Abstract In a previous survey we revealed uncertainty among responders about (a) whether or not to perform hemodialysis in patients with severely reduced renal function who had received contrast medium; and (b) when to perform hemodialysis in patients on regular treatment with hemodialysis or continuous ambulatory dialysis who received contrast medium. Therefore, the Contrast Media Safety Committee of The European Society of Urogenital Radiology decided to review the literature and to issue guidelines. The committee performed a Medline search. Based on this, a report and guidelines were prepared. The report was discussed at the Ninth European Symposium on Urogenital Radiology in Genoa, Italy. Hemodialysis and peritoneal dialysis safely remove both iodinated and gadolinium-based contrast media. The effectiveness of hemodialysis depends on many factors including blood and dialysate flow rate, permeability of dialysis membrane, duration of hemodialysis and molecular size, protein binding, hydrophilicity, and electrical charge of the contrast medium. Generally, several hemodialysis sessions are needed to removal all contrast medium, whereas it takes 3 weeks for continuous ambulatory dialysis to remove the agent completely. There is no need to schedule the dialysis in relation to the injection of iodinated or MR contrast media or the injection of contrast agent in relation to the dialysis program. Hemodialysis does not protect poorly functioning kidneys against contrast-medium-induced nephrotoxicity. Simple guidelines are given.

Keywords Contrast media · Gadolinium · Hemodialysis · Peritoneal dialysis · Renal failure · Nephrotoxicity
Introduction

Contrast-media-induced nephropathy remains an important cause of hospital-acquired acute renal failure. Pre-existing renal impairment, especially diabetic nephropathy, and the dose of the contrast medium are major risk factors in the development of contrast nephropathy [1, 2]. It is generally agreed that if contrast medium injection is clinically necessary, the following measures may reduce the risk:

1. Making sure that the patient is well hydrated [give at least 100 ml oral (e.g., soft drinks) or intravenous (normal saline) depending on the clinical situation per hour starting 4 h before to 24 h after contrast administration – in hot climates increase the fluid volume]
2. Use of low- or iso-osmolar contrast media
3. Stopping administration of nephrotoxic drugs for at least 24 h before contrast medium is given [1]

These measures, combined with the administration of the antioxidant acetylcysteine, have recently shown to be very effective in preventing contrast nephropathy in two small studies [3, 4] but was without any effect in a third study [5]. The use of prophylactic hemodialysis to prevent contrast nephropathy in patients with renal impairment has also been proposed but has not obtained general acceptance. In patients on dialysis it is unclear whether intravascular contrast medium injection should be scheduled in relation to or independent of the time of the hemodialysis session. The Contrast Media Safety Committee of the European Society of Urogenital Radiology decided to evaluate

1. The use of hemodialysis and peritoneal dialysis in the elimination of water-soluble iodinated or gadolinium-based contrast agents in patients with end-stage renal disease
2. The value of hemodialysis in preventing contrast-media-induced nephropathy in patients with pre-existing renal impairment

Hemodialysis in removal of iodinated contrast agents

The pharmacokinetic properties of water-soluble iodinated contrast media are such that they are distributed in the extracellular fluid only, protein binding is minimal, they are not metabolized, and excretion is mainly by glomerular filtration. The half-life of iodinated contrast media in patients with normal glomerular filtration rate is approximately 2 h, whereas in patients with severe renal dysfunction it can be prolonged to over 30 h depending on the extent of renal impairment; therefore, in patients with end-stage renal failure the plasma contrast medium concentration remains high for a long period of time. Such patients are at risk of adverse effects on the central nervous system such as convulsions and respiratory depression. The effects on the central nervous system could be due either to contrast media or to uremia [6]. Severe late adverse reactions, including skin disorders, vasculitis, and salivary gland swelling, have also been reported in chronic renal failure patients after high-dose urography [7]. To reduce the risk of these complications it has been suggested that contrast media be eliminated from the body as soon as possible. Contrast media can be efficiently removed from blood by hemodialysis [6, 7, 8, 9, 10, 11, 12].

Several factors influence the elimination of contrast media by hemodialysis (Table 1); firstly, the size and weight of the contrast media molecules since the smaller the solute molecule the more easily it moves across the membrane. Comparisons of dialysance (Dialysance = blood flow rate of the hemodialysis x extraction ratio) values of contrast media from one study to another are usually meaningless as the time period between contrast medium injection and starting dialysis and the dialysis conditions vary from one study to another. In one study under the same conditions the dialysance of non-ionic monomeric contrast media was slightly higher than that of ionic dimeric contrast media partly due to the lower molecular weight and size of the former [7]; however, in another study the elimination of the non-ionic monomer iohexol by hemodialysis was similar to that of the non-ionic dimer ioxaglate which has a molecular mass almost twice that of the iohexol [8]. Secondly, binding to plasma proteins, which have large molecular size, also decreases the efficiency of hemodialysis of contrast media. Hydrophilicity of non-ionic contrast media is an important factor in determining the protein binding of their molecules. The higher the hydrophilicity the lower is the affinity of the molecules to proteins. The elimination by hemodialysis of the non-ionic dimer ioxaglate, which has high hydrophilicity and very low protein binding,