

# Ethnographic Research of IV Contrast Agent in Hospital CT Scanning Suites

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## EXECUTIVE SUMMARY

- This article focuses on qualitative observational research conducted at nine hospital CT scanning suites using IV contrast agent either in pre-filled syringes (with or without radio frequency identification [RFID]) or in bulk packaging (non-pre-filled syringe).
- The safe and compliant administration of IV contrast agents in CT imaging suites can be accomplished without compromising efficient patient flow. Preventing infection, air embolism, iodine allergic reactions, and extravasations are of prime importance and may be amenable to a technologist best practices approach.
- The use of contrast in pre-filled syringes with RFID technology facilitates adherence to Joint Commission requirements and provides reliable administration and procedural documentation of IV contrast use.
- The application of ethnography in mapping administration of IV contrast agents can provide an illustrative tool to aid in identifying specific areas in need of optimization.

**Hospital computed** tomography (CT) scanning suites are facing multiple challenges and are constantly seeking ways to optimize their processes and improve their financial situations.<sup>1</sup> These challenges range from providing quality diagnostic imaging to ever increasing numbers of patients given finite schedules to adherence with the latest hospital accreditation guidance (see Box 1). The need to avoid and/or reduce the incidence of infectious disease transmission between both patient and healthcare professional is always “top of mind.” Helpful guidelines from the Centers of Disease Control (CDC) and The Joint Commission target methods to mitigate “healthcare associated infections” (HAIs).<sup>2-4</sup> Additionally, the need to eliminate medication error is constant. Though medication error incidence is low in CT suites, occurrences are reportedly more severe as 9 of the top 25 drugs involved in medication errors were contrast agents.<sup>4</sup>

Intravenous (IV) contrast agents can therefore impact CT suite operation and performance. Previous market research involving contrast media has reported upon technologist preferences and trends which manufacturers have used in designing improved methods of contrast packaging and delivery.<sup>1,4</sup> Additional information is needed to align these trends and CT suites need to help guide future product

development. Therefore, ethnographic research (clinical observations) was conducted of the current patient and technologist flow process in hospital CT imaging suites to qualify recent improvements.

Ethnography is a research methodology that consists of observing the practices and behaviors of individuals in their natural environments.<sup>5</sup> Qualitative in its approach, it is able to provide deep insights into a real world setting by observing what “people do” versus what they may “say they do” as captured in surveys or interviews.<sup>6</sup> Ethnography is a valuable tool which allows for the identification of opportunities beyond that of market research, to help provide a road map for process improvement when employed appropriately.

## Methodology

A convenience sampling approach was undertaken and observations were conducted in nine hospital CT departments distributed in seven states across the United States including California, Florida, New Jersey, New York, South Carolina, Texas, and Washington from September 1 through October 15, 2009. The settings for the observations were<sup>7</sup>:

■ **BOX 1. Multiple Challenges Faced by Hospital CT Scanning Suites<sup>1-4</sup>**

- Stress to safely process large number of patients within a tight schedule
- Time-consuming processes which create inefficiencies in many hospital units, for example:
  - Effort to coordinate multiple services and disciplines (eg, patient transport, patient screening process, timing of laboratory results)
  - Cancellation and/or rescheduling of exams
  - Procedural documentation
- Critical need for precise administration of IV contrast agent
- Need to prevent extravasations and/or other potential complication risks related to contrast agent IV administration (ie, allergic reactions)
- Medication safety and awareness of potential medication errors and associated complications (wrong patient, wrong contrast, wrong dose, contrast-induced nephropathy)
- Cost containment
- Adherence to The Joint Commission compliance as part of facility accreditation status

- Pre-filled syringe (PFS) with radio frequency identification (RFID) technology\* (n = 3)
- PFS without RFID technology (n = 3)
- Non-PFS (n = 3)

The observer was a healthcare professional or scientist with in-depth background knowledge in imaging techniques used in CT and of related contrast agents. A detailed discussion guide was developed pre-visit to assist in observation consistency and completeness.

Hospitals agreeing to participate in the study scheduled a day where the observer shadowed one or more of the technologists for 8 to 10 hours and met with the CT manager/director (administrator) or lead technologist. Guided conversations with technologists and administrators during the observations provided valuable insight into both the attitudes and beliefs concerning process challenges and how the studied CT suites have overcome them.

### Findings

A total of nine CT suites were observed as previously described. Seven were inpatient suites also servicing emergency department (ED) patients and two were outpatient suites. Suites included a mix of academic, community, and specialized (oncology) hospitals, and an outpatient co-op facility. Hospital size ranged from 370 to 960 inpatient beds. Though each hospital had multiple suites, the observations were made in only one suite at each location. CT suites observed used ioversol injection for their routine IV contrast needs as follows:

- Ioversol PFS ± RFID (various put-ups) with contrast media power injector
- Ioversol pharmacy bulk package with autoinjector
- Iopamidol unit dose vials for cardiac procedures
- Iodixanol unit dose vials for renal patients per protocol

### CT Suite Operation

Suites were open for scanning 24 hours except for the two outpatient units which operated during normal business hours. Suites were staffed by technologists in three overlapping shifts (varied between 8 and 12 hours) to maximize coverage during the day. Two technologists were usually assigned to each scanner; one primarily assigned to patient transport/suite preparation and one assigned to patient care/imaging. Some suites assigned a technologist to assume “traffic controller” responsibility to help triage scheduling needs and minimize patient backlog. CT procedures were mostly visualized on a 64-slice scanner.

Technologists showed excellent knowledge of protocols, exceptional focus on patient safety, and were keenly aware of the need to do the “right thing.” Technologists observed showed camaraderie and cohesiveness which allowed for efficient multi-tasking. They reported being cross-trained

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\*RFID is the use of a transponder (tag) for contrast identification and tracking via radio waves. An interface is created between the PFS and power injector to ensure that patients receive the precise dosage of contrast during the procedure. This unique feature averts possible erroneous administration and allows the transmission of protocol information to a printer for patient records.<sup>8</sup>

## ■ BOX 2. Estimated Timing of Activities Observed

- Patient screening process: 5–10 min
- Transportation service: 10–60 min (longer in suites without a dedicated transporter)
- Lab results: Up to 60 min (when not available at time of order entry)
- CT room prep (including preparation of IV contrast): 5 min
- CT procedure: <10–20 min
- Image formatting: 5–10 min
- Procedural documentation: <5 min

to allow for “non-territorial” department assistance. As technologists were routinely providing patient care and imaging services, the observer qualitatively assessed the timing of the activities observed as described in Box 2.

Between patients or when a schedule break allowed, free discussion between the observer and technologist occurred. This conversation added depth and understanding to the complex nuances affecting scanning suite efficiency. Tasks such as patient transport and delayed lab results negatively impacted workflow. (See Box 3.)

### Patient Transport

Observers noted that only three suites had dedicated CT suite patient transporters. The remaining suites relied on the hospital patient transport service, except for the ED which moved their own patients.

### IV Contrast Preparation and Administration

Contrast media warmer utilization was variable, with four of the nine suites using warmers. Those not using warmers cited the reason being either lack of space or high patient volume. Observers recorded additional steps in the non-PFS suites due to the filling of the injector syringes from bulk packaging, which included: bulk pack set up (beginning of shift) and refill, contrast loading of empty syringe, and labeling (time and date) of bulk bottle and syringe. The technologists were efficient at performing these additional steps. These additional activities were not observed to be time-limiting and did not impact the turnaround time for the CT procedure.

Syringes drawn up from bulk packaging in the non-PFS suites were hand labeled with time and date prior to patient injection. Two suites believed that the expiration

time of the filled syringes was 4 hours from time of filling instead of 1 hour.

### PFS vs. PFS with RFID Technology

Steps in the contrast preparation and administration were observed to be similar. PFS with RFID provided syringe verification and additional data collection.<sup>8</sup> Upon completion of the scan, the PFS-RFID technology allowed the printing of a 4 × 6 inch adhesive label that provided documentation of date, time, patient name, contrast concentration, lot number, and other procedural information. One suite affixed the label to the scan requisition to be part of the permanent record.

Outside of the IV contrast preparation and administration processes, the general patient flow and procedures were similar among the different settings observed (Figure 1). There were no major qualitative dif-

## ■ BOX 3. Factors Limiting CT Procedure Throughput as Reported by Technologists

- Patient transportation (when the suite relies on the hospital transportation service)
- Unavailable lab test results at the time of order entry
- Order clarifications
- Poor IV access/IV placement
- Patient screening for contraindications (some suites required a completed screening form faxed back to the suite)
- Management of complications

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ferences observed among the settings with regard to overall suite workflow, technologist workload, CT procedure turnaround time, or overall process documentation.

### Unused IV Contrast

No observable differences regarding contrast volume discarded were noted among the three settings (qualitative observation only) nor were discarded volumes documented. This observation differs from previous market research findings which reported less contrast found less discard in PFS settings.<sup>9</sup> When contrast was discarded, it was observed to be the amount contained in tubing (ie, 4–5 mL) which was consistent across all suites and settings. Voluntary unused IV contrast discard was infrequently observed and was not setting related but dependent on scan indication/protocol requirement (eg, 100 mL syringe used for protocol requiring 80 mL of contrast) enabled by scanner computer software and warranted by patient physical characteristics. Again, volume discarded was not documented.

Technical difficulties or malfunctions contributed to unused contrast syringe disposal but were the exception rather than the rule:

- Observed accidental syringe pop-ups and/or false alarms with autoinjector, leading to waste of RFID syringe
- Observed loose tubing connection while filling an empty syringe at non-PFS suite resulting in “foamy” contrast and the discard of the filled syringe

### Trash Disposal

It was frequently observed that both contrast and supplies were disposed of in regular trash bins. One PFS-RFID suite commented that waste increased since transitioning from bulk contrast to PFS; upon questioning, the increased “waste”

described was that of the unit dose syringe cardboard cartons.

### Infection Control and Prevention

All settings were observed to practice proper infection prevention techniques such as proper hand washing and glove use, use of hand sanitizer, changing IV tubing between patients, and cleansing the scanning bed and transfer board. More involved cleaning methods were noted for methicillin-resistant *Staphylococcus Aureus* (MRSA) and other identified patients entering the scanning suite.

Inconsistent alcohol swabbing of tubing tips was observed more frequently in non-PFS suites, due to the additional steps needed to fill syringes from bulk packaging and puncturing bottle septum. When questioned, there seemed to be confusion about what was “clean” versus what was “sterile.” Also observed in this setting were uncapped IV tubing tips between the bulk bottle and syringe loading tip.

### Complications

Complications were universally observed to be disruptive to the patient flow process within the suites regardless of contrast setting. Suites have developed extensive screening procedures designed to prevent and minimize the occurrence of complications. When they do occur, all are managed through approved protocols. Most common complications observed were iodine contrast allergic reactions and extravasations.

One lead technologist noted that the hospital had begun to retrospectively examine charts for contrast allergic reactions. Reportedly, the chart review was positively enhanced due to the detailed information provided by the RFID technology and pre-printed label by recording verification data since the transition to this contrast packaging. This information

reported was an unexpected benefit provided by the RFID technology.

### Outpatient CT Suite Operation

Two dedicated outpatient suites were included in the observations. Observers noted that patient flow, contrast administration, dosing, and all other steps were similar to the flow observed in the inpatient setting with the following exceptions:

- Up-front time was required to allow for patient consent/questionnaire completion
- IV placement primarily by technologist and/or secondarily by expert nurse or phlebotomy technician

### Discussions with CT Administrators

Following the observations, or when schedules allowed, a 30 minute debrief was conducted with administrative personnel to review findings and to probe more deeply to aid in the understanding of suite operation.

Uniformly, all administrators expressed their desire to optimize the scanning process. All expressed a desire to learn more about their suite’s observations as well as other sites in an attempt to improve efficiency.

Administrators were asked how the choice of contrast agent packaging was made. Also, they were asked for their perception of how the packaging impacted suite operation. Patient safety was verbalized as the most important element when selecting a contrast agent or delivery mechanism. Although cost was mentioned as an important driver for selecting a contrast media agent, administrators saw value in the level of service provided by the manufacturer and were willing to pay a “premium” for “peace of mind,” particularly as it relates to the RFID technology.

When the setting of contrast delivery is considered, CT administrators did reveal interesting opinions concerning compliance with Joint Commission guidelines. Those administrators using



**Figure 1** • Detailed view: preparation and administration of IV contrast in hospital CT scanning suites. Process assumes the use of ioversol in PFS ± RFID and pharmacy bulk packages; the use of IV saline is not depicted. *Source:* ParagonRx International LLC. Used with permission.

PFS-RFID mentioned that the technology provided “peace of mind” and that they were Joint Commission ready; RFID was perceived as a fail-safe mechanism for safety and full compliance since vital information was captured without human intervention. Administrators at non-PFS suites mentioned that Joint Commission requirements and compliance need were “top of mind.” Interestingly, two of the three non-PFS suites realized post discussion that their labeling was not in strict Joint Commission compliance in regards to the appropriate expiration time. Additionally, none of the non-PFS administrators were aware that the tubing tips between the bulk contrast bottles and syringes were uncapped and unswabbed between syringe fill and patient administration.

## Discussion

Ethnographic research was conducted to map the use of IV contrast in various settings into a CareMap™ (Figure 2), a graphical representation of the complex, technologist-patient touch points observed and described. Interestingly, the over arching CareMap™ reveals key findings in three specific areas: patient transport, patient lab results, and IV contrast agent dose preparation and administration. As observed, major time limiting factors in the process are not directly related to the preparation and administration of IV contrast but rather to delays in patient transport and delays in obtaining necessary patient laboratory tests. Such delays compound upon each other resulting in scheduling delays and patient backup. Process graphing should provide CT administrators an objective benchmarking tool to

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help identify inefficiencies within their unique suite environments.

Administrators and technologists are committed to patient safety and strive to be in compliance with Joint Commission guidelines. However, inconsistencies were observed in some of the non-PFS suites (ie, tips not capped, improper labeling of syringes and open bottles). When staff was alerted, immediate corrective actions were taken.

Using contrast packaged in either a PFS or bulk bottle was observed to be a choice made uniquely by the institution. Observation of the different settings revealed a range of opinions and preferences. Technologists who had experience with both settings did not express a particular preference, whereas technologists having only PFS experience preferred this contrast packaging. The added steps required to fill syringes from bulk did not appear to slow down the process due to excellent team work observed and because of other time limiting factors. This bias observed is inconsistent with previous market research as technologists who had experience with both PFS and non-PFS did not have a particular preference most likely because human nature generally resists change.<sup>1</sup> In one suite, the transition from non-PFS to PFS was initially disruptive and not embraced by the technologists; as familiarity with PFS increased, so did acceptance.

Suites using PFS expressed opinions that the pre-filled syringes increased patient safety. Suites using PFS with RFID appreciated the automated capture of

information that ensured compliance with Joint Commission data requirements. The Joint Commission recommends that medications be dispensed in the most ready to administer forms available. Where not available, unit doses that have been repackaged by the pharmacy or licensed repackager are acceptable.<sup>3</sup>

Throughout the ethnographic research, the word “waste” was used to describe a variety of practices and objects. The observers soon learned to probe the technologist/administrator usage of the word to accurately characterize its use, definition, and purpose. Examples most often heard were:

- Waste (of time)—due to transport delays, lab result delays
- Waste (contrast)—unused volume of contrast either drawn up in syringe or as provided in a pre-filled syringe
- Waste (trash)—garbage (eg, used tubing, bottles, syringes, plastic containers, and cardboard cartons)

As previously mentioned, no appreciable difference was observed in the amount of unused contrast discarded between the three settings. However, additional benefits were observed in using PFS (with or without RFID) such as reduced spillage of contrast and associated time needed to clean the power injector face or floor. This improved housekeeping led to a clean environment which helped to provide a positive patient experience.

Finally, these findings may differ from other market research results given that observers spent the entire day with the technologists, gaining deeper insights by “entering their world.” This environment allowed for candid discussions and feedback that may not otherwise have been shared in an offsite interview or focus group (eg, difficulty encountered with switching to a different contrast agent setting).

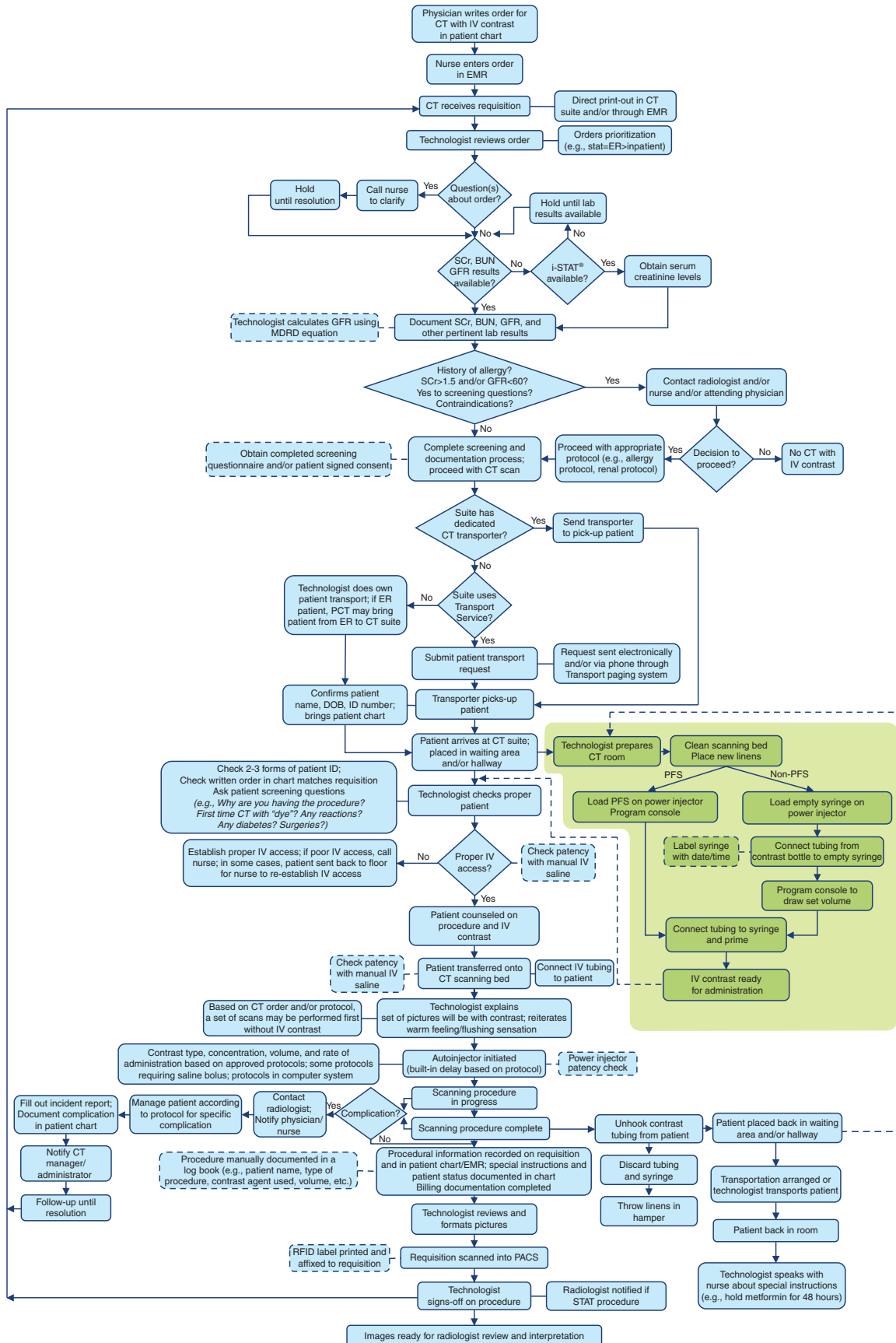


Figure 2 • Use of IV contrast in hospital CT scanning suites. Source: ParagonRx International LLC. Used with permission. --Dotted lines indicate either an optional path, an optional activity, or an activity observed at some CT suites.

## Research Limitations

Ethnography can complement other types of market research as it relies on observations and interviewing skills of the trained observer(s). However, there are limitations associated with this research:

- Findings derive from small sample sizes and are qualitative in nature
- Variations in opinions might be geographically influenced
- Potential site selection bias exists as the CT suites agreeing to participate in this research may exhibit a positive attitude towards the manufacturer's products
- All suites observed were using a majority of one vendor's contrast media and power injectors; therefore, these findings may not apply to CT suites using other CT contrast products or delivery systems
- Unused contrast volume discarded was not measured in the scanning suites and may need to be validated through a quantitative study
- Observations focused on the patient care process to identify challenges and process inefficiencies; it did not specifically focus on the impact of cost and/or cost containment on the selection of contrast delivery methods and overall CT operations

## Conclusion

Radiology administrators strive to optimize their operations in a changing environment of increasing demand for services given finite resources. Patient safety is critically important as both The Joint Commission and CDC provide helpful guidance. IV contrast agents used in CT imaging are an integral component of safe and efficient suite operations and procedures.

The ethnographic "what you do versus what you say you do" observations provided unique insights into suite routine as stratified by contrast packaging, injection, and recording by technologists. The choice of IV contrast agent supply can provide insight into department deci-

sions/procedures, as evidenced by the "peace of mind" provided by RFID technology to eliminate human error potential. Likewise, the use of the term "waste" in conversation with techs and administrators is open to various interpretations and requires definition to effect precise focus on process optimization.

The CareMap™ representation of the imaging suite operation, contrast handling, and patient care process described allow for granular visualization of the entire process. When examined in totality, IV contrast dosing and administration is not a time consuming procedure. Greatest disruption and inefficiencies were observed in the area of patient transport and in obtaining timely patient lab test results and management of complications. Efforts spent in addressing these delays offer the greatest process opportunity to maximize suite optimization. 🌱

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