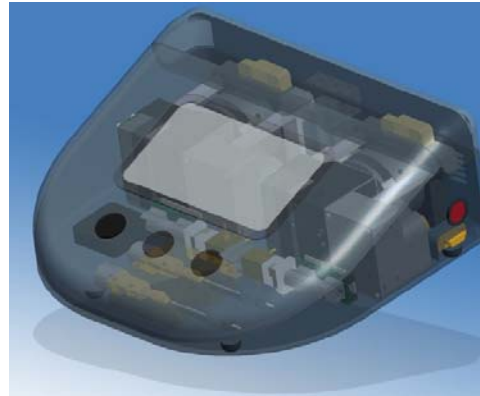


# Lab-on-a-Chip Technology for Oral Diagnostics

## *Rapid Analysis of Human Biological Fluids* Fact Sheet

### *Background*

Sandia National Laboratories' Oral Diagnostics Project was initially funded by the National Institute of Dental and Craniofacial Research (NIDCR), part of the National Institutes of Health. Sandia is one of six research institutions funded to develop point-of-care tools to perform precision analysis of oral fluids. Throughout the last decade, research studies using saliva as a diagnostic fluid have increased exponentially. The primary benefits of saliva-based tests, over more common blood tests, include easier, non-invasive saliva collection and the lower costs associated with saliva testing. The increased interest in saliva diagnostics has also been spurred by rapidly accumulating evidence of correlation between saliva analyte levels and those in serum. Recent development of techniques that



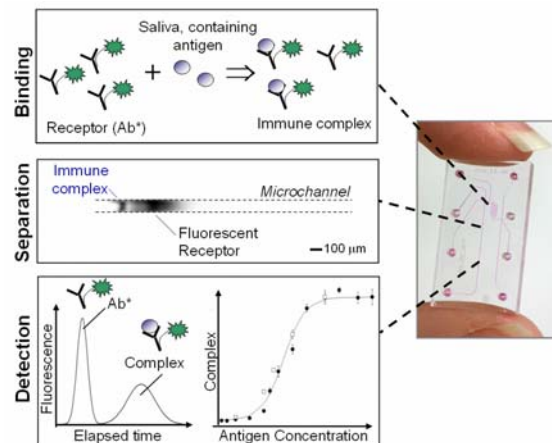
**Sandia's point-of-care diagnostic.**

combine the power of miniaturization with cutting-edge discoveries in fields once distinct as biology and engineering are leading to rapid, high throughput, automated, portable, low cost, and efficient biochemical analyses with small sample volumes.

### *Approach and Key Tasks*

The underpinning technology for Sandia's point-of-care diagnostic allows measurement of protein markers indicative of illness in saliva & other body fluids. Specific advantages enabled by the technology include:

- Fast analysis of fluids samples (5-30 minutes), making clinical or field measurements realistic
- Quantitation of minute biomarker content, as is especially relevant to complex illnesses
- Fully-automated analysis – including sample preparation steps and diagnostic tests
- Analysis of multiple disease indicators, allowing simultaneous measurement of panels of markers.



**Principle of diagnostic immunoassay.**

Our integrated lab-on-a-chip tool makes use of high-specificity, electrokinetic immunoassays (Herr et al., 2005). While developed and benchmarked for an enzyme implicated in periodontal disease, the tool has a broad range of applications – including monitoring of general markers of inflammation in human serum, pen-side analysis of livestock for illnesses such as foot and mouth disease, detection of pathogens in saliva, serum, or nasal mucus.

## Technical Impact

Researchers have envisioned miniaturized diagnostic technologies that could accurately ascertain disease state using droplets (tens of microliters) of human body fluid. Recent reports describe lab-on-a-chip instruments that perform multiple operations in parallel in extra-laboratory settings (i.e., field-deployment, near-patient environments, and resource-poor settings). Current technologies not only provide paths towards such implementation, but are presently being exploited and demonstrated. While recent reports show promise for microfluidic detection of analytes in various body fluids, few, if any, reports on detection of endogenous biomarkers in saliva using a semi-portable instrument have been made. Optimal operating specifications for point-of-care instrumentation can be described as:

- Saliva-based: Ready collection of samples by trained or untrained personnel.
- Microfluidic: Requires small volumes of saliva.
- Multiplexed detection: Simultaneous analysis of multiple analytes for accurate assessment of complex diseases.
- Portable and easy to use: Point-of-care testing with simple user interface.
- Rapid: Simultaneous protein measurements within a routine clinical visit.
- Low cost: Feasible widespread screening, diagnosis, and monitoring.

## Benefit to National Needs

While the primary contributions of the NIDCR-funded project center on detection and monitoring of illness associated with the oral cavity – the technology developed by our group has applicability to systemic illness and infection. As such, we are currently advancing our methods for use in biodefense and infectious disease concerns. The clinical questions and device engineering inherent in the project directly impact a number of critical areas of national need.

- The microsystems developed are a step towards fulfilling the fundamental need for compact, high-sensitivity, highly-multiplexed laboratory analytical tools that not only will improve our understanding of host-response to infection and illness, but also aid researchers engaged in drug discovery, cancer research, and emergency response.
- Troop readiness and efficient field medical diagnosis and treatment are top priorities in national defense. The Oral Diagnostics project has allowed Sandia to identify target body fluids beyond those requiring blood draws, biomolecular markers of early and developing illness, and provide next-generation device capabilities for diagnosis and monitoring of civilian and service member health.

Overall, Sandia's Oral Diagnostics project has advanced and continues to advance point-of-care diagnostics for a multitude of important research, clinical and emergency response concerns.

## Collaborators, Sponsors, & References

University of Michigan, School of Dentistry and National Institute of Dental and Craniofacial Research

- AE Herr, DJ Throckmorton, AA Davenport, AK Singh. *Analytical Chemistry*, 2005, 77, 585-90.
- AV Hatch, AE Herr, DJ Throckmorton, JS Brennan, AK Singh. *Analytical Chemistry*, 2006, 78, 4976-84.
- AE Herr, AV Hatch, DJ Throckmorton, JS Brennan, HM Tran, WV Giannobile, AK Singh. *NY Acad Sci*, 2007, *in press*.

## For More Information, Please Contact



Anup K. Singh, Ph.D., Principal Investigator: (925) 294-1260, [aksingh@sandia.gov](mailto:aksingh@sandia.gov)  
<http://www.sandia.gov/mission/homeland/chembio/development/biotechnology/nih.html>