Guidelines 2025

Contrast Media Safety Committee

European Society of Urogenital Radiology

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Preface

The Contrast Media Safety Committee, which was founded in 1994, is proud to present the Contrast Agent Guidelines 2025. Over the years, more than 200,000 copies of the booklet have been printed, and it has been translated into many languages. Although most contrast agents in current use have been on the market for many years, minor changes occur in their adverse reaction pattern and new observations are reported.

From now on, the guidelines will also be published in electronic form on the ESUR webpage and updated annually. Consequently, following Version 10, the 2025 version of the guidelines is now released. The guidelines should be understood as a permanent work in progress, continuously evolving over time.

The 2025 version of the guidelines includes, among others, updated sections on contrast agent hypersensitivity and extravasation as well as recommended waiting times between successive contrast agent administrations, analytical interference of contrast agents with lab tests and safe use of contrast agents for hysterosalpingography and in patients with myasthenia gravis.

We hope this new version remains helpful in your practice and that it will benefit all our patients. Comments and questions are welcome at esursecretary@esur.org

Contrast Media Safety Committee
November 2025

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Note:
CMSC guidelines are based on evidence in the literature whenever possible. Where there is insufficient published evidence, recommendations are based on clinical consensus within the Committee.

These guidelines summarize the key recommendations. For a complete understanding of the respective topic, readers are encouraged to consult the original ESUR CMSC guideline publication(s).

Some CMSC guidelines may differ from the Summary of Product Characteristics (SPC, label), and/or guidelines drawn up by national and other radiological bodies.

Legal notice:
The Committee and authors of the contrast agent guidelines 2025 claim no responsibility for the content of the translated versions of the guidelines.

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Terminology: Contrast agents and contrast media

A **contrast agent** is a substance which alters the contrast in images produced by any method. It is a general term which can be used for X-ray, MR and ultrasound contrast compounds.

A **contrast medium** is a substance which alters the contrast in X-ray images by altering transmission of the X-ray beam. This term should be reserved for X-ray contrast compounds, e.g. iodine-based, barium, air and carbon dioxide.

Hypersensitivity reactions to contrast agents (in adults)

An **immediate hypersensitivity reaction** occurs **within 1h** of contrast agent administration (rarely up to 6h), while a **non-immediate** hypersensitivity reaction occurs **between 1h and 1 week** (rarely up to 8 weeks) after administration.

Categories of immediate hypersensitivity reactions

For classification of immediate hypersensitivity reactions, the CMSC endorses both the Radiological classification of the American College of Radiology (ACR) and the Allergological classification of Ring and Messmer.

Clinical symptoms of the hypersensitivity reaction	ACR Classification	Ring & Messmer Classification
Nasal congestion	Mild	Grade 1
Sneezing, conjunctivitis, rhinorrhoea		Grade 1
Limited/scattered urticaria & pruritus		Grade 1
Cutaneous oedema		Grade 1
Limited itchy/scratchy throat		Grade 1
Diffuse urticaria & pruritus	Moderate	Grade 1
Diffuse erythema, no hypotension		Grade 1
Facial oedema, no dyspnoea		Grade 1
Throat hoarseness, no dyspnoea		Grade 2
Mild bronchospasm, no hypoxia		Grade 2
Diffuse/facial oedema, with dyspnoea	Severe	Grade 2
Diffuse erythema, with hypotension		Grade 3
Laryngeal oedema, with hypoxia		Grade 3
Severe bronchospasm, with hypoxia		Grade 3
Anaphylactic shock		Grade 3
Cardiopulmonary arrest		Grade 4

Management of hypersensitivity reactions

Immediate/acute hypersensitivity reactions in adults

What to do before the examination

- Be prepared to treat acute adverse reactions: be knowledgeable about the risks and potential reactions, and participate regularly in continuous medical education
- Know your patient and evaluate the risk/ benefit ratio and consider imaging alternatives
- If the patient has experienced a previous hypersensitivity reaction, identify the specific agent that elicited the previous reaction, and if the injection is mandatory, choose an alternative contrast agent.
- Schedule the patient during daytime hours, when most personnel are present, preferably in a hospital-based CT or MRI facility.
- A regularly maintained resuscitation trolley should be available in the department
- Emergency numbers for the hospital resuscitation team should be in the examination room
- Adhere to local protocols for accessibility of a resuscitation and emergency response team.
- Equipment for collecting blood for tryptase measurement should be readily available
- The following first-line emergency equipment and medications should be available in the examination room:
    - Oxygen
    - IV fluids: normal saline or Ringer lactate (stock at least 2L)
    - Sphygmomanometer
    - One-way mouth rebreather apparatus
    - Adrenaline 1 mg/mL (1:1,000)
    - H1-Antihistamine suitable for injection
    - Atropine
    - Short acting β2-agonist metered dose inhaler or nebuliser
    - Anti-convulsive drugs

What to do during the examination

- Monitor the patient closely and judge for progression of the reaction.
- Observe closely for mucosal oedema of the nose, mouth, throat, or larynx.
- If there is an increased risk of an adverse reaction, a venous access should be kept in place.
- In case of symptoms, check heart rate, arterial blood pressure, and consciousness.
- If marked bradycardia is present, consider treatment of a vasovagal reaction (atropine)
- Be aware that a patient with impaired vision or hearing, neurological disease, psychiatric illness, cognitive disorders or under CNS-active medications might have diminished awareness of hypersensitivity symptoms.

Acute management:

General principles

- Check and stabilise patient according to the ABCDE method.
- Stop infusing contrast agent and replace IV line with crystalloid.
- Dyspnoea or stridor: let patient sit up.
- Hypotension: keep patient in prone position, raise legs.
- Consider measuring serum tryptase as soon as practical, but certainly within 4h after start of the reaction
- Record acute allergic reactions and culprit contrast agent in the allergy registry of the electronic health record of the patient

Note: After administration of a sedating H1-antihistamine the patient may no longer be able (or insured) to drive a car/motorcycle or to operate machinery.

Severe reactions (anaphylaxis)

Cardiac or respiratory arrest:
- Call the CPR team.
- Start CPR.

Anaphylactic reaction or stridor:
- Call rapid response team.
- Give oxygen 10 to 15 L/min with non-rebreathing mask.
- Give 0.5mg adrenaline IM in lateral upper thigh, repeat as necessary, guided by heart rate.
- Give fluid bolus of crystalloid 500 ml IV in 10 minutes, repeat as necessary.
- Short acting β2-agonist: *2 - 10 inhalations of 100 µg of salbutamol via inhalation [depending on severity], with option to repeat every 20 minutes, or via nebulization (2.5-5 µg diluted in 3 mL of saline solution) up to 1 hour*
- Give chlorphenamine 20mg or clemastine 2 mg IV, repeat as necessary.
- Consider adding corticosteroid (for example prednisolone 50 mg IV*)

*Prednisolone 50 mg IV is equivalent to:
- 40 mg methylprednisolone
- 8 mg dexamethasone
- 200 mg hydrocortisone

Note: Adding corticosteroids may be beneficial to prevent protracted or biphasic anaphylactic reactions if initial symptoms are severe.

Moderate reactions

Consider transferring the patient to a department with facilities for monitoring of vital functions.

Mild bronchospasm:
- Short acting β2-agonist: 2 - 4 inhalations of 100 µg of salbutamol via inhalation [depending on severity], with option to repeat every 20 minutes, or via nebulisation (2.5-5 µg diluted in 3 mL of saline solution) until clinical improvement.
- In case of deterioration give adrenaline 0.5 mg IM and consider consulting the rapid response team.
- When bronchospasm increases in severity, consider repeating adrenaline 0.5mg IM, guided by heart rate.

Facial oedema without stridor:
- Give oxygen 10 to 15 L/min via a non-rebreathing mask.
- Give chlorphenamine 20 mg or clemastine 2 mg IV.
- If oedema is severe, near airways, or if stridor develops treat as anaphylaxis.

Diffuse urticaria/diffuse erythema:
- Give chlorphenamine 20 mg or clemastine 2 mg IV.
- If accompanied by hypotension: treat as anaphylaxis.

Mild reactions

General:
- Mild reactions may only need reassurance.
- Observe vital signs until symptoms resolve.
- Do not remove IV access during observation.

Consider:
- Prescribing a non-sedating antihistamine, for example desloratadine 5 mg PO or cetirizine 10 mg PO (once daily) for mild allergic reactions.
- Ondansetron 4mg IV for protracted vomiting.

What to do after the examination

- If the patient has experienced a mild reaction, keep them under surveillance until every symptom has disappeared (minimum 30 min, usually <60 min).
- Patients experiencing a greater but non-life-threatening reaction should be observed for 4-6 hours after successful treatment before condisdering discharge.
- Patients being discharged having had antihistamine medication should be advised not to drive
- Patients experiencing a life-threatening reaction should be admitted and observed.
- Obtain serum tryptase within 4h of reaction onset (see Prevention of Recurrent Reactions)

Non-immediate/delayed hypersensitivity reactions

Warn patients who have had a previous non-immediate hypersensitivity reaction to contrast agents, that a repeat non-immediate hypersensitivity reaction may be possible, usually a skin reaction.

Patients should be informed to contact their general practitioner if they have a non-immediate hypersensitivity reaction after contrast media administration.

Consider informing the radiology department where the contrast agent was administered about the occurrence and symptoms of a non-immediate hypersensitivity reaction after contrast agent administration.

When the symptoms of a non-immediate hypersensitivity reaction are mild, a wait-and-see approach can be justified.

Treat non-immediate hypersensitivity reactions symptomatically.
Consider treatment of skin reactions with oral or topical corticosteroids.

When severe cutaneous adverse reactions (SCAR) develop, such as generalised pustulosis or painful cutaneous blisters, refer the patient to a dermatologist for treatment and advice on future use of contrast.

Documentation of hypersensitivity reactions

The physician responsible for the administration of the contrast agent or the drug allergy specialist ensure that the allergy is accurately documented in the Electronic Health Record:

- The location, date, and time of contrast agent administration
- The ***specific*** contrast agent's name and dose (volume, concentration)
- The type (immediate or non-immediate) and severity category of the HSR
- All available patient symptoms and vital signs (blood pressure, pulse, respiration rate, oxygen saturation), time of first symptoms, and their evolution
- The treatment given, and the response of the patient to the treatment
- Any results of telephonic consultation with a drug allergy specialist
- Any clinical follow-up and advice to see a drug allergy specialist

If a HR to a contrast agent is serious or unexpected, the physician responsible for its administration or the drug allergy specialist should report all details of such a reaction to Marketing Authorization Holder and/or the National Pharmacovigilance Authority.

Nonvascular administration of iodine-based contrast media

When iodine-based contrast media are administered in the gastrointestinal tract, the genitourinary tract, the spinal canal, in joints, bile ducts, salivary ducts, fistulas, or abscesses, limited absorption or leakage of the iodine-based contrast media into the systemic circulation is possible, but hypersensitivity reactions are rare. For these hypersensitivity reactions, use the same management as for intravascular iodine-based contrast media administration.

Prevention of recurrent hypersensitivity reactions

In vitro tests

Measure serum tryptase within 4 hours from the start of all moderate to severe immediate hypersensitivity reactions to contrast agents. A second measurement after ≥ 24 hours serves as a baseline for further allergologic examinations.

Reserve basophil activation tests for selected patients with moderate to severe acute hypersensitivity reactions as they are only available in specialized drug allergy centres.

For non-immediate hypersensitivity reactions there are no meaningful ***in vitro*** diagnostic tests in clinical use.

Allergy assessment

Refer the following patients to a drug allergy specialist for an allergy assessment:

- Patients experiencing moderate and severe hypersensitivity reactions, and ***optionally*** patients experiencing mild hypersensitivity reactions when the drug allergy specialist capacity is sufficient
- Patients experiencing hypersensitivity reactions to multiple iodine-based or gadolinium-based contrast agents (either two or more different iodine-based contrast media or gadolinium-based contrast agents or to an iodine-based contrast medium and a gadolinium-based contrast agent).
- Patients experiencing recurrent hypersensitivity reactions of any severity.

During the allergy assessment, test for the suspected culprit contrast agent and several commonly used alternatives, ideally within 6 months after the hypersensitivity reaction.

Always specify the used contrast agent in the referral to the drug allergy specialist.

A detailed documentation about the culprit contrast agent and the severity of the reaction, including a grading scheme, is mandatory (see Management of Hypersensitivity Reactions).

Preventive measures

In all patients with a history of a hypersensitivity reaction to an iodine-based contrast medium or a gadolinium-based contrast agent, consider an alternative imaging modality, or consider performing an unenhanced exam if the diagnostic yield is sufficient for the correct management of the patient. Never deny a patient a clinically well-indicated enhanced examination if alternative imaging strategies are not available.

Immediate hypersensitivity reactions (IHR)

In patients with a history of a **mild** immediate hypersensitivity reaction to an iodine-based

contrast medium or a gadolinium-based contrast agent:

- Interview the patient about their previous hypersensitivity reaction
- *Optionally*, refer the patient to a drug allergy specialist (if not done before) when the local drug allergy specialist capacity is sufficient
- Optimize the allergy registration in the electronic health record
- Apply the advice of the drug allergy specialist for a safe iodine-based contrast medium or gadolinium-based contrast agent or, when not available, choose a different iodine-based contrast medium or gadolinium-based contrast agent if the culprit contrast agent is known*
- When the contrast medium is administered: observe the patient at least 30min with IV line in place
- Be prepared and vigilant for a recurring immediate hypersensitivity reaction
- If an immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

In patients with a history of a **moderate** immediate hypersensitivity reaction to an iodine-based contrast medium or gadolinium-based contrast agent:

- Refer the patient to a drug allergy specialist (if not done before)
- Optimize the allergy registration in electronic health record

For **elective** contrast-enhanced examinations:

- Postpone imaging to wait for the results of the allergy analysis
- Apply the advice of the drug allergy specialist for a safe iodine-based contrast medium or gadolinium-based contrast agent
- When the contrast medium is administered: observe the patient at least 30min with IV line in place
- Be prepared and vigilant for a recurring immediate hypersensitivity reaction
- If an immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

For **emergency** contrast-enhanced examinations:

- Have a trained imaging or emergency room physician nearby
- Choose a different iodine-based contrast medium or gadolinium-based contrast agent if the culprit contrast medium is known*
- When the contrast medium is administered: observe the patient at least 30 minutes with IV line in place
- Be prepared and vigilant for a recurring immediate hypersensitivity reaction
- If an immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

In patients with a history of a **severe** immediate hypersensitivity reaction to an iodine-based contrast medium or gadolinium-based contrast agent:

- Refer the patient to a drug allergy specialist (if not done before)
- Optimize the allergy registration in electronic health record

For **elective** contrast-enhanced examinations:

- Have a trained rapid response (or resuscitation) team member nearby
- Postpone imaging to wait for the results of the allergy analysis

- Apply the advice of the drug allergy specialist for a safe iodine-based contrast medium or gadolinium-based contrast agent
- When the contrast medium is administered: observe the patient at least 30 minutes with IV line in place
- Be prepared and vigilant for a recurring immediate hypersensitivity reaction
- If an immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

For **emergency** contrast-enhanced examinations:
- Have a trained rapid response (or resuscitation) team member nearby
- Consider administration of premedication (EAACI guidelines)
- Choose a different iodine-based contrast medium or gadolinium-based contrast agent if the culprit contrast medium is known*
- When the contrast medium is administered: observe the patient at least 30 minutes with IV line in place
- Be prepared and vigilant for a recurring immediate hypersensitivity reaction
- If an immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

Emergency premedication protocol:
- 50 mg prednisolone IV (or equivalent) – ≥ 30min before contrast administration
- 2mg clemastine IV (or equivalent) – ≥ 30min before contrast administration

Note: 50 mg prednisolone IV is equivalent to:
- 40 mg methylprednisolone IV
- 8 mg dexamethasone IV
- 200mg hydrocortisone IV

Note: 2mg clemastine IV is equivalent to:
- 50 mg diphenhydramine IV
- 20 mg chlorphenamine IV
- 10 mg cetirizine IV

Non-immediate hypersensitivity reactions (NIHR)

In patients with a history of a **mild** non**-**immediate hypersensitivity reaction to an iodine-based contrast medium or a gadolinium-based contrast agent without danger signs:
- Interview the patient about their previous hypersensitivity reaction
- *Optionally*, refer the patient to a drug allergy specialist (if not done before) when the local drug allergy specialist capacity is sufficient
- Optimize the allergy registration in the electronic health record
- Apply the advice of the drug allergy specialist for a safe iodine-based contrast medium or gadolinium-based contrast agent or, when not available, choose a different Iodine-based contrast medium or gadolinium-based contrast agent if the culprit contrast agent is known*
- When the contrast medium is administered: observe the patient at least 30 minutes with

IV line in place
- Give the patient written instructions for a possible repeat non-immediate hypersensitivity reaction
- If a non-immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

In patients with a history of a **moderate** non**-**immediate hypersensitivity reaction to an iodine-based contrast medium or a gadolinium-based contrast agent without danger signs:
- Refer the patient to a drug allergy specialist (if not done before)
- Optimize the allergy registration in the electronic health record
- Apply the advice of the drug allergy specialist for a safe iodine-based contrast medium or gadolinium-based contrast agent or, when not available, choose a different Iodine-based contrast medium or gadolinium-based contrast agent if the culprit contrast agent is known*
- When the contrast medium is administered: observe the patient at least 30 minutes with IV line in place
- Give the patient written instructions for a possible repeat non-immediate hypersensitivity reaction
- If a non-immediate hypersensitivity reaction recurs, referral to a drug allergy specialist is mandatory

In patients with a history of a **severe** non**-**immediate hypersensitivity reaction to an iodine-based contrast medium or a gadolinium-based contrast agent with danger signs** (SCAR):
- Refer the patient urgently to a drug allergy specialist (if not done before)
- Choose an alternative imaging modality
- Optimise the allergy registration in the electronic health record

DO NOT give the group of contrast agent to which the severe skin reaction has occurred:
- *Avoid all* iodine-based contrast media after a severe non-immediate hypersensitivity reaction to an iodine-based contrast medium
- *Avoid all* gadolinium-based contrast agents after a severe non-immediate hypersensitivity reaction to a gadolinium-based contrast agent
- *Individualise the approach* following multidisciplinary consultation after a severe reaction to an unknown contrast agent

* Consider cross-reactivity of contrast media and an increased risk for non-immediate hypersensitivity reaction with use of iso-osmolar dimeric iodine-based contrast media
** Danger signs: erosive and/or haemorrhagic lesions, blistering and skin disruption, mucosal involvement, extracutaneous organ involvement (high fever, abnormal liver / kidney values, lymphadenopathy)

Cross-reactivity between contrast agents

Cross-reactivity is most relevant in *allergic* hypersensitivity reactions and cannot be predicted on the basis of the chemical structure

Based on current knowledge, cross-reactivity can occur with a higher frequency among:
- Iodine-based contrast media with a N-(2,3-hydroxypropyl)-carbamoyl side chain
- Macrocyclic gadolinium-based contrast agents

The drug allergy specialist determines through an evaluation including skin testing with a panel of different iodine-based contrast media and gadolinium-based contrast agents:
- The allergic nature of the hypersensitivity reaction
- Cross-reactivity between contrast media
- Suggestions for safe alternative contrast agents

Change to an alternative contrast agent based on practical experience

CMSC **cannot** make evidence-based recommendations on a robust scientific basis for change to an alternative contrast agent based on practical experience.

Imaging physicians should use their available choices of alternative contrast agents, adhere to local or national guidelines, and ensure that patients get optimal surveillance by adequately trained staff, if needed with rapid response (or resuscitation) team support.

Prevention of contrast-associated acute kidney injury (CA-AKI) when administering iodine-based contrast media

Note: From 2025 onwards, the CMSC will follow the recommendations by the ACR/NKF Consensus 2020, and therefore the older term post-contrast acute kidney injury (PC-AKI) has been updated to contrast-associated acute kidney injury (CA-AKI).

Definitions

- **Contrast-associated acute kidney injury** (CA-AKI) is defined as an increase in serum creatinine > 0.3 mg/dl (or > 26.5 µmol/l), or > 1.5 times baseline, within 48-72 hours of intravascular administration of a contrast agent.
- **Intra-arterial injection with first pass renal exposure** indicates that contrast agent reaches the kidneys in a relatively undiluted form, e.g. injection into the left heart, thoracic and suprarenal abdominal aorta or the renal arteries.
- **Intra-arterial injection with second pass renal exposure** indicates that contrast agent reaches the kidneys after dilution either in the pulmonary or peripheral circulation, e.g. injection into the right heart, pulmonary artery, carotid, subclavian, coronary, mesenteric or infra- renal arteries.

Measurement of renal function

Estimated glomerular filtration rate (eGFR), calculated from the serum creatinine (sCr), is the recommended method to estimate renal function before contrast agent administration.

- In adults ≥ 18 years the creatinine-based 2009 CKD-EPI formula is recommended to calculate eGFR:
  eGFR (ml/min/1.73 m^2) =
  Female sCr ≤ 62 µmol/l: 144 x (sCr / 62)$^{-0.329}$ x 0.993^{Age}
  Female sCr > 62 µmol/l: 144 x (sCr / 62)$^{-1.209}$ x 0.993^{Age}
  Male sCr ≤80 µmol/l: 141 x (sCr / 80)$^{-0.411}$ x 0.993^{Age}
  Male sCr > 80 µmol/l: 141 x (sCr / 80)$^{-1.209}$ x 0.993^{Age}
  (sCr in µmol/l; age in years)
  All equations x 1.159 if African American race.
- In children, the revised Schwartz formula is recommended to calculate eGFR:
  eGFR (ml/min/1.73 m^2) = 36.5 x length / sCr
  (sCr in µmol/l; length in cm)

Note: Neither serum nor plasma creatinine is an ideal indicator of renal function and may miss decreased renal function. Measurement of eGFR is not useful in patients with end stage kidney disease who are receiving dialysis treatment. The person requesting the investigation or procedure should discuss the benefits and risks of administering iodine-based contrast in the context of the patient's residual urine output.

Risk factors

Patient-related risk factors

- eGFR less than 45 ml/min/1.73 m^2 before intra- arterial contrast medium administration with first pass renal exposure or in ICU patients.
- eGFR less than 30 ml/min/1.73 m^2 before intravenous contrast medium or intra-arterial contrast medium administration with second pass renal exposure.
- Known or suspected acute renal failure.

Procedure-related risk factors

- Large doses of contrast medium given intra-arterially with first pass renal exposure.
- Multiple contrast medium injections within 48-72 hours.

At the time of referral

Elective examinations

Measurement of renal function
Measure eGFR before administering intravascular iodine-based contrast medium either
(a) in all patients, or
(b) in patients who have a history of

- Renal disease (eGFR < 60 ml/min/1.73 m2, but not in patients receiving dialysis treatment, compare note above)
- Kidney surgery
- Proteinuria
- Hypertension
- Hyperuricemia
- Diabetes mellitus

Timing of eGFR measurement

- Within 7 days before contrast medium administration in patients with an acute disease, an acute deterioration of a chronic disease, or who are hospital inpatients.
- Within 3 months before contrast medium administration in all other patients.

Emergency examinations

Identify at-risk patients (see above) if possible:

- Determine eGFR if the procedure can be deferred until the result is available without harm to the patient.
- If eGFR cannot be obtained, follow the protocols for patients with eGFR less than 45 ml/min/1.73 m2 for intra-arterial administration with first pass renal exposure and eGFR less than 30 ml/min/1.73 m2 for intravenous administration and intra-arterial administration with second pass renal exposure as closely as clinical circumstances permit.

Before the Examination

Elective examinations

At-risk patients (see above)

- Consider an alternative imaging method not using iodine-based contrast media.
- Intravenous saline and bicarbonate protocols have similar efficacy for preventive hydration.
- For intravenous contrast medium and intra- arterial contrast medium administration with second pass renal exposure hydrate the patient either (a) with intravenous sodium bicarbonate 1.4 % (or 154 mmol/l in dextrose 5 % water): 3 ml/kg/h for 1 hour before contrast medium or (b) with intravenous saline 0.9 % 1 ml/kg/h for 3-4 hours before and 4-6 hours after contrast medium.
- For intra-arterial contrast medium administration with first pass renal exposure hydrate the patient either with (a) intravenous sodium bicarbonate 1.4 % (or 154 mmol/l in dextrose 5 % water): 3 ml/kg/h for 1 hour before followed by 1 ml/kg/h for 4-6 hours after contrast medium or (b) with intravenous saline 0.9 % for 3-4 hours before and 4-6 hours after contrast medium.
- The referring physician responsible for patient care should individualize preventive hydration in patients with severe congestive heart failure (NYHA grade 3-4) or patients with end-stage renal failure (eGFR < 15 ml/min/1.73 m^2).
- Oral hydration is not recommended as the sole method of preventive hydration.

Emergency examinations

At-risk patients (see above)

- Consider an alternative imaging method not using iodine-based contrast media.

- Use preventive hydration before contrast medium administration (see Elective examination above for protocols).
- Individualise if the patients' condition does not allow preventive hydration

At the time of the examination

All patients

- Use low- or iso-osmolar contrast media.
- Use the lowest dose of contrast medium consistent with a diagnostic result.
- For intra-arterial administration of iodine-based contrast media with first-pass renal exposure, it is recommended to maintain either of the following when using a contrast medium concentration of 350 mg iodine/ml:
  - the ratio of contrast medium dose (grams of iodine) to absolute eGFR (ml/min) below 1.1, or
  - the ratio of contrast medium volume (ml) to eGFR (ml/min/1.73 m^2) below 3.0

After the Examination

At-risk patients

- Continue preventive hydration if appropriate (see protocols above).
- Determine eGFR 48 hours after contrast medium administration.
- If at 48 hours there is a diagnosis of CA-AKI, monitor the patient clinically for at least 30 days and determine eGFR at regular intervals.

Note: No pharmacological prophylaxis (with statins, renal vasodilators, receptor antagonists of endogenous vasoactive mediators or cytoprotective drugs, etc.) has been shown to offer consistent protection against CA-AKI.

Prevention of CA-AKI in multiple myeloma patients

- Multiple myeloma patients with normal renal function are not at increased risk of CA-AKI if they are well hydrated and low- or iso-osmolar iodine-based contrast media are used.
- Multiple myeloma patients often have reduced renal function, and such patients are at increased risk of CA-AKI.
- Multiple myeloma patients often have hypercalcemia which can increase the risk of kidney damage. Correction of hypercalcemia before contrast medium administration should be discussed with the haematologist.
- Assessment for Bence Jones proteinuria before contrast medium administration is not recommended.

Renal adverse reactions to gadolinium-based contrast agents

MRI examinations
The risk of CA-AKI is extremely low when gadolinium-based contrast agents are used in approved doses.

Radiographic examinations
Gadolinium-based contrast agents are not approved for x-ray based angiographic examinations or CT.

Safe use of contrast agent administration in patients on dialysis

All iodine- and gadolinium-based contrast agents can be removed by haemodialysis or peritoneal dialysis. However, there is no evidence that haemodialysis protects patients with impaired renal function from post contrast acute kidney injury or nephrogenic systemic fibrosis. In all patients, avoid osmotic and fluid overload.

Patients on haemodialysis

Iodine-based contrast medium

- Coordination of time of the contrast medium injection with the haemodialysis session(s) is unnecessary.
- Extra haemodialysis session(s) to remove contrast medium is not recommended.

Gadolinium-based contrast agent

An immediate dialysis session is not needed after macrocyclic gadolinium-based contrast agents but is indicated after linear agents (e.g., liver-specific agents) and needs to be repeated on the following two days.

Patients on continuous ambulatory peritoneal dialysis

Iodine-based contrast medium

Additional haemodialysis to remove the contrast medium is unnecessary.

Gadolinium-based contrast agent

An immediate dialysis session is not needed after macrocyclic gadolinium-based contrast agents.

The risk of NSF due to linear gadolinium-based contrast agents should be weighed against the risk of placement of a temporary haemodialysis catheter (in consultation with the referring physician).

Management and prevention of contrast agent extravasation

Contrast extravasation is the commonest adverse event in radiological practise and is a complication where there is leakage of intravenously administered contrast agents (either iodine or gadolinium-based), into the surrounding soft-tissues.

Type of injuries

- Most injuries are minor (swelling, discomfort).
- Severe injuries include skin ulceration, soft-tissue necrosis, and compartment syndrome.

Risk factors

Technique-related risk factors

- Less optimal injection sites including lower limb and small distal veins.
- Large volume of contrast.
- High-viscosity contrast.

Patient-related risk factors

- Inability to communicate.
- Fragile or damaged veins.
- Compromised lymphatic and/or venous drainage.
- Obesity.

To reduce the risk

- Meticulous cannula insertion technique using an appropriate size upper arm vein is preferred
- Use an appropriately sized cannula for the vein and anticipated flow rate
- Test injection with saline prior to contrast administration
- Warming of iodine-based contrast medium, especially for compounds with a high viscosity
- Minimising the volume of contrast administered based upon the indication and patient size
- Use of correct flow rates and pressures appropriate to the specific catheter, especially when using central venous catheters
- Effective detection such as direct observation

Recognition and diagnosis

- Instruct the patient to report any pain or swelling, during or after injection
- Observe for signs of extravasation directly both during and following injection, and directly palpate the cannula insertion site
- During contrast infusion observe for any alerts on the contrast injection system and observe the patient for signs of distress. Observe monitoring scans for expected contrast arrival and completed scans for enhancement
    - **Mild**: Minor erythema or swelling, no skin changes.
    - **Moderate**: Skin blistering, progressive oedema and/or ulceration. These will require close monitoring and physician assessment is advised to assess for any neurovascular compromise by checking peripheral pulse and sensation distal in the affected limb

- **Severe**: Any neurovascular compromise, signs of tissue necrosis or compartment syndrome.

Management

Conservative

- Stop injection and scan
- Consult responsible physician
- Mark out affected area
- Assess severity - classify as mild, moderate, or severe (see above):
  - Mild cases: limb elevation, ice packs, monitor patient 2–4 hourly. If improving, then discharge. If no improvement, then requires surgical opinion.
  - Moderate and severe cases: Radiographic documentation — two orthogonal views or cross-sectional imaging can help assess compartmentalisation and extent of extravasation
- Record extravasation as a complication in radiology report and the local incident reporting system
- Patient information leaflet should be given to patient
- Follow-up appointment, if necessary

Involving a surgeon

- If severe injury is suspected, then urgently seek advice of a surgeon
- Surgical opinion also recommended for extravasate >150 ml

Safe time intervals between contrast agent injections

Successive iodine- and gadolinium-based contrast agent administration for routine examinations

When combining contrast-enhanced CT or (coronary) angiography with an **iodine-**based contrast medium and contrast-enhanced MRI with a **gadolinium**-based contrast agent on the same day in elective situations, it is better to **start with** the **MRI** examination, unless the CT examination is intended for the kidneys, ureters, or bladder (CT Urography).

In patients with **normal renal function** (eGFR >60 mL/min/1.73 m^2), consider a waiting time between elective contrast-enhanced MRI with GBCA administration and contrast-enhanced CT or (coronary) angiography with iodine-based contrast medium administration of optimally 6 h (near complete clearance of the effects of the previously administered GBCA) and minimally 2 h (if clinical indication requires rapid follow-up).
In patients with **moderate renal impairment** (eGFR 30-60 mL/min/1.73 m^2), consider a waiting time between elective contrast-enhanced MRI with GBCA administration and contrast-enhanced CT or (coronary) angiography with iodine-based contrast medium administration of optimally 48 h (near complete clearance of the effects of the previously administered GBCA) and minimally 16 h (if clinical indication requires rapid follow-up).

In **severe renal impairment** (eGFR < 30 mL/min/1.73 m^2), consider a waiting time between elective contrast-enhanced MRI with GBCA administration and contrast-enhanced CT or

(coronary) angiography with iodine-based contrast medium administration of optimally 7 days (168h - near complete clearance of the effects of the previously administered GBCA) and minimally 2.5 days / 60h (if clinical indication requires rapid follow-up).

In **emergency** or life-threatening situations, employ no waiting time and perform back-to-back examinations.

Waiting times between two iodine-based contrast medium injections for routine examinations

Patients with **normal renal function** (GFR > 60 ml/min/1.73 m^2):
Consider a waiting time between administrations of optimally 12 h (near complete clearance of the previously administered iodine-based contrast media) and minimally 4h (if clinical indication requires rapid follow-up).

Patients with **moderate renal impairment** (GFR 30-60 ml/min/1.73 m^2):
Consider a waiting time between administrations of optimally 48 h (near complete clearance of the previously administered iodine-based contrast media) and minimally 16 h (if clinical indication requires rapid follow-up).

Patients with **severely reduced renal function and (pre)dialysis patients with remnant renal function** (GFR < 30 ml/min/1.73 m2):
Consider a waiting time between administrations of optimally 7 days / 168h (near complete clearance of the previously administered iodine-based contrast media) and minimally 2.5 days / 60h (if clinical indication requires rapid follow-up).

Patients on dialysis with **no remnant renal function**:
Consider a waiting time between successive iodine-based contrast media administrations of at least 3 dialysis sessions.

In **emergency** or life-threatening situations, employ less waiting time between successive iodine-based contrast media administrations.

Waiting times between two gadolinium-based contrast agent injections for routine examinations

In patients **without known renal impairment**, consider a waiting time between elective contrast-enhanced MRIs with successive GBCA administrations of optimally 12h (near complete clearance of the previously administered iodine-based contrast media) and minimally 4h (if clinical indication requires rapid follow-up).

In patients with **moderate renal impairment** (if available: eGFR 30–60 mL/min/1.73 m2), consider a waiting time between elective contrast-enhanced MRI with successive GBCA administrations of optimally 48h (near complete clearance of the previously administered iodine-based contrast media) and minimally 16h (if clinical indication requires rapid follow-up)

In **severe renal impairment** and **(pre)dialysis patients with remnant renal function** (eGFR < 30 mL/min/1.73 m2), consider a waiting time between elective contrast-enhanced MRI with successive GBCA administrations of optimally 7 days / 168h (near complete clearance of the previously administered iodine-based contrast media) and minimally 2.5 days / 60h (if clinical indication requires rapid follow-up).

In patients **on dialysis with no remnant renal function** consider a waiting time between successive gadolinium-based contrast agent administrations of at least 3 dialysis sessions.

In **emergency** or life-threatening situations, employ less waiting time between contrast-enhanced MRI with successive gadolinium-based contrast agent administrations.

Analytical interference of intravascular contrast agents with clinical laboratory tests

Radiological contrast agents, including iodine- and gadolinium-based compounds, can interfere with commonly used laboratory tests. Therefore, the CMSC offers expert consensus guidance on the timing and use of blood and urine analyses after imaging with contrast agents.

Recommended delay in blood collection after administration of contrast agents:

eGFR > 60 mL/min/1.73 m^2 :
At least 4h and optimally 12h after administration of the contrast

eGFR 30-60 mL/min/1.73 m^2 :
At least 16h and optimally 48h after administration of the contrast

eGFR < 30 mL/min/1.73 m^2 :
At least 2.5 days (60h) and optimally 7 days (168h) after administration of the contrast

Recommended delay in urine collection after administration of contrast agents:

eGFR > 60 mL/min/1.73 m^2 :
At least 24h after administration of the contrast

eGFR 30-60 mL/min/1.73 m^2 :
At least 48h after administration of the contrast

eGFR < 30 mL/min/1.73 m^2 :
At least 7 days (168h) after administration of the contrast

Prevention of Nephrogenic Systemic Fibrosis (NSF)

Diagnosis
A diagnosis of nephrogenic systemic fibrosis (NSF) should only be made if the Yale NSF Registry clinical and histopathological criteria are met (J Am Acad Dermatol 2011; 65: 1095-1106). The association between nephrogenic systemic fibrosis (NSF) and gadolinium-based contrast agents was recognised in 2006.

Clinical features
- Onset can be from the day of exposure for up to 2-3 months. Rarely, it can occur years after exposure.
- Early changes are pain, pruritus, and swelling and erythema of the skin, which usually start in the legs.
- Later changes include fibrotic thickening of the skin and subcutaneous tissues and limb contractures may occur. Fibrosis of internal organs, e.g. muscle, diaphragm, heart, liver, lungs may also occur.
- There may be death if involvement of internal organs is severe.

Risk factors
Patient related risk factors
- Reduced renal function, particularly if eGFR< 15 ml/min/1.73 m^2
- Patients on dialysis.

Contrast agent related risk factors
- Gadodiamide was responsible for most reported NSF cases.
- NSF also occurred after gadopentetate dimeglumine and gadoversetamide.
- Gadopentetate dimeglumine and gadoversetamide are no longer available for intravascular use in Europe.
- Risk increases with increasing contrast agent dose, but NSF has been reported to occur after a single dose.

Estimated incidence in patients with severe renal failure
- 3-18 % in association with gadodiamide.
- 0.1-1 % in association with gadopentetate dimeglumine.

Recommendations for all patients
- Never deny a patient a clinically well-indicated enhanced MR-examination.
- In all patients use the smallest amount of contrast necessary for a diagnostic result. This includes considering for example the use of authority-approved software to enhance contrast signal and/or enable dose reduction of contrast agents and / or the use of high-relaxivity contrast agents.
- Always record the name and dose of the contrast agent used in the patient records.

Risk classification of gadolinium-based contrast agents and recommendations

Highest risk of NSF

Contrast agents

- Gadodiamide (Omniscan®)
  Ligand: Non-ionic linear chelate (DTPA-BMA)
- Gadopentetate dimeglumine (Magnevist®)
  Ligand: Ionic linear chelate (DTPA)
- Gadoversetamide (Optimark®)
  Ligand: Non-ionic linear chelate (DTPA-BMEA)

Recommendations

- European Medicines Agency (EMA) has suspended intravenous use of all high-risk agents (Omniscan®, Magnevist®) and the Marketing Authorization Holder has withdrawn Optimark® from the European market.
- EMA states that Magnevist® may be used for arthrography.
- CMSC supports these recommendations.

Intermediate risk of NSF

Contrast agents

- Gadobenate dimeglumine (Multihance®)
  Ligand: Ionic linear chelate (BOPTA)
  Special feature: It is a combined extracellular and liver specific agent with 2-3% albumin binding. In man ~4% is excreted via the liver.
- Gadoxetate disodium (Primovist®, Eovist®)
  Ligand: Ionic linear chelate (EOB-DTPA)

Recommendations

- EMA states that intermediate risk agents (Multihance®, Primovist®) are approved for hepato-biliary imaging only.
- CMSC supports this recommendation.

Lowest risk of NSF

Contrast agents

- Gadopiclenol (Elucirem® / Vueway®)
  Ligand: Non-ionic cyclic chelate (BP-DO3A)
- Gadobutrol (Gadovist®, Gadavist®)
  Ligand: Non-ionic cyclic chelate (BT-DO3A)
- Gadoterate meglumine (Dotarem®, Magnescope® plus generic products)
  Ligand: Ionic cyclic chelate (DOTA)

- Gadoteridol (Prohance®)
  Ligand: Non-ionic cyclic chelate (HP-DO3A)

Recommendations

- Laboratory testing of renal function (eGFR) prior to contrast agent use is not mandatory.
- In patients with a known or suspected GFR < 30 mL/min, the use of these contrast agents should follow standard risk–benefit considerations, considering the indication, expected benefit, and risk of NSF.
- Pregnant women: these agents can be used to give essential diagnostic information.
- Lactating women: discarding the breast milk in the 24 hours after contrast is not considered necessary, but the patient can discuss with the doctor whether she wishes to do this.

Safe use of contrast agents in pregnancy and lactation

Pregnancy

Iodine-based contrast media

In exceptional circumstances, when radiographic examination is essential, iodine-based contrast media may be given to the pregnant female.

Following administration of iodine-based contrast media to the mother during pregnancy, thyroid function should be checked in the neonate during the first week (neonatal testing of thyroid function is universal and routine in European countries).

Gadolinium-based contrast agents

When there is a very strong indication for enhanced MRI, the smallest possible dose of a macrocyclic gadolinium contrast agent may be given to the pregnant female.

Following administration of gadolinium-based agents to the mother during pregnancy, no neonatal tests are necessary.

Lactation

Iodine-based contrast media

Breast feeding may be continued normally when iodine-based contrast media are given to the mother.

Gadolinium-based contrast agents

Breast feeding may be continued normally when macrocyclic gadolinium-based contrast agents are given to the mother.

Pregnant or lactating mother with renal impairment

Iodine-based contrast media

See Prevention of contrast-associated acute kidney injury.
No additional precautions are necessary for the fetus or neonate.

Gadolinium-based contrast agents

Do not administer gadolinium-based contrast agents.

Safe use of contrast agents in paediatric patients

- Safety considerations when using contrast agents in neonates, infants and children are like, but not the same as, in adults.
- Contrast agent dose must be adjusted for patient age and weight.
- Age-specific normal values of serum creatinine etc. must be used.
- The revised Schwartz equation is recommended to measure eGFR.
- The Summary of Product Characteristics for the contrast agent should be consulted, because not all contrast agents are approved for use in children.
- If no suitable contrast agent approved for use in children is available, informed consent for off-label use must be obtained from parents/guardians. However, if use of a specific contrast agent in children is contra-indicated, it may not be used, even with informed consent.

Safe use of contrast agents in patients with systemic diseases

Safe use of contrast agents in patients with diabetes mellitus taking metformin

Iodine-based contrast media

Patients with eGFR > 30 ml/min/1.73 m^2 and no evidence of AKI, receiving either intravenous or intra- arterial contrast medium with second pass renal exposure: Continue taking metformin normally.

Patients
- with eGFR < 30 ml/min/1.73 m^2 receiving intravenous contrast medium, or intra-arterial contrast medium with second pass renal exposure.
- Receiving intra-arterial contrast medium with first pass renal exposure.
- With acute kidney injury:

Stop taking metformin from the time of contrast medium administration. Measure eGFR within 48 hours and restart metformin if renal function has not changed significantly.

Gadolinium-based contrast agents

No special precautions are necessary when diabetic patients on metformin are given gadolinium-based contrast agents as the risk of CA-AKI is extremely low and lactic acidosis has never been reported in this scenario.

Prevention of iodine-induced hyperthyroidism

Patients at risk:
- Patients with untreated Graves' disease.
- Patients with multinodular goitre and thyroid autonomy, especially if they are elderly and/or live in an area of dietary iodine deficiency.

Patients not at risk:
- Patients with normal thyroid function.

Recommendations
- Iodine-based contrast media should not be given to patients with manifest hyperthyroidism.
- In patients suspected of being at risk of thyrotoxicosis, TSH measurement may be helpful.
- In selected high-risk patients, prophylactic treatment may be given by an endocrinologist.
- Patients at risk should be closely monitored by endocrinologists after iodine-based contrast medium injection.

Safe use of contrast agents in patients with pheochromocytoma - paraganglioma (PPGL)

Preparation
- Before intravenous iodine- or gadolinium-based contrast agent: no special preparation is required.
- Before intra-arterial iodine-based contrast medium: α- and β-adrenergic blockade with orally administered drugs under the supervision of the referring physician is recommended.

Safe use of contrast agents in patients with myasthenia gravis

- Intravenous administration of low-osmolar and iso-osmolar iodine-based contrast media can be associated with an exacerbation of myasthenia gravis symptoms, within the first 24h after administration.
- Exacerbation of myasthenia gravis symptomatology occurs probably in less than 5% of the patients receiving low-osmolar or iso-osmolar iodine-based contrast media IV.
- Gadolinium-based contrast agents are safe for myasthenia gravis patients

Gadolinium retention in the brain and body

Gadolinium retention in the brain

Detection

- Seen as regions of increased signal intensity in the deep brain nuclei on unenhanced T1-weighed MR-images in patients administered GBCAs for prior MRI scans.
- The association between these appearances and gadolinium- based contrast agents was first noted in 2014.

Characteristics

- The signal intensity changes are not specific and may occur after manganese, iron, calcium etc.
- MR is less sensitive for detecting gadolinium in the brain than tissue analysis after biopsy.
- It is not known whether the deposited gadolinium remains chelated.
- No relevant neurological symptoms have yet been confirmed.
- The clinical significance of these changes is not yet known.
- All studies have been retrospective.
- Occurs independent of renal function.

Relation to gadolinium-based agents

- High signal intensity in the deep brain nuclei on MRI has been reported after all linear chelate gadolinium-based agents, but not after macrocyclic agents alone.
- Analysis of brain tissue has detected gadolinium after all gadolinium-based agents with the highest levels of gadolinium in patients who had linear chelate GBCAs and much lower levels in those who had macrocyclic gadolinium-based contrast agents alone.
- The greater the previous cumulative dose of the linear chelate gadolinium-based contrast agent, the more widespread are the areas of increased signal intensity.
- Only occurs after multiple doses

Gadolinium retention in bone, liver and skin

Detection

- Requires biopsy and tissue analysis.

Characteristics

- Occurs independent of renal function.
- May occur after any agent but greater amounts are retained after non-ionic linear chelate gadolinium-based contrast agents.
- Cannot be detected by MRI.
- The amounts deposited are very small but greater than in the brain.
- Bone and liver retention do not produce clinical symptoms.
- Skin deposition has been associated with development of red skin plaques similar to those seen in NSF.
- Apart from NSF, the clinical consequences of bone, liver and skin deposition are unknown.

Safety of ultrasound contrast agents

Statements

- Ultrasound contrast agents are generally safe.
- Clinical evidence of ultrasound contrast agent related events in critically ill patients and patients with acute coronary disease is limited.

Contraindication

- Avoid ultrasound contrast agents in the 24 hours before extracorporeal shock wave treatment.

Type and severity of adverse reactions

- Most reactions are minor (e.g. headache, nausea, sensation of heat, altered taste) and self-resolving.
- More severe acute reactions are rare and are like those after iodine- and gadolinium-based agents

To reduce the risk

- Check for intolerance to any of the components of the contrast agent.
- Use the lowest level of acoustic output and shortest scanning time to allow a diagnostic examination.

Treatment

- If a serious adverse reaction occurs – see Management of Hypersensitivity Reactions

Miscellaneous recommendations and topics

Safety of CO2 as an alternative to iodine-based contrast media in vascular procedures

The evidence in the literature on the safety and benefits of CO_2 angiography as an alternative to iodine-based contrast media is limited due to the small number of meta-analyses, systematic reviews, RCTs and retrospective comparative studies. CO_2 angiography seems to be a safe alternative to iodine-based contrast media in vascular procedures, potentially reducing the risk of CA-AKI, especially in peripheral arterial disease (PAD) procedures when considering specific contraindications and safety measures and the higher incidence of non-serious adverse events. However, more large-scale RCTs are needed to confirm these findings and further investigate risk factors contributing to CA-AKI in both endovascular aneurysm repair (EVAR) and interventional procedures for PAD patients.

Safe use of contrast agents in hysterosalpingography (HSG)

- External validity is limited, as some of the contrast media used in the past are no longer on the market.
- Approximately 10% more pregnancies and live births occur after HSG with oil-based contrast media compared to HSG with water-based contrast media
- Image quality of HSG is significantly better when using oil-based contrast media
- Intravasation during HSG occurs in equal frequency with both contrast media types
- Oil-based contrast media can remain in the abdominal cavity for a prolonged period of time and show a significantly greater inflammatory effect on the peritoneum than water-based contrast media. The clinical consequences are unknown. Caution should be taken when using oil-based contrast media in HSG.
- Subclinical hypothyroidism occurs more often after HSG with oil-based contrast media. Therefore, in every woman receiving oil-based contrast media, thyroid function should be tested before HSG and monitored for 6 months after HSG with oil-based contrast media.
- Routine additional neonatal thyroid function tests after HSG are not indicated.

Fasting before administration of contrast agents

Fasting before intravenous administration of contrast agents dates from the time when high-osmolar iodine-based contrast media were used and many patients vomited. Fasting is not recommended before administration of low- or iso-osmolar non-ionic iodine-based contrast media, gadolinium-based agents or ultrasound contrast agents.

Warming of iodine-based contrast medium before administration

- Appears to make the patient more comfortable, based on clinical observation.
- Reduces viscosity and may reduce the risk of contrast medium extravasation.

- May reduce the rate of general adverse events, but data on this is limited.
- Is widely regarded as good clinical practice.

Off-label use of contrast agents

- Off-label use of diagnostic and therapeutic medication is common.
- The Summary of Product Characteristics (SPC) or label should be checked to see if the proposed contrast agent use is approved for the particular patient and indication.
- Choose a contrast agent which is approved for the particular patient and indication whenever possible.
- If there is no suitable approved contrast agent, the prescriber must tell the patient about the risks and benefits of off-label contrast agent use and obtain the patient's informed consent to off-label contrast agent administration.

Safety of barium contrast media

Contraindications

- Integrity of gut wall compromised: Use iodine-based water- soluble contrast media. In neonates and patients at risk of leakage into mediastinum and/or lungs use low- or iso-osmolar contrast media.
- Previous allergic reactions to barium products: Use iodine-based water- soluble contrast media and be prepared to treat a reaction.

Cautions

- Bowel strictures: Use only small amounts.
- Extensive colitis: Avoid barium enemas.

Complications

- Reduced bowel motility: Encourage fluid intake.
- Venous intravasation: Early identification and careful observation, antibiotics and intravenous fluids, emergency treatment may be needed.
- Aspiration: bronchoscopic removal for large amounts, chest physiotherapy, antibiotics.

Pulmonary effects of iodine-based contrast media

Pulmonary adverse effects

- Bronchospasm.
- Increased pulmonary vascular resistance.
- Pulmonary oedema.

Patients at high risk

- History of asthma.
- History of pulmonary hypertension.
- Incipient cardiac failure.

To reduce the risk of pulmonary adverse effects

- Use low- or iso-osmolar contrast media.
- Avoid large doses of contrast media.

Gadolinium contamination of the environment

- Use of gadolinium-based contrast agents for MRI has led to gadolinium reaching the environment in wastewater.
- At present the amounts of gadolinium in surface and tap water are very low but they are likely to increase with increasing use of gadolinium-based contrast agents.
- The risks of this gadolinium in the environment are not yet known.

The following guidelines are currently being updated

- Safety of ultrasound contrast agents
- Safety of positive gastrointestinal contrast media
- Contrast-associated encephalopathy following procedures requiring iodine-based contrast media
- Safe use of contrast agents in pregnancy and lactation
- Effect of contrast agents on thyroid function in children and adults
- Safe use of contrast agents in patients with type 2 diabetes mellitus using metformin
- Prevention of CA-AKI
- Prevention of NSF

Questionnaires and Letters

Example of a suitable letter for the patient to take to the allergy consultation

Dear colleague,

[PATIENT´S NAME, DOB] had a hypersensitivity reaction after the administration of a contrast agent on [DATE].
Examination type (e.g. CT, MRI, IV...): .....
Type of contrast agent: iodine-based / gadolinium-based / ultrasound
Name of the contrast agent: .....
Dose administered: .....ml
Route of administration (e.g. IV, IA, intra-articular, oral, local...): .....
Time between the injection and the start of the clinical symptoms: .....
Type of symptoms (describe): .....

Grade of the reaction according to the Ring and Messmer classification:

Grade	1	2	3	4
	Dermal	Abdominal	Respiratory	Cardiovascular
1	Pruritus Flushing Urticaria Angioedema			
2	Pruritus Flushing Urticaria Angioedema	Nausea Cramping	Rhinorrhea Hoarseness Dys-pnea	Tachycardia (increase of > 20 bpm), Blood pressure change (> 20 mm Hg systolic), Arrhythmia
3	Pruritus Flushing Urticaria Angioedema	Vomiting Defecation Diarrhea	Laryngeal edema Bronchospasm Cyanosis	Shock
4	Pruritus Flushing Urticaria Angioedema	Vomiting Defecation Diarrhea	Respiratory arrest	Cardiac arrest

Treatment given during the reaction (please specify): .....
Outcome (e.g. follow up, ICU, return home): .....

Tryptase blood test performed
- at the time of the reaction: YES/NO
- < 4 hours later: YES/NO
- Results: .....

Previous history of contrast agent reaction

- Yes/No
- If yes, please specify type of contrast agent and symptoms: .....

Thank you for seeing the patient and performing skin testing to categorize the reaction as either allergic or non-allergic hypersensitivity, and to look for cross-reactivity so that a safer contrast agent can be recommended for future injections.

Your sincerely,

[DATE, NAME, SIGNATURE, DETAILS]

Questionnaire for iodine-based contrast media administration to be completed by the referring clinician

USEFUL INFORMATION FOR PROCEDURES WITH INTRAVASCULAR ADMINISTRATION OF IODINE-BASED CONTRAST MEDIA

Surname ..... **Name** ..... **Date of birth** ...../...../..... **Weight** .....

History of

□ **previous reactions to iodine-based contrast media** ☐ YES ☐ NO
If yes, please describe the type of reaction, its treatment and attach any relevant documentation:

.....

.....

□ idiopathic anaphylaxis (previous shock without known cause) ☐ YES ☐ NO
□ ongoing recurrent angioedema or ongoing chronic urticaria ☐ YES ☐ NO
□ unstable asthma, uncontrolled by therapy, means that in the last 4 weeks the patient experienced:
- symptoms more than twice/week? ☐ YES ☐ NO
- waking up every night because of asthma? ☐ YES ☐ NO
- use of salbutamol more than twice/week? ☐ YES ☐ NO
- any activity limitation because of asthma? ☐ YES ☐ NO

If you selected one of the disease or answered "yes" to one of the questions, the possibility of performing the procedure will be considered in the Radiology Department and the **exam could be postponed** awaiting for the results of the allergy consultation or for the evaluation of the Referring Physician or other Specialists.

Please remember that **premedication is not recommended**, unless prescribed by the Allergologist.

Conditions increasing the risk of kidney injury after administration of iodine-based contrast media

□ *Acute kidney disease (or previous episodes)* ☐ YES ☐ NO
□ *Chronic kidney disease* ☐ YES ☐ NO
□ *Kidney surgery or any kidney intervention or kidney ablation procedure* ☐ YES ☐ NO
□ *Proteinuria* ☐ YES ☐ NO
□ *Diabetes mellitus* ☐ YES ☐ NO *if "yes" please inform if* METFORMIN *is given* ☐ YES ☐ NO

If you answered "yes" to one of the questions remember that **serum creatinine measurement must be available within 3 months at the procedure time in risk patients.**

- **Outpatients** with eGFR<30 ml/min and scheduled examinations with intravenous administration of contrast media (CT, contrast enhanced mammography-CESM) are required to contact the Radiology Department where the procedure is planned – as soon as it is scheduled – in order to organize an adequate iv hydration.
- Patients with eGFR<45 ml/min who should undergo intra-arterial administration need to refer to the Radiology Department/Referring Physician.
-
- **If METFORMIN is given** with eGFR<30 ml/min and an examination with intravenous administration of contrast medium is scheduled (CT, CESM) the Referring Physician is required to stop metformin at the time of contrast administration; the drug can be resumed 48 hours later if renal function has not changed significantly.

Please remember that **withdrawal of nephrotoxic drugs** (such as ACE inhibitors-sartans, aminoglycosides antifungal drugs, antiviral drugs, beta-blockers, biguanides, loop diuretics, non-steroid anti-inflammatory drugs, interleukin-2) **is not required** unless the Nephrologist and/or the Referring Physician considers it is appropriate.

Date ...../...../.....

Completed by .....

General recommendations for scheduled procedures (not in emergency):

- **Fasting is not required**; it could be considered only for some exams (i.e. heart and abdomen studies) as clarified in their informative forms;
- **Continue with the assumption of usual drugs** (unless different advice of the Referring Physician) **and with the usual water intake** (adequate hydration is important);
- Bring **previous clinical documentation, including radiological images**;
- Rememeber that values of some laboratory tests may be altered within 24 hours of contrast administration.

Information on this form refer to international guidelines (ESUR).

Questionnaire for gadolinium-based contrast agent administration to be completed by the referring clinician

USEFUL INFORMATION FOR MRI PROCEDURES WITH INTRAVASCULAR ADMINISTRATION OF GADOLINIUM-BASED CONTRAST AGENTS

Surname ..... **Name** ..... **Date of birth** ...../...../..... **Weight** .....

History of

☐ ***previous reactions to gadolinium-based contrast agents*** ☐YES ☐NO

if yes, please describe the type of reaction, its treatment and attach any relevant documentation:

.....

.....

☐ *idiopathic anaphylaxis (previous shock without known cause)* ☐ YES ☐ NO

☐ *ogoing recurrent angioedema or ongoing chronic urticaria* ☐ YES ☐ NO

☐ *unstable asthma, uncontrolled by therapy, means that in the last 4 weeks the patient experienced:*

- *symptoms more than twice/week?* ☐ YES ☐ NO
- *waking up every night because of asthma?* ☐ YES ☐ NO
- *use of salbutamol more than twice/week?* ☐ YES ☐ NO
- *any activity limitation because of asthma?* ☐ YES ☐ NO

If you selected one of the disease or answered "yes" to one of the questions, the possibility of performing the procedure will be considered in the Radiology Department and the **exam could be postponed** awaiting for the results of the Allergology consultation or for the evaluation of the Referring Physician or other Specialists.

Please remember that **premedication is not recommended**, unless prescribed by the Allergologist.

Serum creatinine measurement is no longer required.

Ongoing dialysis ☐ YES ☐ NO

If yes, please inform in which days :

.....

Date ...../...../.....

Completed by .....

General recommendations for scheduled procedures (not in emergency):

- **Fasting is not required**; it could be considered only for some exams (i.e. heart and abdomen studies) as clarified in their informative forms;
- **Continue with the assumption of usual drugs** (unless different advice of the Referring Physician) **and with the usual water intake** (adequate hydration is important);
- Bring **previous clinical documentation, including radiological images**;
- Rememeber that values of some laboratory tests may be altered within 24 hours of contrast administration.

Information on this form refer to international guidelines (ESUR)

Appendices

Appendix 1. Publications from the ESUR Contrast Media Safety Committee

Aspelin P, Stacul F, Thomsen HS, Morcos SK, van der Molen AJ, Members of Contrast Media Safety Committee of European Society of Urogenital Radiology (ESUR). Iodinated Contrast Media and Blood interactions. Eur Radiol 2006; 16: 1041-1049.

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Appendix 2. Contrast Media Safety Committee, 2025

Olivier Clément (FR) - Chair
Laura Romanini (IT) - Vice Chair
Aart J. van der Molen (NL) - Secretary
Marie-France Bellin (FR)
Michele Bertolotto (IT)
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Carlo C. Quattrocchi (IT)
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Peter Reimer (DE)
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Hubertus Pietsch (Bayer, DE)
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