



## Young Forensic Scientists Forum—2020

---

### Y20 The Benefits of Automation in Forensic Toxicology: A Lean Six Sigma and Cost-Analysis Approach

*Sarah J. Guertin, BS\*, Birmingham, AL 35205; Elizabeth A. Gardner, PhD, University of Alabama Department of Criminal Justice, Birmingham, AL 35294-4562; Hui Liu Yong, BS, Alabama Department of Forensic Sciences, Hoover, AL 35244; Curt E. Harper, PhD, Alabama Department of Forensic Sciences, Hoover, AL 35244*

---

**Learning Overview:** After attending this presentation, attendees will be proficient in Lean Six Sigma and cost-analysis techniques used to identify inefficient methods and processes in the laboratory.

**Impact on the Forensic Science Community:** This presentation will impact the forensic science community by highlighting the advantages of automating extraction and preparation methods for toxicological analysis.

**Background:** Reducing backlogs, improving turnaround times, and streamlining methodology are major focus points for forensic toxicology laboratories. A factory-minded approach in which cases are considered widgets will allow a laboratory to identify areas for improvement. Lean Six Sigma is a process that relies on a collaborative team effort to improve performance by systematically removing waste and reducing variation. By applying this approach combined with a detailed cost-analysis, inefficient or costly processes in the laboratory can be identified. Analytical methods identified in this exercise are excellent candidates for automation transition. Fully automated instruments and equipment, such as the Randox<sup>®</sup> Evidence Analyzer and Hamilton<sup>®</sup> Starlet, are excellent options for automation.

**Method:** Each standard operating procedure used by the Alabama Department of Forensic Sciences was reviewed and observed. An itemized list of consumables was created, and the cost of each item was obtained from previous purchase orders. The average analyst time, salary, and hourly wage were calculated and used to determine the cost of analyst time dedicated to each assay. An MS<sup>®</sup> Excel<sup>®</sup> template for cost compilation (with and without personnel cost) was created in order to determine the cost of each individual method. The cost per maximum-sized batch and cost per case of each assay was calculated. Cost comparison between assays are listed as follows: (1) blood drug screening methods using the Tecan Evo<sup>®</sup> 75 (semi-automated) versus Randox<sup>®</sup> Evidence Analyzer (fully automated), (2) oral fluid drug confirmation methods using Dispersive Pipette Extraction (DPX) on the INTEGRA VIAFLO 96 (semi-automated) versus Hamilton<sup>®</sup> Starlet (fully automated), and (3) opioid quantitation methods using traditional Solid Phase Extractions (SPE) (manual) versus Thermo Scientific<sup>™</sup> SOLA $\mu$ <sup>™</sup> SPE well plate on Hamilton<sup>®</sup> Starlet (fully automated).

**Results:** The most costly and inefficient method identified was the opioid blood quantitation method by traditional SPE. When transitioned to the fully automated Hamilton<sup>®</sup> Starlet, the cost per case and extraction time were reduced by 59% and 50%, respectively. In addition, the sample capacity (batch size) was doubled compared to traditional SPE. Similarly, the oral fluid drug confirmation method using the Hamilton<sup>®</sup> Starlet reduced the cost per case and extraction time by 29% and 38%, respectively. The sample capacity was doubled compared to the semi-automated confirmation method with the INTEGRA VIAFLO 96. The cost per case of a blood drug screen with the fully automated Randox<sup>®</sup> costs 10% more than a blood drug screen with the semi-automated Tecan. However, Randox<sup>®</sup> requires 64% less analyst time per batch.

**Conclusion:** Lean Six Sigma entails removing waste, increasing speed, and reducing variation. A major component of time is the sample preparation and extraction prior to instrumental analysis. If this can be automated, a scientist can focus on other aspects of their duties, such as reporting, reviewing, or providing expert witness testimony. This study provides a better understanding of cost per case, cost per batch, and major contributors to cost, including personnel time. Suggested strategies to reduce inefficiencies and costs include maximizing batch size and reducing analyst time by converting methods to full automation. Future studies will involve evaluating instrument and data analysis cost and time.

---

#### Cost Analysis, Automation, Lean Six Sigma