



Screening for impaired renal function in outpatients before iodinated contrast injection: Comparing the Choyke questionnaire with a rapid point-of-care-test



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ABSTRACT

Rationale and purpose: To determine the usefulness of the Choyke questionnaire with a creatinine point-of-care test (POCT) to detect impaired renal function amongst outpatients receiving intravenous iodinated contrast in a tertiary centre.

Materials and methods: Between July and December 2012, 1361 outpatients had their serum creatinine determined by POCT and answered the Choyke questionnaire just before their examination.

Results: Four hundred and eighty (35.2%) patients had at least one 'Yes' response. Forty-four patients (3.2%) had estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m² and 14 patients (1.0%) have eGFR <45 mL/min/1.73 m². Sensitivity, specificity, positive predictive value and negative predictive value of the Choyke criteria in detecting patients with eGFR <60 mL/min/1.73 m² are respectively: 65.9%, 65.8%, 6.0% and 98.3% and to detect eGFR <45 mL/min/1.73 m²: 92.9%, 65.3%, 2.7% and 99.9%. Only 'Yes' responses to 'Have you ever been told you have renal problems?' and 'Do you have diabetes mellitus?' were statistically significant in predicting eGFR <45 mL/min/1.73 m², with odds ratio 98.7 and 4.4 respectively.

Conclusion: The Choyke questionnaire has excellent sensitivity and moderate-to-good specificity in detecting patients with <45 mL/min/1.73 m², below this level it has been shown that risk of contrast induced nephropathy increases significantly, making it an effective screening tool. Also the use of POCT can potentially reduce waiting time.

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1. Introduction

Contrast induced nephropathy (CIN) is one of the complications of intravenous contrast administration for computer tomography (CT) scans. Some studies do link CIN to significant morbidity and mortality [1,2] although more recent and larger retrospective studies believe that the nephrotoxic nature of intravenous contrast is overstated [3,4]. Patients with impaired renal function appear to be particularly susceptible [5,6]. Kim et al. found that incidences of CIN are 0.0%, 2.9%, and 12.1% in patients with estimated glomerular filtration rate (eGFR) of 45–59, 30–44, and <30 mL/min/1.73 m² respectively [6]. Weisbord et al. also found significantly increased

rates of CIN in patients with eGFR <45 mL/min/1.73 m² [7]. In the 2011 European Society of Urogenital Radiology (ESUR) guidelines, Stacul et al. proposed eGFR <45 mL/min/1.73 m² as a cut off level for increased risk for CIN in patients undergoing intravenous contrast injections [8]. While the incidence of CIN varies, it is known to be low, with pooled incidences of 2.77–6.42% depending on definition of CIN and contrast agents used [9], it is still advisable to develop a simple strategy to try and detect these patients who are at risk. The focus of this study is thus to try and detect those at risk in outpatients coming for contrast enhanced CT scans as it is impractical to test for serum creatinine for all such patients. While this group of patients is generally healthier than inpatients, they are also less likely to have their renal function comprehensively worked up. Earlier survey studies have found that the awareness of individual radiologists and strategies of individual institutions to identify patients at risk of CIN to be highly variable [10–12].

The Choyke questionnaire is one of the ways which we can try to identify those with impaired renal function in this group of patients. The Choyke questionnaire is a list of 6 questions: Have you ever been told you have renal problems? Have you ever been told

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you have protein in your urine? Do you have high blood pressure? Do you have diabetes mellitus? Do you have gout? Have you ever had kidney surgery? In their study of 673 patients, Choyke et al. found that these questions (out of a larger pool of questions) had the strongest association with raised serum creatinine (measured up to 48 h prior to the CT scan). Majority of the patients in their study (85%) had serum creatinine within the predetermined normal range (<114 $\mu\text{mol/L}$ for women, <123 $\mu\text{mol/L}$ for men). In patients who gave all negative responses, 99% of them had serum creatinine levels <150 $\mu\text{mol/L}$; 6% of patients with negative response to all questions had abnormal serum creatinine levels (false negative) [13].

Other authors have since put the Choyke questionnaire to test. Tippins et al. found that the Choyke questionnaire identified 64 out of the 66 patients (97%) with elevated creatinine (defined as 170 $\mu\text{mol/L}$ and above). Renal disease existed in 62 of the 66 patients (94%) [14]. Sena et al. studied if the Choyke questionnaire would be useful for screening outpatients coming for contrast enhanced MRI. They had their patients answer the Choyke questionnaire twice, once during consultation and once before the scan. They showed that the Choyke questionnaire has a 100% sensitivity for patients with eGFR of less than 30 mL/min/1.73 m² when patients answered 'No' to all questions either just before the scan or on both occasions [15].

We have been using this questionnaire to screen for impaired renal function in our outpatients coming for contrast enhanced CT. Our institution is a high volume tertiary centre with large numbers of renal and oncologic patients as well as patients referred from the primary care polyclinics. In our current protocol, patients with 'Yes' answer to any of the above six questions will be further assessed by the radiology trainee, who can either proceed with the contrast enhanced study, change the study to a noncontrast one or another modality, request for a serum creatinine level for verification (while the patient waits up to an hour for the result to return from the laboratory) or have a discussion with the referring clinician as to how to proceed.

This study was performed to screen the prevalence of impaired renal function in outpatients coming for contrast enhanced study and the usefulness of the Choyke Questionnaire. We compared the results with those from a creatinine point-of-care (POC) test (StatSensor Creatinine, Nova Biomedical, Waltham, Massachusetts, USA) (creatinine-POCT). POCTs have been used in the emergency room, intensive care units as well as outpatient imaging settings, providing quick results that can be useful to guide therapy or improve work flow [16–18]. To our knowledge, this is the first study to compare the Choyke questionnaire using creatinine-POCT.

2. Method

The Centralized Institutional Review board was consulted and determined that its approval and informed consent were not required for our study. This study was conducted between July 2012 and December 2012. This work was supported by The Healthcare Quality Improvement and Innovation (HQI2) Fund (HQI2F 2011/09). Inclusion criteria were: 1. Outpatients coming for contrast enhanced CT scan and 2. No serum creatinine result within 3 months. Exclusion criteria were: 1. Inpatients 2. Patients with a serum creatinine result within 3 months of the appointment. The patient first filled out the Choyke questionnaire once he/she arrived for the CT scan appointment. All 'Unsure' responses were taken as 'No'. During the insertion of the IV cannula by our nurses, a small drop of blood was obtained and the creatinine-POCT performed. The results of the Choyke Questionnaire and the creatinine result were then made known to the radiology trainee. Any change in the patient's management (e.g. switch to a non contrast study or another modality) was noted down.

The same intravenous contrast agent, iohexol (Omnipaque 350, GE Healthcare, United States) was used in all patients. We used the Chronic Kidney Disease-Epidemiology Cooperation (CKD-EPI) equation (with StatSensor's creatinine-POCT values) to calculate estimated Glomerular Filtration Rate (eGFR). Logistic regressions were performed using SPSS version 17.

3. Results

Total study population was 1361, 658 (48.3%) males and 703 (51.7%) females. Mean age was 57.3 years (SD 14.2, range 14–91). A positive questionnaire response is defined as 'Yes' answer to ANY of the six questions and a negative questionnaire response is defined as 'No' answer to ALL 6 questions. There were 881 (64.7%) negative questionnaire responses and 480 (35.2%) positive questionnaire responses.

To see how the creatinine-POCT fared against our central laboratory's creatinine test, we performed a correlation study for 52 serum specimens (leftover blood sent for other laboratory investigations). With a Passing-Bablok regression fit of 1.00X+9.0, creatinine-POCT results however, showed a positive bias of 11.3% against the laboratory's results (Figs. 1 and 2).

Using our hospital's reference intervals for serum creatinine (males 63–110 $\mu\text{mol/L}$; females 40–85 $\mu\text{mol/L}$), 39 patients (2.8%) exceeded the upper limit of the reference intervals. We also found that 44 patients (3.2%) had eGFR <60 mL/min/1.73 m², 14 patients (1.0%) have eGFR <45 mL/min/1.73 m² and 10 patients (0.7%) have eGFR <30 mL/min/1.73 m² (Table 1).

Of the 39 patients who had abnormal creatinine values: 3 patients had change in management after POCT, 2 had non contrast scans performed instead and one did not have any scan performed, 9 patients proceeded with contrast CT anyway as they are on dialysis. The rest of the 28 patients proceeded with contrast CT anyway but none of these patients had eGFR below 45 mL/min/1.73 m².

The sensitivity, specificity, positive predictive value and negative predictive value of the Choyke criteria in detecting patients with eGFR <60 mL/min/1.73 m² are respectively: 65.9%, 65.8%, 6.0% and 98.3% and that to detect eGFR <45 mL/min/1.73 m² are respectively: 92.9%, 65.3%, 2.7% and 99.9% (Table 2). Of the patients with eGFR <45 mL/min/1.73 m², 5 of the patients had one 'Yes' response while 6 of the patients have two 'Yes' responses. The most 'Yes' responses were to the question 'Have you ever been told you have renal problems?' (11/14, 78.6%) followed by 'Do you have diabetes mellitus?' (6/14, 42.9%; Table 1).

If we attempt to use the Choyke Questionnaire to screen for patients with eGFR <30 mL/min/1.73 m² only, the sensitivity, specificity, positive predictive value and negative predictive value are respectively: 100.0%, 65.2%, 2.1% and 100.0%. All these patients have known existing chronic renal disease (Table 2).

If we were to subject the same patient population to a modified questionnaire containing only the above two questions, there would be 200 positive questionnaire responses and the sensitivity, specificity, positive predictive value and negative predictive of the modified questionnaire to detect eGFR <45 mL/min/1.73 m² will be: 85.7%, 86.0%, 6.0% and 99.8% respectively. While this will result in a lower sensitivity (1 more patient with eGFR <45 mL/min/1.73 m² would not be detected compared to the original Choyke questionnaire), there is higher specificity and fewer patients will be tested, resulting in cost savings.

We applied logistic regression to see which of the individual questions within the questionnaire are the best predictors of eGFR <45 mL/min/1.73 m². We found that only the questions 'Have you ever been told you have renal problems?' and 'Do you have diabetes mellitus?' were statistically significant predictors, with odds ratio 98.7 (95%CI 25.7–379.0, $p < 0.001$) and 4.4 (95%CI

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