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## An investigation into current protocols and radiographer opinions on contrast extravasation in Irish CT departments

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## ABSTRACT

**Background:** Iodinated contrast extravasation is a serious complication associated with intravenous administration in radiology. Departmental protocols and the radiographer's approach on both prevention techniques and treatment will affect the prevalence of extravasation, and the eventual outcome for the patient when it does occur.

**Aims:** To examine contrast extravasation protocols in place in Irish CT departments for alignment with European Society of Urogenital Radiology (ESUR) Guidelines (2014); to establish radiographer's opinions on contrast extravasation; and to examine radiographer adherence to protocols.

**Methods:** Contrast extravasation protocols from a purposively selected sample of CT departments across Ireland ( $n = 6$ ) were compared to ESUR guidelines, followed by an online survey of CT radiographers practicing in the participating centres.

**Results:** All participating CT departments ( $n = 5$ ) had written protocols in place. High risk patients, such as elderly or unconscious, were identified in most protocols, however, children were mentioned in just one protocol and obese patients were not specified in any. The response rate of CT radiographers was 23% ( $n = 24$ ). 58% ( $n = 14$ ) of respondents indicated that contrast extravasation was more likely during CTA examinations. While high levels of confidence in managing extravasation were reported, suggested treatment approaches, and confidence in same, was more variable. Clinical workload in CT departments was also identified as a factor impacting on patient care and management.

**Conclusion:** While contrast extravasation protocols were generally in line with ESUR Guidelines, high risk patients may not be getting sufficient attention. More radiographer awareness of patient monitoring needs, particularly in busy departments with a heavy workload may also reduce extravasation risk, and improve management of same.

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### Introduction

The use of contrast agents, ionic or non-ionic, is not without its risks. The incidence of any adverse reaction to contrast is about 15%.<sup>1</sup> Contrast extravasation is accidental extravascular injection of contrast media intended for intravascular administration. The consequences of contrast extravasation for the patient can vary from minor pain and swelling, to serious cases of skin ulceration and compartment syndrome.<sup>2</sup>

Studies have shown that with the widespread use of power injectors, and rapid bolus injections, rates of incidence of contrast

extravasation have increased.<sup>3–5</sup> This has led to debate about the risks and prevalence of contrast extravasation in modern CT departments.<sup>6,7</sup> Tonolini et al.<sup>7</sup> indicate the incidence of extravasation with the use of power injectors as one case in every 100–200 procedures when meticulous technique is followed. Thus indicating extravasation is a not negligible risk in radiology practise.<sup>7</sup> However, studies have shown that the frequency of extravasation is not related to injection flow rate.<sup>8,9</sup> All three internationally recognised guidelines on the topic of contrast extravasation, namely, the Royal College of Radiologists (RCR) UK (2015),<sup>10</sup> the American College of Radiology (ACR) (2015)<sup>8</sup> and the European Society of Urogenital Radiology (ESUR) (2014),<sup>11</sup> as well as the professional body for radiographers in Ireland (2014),<sup>12</sup> identify the use of automated power injectors as an increased risk factor for extravasation.

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Much of the literature identifies CT angiography (CTA) examinations as high risk for contrast extravasation.<sup>6</sup> The ACR guidelines on contrast media along with Irish professional guidelines state that a critical step in preventing extravasation is direct monitoring of the injection site, for the first 15 s of injection, with palpation, however, this presents challenges within the CT department for CTA examinations.<sup>8,9,12</sup> There is a limited discussion in literature of the role of the radiographer here, and therefore the approach may very well differ between departments and individual radiographers.

Taking special care, in terms of communication and observation, with particular patients that are considered high risk for extravasation can reduce the risk of extravasation occurring. Infants, elderly, un-co-operative and unconscious patients who cannot communicate or complain of pain are “*high risk patients*”.<sup>7</sup>

Treatment methods for contrast extravasation vary throughout the published literature and there does not seem to be consensus among researchers on the topic. As stated by Hannon et al.,<sup>13</sup> there would appear to be a dearth of literature on the management of extravasation, with no succinct guidelines. The ESUR and RCR guidelines state that conservative management is appropriate, with elevation of the affected limb, applying ice packs to the area and careful monitoring.<sup>10,11</sup> Skin blistering, paraesthesia and increasing or persistent pain for longer than 4 h are suggested indicators of severe injury according to the RCR guidelines, and should be referred for surgical consultation.<sup>10</sup> The ESUR guidelines are not as specific about what injuries would qualify for surgical consultation, only stating “*if serious injury suspected*”.<sup>11</sup>

Aspiration of extravasated contrast through an intravenous cannula is also a much debated topic with Bellin et al.<sup>6</sup> stating that aspiration of fluid from the injection site removes only a small amount of fluid and is also an infection risk while Sum and Ridley<sup>9</sup> support attempting to aspirate the extravasated material back through the cannula. The approach of hot versus cold applications in treating contrast extravasation is a controversial area with the ESUR and RCR both recommending the use of cold compresses<sup>10,11</sup> while Bellin et al. suggest a rationale for also considering hot compress to encourage vasodilation and thus resorption of the extravasated fluid, which cold produces vasoconstriction and limits inflammation.<sup>6</sup> Grol et al. have highlighted that variations, such as the above, in any guidelines and literature can lead to healthcare professionals being both confused and overwhelmed.<sup>14</sup>

Ensuring that radiographers adhere to protocols and have meticulous technique is the first step in prevention as this remains the ideal goal for such injuries.<sup>13</sup> The many discrepancies across the literature regarding contrast extravasation and the ongoing debate on the best treatment methods may leave the radiographer at a loss when it comes to a case of extravasation in the CT department. With this in mind the aims of the current study were:

- to establish what protocols on contrast extravasation are in place in Irish CT departments;
- to compare the contents of these protocols to the internationally recognised ESUR guidelines<sup>11</sup>; and
- to establish radiographer's opinions on the risk and management of contrast extravasation.

## Methodology

An online survey was circulated to all radiographers working in CT in the sample hospitals. The survey was carried out in order to analyse radiographer's opinions on contrast extravasation and its treatment.

## Population and sample

The population was all licensed diagnostic adult CT scanners in Ireland (n = 63), as per the Irish HSE CT population dose survey (2009).<sup>17</sup> The accuracy of the study may have been influenced by the various hospital types. Kumar<sup>16</sup> states the accuracy of the sample depends on the extent of variability or heterogeneity of the study population with respect to characteristics that have a strong correlation with what the research is trying to ascertain. Thus, Irish hospitals were subdivided into stratified groups for sampling: large university teaching hospitals, regional hospitals, and private clinics. A random sample generator, [Randomizer.org](http://Randomizer.org),<sup>17</sup> was then used to generate two random hospitals from each stratified group, which were the sites included in the sample. Gay (1987)<sup>18</sup> stated a sample size of 10% of a large population is reasonable. Thus a sample of 10% (n = 6) hospitals was used based on this evidence and on time and cost constraints and ability to analyse results of the research.<sup>19</sup> The final sample, two large university teaching hospitals, two regional hospitals, and two private clinics, were invited to participate in the study

The first step in the method was obtaining copies of protocols in order to establish the current protocols utilised by Irish CT departments. A copy of the protocol was requested from the CT Clinical Specialist Radiographer (CT CSR) in each hospital. An online survey was then circulated to all radiographers working in CT in the sample hospitals. The survey was carried out in order to analyse radiographer's opinions on contrast extravasation and its treatment.

## Questionnaire design and content

The questions asked in the survey were based on the ESUR guidelines on contrast extravasation,<sup>11</sup> as this was the standard against which responses would be compared to. The questions in the survey were divided into sections and the majority of questions were closed questions. Leading questions were included in order to help radiographers think in sequence and logically about their own technique in practise. To increase response rates, a reminder email was sent two weeks after the survey was originally sent out. A pilot survey was carried out prior to the main study to evaluate the suitability of the questionnaire. According to Connelly (2008), a pilot study should be 10% of the sample size,<sup>15</sup> so one hospital was randomly selected from the population for the pilot survey. The pilot questionnaire was well received by radiographers with no edits needed to wording/format. The benefit of follow up reminders to improve response rates was however highlighted, so these were included in the main study.

## Data analysis and transcription

To analyse protocols from the CT departments, manual review was carried out by the researcher, highlighting key themes and points throughout that may be different to what is recommended in the ESUR guidelines.<sup>11</sup> The ESUR Contrast Media Safety Committee has, since 1994, produced its guidelines on the use of contrast media. These guidelines are peer-reviewed and have been incorporated in protocols of many departments internationally.<sup>11</sup> The contents of the guidelines are based on much other peer-reviewed literature and scientific experimental research, such as Bellin et al.<sup>6</sup> and Tonolini et al.<sup>7</sup> The more recent RCR guideline publication (2015) was also used for comparison in the research. All survey results were entered into Microsoft Excel. Qualitative open questions were analysed a single researcher to identify common themes using thematic analysis.

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