Management of outpatients undergoing contrast enhanced CT at increased risk for contrast induced nephropathy: A retrospective audit of clinical practice

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**Purpose**

Contrast induced nephropathy (CIN) is recognised as a sudden decrease in renal function following the administration of iodinated contrast agents. It has been variably defined as an increase of >44.2 mmol/L - 88.4 mmol/L (0.5 mg/dL - 1.0 mg/dl) or a minimum of 25 - 50% increase in baseline serum creatinine within 3 days of intravascular contrast media exposure (1,2). The incidence of CIN has been reported as anywhere between 1% to 30% (1, 2, 3, 4), the variation being attributed to differing patient populations, inpatient versus outpatient, patient hydration, differing doses of contrast media, timing of patient follow-up and use of serum creatinine as a measure of renal function (2). Patients at the greatest risk for developing CIN are those with chronic kidney disease (CKD), and this risk is even greater when CKD is combined with diabetes mellitus and increasing age (2). The incidence of contrast induced nephropathy has been reported to be between 12-26% in high risk patients where hydration protocols were not administered (3), however an incidence as little as 0 - 10% have been reported amongst low risk patients (3, 4, 5).

Volume expansion prior to and on completion of contrast administration has been shown in some studies to reduce the incidence of CIN (3, 6). The ESUR guidelines recommend intravenous (IV) normal saline to be given for at least 6 hours before and 6 hours after a procedure where IV contrast is administered. The fluid should be administered at a rate of 1 ml per kilogram of body weight per hour (1). A 12 hour period of IV hydration, requiring observation, is not practical for radiology departments performing CT scans on a large number of outpatients, including patients recognised as being at increased risk of CIN. In an attempt to better manage departmental resource requirements a local protocol was developed by renal and radiology services for patients assessed as being at risk of CIN. This protocol guides management of in-patients and out-patients undergoing contrast enhanced CT (CECT).

The aim of this study was to evaluate; (a) adherence to the Auckland City Hospital protocol; and (b) the rate of contrast induced nephropathy in at risk patients following CECT.
Methods and Materials

Ethics approval for this study was obtained from the Northern Regional Ethics Committee and the Auckland District Health Board Research Office.

Our institutional intravenous hydration protocol for outpatient contrast enhanced CT states that at risk patients receiving low dose iodinated contrast (up to 100mL) should receive normal saline for 2-6 hours pre and post contrast in a Day Stay setting. Risk factors include: eGFR <30ml/min in non-diabetic patients, eGFR <40ml/min in diabetic patients, advanced heart failure or multiple myeloma. Patients at risk of CIN receiving larger volumes of contrast or undergoing invasive procedures should be admitted to hospital. Urea and electrolytes should be checked within 48 hours and within one week of the procedure by the referring physician.

CT scan requests, along with the patient’s most recent creatinine and eGFR, are vetted by a consultant or trainee radiologist to assess the risk of CIN. Patients meeting protocol criteria are booked for Day Stay admission. When that patient attends for their CT the rate and volume of pre- and post- IV hydration is decided upon by the consultant or trainee overseeing CT on the day of the scan.

The Radiology Information System (RIS) was reviewed to find 100 consecutive patients admitted to Radiology Day Stay, between February 2009 and July 2010, for the purpose of having a contrast enhanced CT scan. Data was collected retrospectively from review of electronic patient records and clinical laboratory results. The system records the clinician who has viewed laboratory results and when these have been electronically accepted. Hospital policy is for laboratory results to be electronically accepted by the referring clinical team, however the hospital electronic data system automatically "accepts" results after 3 months have elapsed without clinical acceptance.

The following data was collected: patient demographics and date of scan; type of CT scan performed; contrast agent, osmolality and volume administered (Figure 1), relevant co-morbidities including diabetes; pre-scan serum creatinine/eGFR*; post-scan serum creatinine/eGFR* and time taken to review and electronically accept the result; and type of intravenous fluids (if any), volume, and rate of administration.
Of note, eGFR is not routinely included in Auckland City Hospital (ACH) records. If the eGFR was not available it was calculated from serum creatinine using the Modification of Diet in Renal Disease Study Group formula (MDRD).
Results

Of the 100 patients identified as requiring Day Stay admission for IV hydration, 4 were excluded from the study; one was an inpatient admission at the time of scan, two patients were from out of area with records unavailable for follow up, and one had incomplete records with no evidence of a scan or Day Stay admission in the patient’s clinical record.

Of the remaining 96 patients there were 58 men (60.4%) and 38 women (39.6%). Mean patient age was 70 years (40 - 91 years). 20 patients (20.8%) either had documented diabetes, or an HbA1c result consistent with diabetes. 42 patients (43.7%) had their serum creatinine measured within 3 days of the scan being performed and thus followed protocol. A further 14 patients (14.6%) had levels measured within 7 days. The remaining 40 patients (41.7%) were measured after 1 week including some that were not checked within a month. It is unclear whether these were checked in relation to the CT scan protocol or for alternate reasons.

On review only 7 patients (7.3%) admitted to Day Stay met the Institutional protocol for Day Stay admission; 3 non diabetic patients had an eGFR <30ml/min and 4 diabetic patients had an eGFR <40ml/min. 78 (81.2%) patients had an eGFR <60ml/min and 11 patients (11.4%) had an eGFR >60ml/min and were booked into day stay in error by the CT booking system. 56 (58.3%) patients admitted to Day Stay received no peri-procedural intravenous hydration, and 40 (41.7%) patients received intravenous hydration pre and/or post contrast enhanced CT. All patients who received fluid were prescribed 0.9% NaCl, however there was wide variation in the volume and rate prescribed (Figure 2). 6 of the 7 patients who met protocol criteria received IV hydration.
Fig. 2

**References:** Auckland District Health Board - Auckland/NZ

The most common rate was 1000mls at 250mls/hr (25%), followed by 500mls at 250mls (22.5%), and 500mls at 125mls/hr (20%). The time over which IV hydration was given ranged from 1.66 hours - 8 hours.

No patients who received IV hydration had a deterioration in creatinine meeting the criteria for CIN. One patient that did not receive IV hydration therapy had a deterioration of >50% meeting the criteria for CIN. This patient had a pre-CECT eGFR of 56 and was subsequently admitted to hospital for treatment where the primary diagnosis was recorded as contrast induced nephropathy. The remainder of post CT Cr measurements ranged between a 49 - 20% deterioration and a >20% improvement. (Figure 3)
30 (32%) patients had their post study creatinine level measured within the protocol period of 3 days. A further 26 (27%) were checked within 1 week. The remaining 40 patients (41%) had their creatinine checked outside of a week with many not checked for months and in one case over a year.

30 (31%) patients had their post study creatinine results electronically accepted by a clinician within 3 months of their CECT; 12 (12.5%) were accepted within 3 days, 6 (6.2%) within 1 week and 12 (12.5%) greater than 1 week after the blood test. 66 (69%) patients follow-up creatinine result were accepted automatically without clinical review after three months, or were not accepted.

The significance of CIN remains difficult to quantify (2). There appears to be general acceptance that amongst high risk patients CIN represents a clinically significant risk (1). A variety of methods have been used in an attempt to reduce the incidence of CIN, including using N-Acetyl Cysteine (NAC), Mannitol and frusemide with inconsistent results (3,7). Administering 0.9% NaCl at 1mls/kg/hr for 6-12 hrs pre- and post-contrast bolus provides the most effective protection (1). While this intervention is more easily managed for in-patients, it has significant resource implications for out-patients with risk factors for CIN requiring contrast enhanced CT.
The pre-hydration protocol used by our institution was written using a pragmatic approach involving the in-put of both the radiology and renal services. It requires admission of patients with nursing care and the occupation of a bed for between 2 and 8 hours.

Despite having a written departmental protocol the majority of patients were not managed as directed, we think this reflects the misunderstandings surrounding patients thought to be at risk of CIN, with a large number of patients with eGFR <60ml/min admitted for IV hydration, as has been previously recommended (1). The incidence of CIN in our cohort is 0 of 7 if pre eGFR <30 (<40 for diabetic patients) or 1 of 85 if eGFR <60. This is within the range previously reported (2).

In our study fluids were prescribed over an average period of 3.5 hours, ranging between 1 - 8 hours. A wide variety of fluid volumes and rates were prescribed likely reflecting individual clinician interpretation of protocol criteria, their understanding of the risk of CIN and constraints associated with Day Stay resource availability.

The number of patients’ creatinine reviewed at 1 week following CECT was only 18%. This included the one patient with CIN, reviewed at 3 days. We believe this may have been due to the absence of defined communication pathway between the CT department, the referring clinician and primary care doctor about who is responsible for reviewing the results on the Electronic Patient Records (EPR).

The management of outpatients undergoing CECT and thought to be at risk of CIN poses significant challenges. There is uncertainty among clinicians regarding the eGRF threshold level likely to increase risk of CIN, and the true incidence of CIN associated with IV contrast as opposed to IA contrast (2). In addition the resources required to manage these patients includes access to nursing and Day Stay care to allow IV fluid administration, monitoring of patients who may be at risk of fluid overload with over-hydration, a follow-up blood test with appropriate review of the results and further care as indicated. More data is required for this group of patients to justify the significant resources applied to managing a condition with a low incidence.
Conclusion

Our study highlights the difficulty that radiology departments face when implementing a program for patients at risk of CIN having an outpatient CECT. A high level of resource and time are required to effectively manage these patients and adhere to recommended protocols. However even when the protocol is not well followed, the incidence of CIN in our group was low. The findings of this study will form the basis for a revised approach to patients undergoing outpatient CECT at our institution.
References


