Development of a Dried Blood Spot Lead Test by ICP-MS to Increase Screening Compliance in at Risk Populations

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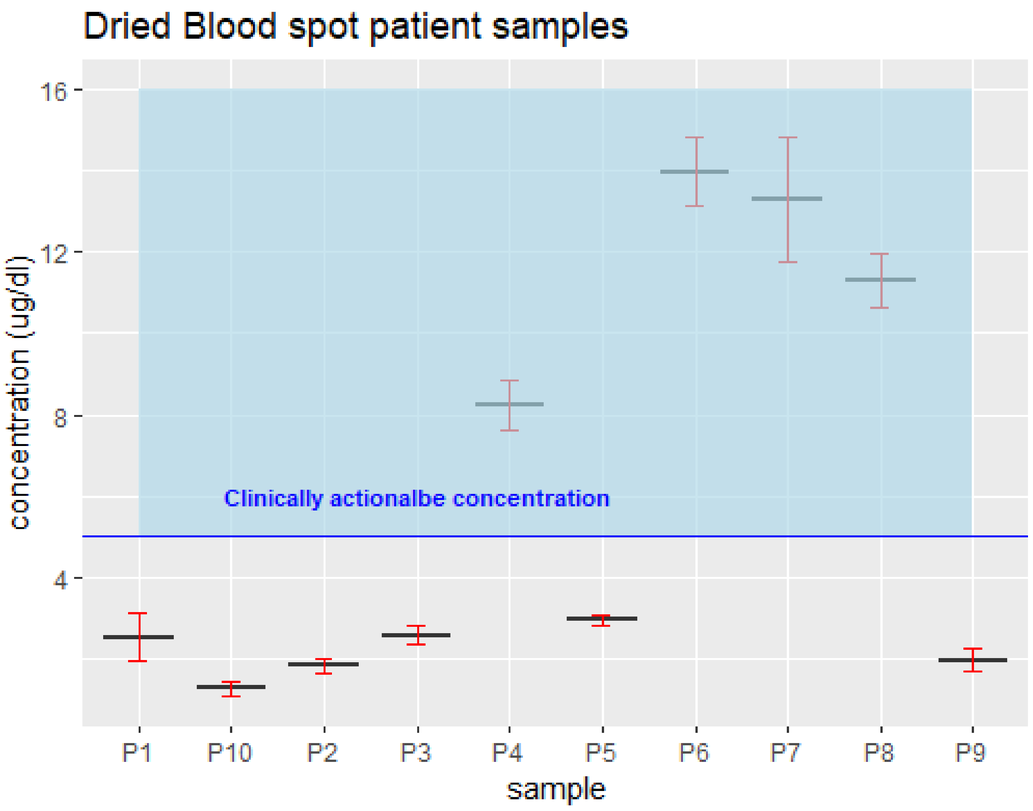
Introduction

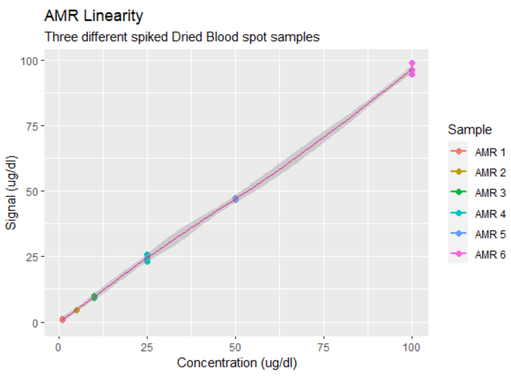
Despite significant progress decreasing blood lead levels among US children 1-5 years of age, demonstrated by a 97.5th percentile of 3.5 µg/dl, lead poisoning remains a public health threat. Lead exposure disproportionately affects Black children, and those below poverty levels, in Medicaid, and living in housing units built before 1978. To improve public safety and testing compliance in children younger than 2 years of age, sample collection can be done by using filter paper and dried blood spots. These cards offer the advantage of easy handling and a less invasive collection method. Lead testing from the dried blood spot is comparable to the gold standard detection of lead from a venous whole blood samples although may be prone to contamination and other interferences. We describe a robust and reproducible test which can be used to measure lead from dried blood spots.

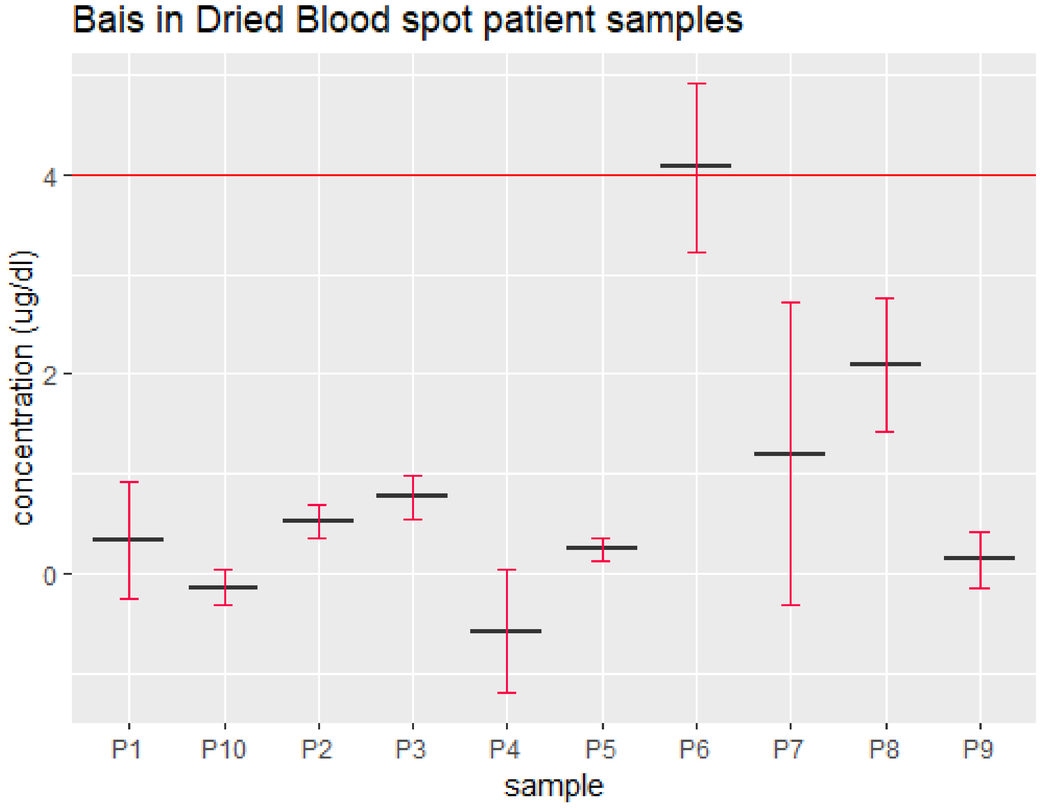
The primary objective of this study was to develop a method using dried blood spot cards for lead testing using inductively coupled plasma-mass spectrometry (ICP-MS).

Methods

This method was developed on a Thermo Fisher iCAP RQ and TQ ICP-MS (Thermo Fisher Scientific, Waltham, MA, USA) in kinetic energy discrimination (KED) mode. The method was calibrated with certified reference material traceable to NIST SRM 3128 (VHG labs, Manchester, NH, USA) in whole blood spotted in Whatman 903 cards at various concentrations and dried for at least two hours. Briefly, 5 ml of extraction buffer was added to a 6mm filter paper disc, followed by a 1-minute vortex at 2,000 RPM, incubation at room temperature for 30 minutes and centrifugation at 4,000 RPM for 5 minutes. Samples were loaded onto an Elemental Scientific Inc. (ESI, Omaha, NE, USA) SC-FSAT sample introduction system and subjected to analysis by the ICP-MS. To assess the performance of the method, the following characteristics were established: linearity, reproducibility, and accuracy. Accuracy and linearity across the measurement range were assessed using a reference standard solution traceable to NIST CRM 3128 (Inorganic Ventures, Christiansburg, VA, USA). Reproducibility and accuracy were assessed using used UTAK controls (Valencia, CA) and 16 patient samples with lead values obtained in a whole blood method.







Show 10 entries Search:

	Sample ID	Concentration (ug/dl)	Target concentration (ug/dl)	%bais	Bais
1	W 21-7	0.00	0.30	100.00	0.30
2	W 21-10	10.24	11.40	10.21	1.16
3	W 21-13	5.79	4.60	-25.98	-1.19
4	W 22-4	37.59	38.00	1.07	0.41
5	W 22-10	25.26	25.60	1.35	0.34

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results

The assay is linear across the analytical measurement range of 1 to 100 µg/dl, and recovery of the linearity materials ranged from 92% to 102%, with an average SD of ± 0.8 µg/dl. In 16 patient samples with concentrations ranging from 1.4 to 19.5 µg/dl run in six replicates, the coefficient of variation (CV) range was 0.6% to 21.1%. In these samples, the bias ranged from 4.4 µg/dl to -0.1 µg/dl. In controls recovery ranged from 88% to 100% and CV ranged from 2.6% to 6.0%. Finally, this method successfully quantified five proficiency testing samples from the Dried Blood Spot Lead Proficiency Testing Program (Wisconsin State Laboratory of Hygiene, University of Wisconsin, Madison, WI).

Conclusion

The dried blood spot method was reproducible and comparable to the routine testing method in whole blood. This dried blood spot lead test meets the performance criteria to be validated as a clinical test in pediatric pa-