

***Quick Guide to***  
**Contrast Media**



# Quick Guide to Contrast Media

## INTRODUCTION

This quick guide to contrast media reviews basic information about iodinated and paramagnetic contrast media. Iodinated contrast media are commonly used for x-ray and computed tomography (CT) imaging studies, while the gadolinium-based paramagnetic agents are used with magnetic resonance imaging (MRI).

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## Iodinated Contrast Media

Iodinated contrast medium is a radiopaque substance used to visualize internal structures of the body in x-ray procedures such as computed tomography (CT) and cardiac catheterization (Table 1). Iodinated contrast media products can be divided into either high-osmolar contrast media (HOCM) or low-osmolar contrast media (LOCM). Iso-osmolar agents, which have similar osmolality to human blood, are included in the class of LOCM. Currently, there are four classes of iodinated contrast media available for clinical use: high osmolar ionic monomers, low osmolar non-ionic monomers, low osmolar ionic dimers, and iso-osmolar non-ionic dimers. The different agents have various iodine concentrations and different physicochemical properties (i.e., osmolality, viscosity, iodine content). When administered intravenously, all contrast media are distributed in the extracellular space of the body, are not able to cross an intact blood-brain barrier, and are renally excreted via glomerular filtration. In general, clinical studies have not shown gross differences



Developed by ASHP Advantage.

TABLE 1.

## Indications for Intravascular Use of Iodinated Contrast Media<sup>2</sup>

### Intravenous

Computed tomography – head, body  
 Digital subtraction angiography  
 Intravenous urography  
 Venography

### Intra-arterial

Angiocardiography  
 Coronary angiography  
 Pulmonary angiography  
 Aortography  
 Visceral and peripheral arteriography  
 Digital subtraction angiography  
 Central nervous system angiography

TABLE 2.

## Patient Risk Factors for Adverse Reactions to Iodinated Contrast Media:<sup>2,17-20</sup>

- History of previous adverse reaction to intravascular iodinated contrast media
- History of asthma
- Previous serious allergic reaction to materials other than contrast agents
- Known cardiac dysfunction, including recent or potentially imminent cardiac decompensation, severe arrhythmias, unstable angina pectoris, recent myocardial infarction, and pulmonary hypertension
- Renal insufficiency

with regard to pharmacokinetics, pharmacodynamics, or diagnostic effect amongst the various low-osmolar iodinated contrast agents. In addition, there is little difference in the incidence of adverse events among agents within each class of iodinated contrast agents.<sup>2,4</sup> Due to these similarities in properties among LOCM, many institutions choose to place only a small selection of contrast media on formulary.

### CONSIDERATIONS FOR PATIENT SCREENING

Patients who are to receive contrast media should be screened for a history of adverse reactions to contrast media as well as for other risk factors for adverse reactions.<sup>7</sup> The risk factors are listed in Table 2. Renal function should be assessed using estimated glomerular filtration rate based on a recent serum creatinine value. Other considerations when assessing renal function include recent administration of agents that could compromise renal function (e.g., chemotherapy, diuretics) or suggest compromised function (e.g., erythropoietin), the patient's state of hydration, and medications contraindicated with contrast media.

### ADVERSE EFFECTS

Adverse effects from the administration of iodinated contrast media range from minor physiological disturbances to rare, life-threatening events.<sup>2,5</sup> Table 3 lists examples of adverse reactions to iodinated contrast agents by category. Mild reactions are events that appear self-limited without evidence of progression (e.g., limited urticaria, one episode of nausea). Mild reactions may require only observation and patient reassurance. Moderate adverse reactions are those with a moderate degree of clinically evident focal or systemic signs or symptoms. These situations require close, careful observation for possible progression to a life-threatening event and treatment as appropriate. Virtually all life-threatening reactions occur immediately or within the first 20 minutes after contrast media injection.<sup>2,4,6</sup> These severe reactions require prompt recognition and treatment, and might require hospitalization.

### Contrast-induced Nephropathy

Nephrotoxicity following the administration of contrast media accounts for more than 10% of hospital-acquired renal failure and is a leading cause of acute renal failure.<sup>8,9</sup> Contrast-induced nephropathy (CIN) is defined as an increase in serum creatinine by 25% or by > 0.5 mg/dL within 72 hours of contrast material administration.<sup>9</sup> The pathophysiology of CIN and renal insufficiency has not been fully elucidated, but the proposed

**TABLE 3.**

**Categories of Adverse Reactions to Iodinated Contrast Agents<sup>2</sup>**

**Mild**

- Nausea and vomiting
- Headache
- Fever and chills
- Rash, pruritis, flushing
- Facial edema

**Moderate**

- Tachycardia/bradycardia
- Hypertension/hypotension
- Bronchospasm/wheezing
- Laryngeal edema

**Severe**

- Convulsions
- Profound laryngeal edema
- Profound hypotension
- Clinically manifest arrhythmias
- Unresponsiveness
- Cardiopulmonary arrest

etiologic factors include: 1) renal vascular changes and 2) direct toxicity to renal tubular cells by the contrast material.

Patients with normal renal function are at low risk for contrast-induced nephropathy. The risk of CIN increases as the estimated glomerular filtration rate decreases.<sup>7</sup> However, all patients should be screened to determine if they have any risk factors for developing CIN (Table 4).<sup>7</sup> According to the American College of Radiology and Consensus Panel for CIN, the following precautions should be considered in patients who are at risk for developing CIN:<sup>2,7</sup>

- All patients receiving contrast media should be adequately hydrated.<sup>7</sup> Pre-hydration should optimally begin 6–12 hours before and continue 4–12 hours after the administration of contrast media.
- Use a LOCM or iso-osmolar contrast agent.
- Addition of a medication that may mitigate the nephrotoxic effect (e.g., N-acetylcystine) may be considered.<sup>9</sup>

- Medications that adversely affect renal function should be withheld prior to and immediately following contrast exposure. There is not an authoritative list of excluded agents, but rather for those agents that produce volume depletion or renal vasoconstriction, the benefit should be weighed against the risk.
- In high risk patients, obtain a follow-up serum creatinine not less than 24 hours or more than 72 hours following contrast exposure.

**DRUG-DRUG INTERACTIONS**

**Concomitant Metformin Therapy and the Risk of Lactic Acidosis**

Intravascular administration of iodinated contrast media to patients taking metformin has been associated with the occurrence of lactic acidosis.<sup>2</sup> Metformin is a biguanide oral antihyperglycemic agent used to treat patients with non-insulin dependent diabetes mellitus. A significant adverse effect of metformin therapy is the potential for the development of metformin-associated lactic acidosis. Metformin is excreted unchanged by the kidneys; therefore, any factors that decrease metformin excretion or increase blood lactate levels are important risk factors for lactic acidosis. Iodinated contrast agents are not an independent risk factor for patients taking metformin, but rather are a concern only in the presence of underlying renal dysfunction. Because of the risk of lactic acidosis, concurrent use of metformin is contraindicated in patients receiving intravascular iodinated contrast media.<sup>10</sup> Metformin should

**TABLE 4.**

**Risk Factors for Contrast-Induced Nephrotoxicity<sup>2,21</sup>**

- Renal insufficiency
- Diabetes mellitus
- Dehydration
- Cardiovascular disease
- Age > 70 years
- Myeloma
- Hypertension
- Hyperuricemia

**TABLE 5.**  
**Indications for Intravenous Use of MR Contrast Media**<sup>16,22-25, 25a</sup>

**Magnetic Resonance Imaging**

- Central Nervous System
- Extracranial/extraspinal head and neck
- Body\* Intrathoracic (noncardiac), intra-abdominal, liver, pelvic, and retroperitoneal regions

\*Excluding the heart

be withheld for 48 hours following intravenous administration of iodinated contrast media. Renal function should be checked prior to restarting metformin to assure that acute renal failure or a reduction in renal function has not occurred.<sup>2</sup>

**Paramagnetic Contrast Media**

Gadolinium (Gd) chelates have been approved by the Food and Drug Administration (FDA) for use in magnetic resonance imaging (MRI) since the

late 1980s (Table 5). Unlike iodinated agents that are radiopaque and block x-rays, paramagnetic agents, when injected intravenously, alter the local magnetic field of surrounding tissue. The effect of paramagnetic contrast medium is a change of the signal intensity created by the water or hydrogen protons found in the body. As a group, these agents are referred to as paramagnetic agents or gadolinium based contrast agents (GBCAs). Six FDA-approved intravenous gadolinium-based agents are currently marketed in the United States (Tables 6–8). There are similarities and differences among these agents in their chemical structures, physicochemical properties (e.g., ionicity, osmolality, viscosity), pharmacodynamics, and pharmacokinetics.<sup>3, 12, 25a</sup> Viscosity is a measure of the fluidity of solutions expressed in millipascal seconds. Contrast media with low viscosity can be quickly injected without too much effort or pressure. Osmolality is the osmotic pressure of a solution expressed in osmols or milliosmols per kilogram of water. Contrast agents with low osmolality may cause fewer disturbances in cardiac hemodynamic and electrophysiological function than high-osmolality contrast agents.<sup>25b</sup>

**TABLE 6.**  
**Properties of Contrast Media for Magnetic Resonance Imaging**

Product	Chemical Structure	Ionicity	Osmolality (mOsm/kg H <sub>2</sub> O)*	Viscosity at 37° C**	Renal Elimination (%)	Hepatic Elimination (%)
EOVIST® (Bayer HealthCare Pharmaceuticals)	Gadoxetate disodium, Gd-EOB-DTPA Linear	Ionic	688	1.2	50	50
Magnevist® (Bayer HealthCare Pharmaceuticals)	Gadopentetate dimeglumine, Gd-DTPA Linear	Ionic	1960	2.9	100	0
MultiHance® (Bracco)	Gadobenate dimeglumine, Gd-BOPTA Linear	Ionic	1970	5.3	78–96	0.6–4
ProHance® (Bracco)	Gadoteridol, Gd-HP-DO3A Macrocyclic	Nonionic	630	1.3	94	0
Omniscan™ (GE Healthcare)	Gadodiamide, Gd-DTPA-BMA Linear	Nonionic	789	1.4	95	0
OptiMARK® (Tyco Healthcare)	Gadoversetamide, Gd-DTPA-BMEA Linear	Nonionic	1110	2.0	96	0

References: 16, 22-25, 25a

\*The osmolality of normal adult blood is 285-295 mOsm/kg H<sub>2</sub>O.

\*\*The unit of measure for viscosity is millipascal seconds (mPa·s), and the viscosity of normal blood at 37° C is 3-4 mPa·s.

TABLE 7

## Dosing Recommendations for Contrast Media for Magnetic Resonance Imaging

Product	Adult Dosage by Indication	Pediatric** Dosage by Indication	Comments
EOVIST® (Bayer Healthcare Pharmaceuticals)	Liver: 0.1 mL/kg (0.025 mmol/kg) bolus I.V. injection undiluted at approximately 2 mL/sec	Not approved for use in children	Injection should be followed by flushing of the I.V. cannula with physiological saline. Dynamic imaging should begin approximately 15-25 seconds after completion of injection. The hepatocyte imaging phase may begin approximately 20 minutes after injection and may be performed up to 120 minutes after injection.+
Magnevist® (Bayer HealthCare Pharmaceuticals)	CNS, head and neck, body* (intrathoracic (noncardiac)/intra-abdominal/ pelvic): 0.2 mL/kg (0.1 mmol/kg) administered intravenously, at a rate not to exceed 10 mL per 15 seconds.	CNS, head and neck, body (intrathoracic (noncardiac)/intra-abdominal/ pelvic): 0.2 mL/kg (0.1 mmol/kg) administered intravenously, at a rate not to exceed 10 mL per 15 seconds.	Injection should be followed by a 5 mL flush of 0.9% sodium chloride. The imaging procedure should be completed within 1 hr of the injection.
MultiHance® (Bracco)	CNS: 0.1 mmol/kg (0.2 mL/kg) administered as a rapid bolus intravenous injection.	Not approved for use in children.	Injection should be followed by a 5 mL flush of 0.9% sodium chloride.
Omniscan® (GE Healthcare)	CNS: 0.2 mL/kg (0.1 mmol/ kg) administered as a bolus I.V. injection. An additional 0.4 mL/kg (0.2 mmol/kg) can be given within 20 minutes of the first dose. Kidney: 0.1 mL/kg (0.05 mmol/kg). Body (Intrathoracic (noncardiac)/intra-abdominal/pelvic): 0.2 mL/kg (0.1 mmol/kg).	CNS: 0.2 mL/kg (0.1 mmol/ kg) administered as a bolus I.V. injection. Kidney: 0.1 mL/kg (0.05 mmol/kg). Intrathoracic (noncardiac)/intra-abdominal/ pelvic: 0.2 mL/kg (0.1 mmol/kg).	Injection should be followed by a 5 mL flush of 0.9% sodium chloride. The imaging procedure should be completed within 1 hr of the injection.
OptiMARK® (Tyco Healthcare)	CNS: 0.2 mL/kg (0.1 mmol/kg) bolus I.V. injection at a rate of 1 to 2 mL/sec delivered by manual or by power injection. Kidney: 0.2 mL/kg (0.1 mmol/kg)—not sure of injection parameters.	Not approved for use in children.	The imaging procedure should be completed within 1 hour of the injection.
ProHance® (Bracco)	CNS: 0.1 mmol/kg (0.2 mL/kg) administered as a rapid I.V. infusion (10-60 mL/min) or bolus (> 60mL/min). A second dose of 0.2 mmol/kg may be given up to 30 min after the first dose. Body (intrathoracic (noncardiac)/intra-abdominal/pelvic): 0.1 mmol/kg (0.2 mL/kg) administered as a rapid I.V. infusion (10-60 mL/min) or bolus (> 60mL/min).	CNS: 0.1 mmol/kg (0.2 mL/kg) administered as a rapid I.V. infusion (10-60 mL/min) or bolus (> 60mL/min).	Injection should be followed by a 5 mL flush of 0.9% sodium chloride. The imaging procedure should be completed within 1 hr of the injection.

References: 16, 22–25, 25a

\*excludes the heart

\*\* 2 years of age and older

+ Perform hepatocyte imaging phase no later than 60 minutes following EOVISt administration to patients with elevated bilirubin or ferritin levels.

++ See boxed warning and safety information immediately following this chart.

Continued on next page.

**Table 7** (continued from previous page)

**WARNING: NEPHROGENIC SYSTEMIC FIBROSIS**

**Gadolinium-based contrast agents increase the risk for nephrogenic systemic fibrosis (NSF) in patients with:**

- acute or chronic severe renal insufficiency (glomerular filtration rate <30 mL/min/1.73m<sup>2</sup>), or
- acute renal insufficiency of any severity due to the hepato-renal syndrome or in the perioperative liver transplantation period.

In these patients, avoid use of gadolinium-based contrast agents unless the diagnostic information is essential and not available with non-contrast enhanced magnetic resonance imaging (MRI). NSF may result in fatal or debilitating systemic fibrosis affecting the skin, muscle and internal organs. Screen all patients for renal dysfunction by obtaining a history and/or laboratory tests. When administering a gadolinium-based contrast agent, do not exceed the recommended dose and allow a sufficient period of time for elimination of the agent from the body prior to any readministration.

**TABLE 8.**

### Storage Recommendations for Contrast Media for Magnetic Resonance Imaging

Product	Chemical Structure	Storage	Shelf Life at 37° C	Comments
EOVIST® (Bayer HealthCare Pharmaceuticals)	Gadoxetate disodium	Store at 20 to 25° C. Excursions permitted to 15 to 30° C.		
Magnevist® (Bayer HealthCare Pharmaceuticals)	Gadopentetate dimeglumine	Store at 15 to 30° C.		Protect from light. Do not freeze.
MultiHance® (Bracco)	Gadobenate dimeglumine	Store at 25° C. Excursions permitted to 15 to 30° C.		Do not freeze.
Omniscan® (GE Healthcare)	Gadodiamide	Store at 15 to 30° C.		Do not freeze.
OptiMARK® (Tyco Healthcare)	Gadoversetamide	Store at 20–25° C.	Up to 1 month in a contrast media warmer	Protect from light. Do not freeze.
ProHance® (Bracco)	Gadoteridol	Store at 25° C. Excursions permitted to 15 to 30° C.		Protect from light. Do not freeze.

References: 16, 22–25, 25a

Although most GBCAs are eliminated exclusively or primarily via the kidneys, the most recently approved GBCA, EOVI<sup>ST</sup>® (gadoxetate disodium), has both intracellular and extracellular components, allowing for a dual route of elimination (approximately 50% renal and 50% hepatobiliary) and an additional hepatocyte phase of liver imaging.<sup>25a</sup>

#### ADVERSE EFFECTS

The GBCAs are well tolerated by the majority of patients to whom they are administered. The frequency of all adverse reactions to GBCAs ranges from 0.07–2.4%.<sup>2</sup> The vast majority of these

reactions are mild, including coldness at the injection site, nausea, headache, paresthesias, dizziness, and itching. Allergic-like reactions (e.g., rash, hives, urticaria) are very unusual, with reported frequencies of 0.004–0.7%.<sup>2</sup> Severe, life-threatening reactions are exceedingly rare. Please see the full prescribing information for each GBCA for more information. The risk factors for adverse reactions to gadolinium-based contrast agents include:

- History of reactions to iodinated contrast agents or previous reaction to gadolinium-based contrast agents (GBCAs).
- History of asthma or allergies.

Gadolinium-based contrast agents have been associated with the development of nephrogenic systemic fibrosis (NSF) in patients with impaired kidney function, and the state of knowledge about this condition is rapidly evolving. In May of 2007, the FDA called for a boxed warning to be included in prescribing information for all gadolinium-based agents.<sup>13</sup> The American College of Radiology has updated its MR safety guidelines.<sup>14</sup> All patients referred to MR imaging should be pre-screened for renal disease by obtaining a history and/or laboratory tests.

### **Nephrogenic Systemic Fibrosis**

Nephrogenic systemic fibrosis (NSF) is a rare scleroderma-like condition of unknown etiology that has been recently reported in patients with severe renal insufficiency who received gadolinium-based contrast media.<sup>4,15</sup> However, a number of cases of NSF have also been reported in the medical literature in patients with no identified exposure to gadolinium-based contrast media.<sup>13,26</sup> NSF typically involves the upper and lower extremities and can less commonly involve the trunk. The skin is usually the primary site of involvement, although fibrotic changes of internal organs have also been reported. NSF is characterized by tightening and hardening of the skin that can lead to contractures and reduced mobility. The reported time between receiving a GBCA and subsequent diagnosis of NSF is highly variable.<sup>13</sup> Symptoms usually occur within a few days to several months following exposure to gadolinium-based contrast media.<sup>4</sup>

The etiology of NSF is still unknown but is likely to be multifactorial. Specific triggers under scientific evaluation have included surgery and the occurrence of thrombosis or other vascular injury, proinflammatory state, the administration of high doses of erythropoietin, and more recently the use of gadolinium-based contrast agents.<sup>26-30</sup> The first report in the medical literature of a possible association between NSF and the administration of GBCAs in patients with severe renal impairment was in January 2006. The risk, if any, for developing NSF among patients with mild to moderate renal insufficiency or normal renal function is not known. To date, there has not been a report of NSF in a patient with normal renal function or mild to moderate renal insufficiency following GBCA

exposure.<sup>13</sup> A boxed warning was recently added to the package insert of all GBCAs marketed in the United States that states:

- Exposure to GBCAs increases the risk of NSF in patients with:
  - Acute or chronic severe renal insufficiency (glomerular filtration rate < 30 mL/min/1.73 m<sup>2</sup>)<sup>13</sup>
  - Acute renal insufficiency of any severity due to hepato-renal syndrome or in the perioperative liver transplantation period<sup>13</sup>
- Avoid the use of GBCAs unless the diagnostic information is essential and not available with non-contrast enhanced MRI.
- NSF may result in fatal or debilitating systemic fibrosis affecting the skin, muscle and internal organs.
- Screen all patients for renal dysfunction by obtaining a history and/or laboratory tests.
- When administering a GBCA do not exceed the recommended dose and allow a sufficient period of time for elimination of the agent from the body prior to any readministration.

The updated package insert for all these agents also identify additional factors that may increase the risk for NSF. Healthcare practitioners should become familiar with the patient populations who are at known risk for NSF.<sup>13</sup>

- Repeated or higher-than-recommended doses of GBCAs and the degree of renal function impairment at the time of exposure to GBCAs.

Additional warnings include:

- For patients receiving hemodialysis, healthcare professionals may consider prompt hemodialysis following GBCA administration in order to enhance the contrast agent's elimination. However, it is unknown if hemodialysis prevents NSF.<sup>13</sup>
- Determine the renal function of patients by obtaining a medical history or conducting laboratory tests that measure renal function prior to using a GBCA.<sup>13</sup>
- The risk, if any, for developing NSF among patients with mild to moderate renal insufficiency or normal renal function is unknown.<sup>13</sup>

- Post-marketing reports have identified the development of NSF following single and multiple administrations of GBCAs. These reports have not always identified a specific agent. Where a specific agent was identified, the most commonly reported agent was Omniscan<sup>®</sup>, followed by Magnevist<sup>®</sup> and OptiMARK<sup>®</sup>. NSF has also developed following the sequential administration of Omniscan<sup>®</sup> and MultiHance<sup>®</sup> and Omniscan<sup>®</sup> and ProHance<sup>®</sup>. The distribution of the number of reports for the individual GBCAs may relate to multiple factors, including more limited use of some GBCAs, under-reporting of NSF, characteristics of the agent and a lack of patients' complete GBCA exposure history.<sup>13</sup>
- Report possible cases of NSF to the FDA through the FDA's MedWatch program by completing a form online at [www.fda.gov/medwatch/report/hcp.htm](http://www.fda.gov/medwatch/report/hcp.htm), by faxing (1-800-FDA-0178), by mail using the postage-paid address form provided online, or by phone (1-800-FDA-1088).

## DRUG-DRUG INTERACTIONS

MultiHance<sup>®</sup> (gadobenate dimeglumine) injection is a substrate for the canalicular multispecific organic anion transporter (cMOAT, also referred to as MRP2 or ABCC2) and may compete with other drugs for cMOAT sites.<sup>16</sup> Caution should be exercised in administering MultiHance<sup>®</sup> to patients who receive drugs such as cisplatin, anthracyclines (e.g., doxorubicin, daunorubicin), vinca alkaloids

(e.g., vincristine), methotrexate, etoposide, tamoxifen, paclitaxel that are substrates for this transporter. Caution should also be exercised for those subjects in whom the cMOAT sites may be affected due to underlying metabolic disorders (e.g., Dubin Johnson syndrome). Anionic drugs primarily excreted in the bile (e.g., rifampicin) may reduce the hepatic contrast enhancement and biliary excretion of EOVISt<sup>®</sup> (gadoxetate disodium).<sup>25a</sup>

## DRUG-LABORATORY INTERACTIONS

Gadodiamide (Omniscan<sup>®</sup>) and gadoversetamide (OptiMARK<sup>®</sup>) chelates are known to interfere with some common colorimetric methods of measuring serum calcium. The interference may occur when measurements are performed with blood samples obtained before the agent is sufficiently cleared from the body. The chelators used in the products interfere with the assay and may cause a falsely low serum calcium value. The interaction is a significant concern because of the possibility that a patient could receive supplemental calcium to correct a false lab value because a clinician believes it to be accurate.<sup>23,24</sup> Gadopentetate dimeglumine (Magnevist) and gadoteridol (ProHance) do not interfere with calcium measurement. However, gadopentetate dimeglumine can cause transitory changes in serum iron, bilirubin and transaminase levels. Serum iron determination using complexometric methods (e.g., Ferrocine complexation method) may result in falsely high and low values for up to 24 hours after the examination with EOVISt<sup>®</sup> (gadoxetate disodium) because of the caloxetate trisodium excipients.<sup>25a</sup>

APPENDIX A.

**Properties of Radiographic Contrast Media**

<b>Product</b>	<b>Chemical Structure</b>	<b>Ionicity</b>	<b>Osmolality Class</b>	<b>Osmolality (mOsm/kg H<sub>2</sub>O)</b>	<b>Iodine (mgI/L)</b>	<b>Viscosity at 25° C</b>	<b>Viscosity at 37° C</b>
Isovue®-200 (Bracco)	lopamidol	Nonionic	Low	413	200	3.3*	2.0
Isovue®-250 (Bracco)	lopamidol	Nonionic	Low	524	250	5.1*	3.0
Isovue®-300 (Bracco)	lopamidol	Nonionic	Low	616	300	8.8*	4.7
Isovue®-370 (Bracco)	lopamidol	Nonionic	Low	796	370	20.9*	9.4
Omnipaque™ 140 (GE Healthcare)	lohexol	Nonionic	Low	322	140	2.3*	1.5
Omnipaque® 180 (GE Healthcare)	lohexol	Nonionic	Low	408	180	3.1*	2.0
Omnipaque™ 240 (GE HealthCare)	lohexol	Nonionic	Low	520	240	5.8*	3.4
Omnipaque™ 300 (GE Healthcare)	lohexol	Nonionic	Low	672	300	11.8*	6.3
Omnipaque™ 350 (GE Healthcare)	lohexol	Nonionic	Low	844	350	20.4*	10.4
Optiray® 160 (Tyco Healthcare)	loversol	Nonionic	Low	355	160	2.7	1.9
Optiray®240 (Tyco Healthcare)	loversol	Nonionic	Low	502	240	4.6	3.0
Optiray® 300 (Tyco Healthcare)	loversol	Nonionic	Low	651	300	8.2	5.5
Optiray® 320 (Tyco Healthcare)	loversol	Nonionic	Low	702	320	9.9	5.8
Optiray® 350 (Tyco Healthcare)	loversol	Nonionic	Low	792	350	14.3	9.0
Oxilan® 300 (Guerbet)	loxilan	Nonionic	Low	585	300	9.4*	5.1
Oxilan® 350 (Guerbet)	loxilan	Nonionic	Low	695	350	16.3*	8.1
Ultravist® 150 (Bayer HealthCare Pharmaceuticals)	lopromide	Nonionic	Low	328	150	2.3*	1.5
Ultravist® 240 (Bayer HealthCare Pharmaceuticals)	lopromide	Nonionic	Low	483	240	4.9*	2.8
Ultravist® 300 (Bayer HealthCare Pharmaceuticals)	lopromide	Nonionic	Low	607	300	9.2*	4.9
Ultravist® 370 (Bayer HealthCare Pharmaceuticals)	lopromide	Nonionic	Low	774	370	22.0*	10.0
Visipaque-320™ (GE Healthcare)	lodixanol	Nonionic	Low	290	320	26.6*	11.8

\*Measured at 20° C; References 31–37

APPENDIX B.

## Storage Recommendations for Iodinated Contrast Media

Product	Chemical Structure	Storage	Shelf Life at 37° C	Comments
Isovue® -200 (Bracco)	lopramidol	Store at 20–25° C.		Protect from light.
Isovue® -250 (Bracco)	lopamidol	Store at 20°–25° C.		Protect from light.
Isovue® -300 (Bracco)	lopamidol	Store at 20–25° C.		Protect from light.
Isovue® -370 (Bracco)	lopamidol	Store at 20–25° C.		Protect from light.
Omnipaque™ 140 (GE Healthcare)	lohexol	Store at controlled room temperature 20–25° C. Excursions permitted to 15 to 30° C.		Protect from strong daylight and direct sunlight. Do not freeze.
Omnipaque™ 180 (GE Healthcare)	lohexol	Store at controlled room temperature 20–25° C. Excursions permitted to 15 to 30° C.		Protect from strong daylight and direct sunlight. Do not freeze.
Omnipaque™ 240 (GE Healthcare)	lohexol	Store at controlled room temperature 20–25° C. Excursions permitted to 15 to 30° C.		Protect from strong daylight and direct sunlight. Do not freeze.
Omnipaque™ 300 (GE Healthcare)	lohexol	Store at controlled room temperature 20–25° C. Excursions permitted to 15 to 30° C.		Protect from strong daylight and direct sunlight. Do not freeze.
Omnipaque™ 350 (GE Healthcare)	lohexol	Store at controlled room temperature 20–25° C. Excursions permitted to 15 to 30° C.		Protect from strong daylight and direct sunlight. Do not freeze.
Optiray® 160 (Tyco Healthcare)	loversol	Store below 30° C.	Up to 1 month in a contrast media warmer	Protect from light. May be frozen.
Optiray® 240 (Tyco Healthcare)	loversol	Store below 30° C.	Up to 1 month in a contrast media warmer	Protect from light. May be frozen.
Optiray® 300 (Tyco Healthcare)	loversol	Store below 30° C.	Up to 1 month in a contrast media warmer	Protect from light. May be frozen.
Optiray® 320 (Tyco Healthcare)	loversol	Store below 30° C.	Up to 1 month in a contrast media warmer	Protect from light. May be frozen.
Optiray® 350 (Tyco Healthcare)	loversol	Store below 30° C.	Up to 1 month in a contrast media warmer	Protect from light. May be frozen.

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**Appendix B** (continued from previous page)

<b>Product</b>	<b>Chemical Structure</b>	<b>Storage</b>	<b>Shelf Life at 37° C</b>	<b>Comments</b>
Oxilan® 300 (Guerbet)	loxilan	Store at 15 to 30° C.		Protect from light. Do not freeze.
Oxilan® 350 (Guerbet)	loxilan	Store at 15 to 30° C.		Protect from light. Do not freeze.
Ultravist® 150 (Bayer HealthCare Pharmaceuticals)	lopromide	Store at controlled temperature. Excursions permitted to 15 to 30° C.		Protect from light.
Ultravist® 240 (Bayer HealthCare Pharmaceuticals)	lopromide	Store at controlled temperature. Excursions permitted to 15 to 30° C.		Protect from light.
Ultravist® 300 (Bayer HealthCare Pharmaceuticals)	lopromide	Store at controlled temperature. Excursions permitted to 15 to 30° C.		Protect from light.
Ultravist® 370 (Bayer HealthCare Pharmaceuticals)	lopromide	Store at controlled temperature. Excursions permitted to 15 to 30° C.		Protect from light.
Visipaque™ 320 (GE Healthcare)	iodixanol	Stable in both glass and polymer bottles	1 month	Protect from light.

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