Clinical Biochemistry 53 (2018) 139–142

Contents lists available at ScienceDirect

Clinical Biochemistry

journal homepage: www.elsevier.com/locate/clinbiochem

Determining the utility of creatinine delta checks: A large retrospective analysis

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A B S T R A C T

Introduction: Delta checks are a long-standing practice for identifying errors in the laboratory. However, with the decrease in errors due to laboratory automation, their utility is unclear. The objective of this retrospective analysis was to determine whether establishment of a creatinine delta check would be an effective means for capturing true laboratory error.

Methods: All patients with a minimum of two creatinine results during March of 2015 were selected for review (n = 23,410 creatinine results). The lowest % change for a previously confirmed creatinine error in our laboratory was approximately 60%; therefore only results that changed by at least ± 60% (n = 254) were reviewed. The etiology of creatinine value change was categorized as laboratory error, pathologic change, or non-pathologic change, based upon chart review.

Results: 1.2% (3/254) of reviewed delta checks were determined to reflect 2 instances of true laboratory error that went unrecognized by laboratory staff. 91.3% (232/254) of the delta checks were determined to reflect a pathologic or dialysis-related change in creatinine levels. The remaining 7.5% of delta checks (19/234) were deemed to be non-pathologic changes in creatinine.

Discussion: This study identified two instances of laboratory error reflected by 3 delta checks (1.2%); the vast majority (91.3%) of creatinine results that changed by ± 60% were pathologic or dialysis-related. Thus, establishment of a ± 60% delta check for creatinine would overwhelmingly flag true biological change and would not be an efficient means for identifying rare laboratory errors. Clinical laboratories should perform similar retrospective analyses prior to enacting delta checks to determine whether they will effectively capture laboratory error.

1. Introduction

Delta checks use two successive test results to detect changes greater than expected for physiological variation [1]. A flagged delta check holds the result for further review by laboratory staff – a long-standing practice for identifying errors that are not detected by other routine quality control measures in the lab. Delta checks were originally introduced in the 1970s, mainly as a method to detect mislabeled samples [2–4]. However, now with relatively fewer specimen mix-ups since the introduction of modern automated analyzers and laboratory information systems (LIS), excessive or "false alarm" delta checks can increase workload, inefficiency of staff, and turnaround times. As a result, the utility of delta checks in detecting true error is unclear. In our laboratory, we experienced a small number of erroneous creatinine results, which raised the question of whether we should institute delta checks for creatinine. Therefore, the objective of this study was to perform a retrospective analysis of creatinine results to determine whether establishment of a creatinine delta check would be an effective means for capturing true laboratory error in the future.

2. Methods

The University of Minnesota Medical Center is the flagship hospital of the larger Fairview Health system, which includes 11 hospitals and 55 clinics. The study population selected for preliminary review included all inpatients and outpatients within our health system who had a minimum of two creatinine results during March of 2015 (n = 23,410 creatinine results). Serum creatinine measurements were performed on Siemens Dimension Vista® 500 or 1500 instruments using the enzymatic creatinine method. Of the creatinine errors previously confirmed in the lab, the minimum percent change was approximately 60%; therefore it was decided to review all consecutive results that changed by ± 60% (n = 254 delta checks) over a 31 day period in March 2015 to determine the utility of establishing a delta check of this magnitude.

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https://doi.org/10.1016/j.clinbiochem.2018.01.023
Received 18 December 2017; Received in revised form 22 January 2018; Accepted 30 January 2018
Available online 01 February 2018

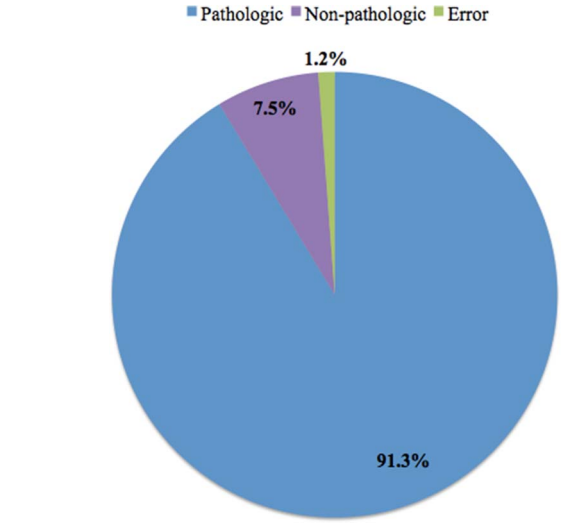

Fig. 1. Etiologies of creatinine change.

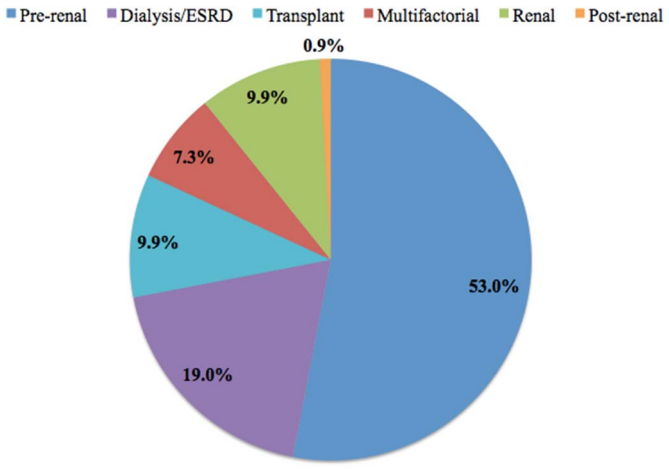

Fig. 2. Sub-classification of pathologic creatinine changes.

Patient medical records were initially reviewed and categorized by a medical student or pathology resident, with confirmatory review of all cases performed by a staff clinical pathologist board certified in clinical chemistry (MD/PhD). Result review entailed thorough examination of patient medical records, including provider notes, ancillary studies, and other laboratory tests at the time of the delta check results. Based on this review, the etiology of creatinine value change was categorized as laboratory error, pathologic change, or non-pathologic change. Pathologic change was further sub-classified into pre-renal, renal, post-renal, dialysis and/or end stage renal disease (ESRD), transplant, or multifactorial (i.e. renal and pre-renal) etiologies, based on the clinician's assessment through medical chart review. Cases were classified as non-pathologic when there was no evidence of renal disease, and creatinine changes were caused by a significant change in hydration status in patients with low-normal creatinine levels (< 0.8 mg/dL or < 70.7 μmol/L), where a 60% change reflects a small absolute change in creatinine.

3. Results

Out of the 254 delta checks reviewed (Fig. 1), 1.2% (3/254) were determined to reflect 2 instances of true laboratory error that went unrecognized by laboratory staff (one error flagged a single delta check; the other error flagged 2 delta checks on the same patient).

91.3% (232/254) of the delta checks were determined to reflect a pathologic or dialysis-related change in creatinine levels. The most common pathologic etiology for change in creatinine was pre-renal at 53.0% (123/232), compared to dialysis/ESRD (19.0%, 44/232), transplant (9.9%, 23/232), multifactorial (7.3%, 17/232), renal (9.9%, 23/232), and post-renal (0.9%, 2/232) (Fig. 2). 7.5% of delta checks (19/254) were deemed non-pathologic.

In the two cases that were errors, the clinical team promptly recognized that the results were likely erroneous because multiple lab results (in addition to creatinine) were inconsistent with prior results, and they immediately ordered re-draws. For both patients, retesting was consistent with earlier lab results and confirmed the erroneous set of results (Tables 1 & 2). Because these errors were identified retrospectively, the etiology of the error could not be determined in real time.

However, patient 1 was hyponatremic and receiving normal saline infusions, which have a sodium concentration of 154 mmol/L [5]; we hypothesize that the erroneous results were due to contamination of the sample with normal saline, leading to an erroneously high sodium level and erroneously low creatinine level. For patient 2, the consistently low values for several analytes led us to hypothesize that the errors were due to a short sample or a sampling error on the instrument. Specimen mix-up is an additional possibility but is less likely, given that our dataset did not identify a complementary delta check for another patient at the same time that would be consistent with two tubes getting switched.

4. Discussion

This retrospective analysis revealed two instances of laboratory error reflected by 3 delta checks (1.2%). In both cases, the clinicians immediately identified the result as likely erroneous as it was not consistent with clinical presentation and prior results, and ordered repeat testing. Therefore, the errors were caught in the post-analytical phase of testing, and thus a creatinine delta check would not have

Table 1
Lab results for Patient 1. The erroneous lab results are highlighted in red.

Date/time of results for Patient 1	03/19/2015 @ 15:17	03/19/2015 @ 21:01	03/19/2015 @ 22:44
Creatinine Reference interval: 0.52 –1.04 mg/dL [45.6 – 92.0 μmol/L]	1.12 mg/dL (↑) [99.0 μmol/L]	0.57 mg/dL [50.4 μmol/L]	1.09 mg/dL (↑) [94.6 μmol/L]
Sodium (mmol/L) Reference interval: 133 –144 mmol/L	127 mmol/L (↓)	146 mmol/L (↑)	128 mmol/L (↓)