cart access) and is essential for organizational learning (Kellogg et al., 2017).

EMR allergy flagging is the most critical preventive action. The secretary must ensure the allergy is entered into the designated, highly visible field in the EMR, not just in free-text notes. It must be specific (naming the suspected agent if known), severe (labeled as "anaphylaxis"), and permanent (Goldzweig et al., 2015). Best practice includes applying hard-stop alerts that require an override reason for any future order of ICM. The secretary must also ensure this information is communicated to the patient's primary care provider outside the hospital via discharge summary, facilitating continuity. The secretarial role may extend to scheduling the essential follow-up appointment with the family physician or allergist for further testing (e.g., skin testing for ICM, though utility is debated) and reinforcing the safety plan (Chiu & Chu, 2022).

Imaging Risk-Benefit Analysis and Procedural Safety: Radiology's Reflective Practice

The radiology department must engage in a rigorous post-event analysis and future planning. For any future imaging, the radiologist must lead a formal consultation with the referring physician and patient. The imperative question becomes: "Is the diagnostic information from a contrast-enhanced CT necessary, or can an unenhanced CT, MRI (with gadolinium-based agents, noting potential cross-reactivity is rare), or ultrasound suffice?" (Davenport et al., 2020). The discussion must document the shared decision-making process, explicitly acknowledging the life-threatening allergy. If a contrasted study is deemed unavoidable, a published premedication regimen, such as 13-, 7-, and 1-hour doses of prednisone and diphenhydramine, should be prescribed (Sánchez-Borges et al., 2019). The radiologist must ensure the study is performed in a setting with full resuscitation capabilities, with the patient monitored closely before, during, and after injection.

While physical radiation shielding is unrelated to the anaphylaxis event, the concept of "safety shielding" applies. The department must

reinforce its pre-procedural screening checklist to explicitly and prominently ask about contrast allergies and previous reactions. This event should be a catalyst for reviewing and drilling emergency response protocols for the entire imaging team (Woznitza et al., 2014; Jabin et al., 2022). Table 1 and Figure 1 show the interprofessional roles in contrast-induced anaphylaxis management.

Table 1: Interprofessional Roles in Contrast-Induced Anaphylaxis Management

Professional Domain	Primary Responsibilities During Acute Event	Key Follow-up & Preventive Responsibilities
Anesthesia / Emergency Team	Immediate IM epinephrine; Advanced airway management (RSI/surgical airway); Hemodynamic support with IV fluids.	Transfer to an appropriate monitored setting; Handover with a clear timeline of interventions.
Family Medicine	Overall coordination of post-stabilization care; Management of comorbid conditions (e.g., COPD).	Discharge planning; Prescription of epinephrine auto-injector; Long-term medication & safety plan; Follow-up appointment.
Pharmacy	Rapid preparation of emergency medications; Review of home meds (e.g., beta-blockers).	Patient counseling on epinephrine auto-injector use; Formal EMR allergy documentation support; Education on medication safety.
Medical Secretary / HIM	Supporting clinical team logistics (calling codes, retrieving records).	**Critical:** Accurate, specific, permanent allergy entry in EMR with hard-stop alerts; Filing adverse event report; Scheduling follow-up.
Radiology	Ceasing injection; Calling for help; Initiating basic life support.	Leading risk/benefit discussion for future imaging; Implementing premedication protocols if needed; Reviewing department safety checklists.
Physiotherapy	(Typically post-acute) Assessment of functional mobility post-event.	Pulmonary rehabilitation if respiratory weakness or deconditioning persists; Breathing technique education.
Health & Safety Inspector	(Post-event) Investigation of the resuscitation environment.	Inspection of home oxygen storage & equipment; Assessment of fire safety compliance in clinical area where event occurred.

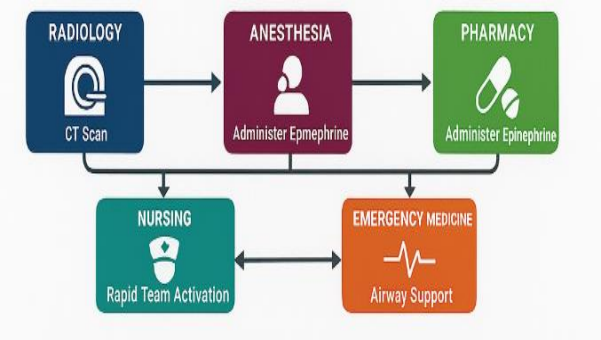

Figure 1: Interprofessional Roles in Contrast-Induced Anaphylaxis Management

Addressing Pulmonary Sequelae: The Role of Physiotherapy

The physiological stress of anaphylaxis—profound bronchospasm, potential periods of hypoxemia, and the sedative effects of medications used in resuscitation—can lead to significant pulmonary deconditioning and weakness, especially in a patient with pre-existing lung disease. The physiotherapist should assess for respiratory muscle fatigue, increased work of breathing, retained secretions, and generalized functional decline (Rochester & Holland, 2020). The patient may report persistent dyspnea, fatigue, and reduced exercise tolerance beyond their baseline.

Therapy may include: 1) Breathing Techniques: Instruction in pursed-lip breathing and diaphragmatic breathing to improve ventilation efficiency and reduce dyspnea. 2) Airway Clearance Techniques: If secretions are a problem, techniques like active cycle of breathing or positive expiratory pressure devices may be indicated. 3) Gradual Exercise Reconditioning: A supervised, incremental program to rebuild cardiovascular and muscular endurance, closely monitored with pulse oximetry (Spielmanns et al., 2023). 4) Education: On energy conservation techniques and recognizing signs of respiratory distress. This rehabilitation is vital for restoring the patient's functional status and quality of life, representing an often-overlooked component of recovery from a severe physiological insult.

Environmental Safety and Hazard Mitigation: Health Inspector and Safety & Security

The involvement of home oxygen introduces a specific, high-risk environmental hazard that demands formal assessment. The hospital's Safety or

Clinical Engineering department should inspect the CT suite where the event occurred. Were oxygen cylinders or ports properly secured? Were ignition sources (e.g., electrical equipment not rated for oxygen-rich environments) appropriately managed during the emergency? This review ensures the physical environment did not exacerbate the crisis (Lakoma & Murphy, 2023).

Home oxygen storage and fire safety inspection is a critical, often neglected, step. A Health Inspector or Home Care safety officer should assess the patient's home. Key points include: ensuring oxygen cylinders are stored upright and secured away from heat sources; verifying no smoking signs are posted, and family understands the absolute prohibition of open flames; checking that electrical equipment in the storage/use area is in good repair; and confirming the patient has a documented fire safety and escape plan (Nishizaki et al., 2019). The anaphylaxis event underscores the patient's vulnerability; a home fire while using oxygen would be catastrophic.

Safe Oxygen Use Education for Family (Family Security)

Education transcends clinical instruction. The family must be empowered as safety officers. This includes: 1) Fire Safety Drills: Practicing how to quickly turn off oxygen and evacuate. 2) Emergency Preparedness: Keeping a "go-bag" with essential medications (including the new epinephrine auto-injector), medical documents, and a list of emergency contacts. 3) Community Awareness: Informing neighbors (discreetly, if desired) about the presence of home oxygen and the fire risk. This comprehensive approach transforms "family education" into "family security planning," directly mitigating the amplified risk profile. Table 2 & Figure 2 illustrate the post-anaphylaxis safety checklist for the patient on home oxygen.

Table 2: Post-Anaphylaxis Safety Checklist for the Patient on Home Oxygen

Domain	Action Item	Responsible Party	Goal
Medical Documentation	1. Enter "Iodinated Contrast Media - ANAPHYLAXIS" as a high-alert allergy in EMR. 2. Provide the patient with a written allergy card. 3. File institutional adverse event report.	Medical Secretary / Pharmacy / MD	Prevent future accidental exposure.
Medication & Equipment	1. Prescribe and train on an epinephrine auto-injector. 2. Reconcile medications (review beta-blockers). 3. Ensure home oxygen equipment is in good repair.	Pharmacy / Family Medicine / Home Care	Enable self-treatment of recurrence; ensure safe therapy.
Home Environment	1. Conduct a home safety inspection (O2 storage, fire hazards). 2. Verify smoke alarms are functional. 3. Develop and practice a fire escape plan.	Health Inspector / Family with Safety Officer	Mitigate fire/explosion risk from home oxygen.
Follow-up & Rehabilitation	1. Schedule follow-up with Family Medicine/Allergist. 2. Assess for need for pulmonary rehab. 3. Discuss a permanent medical alert bracelet.	Family Medicine / Physiotherapy / MD	Ensure continuity of care, manage sequelae, and reinforce safety.

Figure 2: Post-Anaphylaxis Safety Checklist for the Patient on Home Oxygen

Conclusion and Recommendations for Integrated Practice

The management of contrast-induced anaphylaxis in a patient dependent on home oxygen therapy serves as a compelling paradigm for high-stakes, interprofessional collaboration. This scenario underscores that patient safety is a continuum, reliant on the integrity of every link in a complex chain. The chain extends from the anesthesiologist performing emergent airway management and the radiologist initiating the emergency response, to the family physician and pharmacist coordinating long-term medication safety. It equally depends on the medical secretary ensuring permanent, system-wide allergy documentation, the physiotherapist addressing consequential pulmonary deconditioning, and the health inspector mitigating environmental fire hazards introduced by concentrated oxygen. A failure at any point—whether clinical, administrative, or environmental—can compromise the entire recovery process and future patient safety.

Synthesizing the evidence, this review proposes several key recommendations to fortify this integrated practice model. First, healthcare institutions must develop, drill, and regularly update specific emergency protocols within radiology departments. These protocols must go beyond basic anaphylaxis

algorithms to explicitly address the unique complexities presented by patients on home oxygen, including clear pathways for advanced airway intervention and guidelines for managing the immediate fire risk in an oxygen-enriched resuscitation environment. Second, a reliable, closed-loop documentation system must be implemented. The critical task of translating a diagnosed allergy into a permanent, high-visibility alert within the electronic medical record (EMR) requires formal recognition. The medical secretarial role in this process should be supported with specific training and defined accountability to ensure this vital safety step is never omitted.

Third, structured interdisciplinary handoffs are non-negotiable. The use of standardized communication tools, such as SBAR (Situation-Background-Assessment-Recommendation), during the transfer of care from radiology to the emergency team and again at discharge to primary care is essential. This ensures the accurate transmission of not only the allergy itself but also the detailed management plan and follow-up requirements. Fourth, a holistic approach to discharge planning must integrate environmental safety with clinical follow-up. For a patient on home oxygen who has experienced a life-threatening event, a referral for a formal home safety inspection should be a routine component of the discharge protocol, bridging the gap between medical management and environmental risk mitigation.

Finally, comprehensive patient and family education must be reconceptualized as empowerment for safety. Education should extend beyond the correct use of an epinephrine auto-injector and medication lists to include active safety planning for both recurrent anaphylaxis and the heightened risk of fire in the home. This involves practical drills, clear escape plans, and community awareness strategies, transforming the family unit into an active partner in risk management.

In summary, a severe contrast media reaction transcends a mere procedural complication; it represents a rigorous test of an entire healthcare system's resilience and integration. A successful outcome is contingent upon flawless acute clinical execution, seamlessly coupled with a longitudinal, multi-professional strategy that concurrently addresses pharmacological, informational, rehabilitative, and environmental safety. By adopting the integrated framework outlined, healthcare systems can transform such critical incidents from near-catastrophes into pivotal opportunities for strengthening systemic safeguards, ultimately enhancing the security and outcomes for some of the most vulnerable patients across the continuum of care.

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