

# Rethinking iodine contrast use: A stewardship maturity model

## The case for iodine stewardship

Iodinated contrast media (ICM) is foundational to modern diagnostic imaging, enabling fast, accurate clinical decision-making across emergency, oncologic, cardiovascular, and routine care settings.<sup>1</sup>

Imaging volumes have continued to rise,<sup>2,3</sup> and health systems' reliance on ICM — and iodine, its active ingredient — has intensified. At the same time, ICM production is dependent on complex supply chains and a finite geographic supply of iodine. Recent ICM shortages have put a spotlight on these vulnerabilities, forcing imaging and interventional departments to implement reactive conservation measures, alter protocols, and delay or redirect patient care.<sup>4</sup>

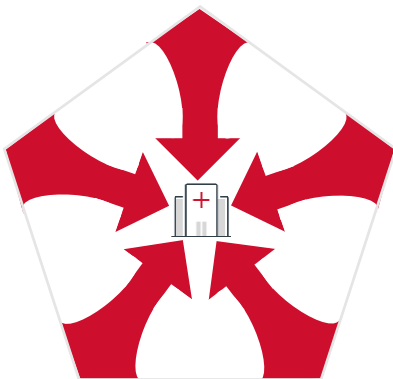
On top of these pressures, ICM inefficiency leads to broad, long-term environmental effects, such as groundwater contamination,<sup>2</sup> increased carbon emissions,<sup>5</sup> and increased packaging waste<sup>5</sup> — all of which can affect health system sustainability and environmental, social, and governance (ESG) targets.

## Health systems have a role in stewardship

Health systems can't easily expand ICM supply or reduce imaging demand, but they can determine ways to use every milliliter (mL) of contrast efficiently.

Iodine stewardship is the intentional management of ICM to reduce avoidable waste and preserve supply. Done well, stewardship improves supply resilience, lowers costs, eases operational strain on imaging teams that are already stretched thin, reduces environmental impact, and protects patient access to contrast-enhanced imaging.

## 5 converging pressures affect ICM use in health systems



1. Iodine is a finite resource extracted from limited geographic regions worldwide.
2. The ICM supply chain is complex, concentrated, and vulnerable when demand consistently outstrips capacity.
3. Demand for CT imaging has accelerated,<sup>2,3</sup> straining staff already at capacity and escalating pressure on contrast production that can't easily scale to match.
4. Unnecessary and inefficient contrast use increases volumes and adds procedural complexity, further burdening staff.<sup>6</sup>
5. Imaging staffing shortages, extended turnaround times at high-volume centers, and backlogs already delay vital care.<sup>6</sup>

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Recent shortages have demonstrated that health systems can embrace iodine stewardship by adjusting imaging protocols, reducing ICM-related waste, and coordinating across departments and functions.<sup>7</sup> Many health systems continued at least some ICM conservation strategies outside of periods of shortage, while others reverted to pre-shortage practices.<sup>7</sup> But institutions that reduced contrast volumes during a crisis demonstrated that meaningful dose reduction is clinically viable, rather than a compromise.

Good stewardship doesn't ration or sacrifice diagnostic quality. Health systems, imaging leaders, clinicians, other interventional specialists, and manufacturers share a responsibility to design iodine stewardship solutions from the system level — moving from reactive rationing toward ongoing stewardship practices that improve resilience, efficiency, and care delivery over time.

This guide details a five-level maturity model for health systems to evaluate their own iodine and ICM stewardship practices. To use this guide, leaders should:

1. Identify the highest maturity level where their organization has demonstrated systemic, repeatable capabilities (excluding pilot efforts).
2. Use the readiness criteria to determine what is required to advance to the next level.
3. Determine achievable next steps for your organization.

Resource stewardship includes all resources: human capital, environmental resources, money, infrastructure, time — all of these things play into the calculation of value.

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## Maturity model: 5 levels of iodine stewardship

1

**Reactive management.** No standing iodine stewardship program. Fixed-dose protocols that are rarely revisited.

2

**Reducing waste within current protocols.** Targeted contrast waste reduction within existing workflows. Imaging ordering process remains unchanged.

3

**Standardized protocols and workflow stability.** Iodine stewardship is embedded in operations, training, and quality audits.

4

**Upstream ordering reform.** Collaboration with clinicians to reduce unnecessary imaging referrals.

5

**Proactive, systemic stewardship.** Stewardship is an organizational priority with executive ownership, metrics, governance, and regular reporting.

## Level 1: Reactive management

### What it looks like

Health systems in Level 1 have no standing iodine stewardship program. Contrast use is determined by fixed-dose protocols that are rarely revisited, and ICM waste is not measured. When a shortage or supply disruption occurs, the health system responds with emergency conservation measures — such as contrast rationing, protocol changes, and imaging delays — then returns to prior practices once supply normalizes. Efficiency gains made during the disruption are not retained.

Historically, stewardship hasn't been a priority for the healthcare industry, so many health systems didn't have the infrastructure or incentives to support it. Level 1 is the natural starting point for organizations being asked to think differently, often for the first time, about ICM as a resource.

### Why this matters

- Organizations operating at Level 1 are more vulnerable to impacts from supply disruption. Emergency rationing without preparation compromises care quality, creates workflow chaos, and forces clinical decisions under duress rather than best-practice protocols. Even without a shock event, structural demand growth creates a slow-burn version of the same pressures.
- Significant contrast waste — and its associated cost, environmental burden, and supply pressure — continues unchecked every day.
- Fixed-dose protocols developed for average patients result in systematic overdosing for smaller patients and may underdose larger patients, creating both quality and safety risks.

### Steps to advance

1. **Audit current contrast use and waste**, including mapping administered doses against patient weight distributions. Review protocols for the highest-volume ICM-enhanced imaging.<sup>8</sup>
2. **Identify what worked during previous shortages or conservation efforts** and build on those efforts. Talk to radiologists, cardiologists, technologists, and ordering clinicians to learn which adjustments were clinically feasible, created heightened administrative or workforce burden, or were continued after the shortage.
3. **Build a basic business case for conservation efforts** by connecting ICM stewardship back to your institution's priorities (such as supply resilience, cost reduction, patient access, quality care, or sustainability targets). Frame ICM as a strategic resource, rather than a commodity.
4. **Identify a stewardship champion** within imaging and/or the supply chain team. Stewardship efforts without named ownership rarely survive the next operational surge.
5. **To start, choose one Level 2 strategy** to build into your ongoing operations.

### Readiness to move to the next level

Organizations are ready to move to Level 2 once they are able to invest the resources to build efficiency and quality improvements and move away from ad hoc or reactive responses.

## Level 2: Reducing waste within current protocols

### What it looks like

Level 2 organizations have implemented targeted practices to reduce contrast waste within existing radiology, cardiology and catheterization lab, and interventional imaging workflows. Upstream clinical pathways that direct how and whether imaging is ordered have not yet changed. Instead, the focus is on smarter ICM use once an order is placed, including efficient dosing, packaging, delivery, and use of available scanner technology.

### Steps to reach Level 2

- 1. Replace fixed-volume protocols with weight-based dosing** for high-volume CT exams where appropriate. Weight-based dosing is low-cost and conserves contrast while maintaining diagnostic quality.<sup>9,10</sup> In addition, keeping contrast exposure at the lowest levels possible protects more patients from kidney risk.
- 2. Select the smallest single-use vial that meets the required dose.** Where clinically appropriate, implement use of bulk, multi-dose vial formats. Multi-dose formats developed in alignment with FDA multi-dose safety standards reduce per-exam packaging waste, disposal costs, and contrast discard.<sup>5</sup> Assess end-of-day and overnight waste to determine whether mixed vial sizes or smarter bulk use are warranted.
- 3. Address over-ordering and inefficient shipping.** Work with supply chain and procurement partners to consolidate ordering and align delivery to actual ICM usage. Larger health systems with storage capacity may explore centralized distribution models with suppliers and third-party logistics providers to maintain stock buffers and prevent supply disruptions. Organizing ICM storage to prioritize the use of vials nearing their expiration date is a no-cost, immediate option for procurement and technologist teams.
- 4. Optimize protocols with advanced CT technology** (such as dual-energy, spectral, and photon-counting CT) where available. Dual-energy or spectral CT can reduce dosage in selected applications, and photon-counting CT supports dosage reductions without sacrificing image quality. That said, departments without those technologies can reduce contrast volumes using a lower kilovoltage peak (kVp) on conventional scanners.
- 5. Engage contrast media industry partners as a practical resource.** Leverage vendor clinical applications support, bulk packaging options, reimbursement guidance, and educational optimization resources to accelerate the work you're already doing at this level.

### Why these changes matter

- These stewardship actions offer the highest leverage with the least regulatory complexity.
- Health systems can usually implement Level 2 changes within existing clinical pathways, so they are less disruptive than upstream ordering reform. Level 2 changes build institutional capability to tackle deeper systemic change at later levels.
- A large percentage of contrast media is excreted unmetabolized,<sup>11</sup> and every mL conserved at the point of care reduces environmental contamination downstream.

### Readiness to move to the next level

Organizations are ready to move to Level 3 when these practices become standardized within clinical pathways, including protocols and training, rather than high-level ideas used inconsistently.

## Level 3: Standardized protocols and workflow stability

### What it looks like

At Level 3, iodine stewardship practices are no longer individual choices made by some staff, on some shifts, or at some sites. Instead, these practices are embedded in imaging and interventional departments' standard operating procedures, protocol documentation, training, onboarding, and quality audits. Stewardship survives turnover, volume surges, and supply fluctuation because it is institutional infrastructure rather than individual habit.

### Steps to reach Level 3

1. **Identify areas of persistent variation in ICM use** across technologists, scanners, shifts, or locations, and prioritize these outliers for standardization.
2. **Formalize workflows within imaging and interventional departments** through protocol documentation, training and onboarding materials, and quality or operational audits.
3. **Monitor waste rates and workflow performance** during routine operations and periods of stress to ensure stewardship practices remain stable.

### Why these changes matter

- Imaging volumes are projected to outpace workforce growth, exacerbating the impacts of workforce shortages. Eliminating unnecessary variability helps clinical staff who make stewardship possible by lightening their cognitive load, supporting their ability to focus on patients rather than variation management.<sup>6</sup>
- Crisis resilience depends on standardized infrastructure, because practices that exist only in the knowledge of specific individuals are fragile.

### Readiness to move to the next level

At organizations ready to move to Level 4, standardized workflows have been achieved within imaging departments, and the organization is prepared to shift focus from how contrast is used to whether and how imaging is ordered.

## Level 4: Upstream ordering reform

### What it looks like

Organizations at Level 4 shift their stewardship focus upstream from imaging and interventional departments to where imaging is ordered. Rather than optimizing how contrast is used during scans, these organizations ensure that only necessary imaging is ordered in the first place, reducing unnecessary contrast-enhanced studies before a vial is even opened.

### Steps to reach Level 4

1. **Build or enhance clinical decision support (CDS) tools** that help clinicians choose the most appropriate modality when they refer a patient for imaging.
2. **Codesign guidance with radiologists and referring clinicians** to prevent unnecessary imaging orders (rather than cancelling them after the fact) and ensure clinical credibility.
3. **Continuously check imaging orders to ensure appropriateness.** Create stopgaps to ensure that patients scanned once for an issue are not given repeat imaging due to lack of system integration.
4. **Consider alternative modalities** — such as contrast-enhanced ultrasound, gadolinium-based MRI, or barium-based oral contrast — to reduce ICM use in specific clinical scenarios. These are not substitutes for contrast-enhanced CT where it is the right tool, but equivalent or superior choices in a defined set of situations that often default to ICM-based CT out of habit or convenience.

### Why these changes matter

- Low-value imaging carries real costs, such as higher contrast usage, more patient exposure to radiation, and environmental impacts.<sup>12</sup> This is also relevant to radiology and cath lab workflows, where ordering pathways and appropriateness criteria vary.
- No amount of vial optimization or weight-based dosing eliminates the contrast consumed by a scan that shouldn't have been ordered. While Levels 2 and 3 reduce waste within necessary imaging, Level 4 eliminates unnecessary imaging at its source.
- Reducing low-value imaging can preserve imaging department capacity, so the most acute and high-priority cases are addressed more efficiently and workforce strain is alleviated.<sup>6</sup>
- Reducing unnecessary imaging lowers the total cost of care,<sup>12</sup> which is particularly beneficial for health systems operating with value-based contracts.

### Readiness to move to the next level

At organizations ready to move to Level 5, guidelines for whether imaging is appropriate for specific cases have become part of systemwide stewardship. The health system wants to create efforts and/or expand their leadership in the space.

## Level 5: Proactive, systemic stewardship

### What it looks like

At Level 5 organizations, iodine stewardship is a named organizational priority with executive ownership, defined metrics, cross-functional governance, and regular reporting. It is integrated into existing quality, sustainability, and operational performance structures rather than operating as a parallel program. The organization monitors its stewardship performance the same way it monitors patient safety or financial performance: as a leadership accountability.

Level 5 organizations recognize that iodine stewardship is a collective challenge. They share what they have learned with peer institutions, professional societies, and industry partners. They advocate for policies and standards that support stewardship across the health system as a whole. They understand that iodine supply is a shared global resource, and that their conservation practices make more contrast available to other patients and institutions including those with fewer resources or greater vulnerability to supply disruption.

### Steps to reach Level 5

1. **Assign clear accountability for iodine stewardship at a leadership level**, ideally with a joint imaging-supply chain ownership structure. Integrate stewardship metrics into existing executive and quality governance forums. Do not create a parallel structure that risks being deprioritized when other pressures mount.
2. **Track a small, meaningful set of indicators**, such as contrast utilization trends by volume and per patient, waste rates, dosing protocol compliance, imaging appropriateness rates, environmental performance against sustainability targets, and workforce indicators. Publish these alongside other operational key performance indicators. Where possible, integrate contrast utilization into sustainability reporting and supply chain dashboards. Metrics that live only in imaging departments are less likely to sustain durable change.
3. **Deepen industry partner relationships**. Leading manufacturers carry their own stewardship obligations: Iodine reclamation at the production level, contrast container and packaging innovation, and production capacity transparency are the industry-side counterparts to what health systems are doing internally. Engage manufacturers as codevelopers of stewardship benchmarks and advocates for systemic change.
4. **Share stewardship practices and outcomes with professional societies**, peer institutions, and policy bodies. Standardized benchmarks for contrast utilization, waste rates, and environmental impact do not yet exist at the national level, and Level 5 organizations are well-positioned to help develop benchmarks through exactly these channels, filling a gap that currently limits sector-wide progress.

### Why these changes matter

- Treating iodine stewardship as a strategic priority enables health systems to balance access, quality, cost, and environmental responsibility in the long term.
- Systemic stewardship supports organizational resilience in the face of future disruptions.
- Becoming a leader in iodine stewardship can positively influence a health system's reputation.

## Final thoughts: Taking the next step

ICM availability is tightly coupled to both global supply chains and day-to-day clinical operations. Health systems have learned that ICM use is not only an imaging issue, it's an issue shaped upstream by ordering behavior, protocols, workflows, and governance decisions spanning clinical, operational, and executive teams.

This maturity model is designed to help achieve sustained progress. Rather than attempting to overhaul all processes at once, it encourages deliberate, stepwise improvement grounded in a practical path forward. To begin, organizations should evaluate where they are today, then select one concrete action that helps advance them toward the next level. In doing so, organizations can move beyond reactive management and build momentum toward iodine stewardship.



### Monitoring technologies on the horizon

Emerging technologies may reshape stewardship options in the future. AI-based synthetic or virtual contrast tools, which aim to generate contrast-like images from non-contrast scans, are experimental and not currently approved for or deployed routinely in clinical settings. These tools require further technical development, clinical validation across the range of relevant exam types, and regulatory review before broader adoption.<sup>13</sup> Other areas of emerging interest include biodegradable contrast alternatives and novel imaging agents.<sup>14,15</sup> Organizations that track emergent technologies will be positioned to evaluate and integrate such tools systematically, if and when they achieve regulatory clearance.



### Future iodine recycling programs

Industry stakeholders are exploring efforts to recover contrast media after patient administration through take-back collection programs or point-of-collection catchment approaches at the toilet. These programs exist across various countries at varying stages of development, but they aren't currently viable at scale because they involve significant logistical and regulatory complexity.

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## Endnotes

1. Unless otherwise noted, this maturity model was developed from Advisory Board interviews with clinical and operations experts in imaging and contrast dye use.
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