Published in final edited form as:

Clin Chem Lab Med. 2015 September 1; 53(10): 1585–1591. doi:10.1515/cclm-2014-0955.

Method to Identify Saline-Contaminated Electrolyte Profiles

Devin K. Patel, M.D.¹, Rishi D. Naik, M.D.¹, Richard B. Boyer, B.S.², John Wikswo, Ph.D.³, and Eduard E. Vasilevskis, M.D. M.P.H.^{4,5}

¹Vanderbilt University Medical Center, Department of Internal Medicine

²Vanderbilt University School of Medicine, Nashville, TN

³Vanderbilt Institute for Integrative Biosystems Research and Education, Vanderbilt University, Nashville, TN

⁴Vanderbilt University Medical Center, Department of Internal Medicine, Division of General Internal Medicine and Public Health, Section of Hospital Medicine

⁵VA Tennessee Valley, Geriatric Research, Education and Clinical Center (GRECC), Nashville TN. Center for Health Services Research

Abstract

Background—With providers becoming more selective in ordering daily chemistry profiles, it is critical that profiles ordered are accurate. Contaminated electrolyte profiles are an overlooked and potentially dangerous source of inaccurate clinical data. This study aimed to develop a method to accurately identify electrolyte profiles contaminated with normal saline to prevent reporting of erroneous measurements.

Methods—We conducted a retrospective cohort study of 76,497 electrolyte profiles from 5,032 patients in a deidentified clinical database of all patients in the electronic medical record at Vanderbilt University Medical Center. Five methods to identify errors in quantification based on either deviations from observed concentration distributions or expected numerical changes from saline contamination were developed and tested. Potentially contaminated measurements were validated based on changes in electrolyte concentrations observed in the subsequent sample.

Results—Identification of erroneous electrolyte profiles based on absolute and percent deviations from normal variation rarely resulted in greater than 50% of identified samples validated as contaminated. A targeted methodology based on expected changes in calcium and chloride concentrations due to saline contamination validated approximately 80% of identified samples when higher thresholds for changes in electrolyte concentration were used and 50% of identified samples when lower thresholds were used.

Conclusion—Targeted methodology based on changes in chloride and calcium successfully identified electrolyte profiles suspicious for contamination. Implementation of this methodology could prevent misinterpretation of a patient's clinical course, inappropriate interventions, and unwarranted changes in treatment strategy.

Keywords

Electrolytes; diagnostic errors; medical error

BACKGROUND

As providers become more selective in ordering chemistry testing, it is critical that reported laboratory data is accurate. While numerous efforts are made to minimize inaccurate laboratory measurements, errors in sample collection, storage, analysis, or reporting can result in erroneous measurement that alter a provider's perception of a patient's clinical progress and cause unnecessary and potentially harmful interventions [1–12]. Saline-contaminated samples represent a specific example of inaccurate measurements. While serum is usually discarded prior to sample collection, samples contaminated with saline during collection can still occur and lead to inaccurate measurement of electrolytes, inappropriate electrolyte replacement, unnecessary additional testing, and misinterpretation of a patient's true clinical status [13–14]. The contamination of blood samples with saline is of particular concern given the high prevalence of venous access devices during patient hospitalization, the frequency with which chemistry panels are ordered, and the practical difficulty of estimating deadspace volume when discarding initial sample [13, 15–25].

Methods are needed to identify instances where there is a high likelihood of sample contamination by saline to avoid inappropriate treatment and testing. The aim of this study was to develop and validate a standardized method to identify electrolyte profiles contaminated with saline so they can be flagged and reported to providers prior to their integration into clinical care.

METHODS**Study Design and Population**

We performed a retrospective cohort study of all records from adult and pediatric patients seen at Vanderbilt University Medical Center, a large tertiary care medical center in Nashville, TN, between 1994 and 2013. Records were screened for documentation of an electrolyte profile, defined as simultaneous quantification of the concentrations of chloride, calcium, creatinine and potassium from a single blood draw. Of the 2,323,149 records screened, 668,701 (28.8%) had documentation of an electrolyte profile and a random sample of 18,545 (2.8%) records containing 278,182 electrolyte profiles were selected for further analysis. Electrolyte profiles were included in analysis if they were both preceded and followed by an additional electrolyte profile within 48 hours of collection. A total of 76,497 (27.5%) from 5,032 unique records met criteria and were included in analysis. This selection process is shown in Figure 1.

Data Source

The Synthetic Derivative (SD), a database of over 2.3 million deidentified patient records at Vanderbilt University Medical Center in Nashville, TN, was used for this study. All tests, imaging reports, significant clinical encounters, laboratory measurement, and provider

coding in Vanderbilt's electronic medical records are stripped of identifying information and stored in SD which can then be searched based on structured and unstructured queries. Use of the SD is classified as non-human research by Vanderbilt University's Institutional Review Board who approved this study.

Laboratory Analyzers

Vanderbilt University Medical Center's clinical laboratory used the Roche Modular system prior to March 2007 when it switched to the Beckman Coulter UniCel DxC 800. This system was in place until September 2013 at which point the Abbott Architect Chemistry Analyzer (c8000 and c16000) was adapted. Specifications for each analyzer are available on their respective websites [26–28]. Analyzers are calibrated every 8 hours for basic electrolyte profiles to ensure continued accuracy over time.

Identification of Contaminated Electrolyte Profiles

Five separate models, summarized in Table 1, were assessed for identification of potentially contaminated electrolyte profiles. Only calcium and chloride were used in the methods as they had significant concentration differences between blood and normal saline and the least variability between samples consecutive samples, as shown in the probability density function plots. Models 1–3 assessed the electrolyte concentrations and changes in concentration within the context of their overall distributions to identify electrolyte profiles suspicious for contaminant. Methods 4 and 5 used predicted concentration changes due to saline contamination to guide identification. Specifically, a new quantity called percent dilution towards saline was developed to estimate the proportion of saline contaminant needed to obtain the observed concentration changes for chloride and calcium. Method 4 identified patient when the percent dilution towards saline for calcium and chloride were both above a cutoff value while Method 5 identified patient if the average of the percent dilution towards saline for calcium and chloride were above a cutoff value. Full description of the methods and example calculations are provided in the Supplemental Methods.

Validation of Contaminated Electrolyte Profiles

Two methods were used to validate electrolyte profiles as contaminated. Method 1 validated profiles if the electrolyte changes on the subsequent electrolyte profile were outside the usual distribution of changes in concentration. Method 2 validated profiles based on the observed concentration changes on the subsequent electrolyte profile relative to the previous electrolyte profile. Specifically, a measurement called return to previous was created which quantifies the proportion the concentration on the subsequent electrolyte profile shifted towards the preceding profile. If the return to previous was greater than 50% for the electrolyte(s) being tested, the profile was validated as contaminated. Full description of the methods and example calculations are provided in the Supplemental Methods.

Sensitivity Analysis

Additional analyses were done to assess the sensitivity of the proposed methods. The model was assessed separately on pediatric (age under 18) and adult (age greater than or equal to 18) populations to determine if the methods remained accurate. Also, analysis based on date

of electrolyte profiles was assessed to control for advances in technology or changes in calibration methods over time. Cutoff years were selected as to split the electrolyte profiles into approximately three equal sized cohorts. Separation based on analyzer use was not possible as dates within Synthetic Derivative are randomly shifted up to one year to ensure patient anonymity, thus preventing identification of analyzer used in quantification.

RESULTS

A total of 76,497 electrolyte profiles from 5,032 patients (15.2 electrolyte profiles/patient, median 23.2 hours between consecutive profiles) were included in this study. The demographics of patients with qualifying electrolyte profiles and distribution of the year of electrolyte profiles are shown in Table 2. Due to deidentification methods utilized by Synthetic Derivative to ensure patient anonymity, only limited demographic information is available. Still, there was no significant gender predominance with 51.6% males and 48.2% female. The majority of patients were Caucasian (70.3%), with a significant number of African American patients (13.0%) and patients with unknown race (13.3%). The mean patient age was 53.8 years with a standard deviation of 24.1 years. A large percentage of patients were elderly with 37.3% of patients over the age of 65. Children under the age of 18 represented 11.6% of the population. The majority of the electrolyte profiles were from between the years 2009 and 2012.

The probability density function and cumulative density function of the concentration, absolute change in concentration, and percent change in concentration for each electrolyte is shown in Figure 2. Notable percentiles within the distributions are shown in Supplemental Table 1. The overall distribution of the concentrations of chloride, calcium and potassium followed an approximately normal distribution centered around 105 mmol L⁻¹, 8.6 mmol L⁻¹, and 3.9 mmol L⁻¹, respectively, with standard deviations of 6.47 mmol L⁻¹, 0.84 mmol L⁻¹, and 0.65 mmol L⁻¹, respectively. The distribution of creatinine is skewed to the right with a median of 1000 µmol L⁻¹, mean of 1500 µmol L⁻¹, interquartile range of 700 µmol L⁻¹ to 1700 µmol L⁻¹ and standard deviation of 1670 µmol L⁻¹. Both the absolute and percent change in concentration of each electrolyte followed approximately normal distributions with means centered around zero. Creatinine and potassium had the highest percent variability between consecutive draws with standard deviations of 21.4% and 15.9%, respectively, which correlated to absolute changes of 500 µmol L⁻¹ and 0.61 mmol L⁻¹. Chloride and calcium had significantly lower percent variability between consecutive draws with standard deviations of 3.7% and 7.6%, respectively, which correlated to absolute changes of 3.77 mmol L⁻¹ and 0.58 mmol L⁻¹.

Figure 3 shows the relationship between proportion of samples identified as contaminated and proportion of identified samples verified as contaminated for each identification methods. Both calcium and chloride were used in each identification methods and Validation Method 2 was used for each to ensure consistency in methodology and to allow for comparison between identification methods. These methods were representative of the overall trends for each electrolyte, identification method and validation method, shown in Supplemental Figures 1–5. Identification Methods 4 and 5 outperformed Identification Methods 1–3 at all identification rates, especially at lower identification rates.

The proportion of profiles identified as contaminated and proportion of identified profiles confirmed as contaminated as a function of cutoff for dilution towards saline is shown in Figure 4 for Identification Methods 4 and 5. Validation Method 2 was used for each identification method. As expected, higher cutoff values resulted in fewer contaminated electrolyte profiles detected but higher confirmation rates of identified profiles. Approximately 1 in 600 samples were detected at cutoff values of 25% minimal dilution toward saline with Method 4 and 29% average dilution towards saline with Method 5. Approximately 80% were validated as contaminated for each. Lower thresholds for identification resulted in approximately 1 in 150 samples being detected at cutoff values of 16% minimal dilution toward saline with Method 4 and 19% average dilution towards saline with Method 5. Approximately 50% were validated as contaminated.

The sensitivity of the methodology was tested by comparing the pediatric and adult populations separately and by stratifying the electrolyte profiles by year of test. Supplemental Figure 6 shows the identification and confirmation rates as a function of cutoff values based on these stratifications. Identification Method 4 and Validation Method 2 were used for these analyses. The identification and validation rates are similar for both pediatric and adult populations and for each time interval tested.

DISCUSSION

This study established a method to identify electrolyte profiles contaminated with saline. While identification of samples based on absolute concentrations or changes in concentration alone did not result in accurate selection, a targeted approach based on the expected concentration changes in calcium and chloride due to contamination with saline successfully predicted erroneous electrolyte profiles. Using cutoffs of 25% minimum dilution towards saline for calcium and chloride or 29% average dilution towards saline, 80% samples identified as contaminated were validated based on statistical and laboratory parameters. Further clinical confirmation and implementation of this method could reduce unnecessary diagnostic work-ups and unwarranted treatments due to erroneous laboratory measurements [29–30].

Our findings offer a new method to assess for laboratory error. Prior studies have focused on critical laboratory values and screened for single electrolyte concentrations. Identification based on critical measurements or change in single electrolyte concentration have been shown to be ineffective, yet is still frequently done resulting in time delays in measurement reporting [31–34]. An integrated approach based on changes in multiple electrolytes within a single blood draw that successfully identify contaminated samples has not previously been developed.

Given the reliability and potential benefits of the proposed methods, an automated mechanism within the laboratory reporting system that warns providers of possible contaminated electrolyte profiles could help decrease erroneous laboratory measurements. This could decrease unwarranted electrolyte repletion and prevent integration of inaccurate data in a patient's clinical picture that may otherwise result in costly clinical tests and potential extension of hospitalizations due to perceived changes in renal function or

electrolyte concentrations. Further, contaminated samples can be further investigated to determine if certain circumstances such as patient demographics, urgency of provider orders, clinical acuity, or operator technique affects likelihood of contamination and ultimately lead to interventions that decrease the incidence of contamination in all serum testing.

The identification methods that detected electrolyte profiles consistent with saline contamination were developed based on numerous clinical and physiological features. Chloride and calcium were selected as they have significant concentration differences between blood and saline ($\sim 105 \text{ mmol L}^{-1}$ vs 154 mmol L^{-1} and $\sim 9 \text{ mmol L}^{-1}$ vs 0 mmol L^{-1} , respectively) compared with sodium ($\sim 140 \text{ mmol L}^{-1}$ vs 154 mmol L^{-1}) meaning saline contamination would result in significant and predictable changes in the measured electrolyte concentration. Calcium and chloride also had less variability between consecutive profiles than potassium and creatinine (standard deviations for percent change between consecutive samples of 7.6% and 3.7% compared to 15.9% and 21.4%, respectively) meaning large numerical changes in their concentrations were more likely due to contamination than *in vivo* changes.

Despite the use of robust methods to identify and confirm potential lab errors, certain limitations of this work must be acknowledged. First, this study was done at a single center and, accordingly, error rates during collection of samples and precision of measurements may differ by institution. Still, similar electrolyte changes would be expected with saline contamination and our results were consistent throughout multiple time periods tested, despite advances in technology. Next, while multiple validation techniques were used, this was a retrospective study and verification of contamination was based on laboratory and statistical methods rather than a true gold standard such as immediate repeat serum testing. This validation method may under-estimated the extent of the contamination, as we were unable to validate one-fifth of samples using this method. Prospective clinical validation of the proposed methods has not yet been completed and will need to be performed to further define the magnitude of the contamination. We also were unable to examine laboratory errors laboratory samples that occur upon patient presentation to the hospital or in patients for whom a recent electrolyte profile is not available. An alternate method would need to be used in these situations. Finally, the use of a 48 hour cutoff is arbitrary, and we assume that electrolyte concentrations are approximately stable in the intervening time. Although the electrolytes chosen have low day-to-day variation and are rarely intervened upon, the true serum electrolyte concentration may change between draws due to interventions to correct laboratory abnormalities or changes in clinical status [35–36].

CONCLUSION

Using a large retrospective database, we developed a method based on expected concentration changes that identifies electrolyte profiles suspicious for contamination. This methods can be integrated into the electronic reporting system to alert providers of possible contamination and trigger redraw of samples so that data from saline contaminated samples is not reported. This could prevent inappropriate interventions, change in treatment strategy and misinterpretation of a patient's clinical course due to inaccurate clinical data.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENTS

The dataset used for the analyses described were obtained from Vanderbilt University Medical Center's Synthetic Derivative, which is supported by institutional funding and by the Vanderbilt CTSA grant ULTR000445 from NCATS/NIH. Dr. Vasilevskis is supported by the National Institutes of Health (K23AG040157), the Veterans Affairs Clinical Research Center of Excellence, and the Geriatric Research, Education and Clinical Center (GRECC). The authors' funding sources did not participate in the planning, collection, analysis or interpretation of data or in the decision to submit for publication.

REFERENCES

1. Yuan S, Astion M, Schapiro J, Limaye AP. Clinical Impact Associated with Corrected Results in Clinical Microbiology Testing J. Clin. Microbiol. 2005; 43:2188–2193.
2. Ismail AAA, Walker PL, Barth JH, Lewandowski KC, Jones R, Burr WA. Wrong biochemistry results: two case reports and observational study in 5310 patients on potentially misleading thyroid-stimulating hormone and gonadotropin immunoassay results. Clin Chem. 2002; 48:2023–2029. [PubMed: 12406989]
3. Marks V. False-positive immunoassay results: a multicenter survey of erroneous immunoassay results from assays of 74 analytes in 10 donors from 66 laboratories in seven countries. Clin Chem. 2002; 48:2008–2016. [PubMed: 12406987]
4. Wiwanitkit V. Types and frequency of preanalytical mistakes in the first Thai ISO 9002: 1994 certified clinical laboratory, a 6 - month monitoring. BMC Clin Pathol. 2001; 1:5. [PubMed: 11696253]
5. Tholen DW, Kallner A, Kennedy JW, Krouwer JS, Meier K. Evaluation of precision performance of quantitative measurement methods; approved guideline—second edition. CLSI EP5-A2. 2004; 24:25.
6. Tholen DW, Linnet K, Kondratovich M, et al. Protocols for determination of limits of detection and limits of quantitation; approved guideline—second edition. CLSI EP17-A. 2004; 24:34.
7. NCCLS. Procedures for the Collection of Diagnostic Blood Specimens by Venipuncture; Approved Standard — Fifth Edition. NCCLS document H3-A5. Wayne, PA: NCCLS; 2003.
8. NCCLS. Evaluation of precision performance of clinical chemistry devices; approved guideline. NCCLS document EP5-A. Wayne, PA: NCCLS; 1999.
9. Bonini P, Plebani M, Ceriotti F, Rubboli F. Errors in laboratory medicine. Clin Chem. 2002 May. 48:691–698. [PubMed: 11978595]
10. Leape LL. Striving for Perfection. Clin Chem. 2002; 48:1871–1872. [PubMed: 12406970]
11. Plebani M, Carraro P. Mistakes in a stat laboratory: types and frequency. Clin Chem. 1997; 43:1348–1351. [PubMed: 9267312]
12. Hollensead SC, Lockwood WB, Elin RJ. Errors in pathology and laboratory medicine: consequences and prevention. J Surg Oncol. 2004; 88:161–181. [PubMed: 15562462]
13. Templin K, Shively M, Riley J. Accuracy of drawing coagulation samples from heparinized arterial lines. Amer J Crit Care. 1993; 2:88–95. [PubMed: 8353585]
14. Clapham MC, Willis N, Mapleson WW. Minimum volume of discard for valid blood sampling from indwelling arterial cannulae. Br J Anaesth. 1987; 59:232–235. [PubMed: 3103659]
15. Bamberg R, Cottle JN, Williams JC. Effect of drawing a discard table on PT and APTT results in healthy adults. Clin Lab Sci. 2003; 161:16.
16. Young, DS.; Bermes, EW. Specimen collection and processing: Sources of biological variation. In: Tietz, NS., editor. Textbook of Clinical Chemistry. Philadelphia: WB Saunders; 1986. p. 494
17. Laxson CJ, Titler MG. Drawing coagulation studies from arterial lines: an integrative literature review. Am J Crit Care. 1994; 1:16–22. [PubMed: 8118489]

18. Soong WJ, Hwang B. Contamination errors when sampling blood from an arterial line. *Clin Pediatr*. 1993; 32:501–503.
19. Zingg W, Pittet D. Peripheral venous catheters: an under-evaluated problem. *Int J Antimicrob Agents*. 2009; 34:S38–S42. [PubMed: 19931816]
20. Lederle FA, Parenti CM, Berskow LC, Ellingson KJ. The idle intravenous catheter. *Ann Intern Med*. 1992; 116:737–738. [PubMed: 1558345]
21. Waitt C, Waitt P, Pirmohamed M. Intravenous therapy. *Postgrad Med J*. 2004; 80:1–6. [PubMed: 14760169]
22. Tager IB, Ginsberg MB, Ellis SE, et al. An epidemiologic study of the risks associated with peripheral intravenous catheters. *Am J Epidemiol*. 1983; 118:839–851. [PubMed: 6650485]
23. May TA, Clancy M, Critchfield J, et al. Reducing unnecessary inpatient laboratory testing in a teaching hospital. *Am J Clin Pathol*. 2006; 126:200–206. [PubMed: 16891194]
24. van Walraven C, Naylor CD. Do we know what inappropriate laboratory utilization is? A systematic review of laboratory clinical audits. *JAMA*. 1998; 280:550–558. [PubMed: 9707147]
25. Baigelman W, Bellin SJ, Cupples LA, Dombrowski D, Coldiron J. Overutilization of serum electrolyte determinations in critical care units: savings may be more apparent than real but what is real is of increasing importance. *Intensive Care Med*. 1985; 11:304–308. [PubMed: 4086705]
26. Coulter, Beckman. UniCel DxC 800 Synchron Clinical Systems. Retrieved May 2, 2014, from www.beckmancoulter.com/wsrportal/wsr/diagnostics/clinical-products/chemistry/unicel-dxc-800-synchron-clinical-systems/index.htm
27. Abbott Diagnostics. Architect c8000. Retrieved May 2, 2014. <http://www.captodayonline.com/productguides/instruments/chemistry-mid-high-2013/architect-c8000-and-ci8200.html>
28. Abbott Diagnostics. Architect c16000. Retrieved May 2, 2014. http://international.abbottdiagnostics.com/Products/Instruments_by_Platform/default.cfm?sys_id=165
29. National Center for Health Statistics. [Accessed: June 6 2014] Hospital admissions, average length of stay, outpatient visits, and outpatient surgery, by type of ownership and size of hospital: United States, Selected years 1975–2011. Public-use data file and documentation. <http://www.cdc.gov/nchs/data/hsr/2013/100.pdf>
30. Neilson EG, Johnson KB, Rosenbloom ST, et al. The impact of peer management on test-ordering behavior. *Ann Intern Med*. 2004; 141:196–204. [PubMed: 15289216]
31. Niu A, Yan X, Wang L, Min Y, Hu C. Utility and Necessity of Repeat Testing of Critical Values in the Clinical Chemistry Laboratory. *PLoS ONE*. 2013; 8:e80663. [PubMed: 24260448]
32. Deetz CO, Nolan DK, Scott MG. An examination of the usefulness of repeat testing practices in a large hospital clinical chemistry laboratory. *Am J Clin Pathol*. 2012; 137(1):20–25. [PubMed: 22180474]
33. Paxton A. Critical value repeats: redundancy, necessity? *CAP Today*. 2010; 24:1.
34. Lehman CM, Howanitz PJ, Karcher DS. QP102—Utility of Repeat Testing of Critical Values Data Analysis and Critique. *Q-PROBES*. College of American Pathologists. 2010:1–12.
35. Thakker, R. Primer on the Metabolic Bone Diseases and Disorders of Mineral Metabolism. Vol. 6. American Society of Bone and Mineral Research; 2006. Hypocalcemia: pathogenesis, differential diagnosis, and management; p. 213
36. Tohme JF, Bilezikian JP. Hypocalcemic emergencies. *Endocrinol Metab Clin North Am*. 1993; 22:363–375. [PubMed: 8325292]

Figure 1. Selection of Patient Population

The selection method for patients in this study is shown here.

Figure 2. Distributions of Absolute Concentration, Percent Change in Concentration and Absolute Change in Concentration of Each Electrolyte

Distributions of the absolute concentrations, percent changes in concentration, and absolute changes in concentration of calcium, potassium, chloride, and creatinine are shown here. The solid lines represent the probability density function (PDF) while the dashed lines represent the cumulative density function (CDF).

Figure 3. Validation Rate as Function of Detection Rate by Identification Method

This plot shows the percent of identified profiles confirmed as contaminated as a function of the percent of profiles identified for each identification method using both calcium and chloride. Validation Method 2 was use for each.

Figure 4. Identification and Validation Rate as Function of Cutoff towards Saline for Identification Methods 4 and 5

The proportion of electrolyte profiles identified as contaminated and proportion of identified profiles confirmed as contaminated as a function of cutoff for minimum dilution towards saline is shown here. Validation Method 2 was used for confirmation of contaminated samples.

Table 1
Identification Methods and Validation Methods

The methods of identifying electrolyte profiles as contaminated and confirming identified electrolyte profiles as contaminated is shown here.

IDENTIFICATION METHODS	
Number	Methodology
1 *	Absolute Concentration [#]
2 *	Percent Change in Concentration [#]
3 *	Absolute Change in Concentration [#]
4	Dilution Toward Saline of Calcium and Chloride Both above Cutoff [^]
5	Average Dilution Toward Saline of Calcium and Chloride above Cutoff [^]
VALIDATION METHODS	
Number	Methodology
1	Percent change in Subsequent Outside the 95% Confidence Interval
2	Return to Previous Greater than 50%

* Methods were assessed separately for calcium and chloride and for both electrolytes together

[#] Samples were identified if measurement fell outside the middle N percentile of the distribution for that measurement, with N modeled as a continuous variable from 0% to 100%

[^] Cutoff modeled as continuous variable from -100% to 100%

Table 2**Patient Demographics**

The demographics of patients with qualifying electrolyte profiles is shown here.

Characteristic		Count	Percent
Gender	Male	2,595	51.6%
	Female	2,426	48.2%
	Unknown	11	0.2%
Race	Caucasian	3,542	70.4%
	Black	656	13.0%
	Hispanic	79	1.6%
	Asian	41	0.8%
	Native American	35	0.7%
	Indian	10	0.2%
	Unknown	669	13.3%
Age	Age 0–18	583	11.6%
	Age 19–45	952	18.9%
	Age 46–65	1,618	32.2%
	Age >65	1,879	37.3%
	Mean	53.8+/-24.1	
Year of Electrolyte Profile	Prior to 2005	5,570	7.3%
	2005	1,675	2.2%
	2006	3,174	4.1%
	2007	5,994	7.8%
	2008	7,994	10.5%
	2009	10,775	14.1%
	2010	13,880	18.1%
	2011	15,019	19.6%
	2012	11,653	15.2%
	2013	763	1.0%