Project FORESIGHT Annual Report, 2011-2012

Forensic Science Initiative, College of Business & Economics, West Virginia University

Redacted
FORESIGHT
Laboratory
Participant ABC

FORESIGHT Benchmark Data 2011-2012

The benchmark data for the 2011-2012 performance period includes laboratory submissions for a variety of fiscal year definitions. However, all submissions have December 31, 2011 as part of their fiscal year accounting. The majority of submissions follow a July 1, 2011 through June 30, 2012 convention. Others follow a year that begins as early as April 1, 2011 (ending March 31, 2012) while the other extreme includes laboratories with a fiscal year originating October 1, 2011 and ending September 30, 2012.

Consider the summary statistics for several of the key performance indicators. Two measures of central tendency, mean and median, are reported. Because of outliers in several of the investigative areas, the most meaningful comparisons might best be made with respect to median as a representation of "typical" laboratory performance.

Cost per Case

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	$74	$271	$121	$360
Crime Scene Investigation		$4,433	$5,409	$3,441
Digital evidence - Audio & Video		$4,527	$4,824	$1,011
DNA Casework	$1,128	$1,902	$1,746	$641
DNA Database	$54	$71	$54	$54
Document Examination	$3,323	$3,965	$3,899	$2,071
Drugs - Controlled Substances	$174	$229	$187	$105
Evidence Screening & Processing	$397	$520	$525	$121
Explosives		$8,542	$5,205	$6,949
Fingerprints	$672	$416	$326	$348
Fire analysis	$277	$2,088	$956	$1,957
Firearms and Ballistics	$1,582	$1,331	$820	$1,402
Forensic Pathology	$2,255	$3,115	$3,291	$644
Gun Shot Residue (GSR)	$628	$2,168	$1,215	$1,852
Marks and Impressions	$4,278	$4,349	$3,989	$3,078
Serology/Biology	$437	$690	$591	$370
Toxicology ante mortem (excluding BAC)	$403	$694	$607	$561
Toxicology post mortem (excluding BAC)	$362	$715	$637	$412
Trace Evidence	$5,143	$5,679	$2,843	$7,201

The **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses. A **case** in an investigative area refers to a request from a crime

laboratory customer that includes forensic investigation in that investigative area. Note that a customer request may lead to a case in multiple investigative areas.

Cost per Item

Differences in case detail and differences in case complexity across laboratories (and across time) suggest that other relative cost measures may offer more meaningful comparison. FORESIGHT data collection includes measures for items, samples, and tests in each investigative area.

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	$74	$218	$104	$274
Crime Scene Investigation		$12,878	$5,620	$18,469
Digital evidence - Audio & Video		$3,767	$3,424	$1,449
DNA Casework	$801	$766	$689	$218
DNA Database	$56	$984	$52	$2,479
Document Examination	$556	$1,501	$1,219	$1,236
Drugs - Controlled Substances	$112	$127	$106	$87
Evidence Screening & Processing	$97	$260	$97	$288
Explosives		$4,408	$2,801	$3,749
Fingerprints	$198	$191	$133	$183
Fire analysis	$122	$738	$444	$825
Firearms and Ballistics	$304	$436	$338	$321
Forensic Pathology	$2,255	$3,115	$3,291	$644
Gun Shot Residue (GSR)	$483	$1,197	$732	$1,007
Marks and Impressions	$2,456	$1,421	$1,086	$813
Serology/Biology	$208	$193	$139	$120
Toxicology ante mortem (excluding BAC)	$351	$486	$446	$392
Toxicology post mortem (excluding BAC)	$333	$373	$333	$210
Trace Evidence	$1,940	$3,025	$1,629	$3,581

An **item** refers to a single object for examination submitted to the laboratory. Note that one item may be investigated and counted in several investigation areas. As noted above, the **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses.

Cost per Sample

The sample (defined below) offers a consistently applied metric across laboratories and suggests and average cost measure that is intuitively comparable in cross sectional commentary.

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	$74	$160	$85	$175
Crime Scene Investigation		$13,737	$940	$22,979
Digital evidence - Audio & Video		$2,174	$870	$2,469
DNA Casework	$801	$514	$481	$222
DNA Database	$56	$984	$52	$2,479
Document Examination	$556	$1,637	$1,247	$1,481
Drugs - Controlled Substances	$112	$110	$81	$87
Evidence Screening & Processing	$97	$161	$110	$99
Explosives		$2,821	$2,914	$485
Fingerprints	$198	$166	$129	$132
Fire analysis	$122	$743	$396	$922
Firearms and Ballistics	$304	$355	$277	$258
Forensic Pathology	$2,255	$2,954	$2,986	$683
Gun Shot Residue (GSR)	$483	$702	$324	$1,060
Marks and Impressions	$2,456	$1,421	$1,042	$1,203
Serology/Biology	$208	$127	$110	$92
Toxicology ante mortem (excluding BAC)	$351	$327	$332	$204
Toxicology post mortem (excluding BAC)	$333	$311	$333	$225
Trace Evidence	$1,940	$2,926	$1,308	$4,050

A **sample** refers to an item of evidence or a portion of an item of evidence that generates a reported result. As noted above, the **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses.

Cost per Test

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	$35	$85	$45	$87
Crime Scene Investigation		$7,374	$1,984	$11,094
Digital evidence - Audio & Video		$85	$79	$28
DNA Casework	$237	$294	$137	$546
DNA Database	$51	$269	$45	$610
Document Examination		$567	$222	$835
Drugs - Controlled Substances	$34	$41	$36	$25
Evidence Screening & Processing	$39	$46	$39	$24
Explosives		$804	$840	$404
Fingerprints	$82	$62	$61	$31
Fire analysis	$121	$306	$191	$234
Firearms and Ballistics	$213	$158	$151	$131
Forensic Pathology	$2,255	$1,166	$698	$946
Gun Shot Residue (GSR)	$157	$377	$175	$384
Marks and Impressions	$942	$433	$401	$306
Serology/Biology	$29	$39	$29	$21
Toxicology ante mortem (excluding BAC)	$98	$88	$82	$53
Toxicology post mortem (excluding BAC)	$143	$79	$60	$54
Trace Evidence	$230	$627	$378	$554

A **test** refers to an analytical process, including but not limited to visual examination, instrumental analysis, presumptive evaluations, enhancement techniques, extractions, quantifications, microscopic techniques, and comparative examinations. This does not include technical or administrative reviews. As noted above, the **cost** includes allocations for capital, wages & salary, benefits, overtime & temporary hires, chemicals, reagents, consumables, gases, travel, quality assurance and accreditation, subcontracting, service of instruments, advertisements, non-instrument repairs and maintenance, equipment leasing, utilities, telecommunications, overhead, and other expenses

The various unit cost metrics may be interpreted using the technique highlighted in The Decomposition of Return on Investment for Forensic Laboratories, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 2, 2009, Paul J. Speaker, pages 96-102. Consider the Cost/Case metric which may be decomposed into:

$$\frac{Cost}{Case} = \frac{Average\ Compensation\ x\ Testing\ Intensity}{Personnel\ Productivity\ x\ Personnel\ Expense\ Ratio}$$

From the decomposition expression for the Cost/Case, an increase in the numerator components, Average Compensation or Testing (or Sampling) Intensity, will increase the cost per case. Similarly, a decrease in denominator component will increase the cost per case. This may occur from either a drop in productivity, as measured by cases processed per FTE, or from an increase in capital investment for future productivity but financed via a drop in personnel expenses relative to total expenses.

Average Compensation

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	$75,441	$74,241	$76,292	$19,653
Crime Scene Investigation		$88,082	$91,150	$16,881
Digital evidence - Audio & Video		$82,709	$78,321	$10,813
DNA Casework	$61,148	$95,804	$87,242	$41,919
DNA Database	$46,827	$60,354	$66,988	$18,431
Document Examination	$63,997	$78,142	$74,439	$19,364
Drugs - Controlled Substances	$65,855	$77,120	$71,772	$16,264
Evidence Screening & Processing	$42,992	$73,357	$60,732	$38,644
Explosives		$79,893	$81,758	$34,260
Fingerprints	$60,302	$75,901	$72,517	$16,092
Fire analysis	$50,427	$88,241	$76,038	$40,314
Firearms and Ballistics	$58,872	$87,344	$82,689	$23,627
Forensic Pathology	$103,982	$103,604	$102,783	$5,804
Gun Shot Residue (GSR)	$73,959	$74,646	$69,843	$19,968
Marks and Impressions	$82,190	$71,747	$70,943	$27,460
Serology/Biology	$62,416	$74,165	$67,487	$27,022
Toxicology ante mortem (excluding BAC)	$60,236	$75,675	$62,374	$25,312
Toxicology post mortem (excluding BAC)	$56,718	$75,821	$66,211	$26,589
Trace Evidence	$64,075	$100,599	$90,490	$62,848

Note that **compensation** includes all personnel expenditures. This includes wages, salary, and benefits operating staff, support staff, and administrative staff. Centrally assigned compensation is apportioned to each investigative area according to the percentage of full-time equivalent employees assigned to a particular investigative area.

There are a variety of metrics that may be used in the decomposition of average cost to suggest quality and/or risk. Three of these metrics follow to highlight the level of testing, sampling, and items examined per case.

Items per Case

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	1.00	1.26	1.03	0.38
Crime Scene Investigation		31.96	1.00	62.43
Digital evidence - Audio & Video		1.25	1.35	0.22
DNA Casework	1.41	2.63	2.35	1.00
DNA Database	0.96	0.89	1.00	0.41
Document Examination	5.98	4.35	3.46	3.28
Drugs - Controlled Substances	1.55	2.46	2.03	1.59
Evidence Screening & Processing	4.07	4.03	4.07	3.13
Explosives		2.03	1.75	0.85
Fingerprints	3.40	2.74	2.25	1.54
Fire analysis	2.28	2.99	2.54	1.41
Firearms and Ballistics	5.20	3.76	2.47	3.66
Forensic Pathology	1.00	1.00	1.00	0.00
Gun Shot Residue (GSR)	1.30	1.96	2.22	0.76
Marks and Impressions	1.74	3.10	3.31	1.39
Serology/Biology	2.10	4.93	3.95	3.26
Toxicology ante mortem (excluding BAC)	1.15	1.71	1.35	1.19
Toxicology post mortem (excluding BAC)	1.09	2.76	2.09	2.48
Trace Evidence	2.65	2.06	2.13	0.47

Samples per Case

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	2.00	1.69	1.51	0.80
Crime Scene Investigation		44.17	7.60	69.82
Digital evidence - Audio & Video		4.00	5.40	2.54
DNA Casework	1.79	4.08	3.98	1.52
DNA Database	0.96	0.89	1.00	0.41
Document Examination	5.98	5.08	2.66	4.59
Drugs - Controlled Substances	1.90	3.06	2.21	2.93
Evidence Screening & Processing	4.07	3.92	4.07	1.94
Explosives		4.00	3.89	2.56
Fingerprints	5.39	3.63	2.40	4.03
Fire analysis	2.28	4.09	2.88	2.90
Firearms and Ballistics	6.02	5.12	3.97	4.19
Forensic Pathology	1.00	1.00	1.00	
Gun Shot Residue (GSR)	4.00	5.15	4.58	2.85
Marks and Impressions	0.98	3.93	3.50	3.16
Serology/Biology	6.73	6.30	7.82	2.60
Toxicology ante mortem (excluding BAC)	1.16	3.16	1.65	3.55
Toxicology post mortem (excluding BAC)	1.09	4.81	2.08	6.16
Trace Evidence	14.09	3.41	2.13	3.33

Tests per Case

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	2.10	2.98	2.19	1.73
Crime Scene Investigation				
Digital evidence - Audio & Video		57.52	43.20	26.32
DNA Casework	4.76	15.30	10.94	12.47
DNA Database	1.06	1.35	1.06	1.24
Document Examination		30.99	11.64	43.16
Drugs - Controlled Substances	5.18	7.02	5.28	4.30
Evidence Screening & Processing	10.18	13.60	10.18	8.61
Explosives		14.07	15.31	5.90
Fingerprints	8.21	9.39	6.24	12.76
Fire analysis	2.30	7.87	6.00	3.87
Firearms and Ballistics	7.43	27.20	7.43	50.87
Forensic Pathology	1.00	3.89	5.19	2.51
Gun Shot Residue (GSR)	4.00	9.08	6.49	8.86
Marks and Impressions	4.54	16.02	10.75	16.61
Serology/Biology	14.88	20.82	21.90	10.44
Toxicology ante mortem (excluding BAC)	4.13	7.70	8.07	3.76
Toxicology post mortem (excluding BAC)	2.53	11.49	11.98	5.80
Trace Evidence	22.36	11.60	10.60	6.23

Tests per Sample

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	1.05	1.80	2.00	0.44
Crime Scene Investigation				
Digital evidence - Audio & Video		32.62	8.00	43.11
DNA Casework	2.65	3.70	3.74	2.51
DNA Database	1.10	1.89	1.10	1.44
Document Examination		21.40	3.44	45.67
Drugs - Controlled Substances	2.72	2.64	2.63	1.17
Evidence Screening & Processing	2.50	3.45	3.79	0.83
Explosives		4.31	4.02	2.14
Fingerprints	1.52	3.14	2.19	2.80
Fire analysis	1.01	2.33	2.00	1.09
Firearms and Ballistics	1.23	4.53	2.87	6.53
Forensic Pathology	1.00	3.89	5.19	2.51
Gun Shot Residue (GSR)	1.00	2.34	1.00	2.72
Marks and Impressions	4.64	3.85	3.07	2.59
Serology/Biology	2.21	3.39	2.98	1.20
Toxicology ante mortem (excluding BAC)	3.56	3.54	2.90	3.15
Toxicology post mortem (excluding BAC)	2.33	2.68	2.62	1.48
Trace Evidence	1.59	4.44	3.70	2.49

Return to the decomposition measure for the cost/case. The denominator terms have the opposite effect on average cost. That is, as ***labor productivity*** or the ***labor expense ratio*** increase, average costs will fall. This confirms that, as a representative scientist is able to process more cases per year, then the effect will be a decrease in the average cost as fixed expenditures are averaged over a higher volume of processed cases. Similarly, if a greater portion of the budget is devoted to personnel expenditures (as opposed to capital investment) *ceteris paribus*, more cases will be processed for the same expenditure at the opportunity cost of delaying investment in capital equipment for future returns.

The next five tables contain the LabRAT summary statistics for alternative personnel productivity ratio measures.

Cases per FTE

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	1,487	857	831	580
Crime Scene Investigation		54	22	65
Digital evidence - Audio & Video		23	18	9
DNA Casework	98	82	82	28
DNA Database	2,494	2,604	2,523	493
Document Examination	26	33	26	25
Drugs - Controlled Substances	538	545	468	239
Evidence Screening & Processing	162	194	162	85
Explosives		32	28	24
Fingerprints	122	367	310	250
Fire analysis	259	103	99	68
Firearms and Ballistics	58	136	119	93
Forensic Pathology	57	46	44	7
Gun Shot Residue (GSR)	162	85	74	62
Marks and Impressions	24	33	24	27
Serology/Biology	210	167	165	77
Toxicology ante mortem (excluding BAC)	219	245	193	147
Toxicology post mortem (excluding BAC)	243	217	195	135
Trace Evidence	23	46	40	27

This measure is simply the number of Cases completed for each full-time equivalent (FTE) employee (the work input of a full-time employee working for one full year) retained by the laboratory. It gives an indication of the level of productivity within the average laboratory by investigative area.

Items per FTE

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	1,487	1,008	966	627
Crime Scene Investigation		2,735	19	5,443
Digital evidence - Audio & Video		29	25	14
DNA Casework	138	210	171	103
DNA Database	2,395	2,471	2,395	1,304
Document Examination	154	197	79	371
Drugs - Controlled Substances	834	1,597	870	1,903
Evidence Screening & Processing	658	614	658	336
Explosives		57	50	40
Fingerprints	413	900	655	604
Fire analysis	589	273	266	162
Firearms and Ballistics	300	383	296	277
Forensic Pathology	57	46	44	7
Gun Shot Residue (GSR)	211	140	150	80
Marks and Impressions	42	84	82	44
Serology/Biology	441	644	559	330
Toxicology ante mortem (excluding BAC)	252	487	252	662
Toxicology post mortem (excluding BAC)	264	799	300	1,459
Trace Evidence	62	84	75	46

Samples per FTE

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	2,974	1,277	1,081	914
Crime Scene Investigation		3,688	240	6,178
Digital evidence - Audio & Video		99	100	79
DNA Casework	176	327	320	143
DNA Database	2,395	2,471	2,395	1,304
Document Examination	154	267	79	464
Drugs - Controlled Substances	1,025	1,822	1,276	2,395
Evidence Screening & Processing	658	654	658	97
Explosives		48	47	8
Fingerprints	656	1,080	656	982
Fire analysis	589	341	410	207
Firearms and Ballistics	347	421	335	228
Forensic Pathology	57	47	43	8
Gun Shot Residue (GSR)	649	383	385	255
Marks and Impressions	24	103	87	78
Serology/Biology	1,414	892	869	316
Toxicology ante mortem (excluding BAC)	254	883	386	1,670
Toxicology post mortem (excluding BAC)	264	1,600	380	3,490
Trace Evidence	330	118	87	88

Tests per FTE

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	3,123	2,113	1,863	1,269
Crime Scene Investigation				
Digital evidence - Audio & Video		1,249	1,418	444
DNA Casework	467	1,229	904	1,120
DNA Database	2,635	3,537	2,635	2,740
Document Examination		988	580	1,182
Drugs - Controlled Substances	2,788	3,839	2,749	3,217
Evidence Screening & Processing	1,644	2,258	2,100	707
Explosives		212	166	132
Fingerprints	998	2,292	1,935	2,354
Fire analysis	595	589	576	342
Firearms and Ballistics	428	1,904	828	2,814
Forensic Pathology	57	169	217	98
Gun Shot Residue (GSR)	649	1,044	504	1,873
Marks and Impressions	109	382	224	390
Serology/Biology	3,127	2,870	2,855	1,068
Toxicology ante mortem (excluding BAC)	905	2,049	1,378	1,772
Toxicology post mortem (excluding BAC)	615	3,210	2,223	3,846
Trace Evidence	524	385	411	203

Reports per FTE

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	1,580	880	826	580
Crime Scene Investigation		62	22	83
Digital evidence - Audio & Video		25	24	4
DNA Casework	79	99	81	67
DNA Database	2,395	5,410	2,497	7,601
Document Examination	25	36	25	28
Drugs - Controlled Substances	661	610	510	228
Evidence Screening & Processing	177	157	157	28
Explosives		30	32	19
Fingerprints	99	395	343	265
Fire analysis	270	111	91	82
Firearms and Ballistics	57	149	130	115
Forensic Pathology	59	47	44	8
Gun Shot Residue (GSR)	203	103	108	71
Marks and Impressions	9	34	24	36
Serology/Biology	321	184	163	111
Toxicology ante mortem (excluding BAC)	242	267	208	177
Toxicology post mortem (excluding BAC)	264	209	137	146
Trace Evidence	25	46	36	32

The next decomposition measure, **Personnel Expense/Total Expense**, serves as a proxy for the level of analytical technology chosen. This measure has a significant negative correlation with **Capital Expense/Total Expense** and serves as simpler decomposition term for the return on investment.

Below, the cost structure is detailed with a breakdown of expenses in capital, labor, consumables, versus other costs. Investigative areas that are highly automated, such as evidenced by the DNA database processing line, should show a lower Personnel Expense/Total Expense.

Personnel Expense as a proportion of Total Expense

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	68.93%	75.31%	79.17%	15.74%
Crime Scene Investigation		76.62%	78.72%	15.11%
Digital evidence - Audio & Video		84.16%	85.11%	2.68%
DNA Casework	55.15%	64.74%	65.75%	12.01%
DNA Database	34.76%	45.80%	54.89%	25.36%
Document Examination	74.93%	79.82%	82.22%	8.28%
Drugs - Controlled Substances	70.33%	72.66%	73.07%	8.44%
Evidence Screening & Processing	67.10%	83.87%	84.19%	13.44%
Explosives		60.97%	63.49%	19.82%
Fingerprints	73.85%	79.47%	77.64%	8.96%
Fire analysis	70.32%	74.61%	77.49%	13.81%
Firearms and Ballistics	64.51%	77.43%	78.62%	9.51%
Forensic Pathology	81.42%	73.66%	74.44%	8.33%
Gun Shot Residue (GSR)	72.55%	69.98%	73.22%	12.54%
Marks and Impressions	79.80%	78.74%	84.91%	14.71%
Serology/Biology	68.05%	76.28%	76.80%	8.18%
Toxicology ante mortem (excluding BAC)	68.23%	63.18%	64.16%	11.40%
Toxicology post mortem (excluding BAC)	64.52%	62.93%	63.99%	13.21%
Trace Evidence	53.16%	67.75%	72.34%	16.06%

Capital Expense as a proportion of Total Expense

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	0.37%	5.89%	4.83%	5.15%
Crime Scene Investigation		3.00%	2.52%	3.19%
Digital evidence - Audio & Video		8.88%	8.24%	2.52%
DNA Casework	16.14%	11.10%	11.09%	4.12%
DNA Database	11.27%	6.93%	6.05%	5.77%
Document Examination	0.48%	2.62%	1.58%	2.26%
Drugs - Controlled Substances	0.66%	10.96%	10.49%	6.79%
Evidence Screening & Processing	0.64%	3.88%	4.36%	3.03%
Explosives		18.46%	9.18%	18.53%
Fingerprints	0.50%	6.72%	5.53%	7.73%
Fire analysis	0.57%	5.39%	3.99%	3.77%
Firearms and Ballistics	13.32%	9.00%	5.48%	8.56%
Forensic Pathology	0.32%	5.12%	6.26%	3.30%
Gun Shot Residue (GSR)	0.40%	13.41%	8.14%	11.57%
Marks and Impressions	0.40%	4.77%	4.34%	4.29%
Serology/Biology	0.45%	5.63%	6.34%	3.81%
Toxicology ante mortem (excluding BAC)	1.84%	12.97%	9.95%	8.61%
Toxicology post mortem (excluding BAC)	2.77%	11.39%	10.73%	7.38%
Trace Evidence	28.07%	17.55%	11.41%	16.03%

Consumables Expense as a proportion of Total Expense

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	12.74%	8.85%	6.62%	7.87%
Crime Scene Investigation				
Digital evidence - Audio & Video		2.69%	2.69%	
DNA Casework	10.98%	13.72%	11.48%	9.19%
DNA Database	39.38%	13.42%	11.06%	11.26%
Document Examination	1.58%	2.32%	1.42%	2.81%
Drugs - Controlled Substances	8.02%	6.70%	6.21%	3.79%
Evidence Screening & Processing	1.58%	3.89%	4.44%	2.09%
Explosives		5.12%	4.37%	3.41%
Fingerprints	1.58%	3.54%	1.32%	4.37%
Fire analysis	1.70%	4.68%	5.02%	2.19%
Firearms and Ballistics	0.63%	2.61%	1.53%	2.49%
Forensic Pathology	2.87%	3.31%	3.16%	0.69%
Gun Shot Residue (GSR)	7.77%	4.04%	3.38%	3.27%
Marks and Impressions	0.72%	4.76%	1.74%	4.90%
Serology/Biology	10.08%	6.67%	7.50%	2.01%
Toxicology ante mortem (excluding BAC)	7.67%	10.26%	10.46%	3.86%
Toxicology post mortem (excluding BAC)	10.36%	8.81%	7.42%	2.35%
Trace Evidence	2.47%	3.50%	2.64%	2.93%

Turn-around Time

Note that turn-around time is offered in two forms. The first is a measure that begins when the last item of evidence in an investigative area has been submitted to the laboratory. The second measure begins the turn-around time count with the submission of the first piece of evidence in an investigative area. Because many laboratories only record one or the other of these measures, there is some seeming inconsistency which is attributed to the limited sample. In future years the metric will be slightly altered to correspond to recommendations from the May 2013 FORESIGHT participant meeting. The change in the metric will reflect the time from each request for analysis to issuance of a report. As such, a case in one investigative area may have multiple turn-around times that correspond to separate requests.

Median Turn-around Time (Timed in days from **last** submission of evidence to Report submission)

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	40	29	12	41
Crime Scene Investigation		39	29	36
Digital evidence - Audio & Video		48	48	6
DNA Casework	63	77	66	59
DNA Database	15	113	82	92
Document Examination	56	43	34	14
Drugs - Controlled Substances	59	45	38	24
Evidence Screening & Processing	36	27	27	13
Explosives		101	31	144
Fingerprints	59	34	35	17
Fire analysis	44	42	46	19
Firearms and Ballistics	132	52	39	57
Forensic Pathology	86	57	57	41
Gun Shot Residue (GSR)	56	44	34	39
Marks and Impressions	39	41	39	28
Serology/Biology	39	43	31	38
Toxicology ante mortem (excluding BAC)	91	33	24	27
Toxicology post mortem (excluding BAC)	49	28	24	14
Trace Evidence	67	75	68	37

Median Turn-around Time (Timed in days from **first** submission of evidence to Report submission)

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol		21	18	13
Crime Scene Investigation		35	27	32
Digital evidence - Audio & Video		76	64	40
DNA Casework		77	68	48
DNA Database		147	82	139
Document Examination		68	59	26
Drugs - Controlled Substances		49	44	32
Evidence Screening & Processing		18	18	
Explosives		137	139	131
Fingerprints		44	45	18
Fire analysis		41	43	21
Firearms and Ballistics		79	62	67
Forensic Pathology		28	28	
Gun Shot Residue (GSR)		36	34	28
Marks and Impressions		68	60	47
Serology/Biology		56	48	33
Toxicology ante mortem (excluding BAC)		44	36	25
Toxicology post mortem (excluding BAC)		42	33	22
Trace Evidence		86	93	35

Backlog

Another area of concern involves the increased demand for laboratory services and the level of backlog. For data collection purposes, the definition of backlog has been defined as open cases at the end of the fiscal year that have been open for more than thirty days. As a relative comparative measure, the ratio of open cases to total cases for the year is presented in the following table.

Cases Open over 30 Days/Annual Caseload

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol	0.80%	2.62%	0.50%	5.34%
Crime Scene Investigation		9.53%	0.27%	16.24%
Digital evidence - Audio & Video		9.55%	9.55%	0.64%
DNA Casework	9.34%	18.99%	9.34%	22.41%
DNA Database	0.07%	26.92%	25.76%	20.51%
Document Examination	183.16%	40.19%	18.48%	57.79%
Drugs - Controlled Substances	5.94%	6.84%	5.75%	5.45%
Evidence Screening & Processing	25.50%	33.44%	33.44%	11.23%
Explosives		31.07%	20.00%	21.24%
Fingerprints	62.83%	13.52%	5.74%	19.39%
Fire analysis	1.57%	6.18%	7.50%	6.82%
Firearms and Ballistics	94.11%	32.43%	16.46%	34.45%
Forensic Pathology	13.19%	54.06%	39.38%	52.85%
Gun Shot Residue (GSR)	19.50%	10.45%	4.32%	15.67%
Marks and Impressions	239.33%	51.98%	43.75%	74.05%
Serology/Biology	9.08%	6.71%	8.20%	4.21%
Toxicology ante mortem (excluding BAC)	9.91%	6.74%	5.83%	4.96%
Toxicology post mortem (excluding BAC)	5.32%	11.17%	9.74%	6.75%
Trace Evidence	42.42%	53.19%	25.87%	91.74%

Time in Casework

The final table presents the percentage of time that is dedicated to casework. Alternatives to time spent in casework include testimony (including preparation and wait time), research & development activities, teaching to the profession, teaching for customers, taking continuing education/training sessions, participating in international and/or interagency cooperative efforts, and developing materials for publication.

Percentage of Time in Casework

Investigative Area	Lab ABC	Mean	Median	Std. Dev.
Blood Alcohol		37.15%	36.52%	20.78%
Crime Scene Investigation		45.57%	50.19%	20.96%
Digital evidence - Audio & Video		46.16%	48.71%	4.44%
DNA Casework		55.71%	56.09%	10.38%
DNA Database		48.64%	56.32%	24.19%
Document Examination		45.90%	52.19%	18.09%
Drugs - Controlled Substances		51.19%	47.18%	17.26%
Evidence Screening & Processing		43.63%	43.63%	
Explosives		39.68%	34.18%	23.34%
Fingerprints		60.28%	55.97%	17.55%
Fire analysis		51.24%	50.84%	35.61%
Firearms and Ballistics		41.47%	46.20%	17.18%
Forensic Pathology		50.85%	50.85%	
Gun Shot Residue (GSR)		55.29%	55.44%	14.64%
Marks and Impressions		48.33%	47.22%	26.09%
Serology/Biology		62.62%	65.82%	12.43%
Toxicology ante mortem (excluding BAC)		57.03%	59.06%	11.58%
Toxicology post mortem (excluding BAC)		57.11%	56.66%	5.39%
Trace Evidence		44.39%	50.30%	25.42%

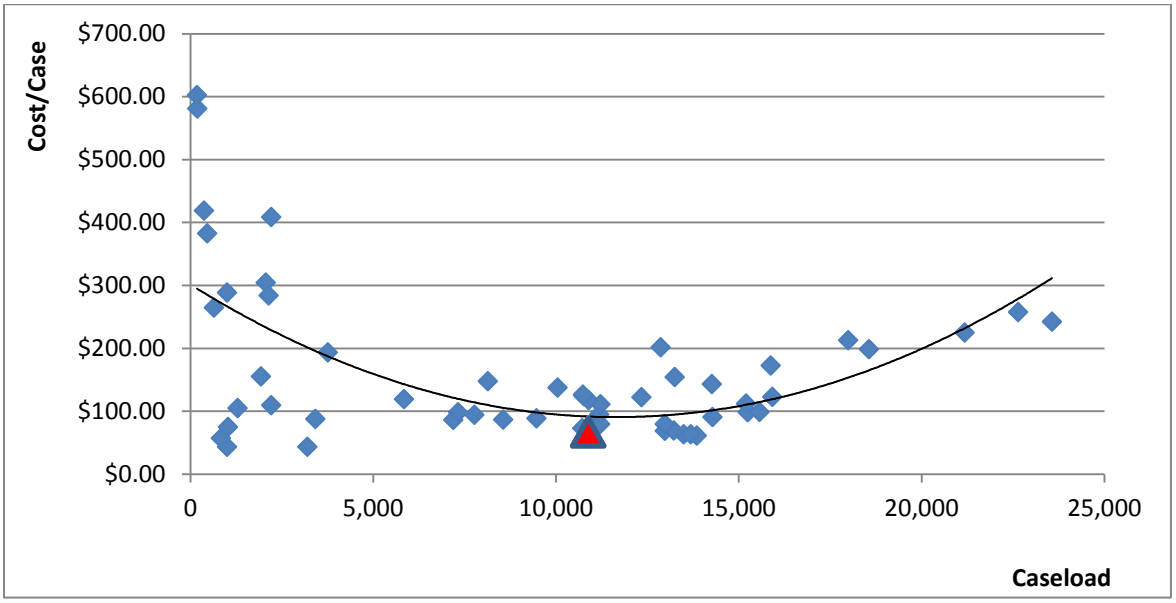
Efficiency and Cost Effectiveness of Forensic Science Services FORESIGHT 2011-2012 Benchmark Data

The summary statistics offer a one-dimensional view of performance. In this section, that view is expanded through a consideration of cost effectiveness and efficiency. Economic theory indicates that any industry, including forensic science laboratories, will have average costs (Cost/Case) that decline as caseload is increased until reaching a point of perfect economies of scale. Thereafter, diseconomies of scale will be realized and average costs will rise as caseload increases. This behavior is exemplified via U-shaped average cost curves.

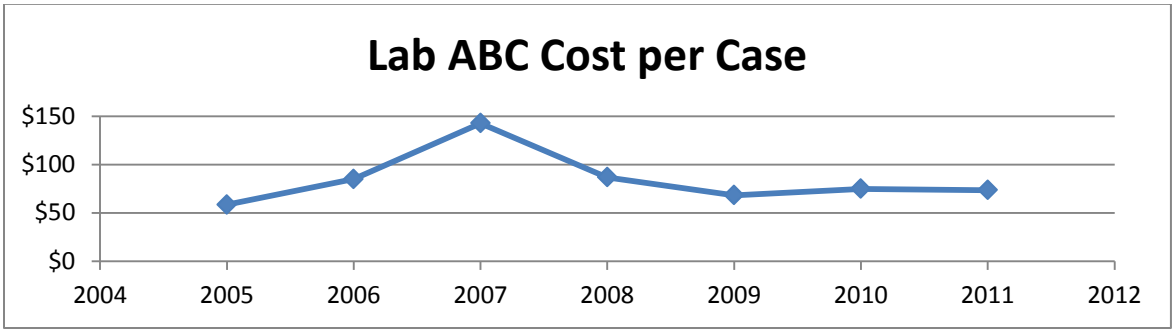
For each investigative area, the industry average cost curve has been estimated by a second degree polynomial regression. When a laboratory performs on or near the curve, it is an indication of efficiency for the corresponding caseload. For an efficient performance that is near the bottom of the U-shaped curve, the laboratory exhibits cost effective performance as it approaches perfect economies of scale.

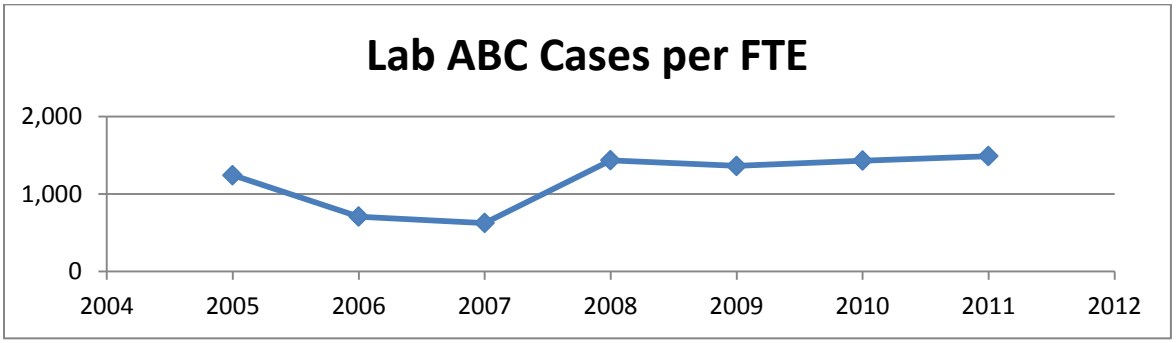
In addition to this cross –sectional comparison, average cost and productivity are illustrated for all past FORESIGHT submissions. Costs have been adjusted for inflation and converted to the most recent year's price index.

Blood Alcohol Analysis

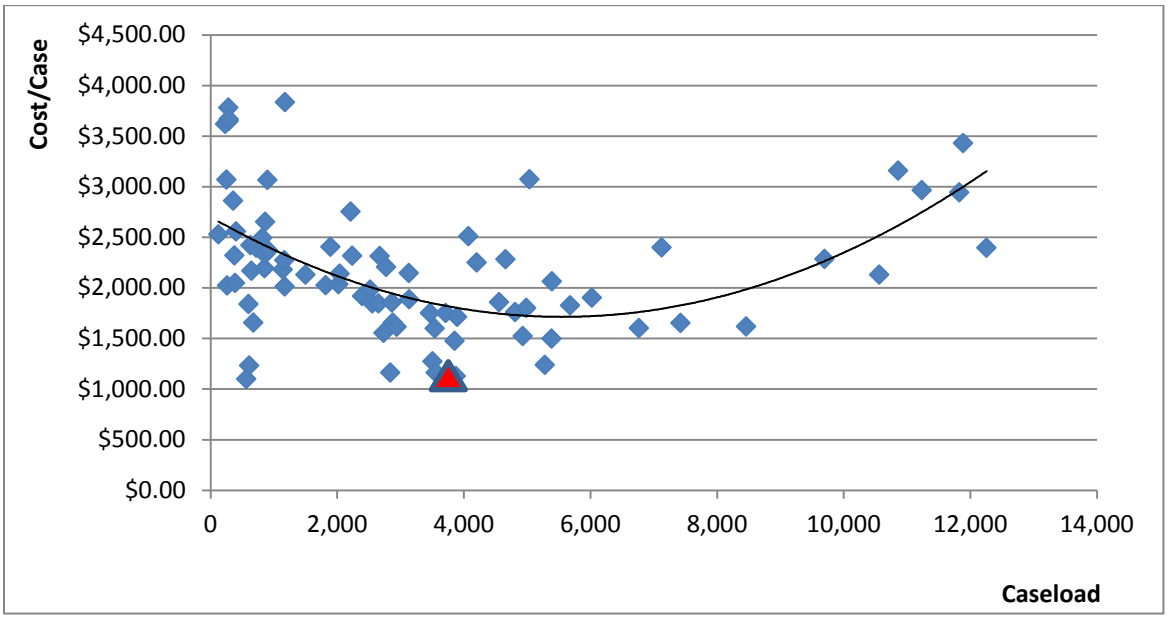


Foresight Project 2011-2012, West Virginia University, Morgantown, WV, USA





DNA Casework Analysis



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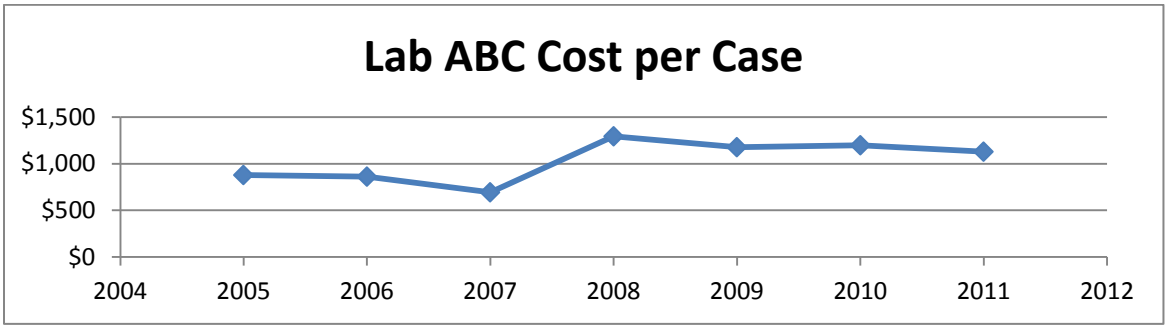
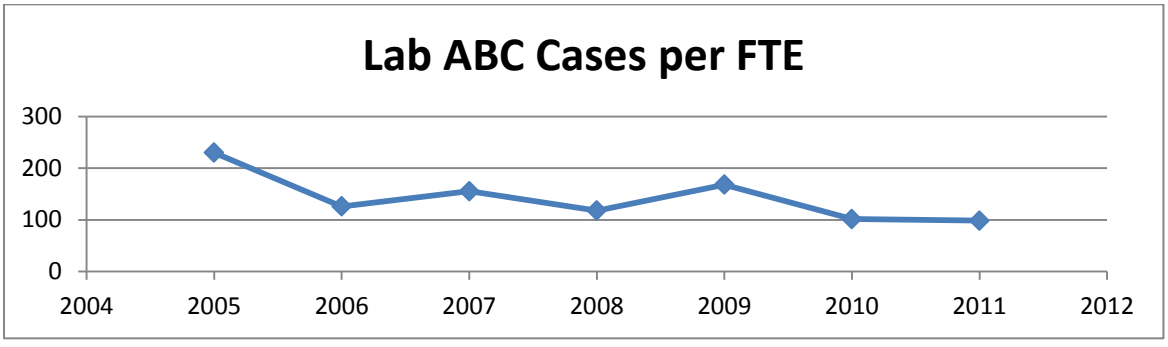
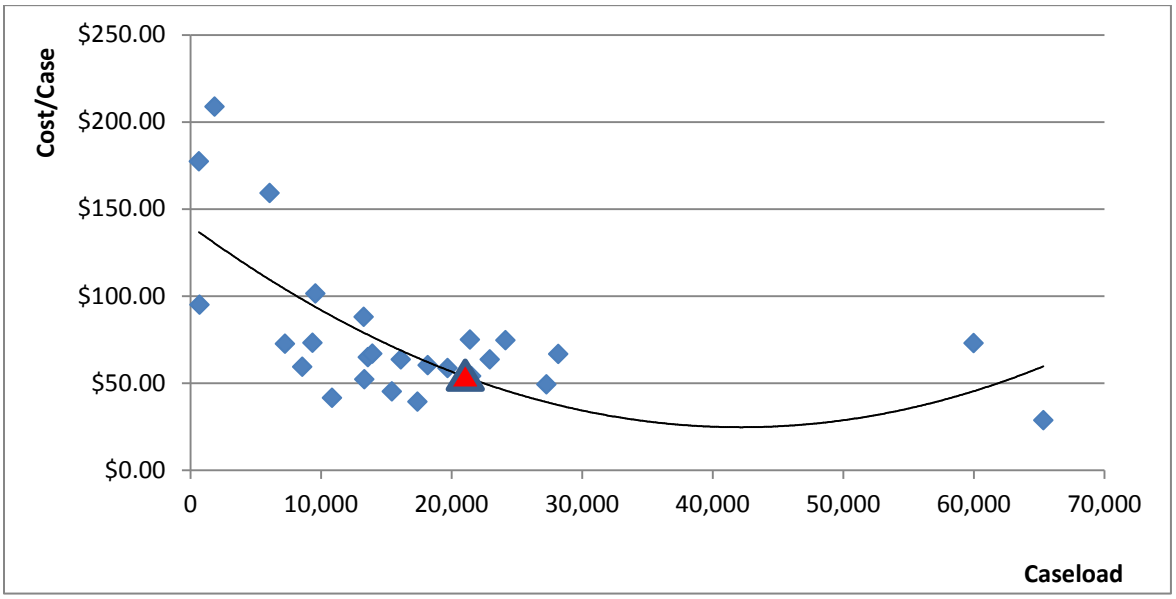




DNA Database



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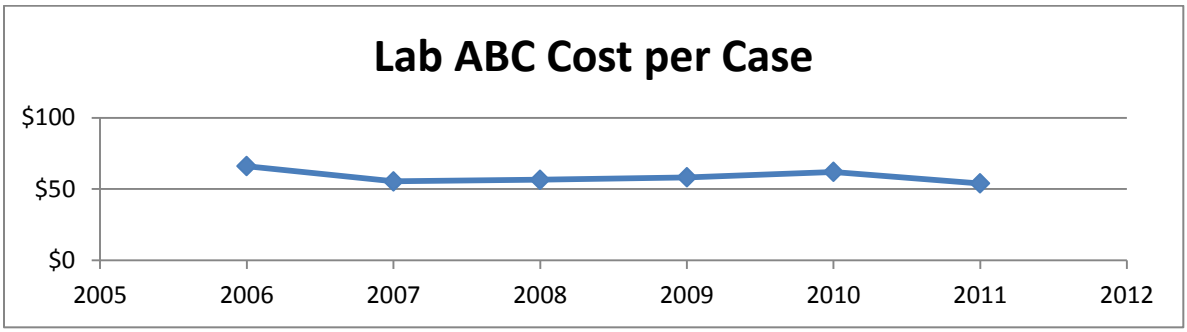
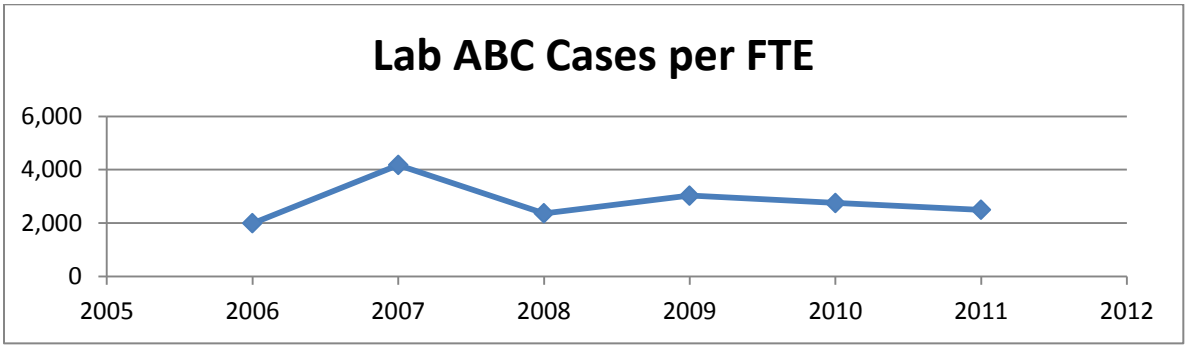
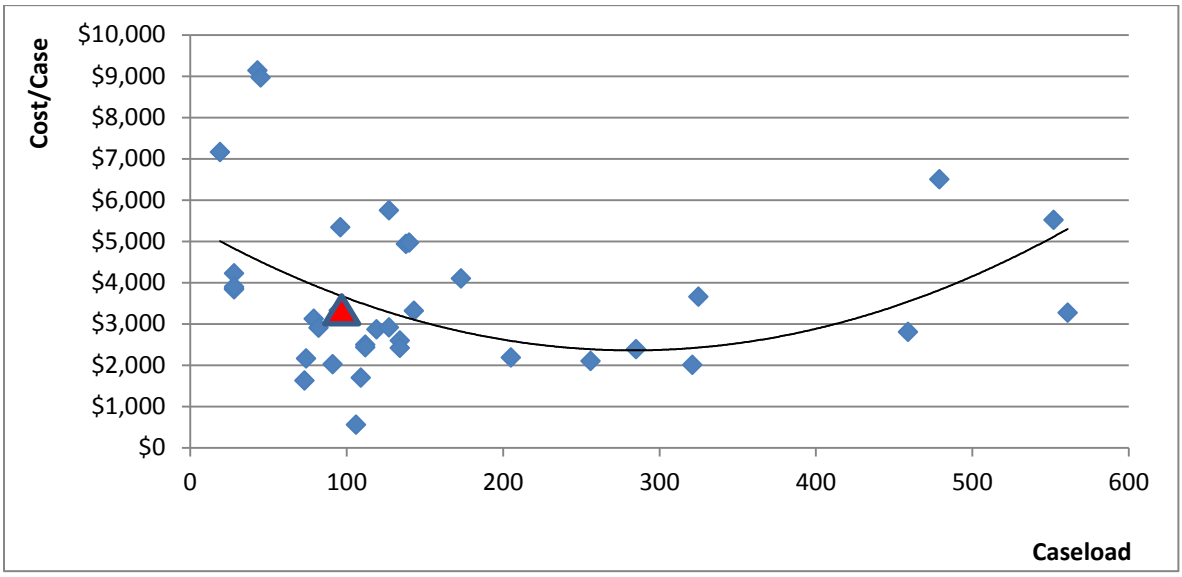




Document Examination



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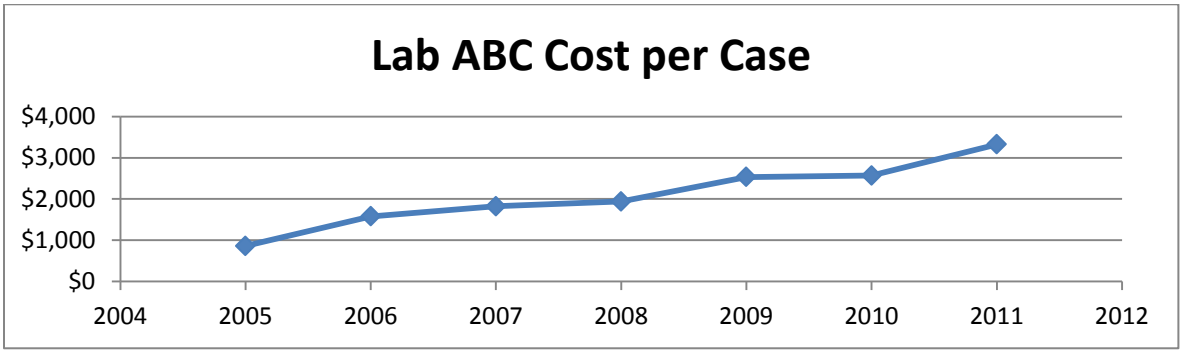
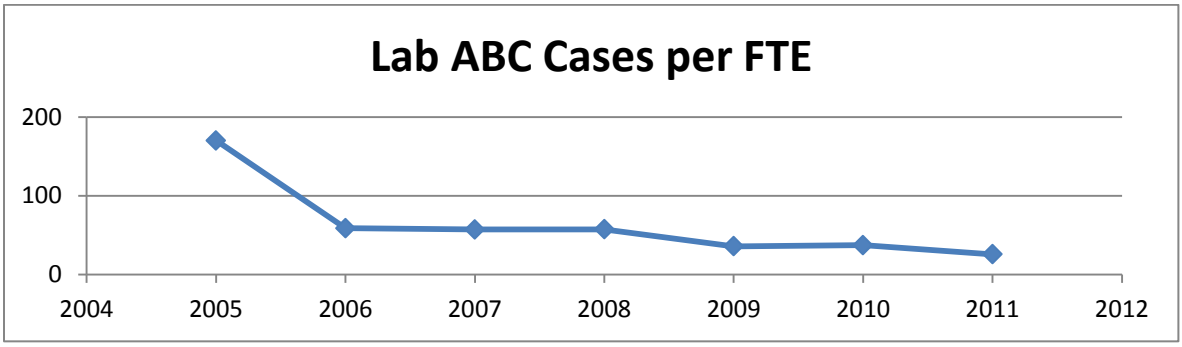
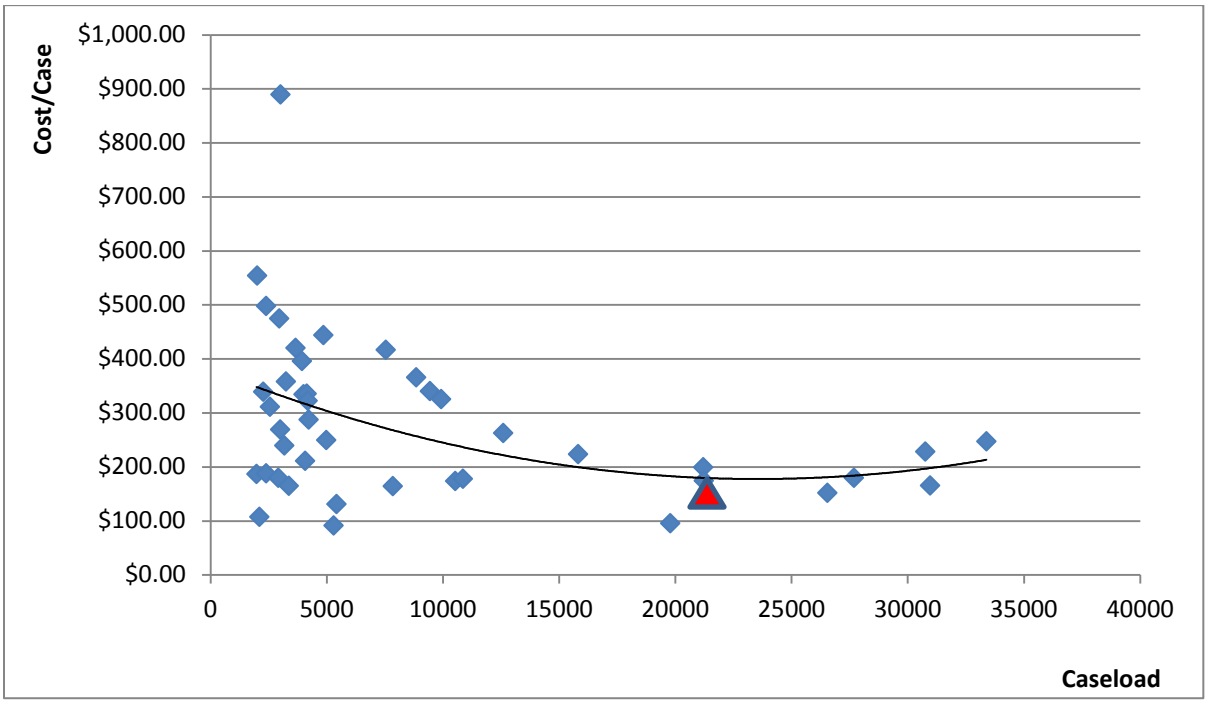




Drugs—Controlled Substance Analysis



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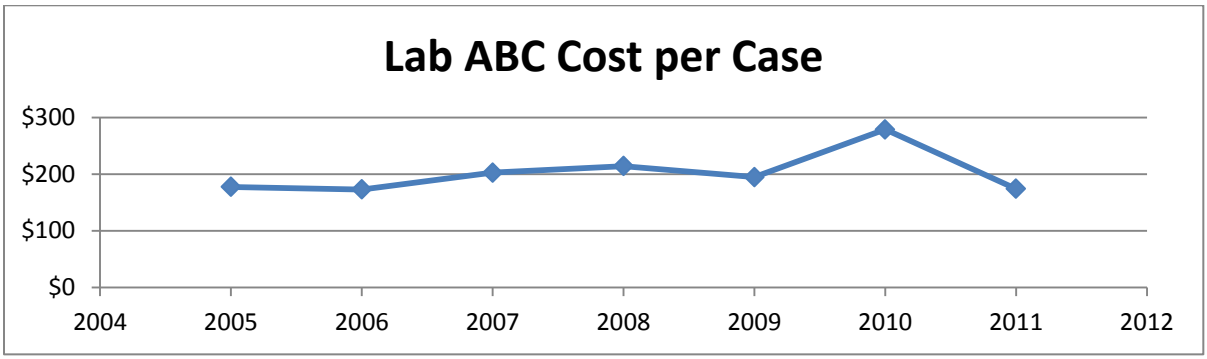
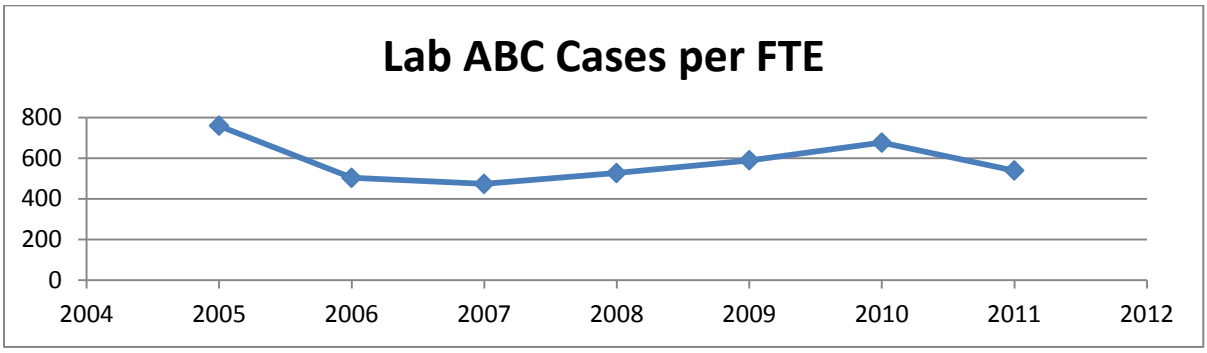
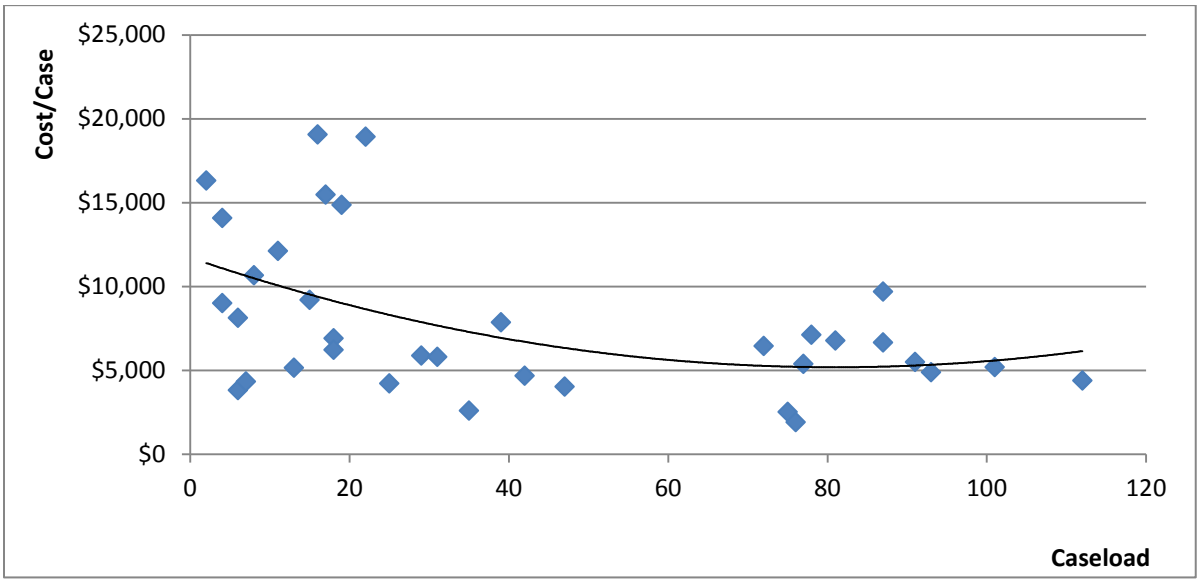




Explosives Analysis



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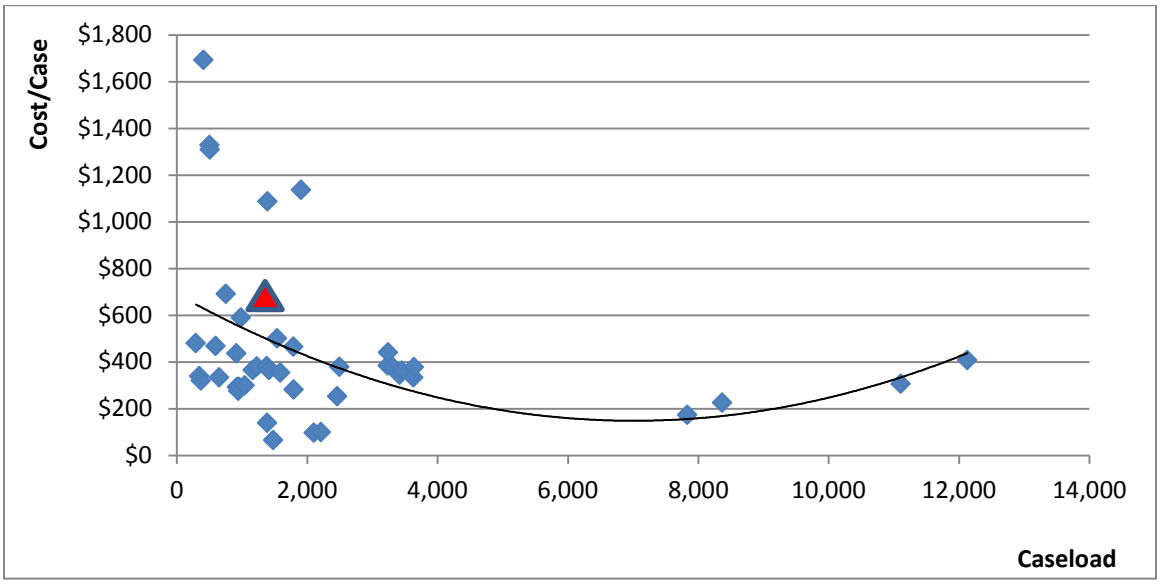
Fingerprint ID



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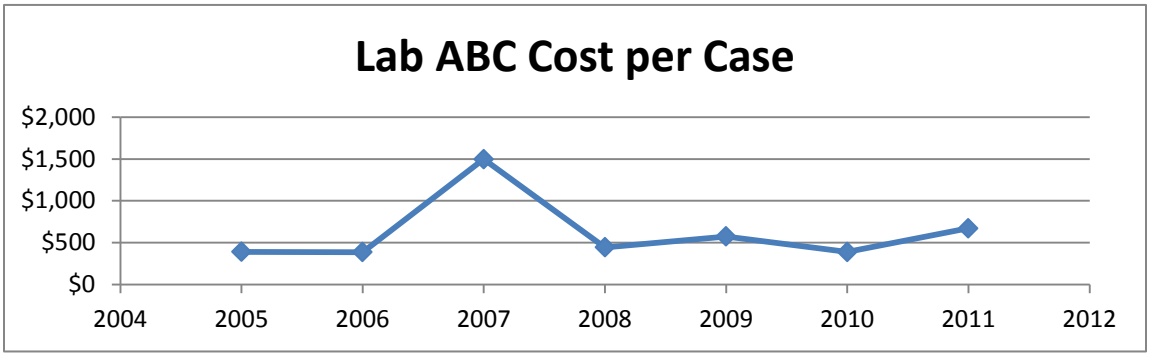
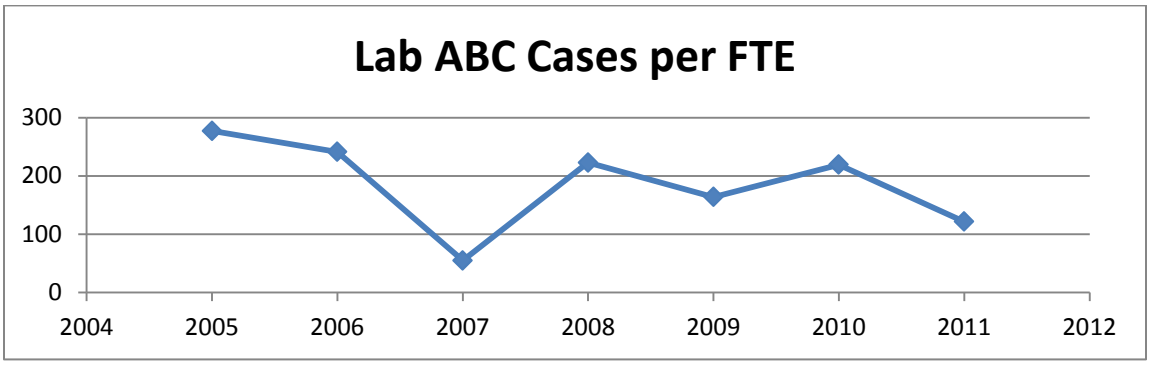
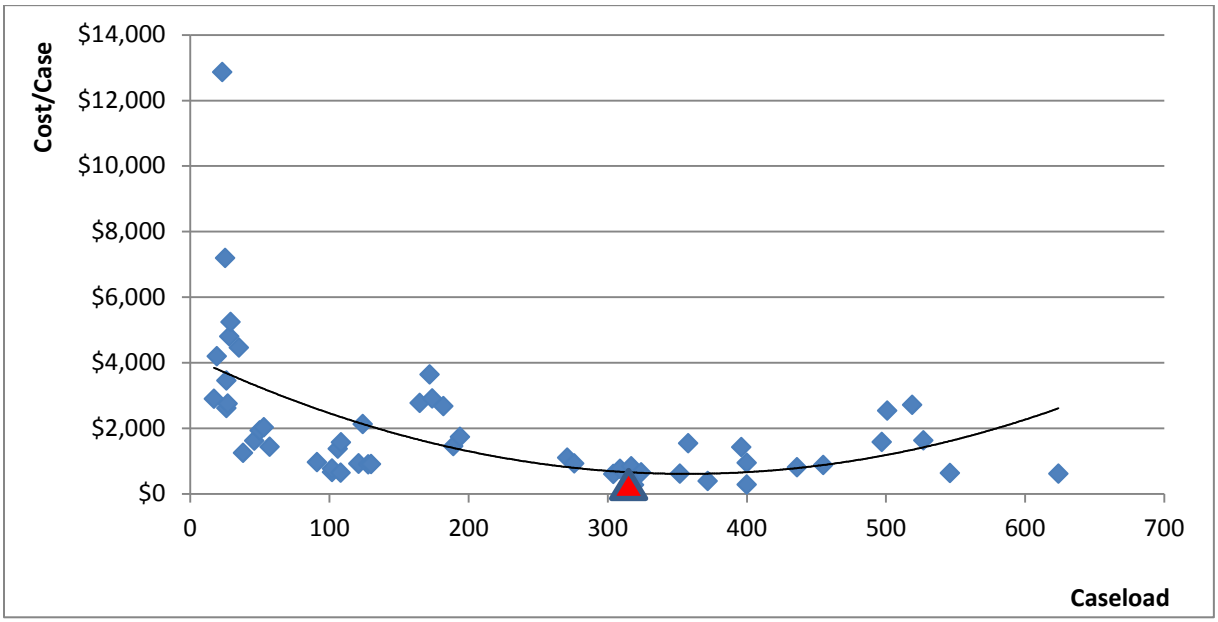




Fire Analysis



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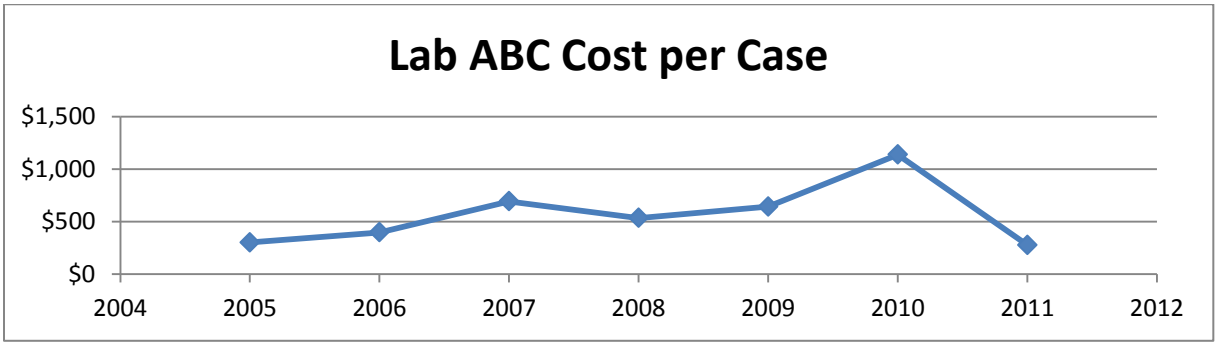
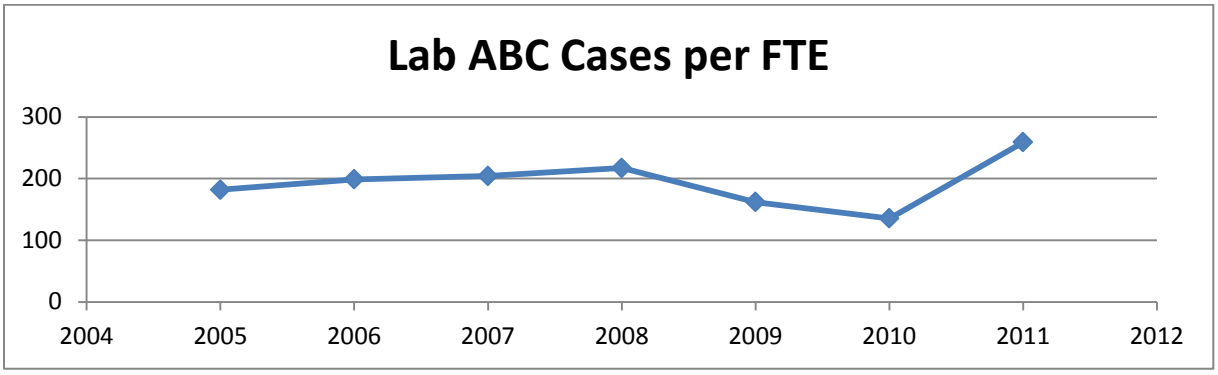
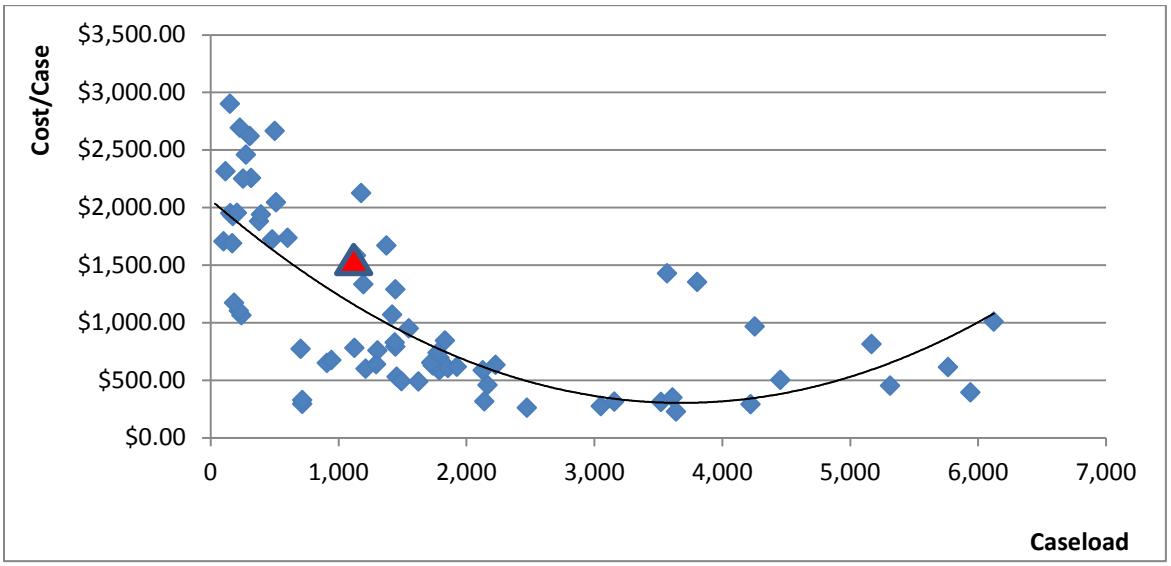




Firearms & Ballistics Analysis



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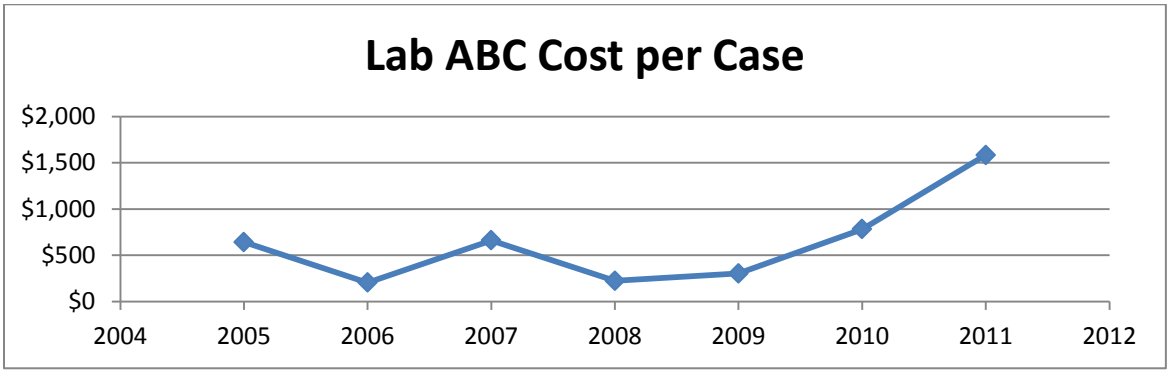
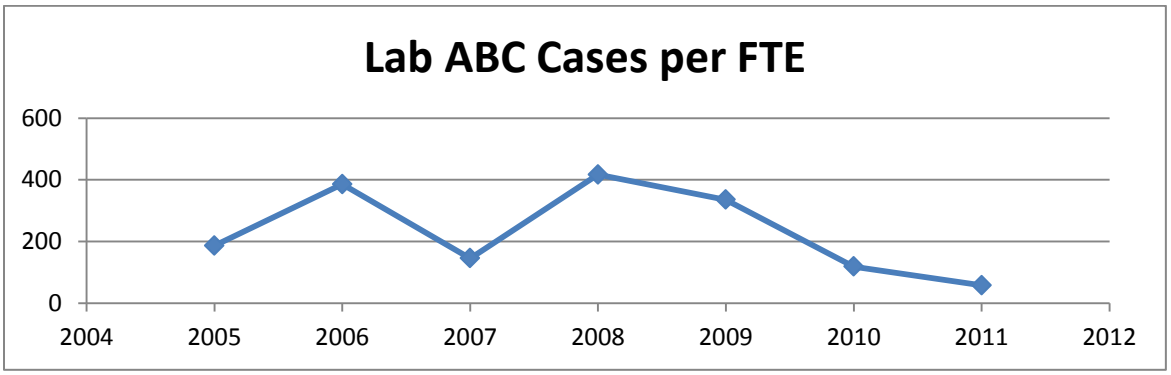
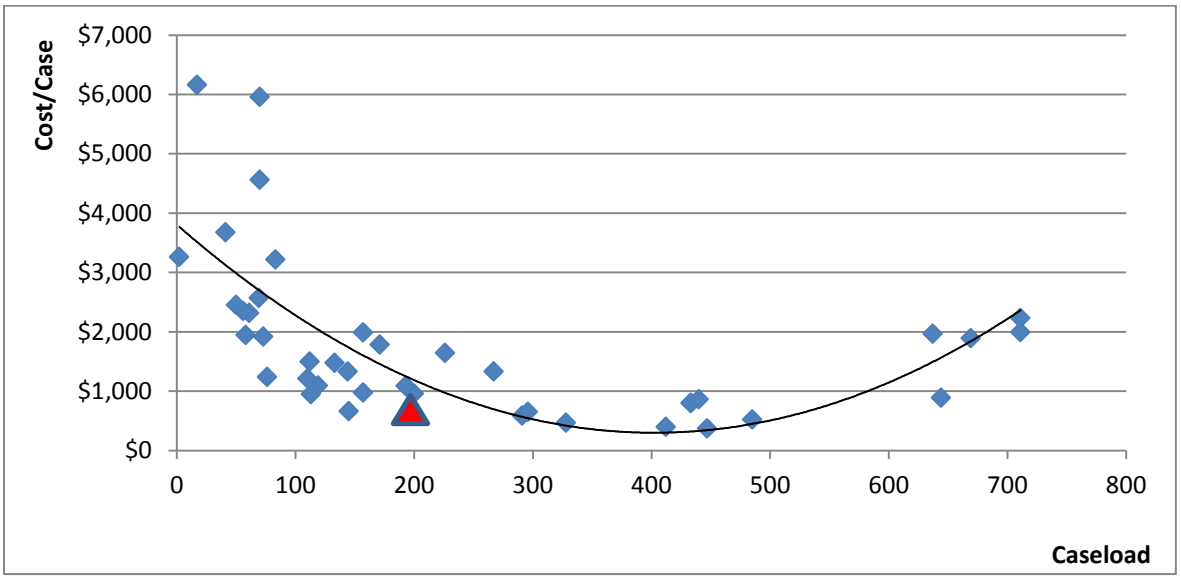




Gun Shot Residue Analysis



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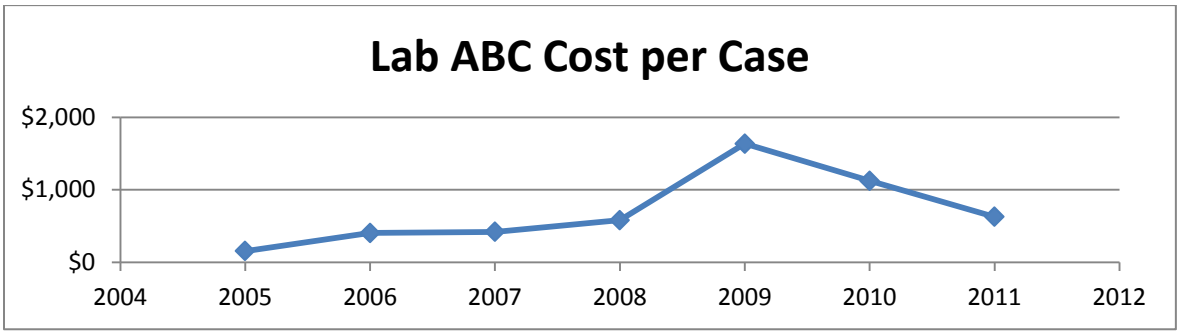
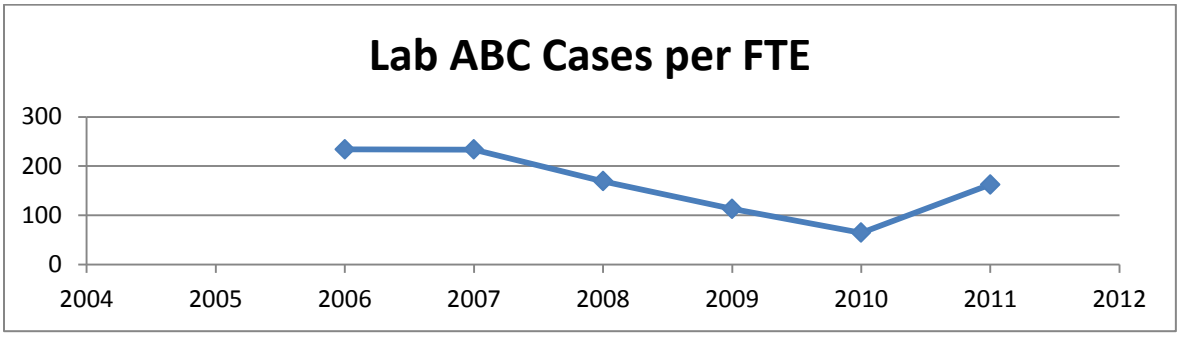
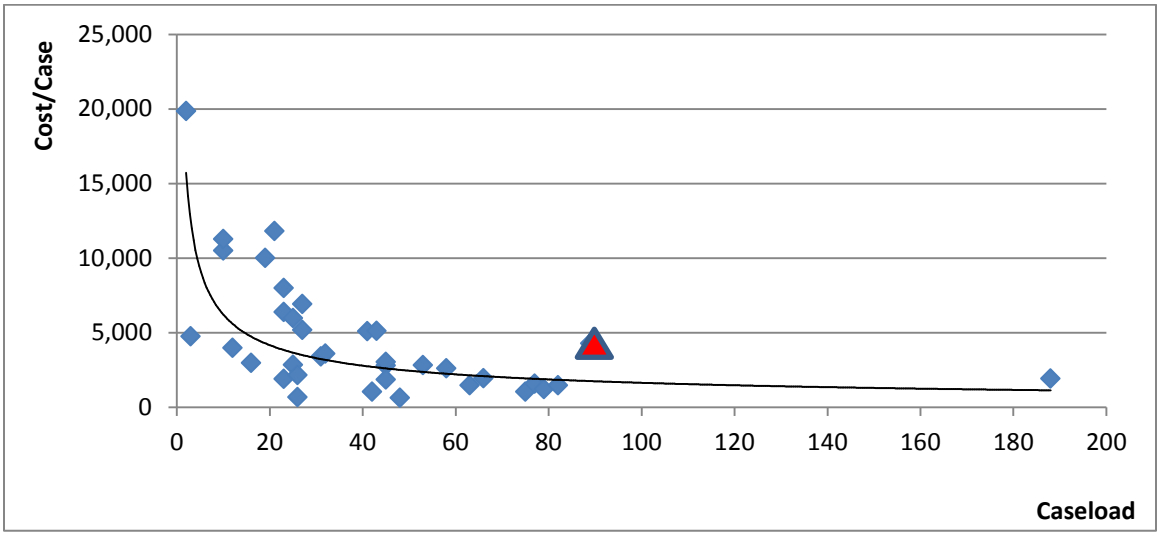




Marks & Impressions Analysis



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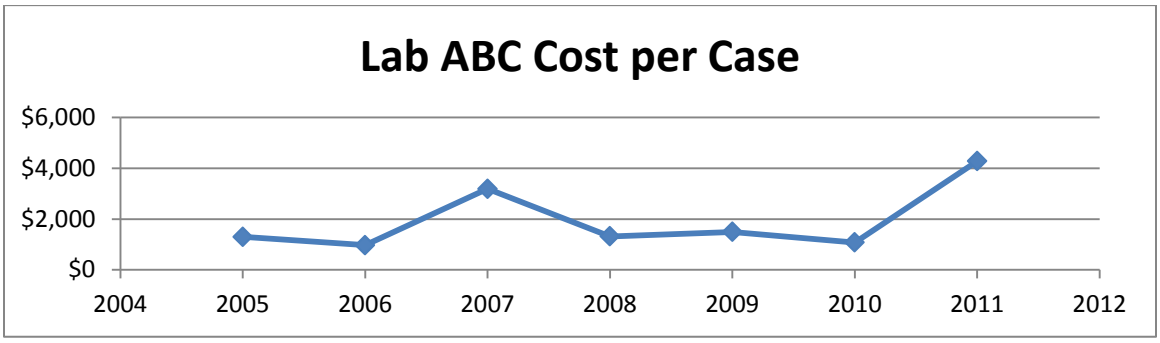
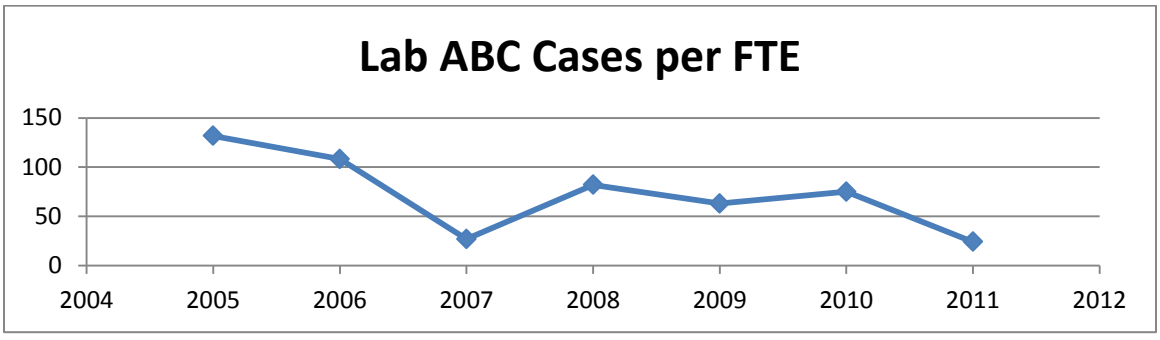
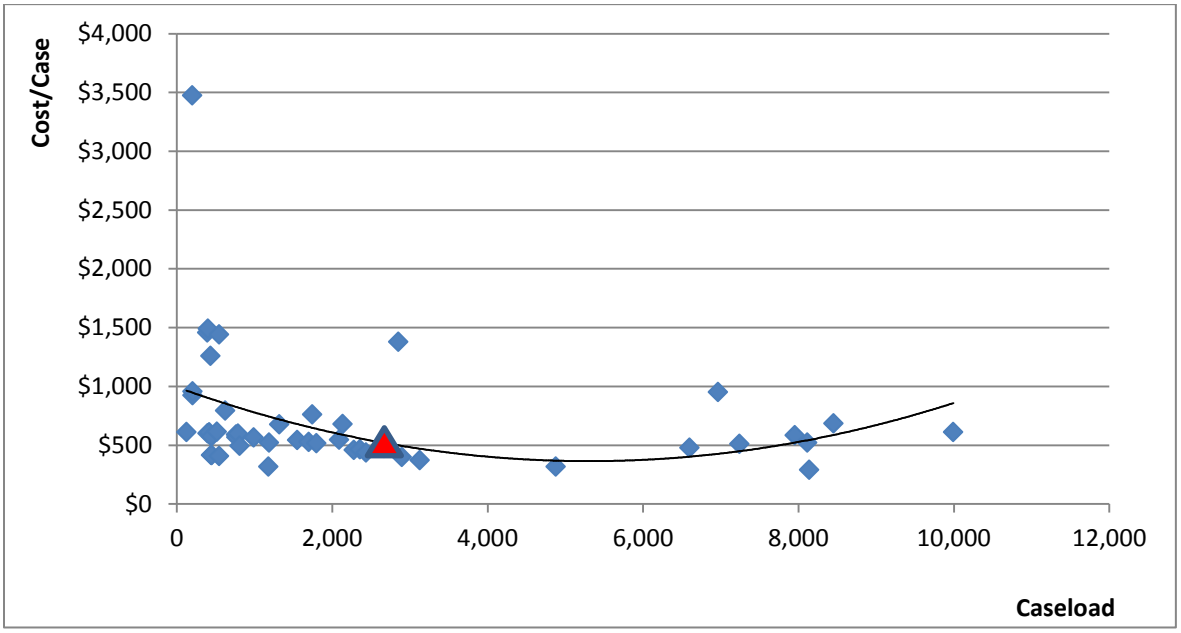




Serology/Biology



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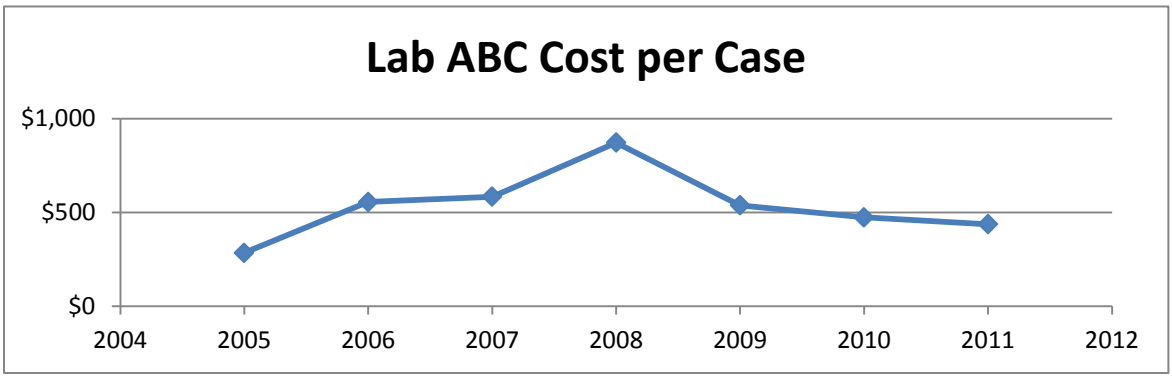
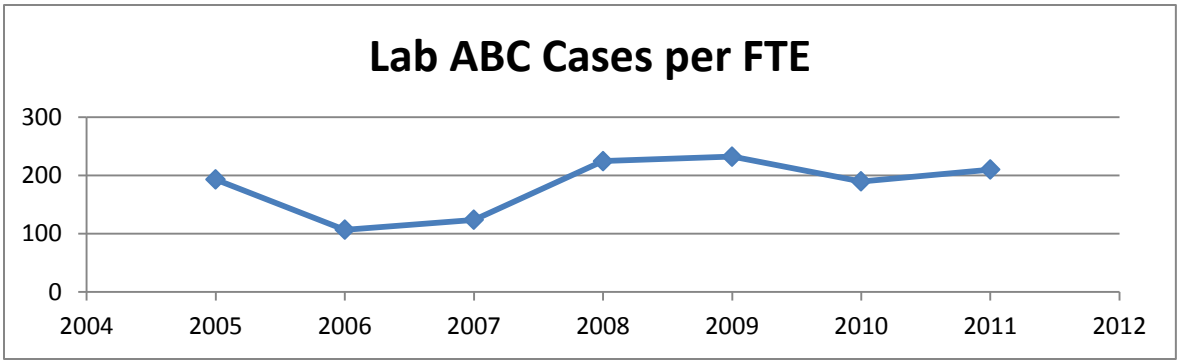
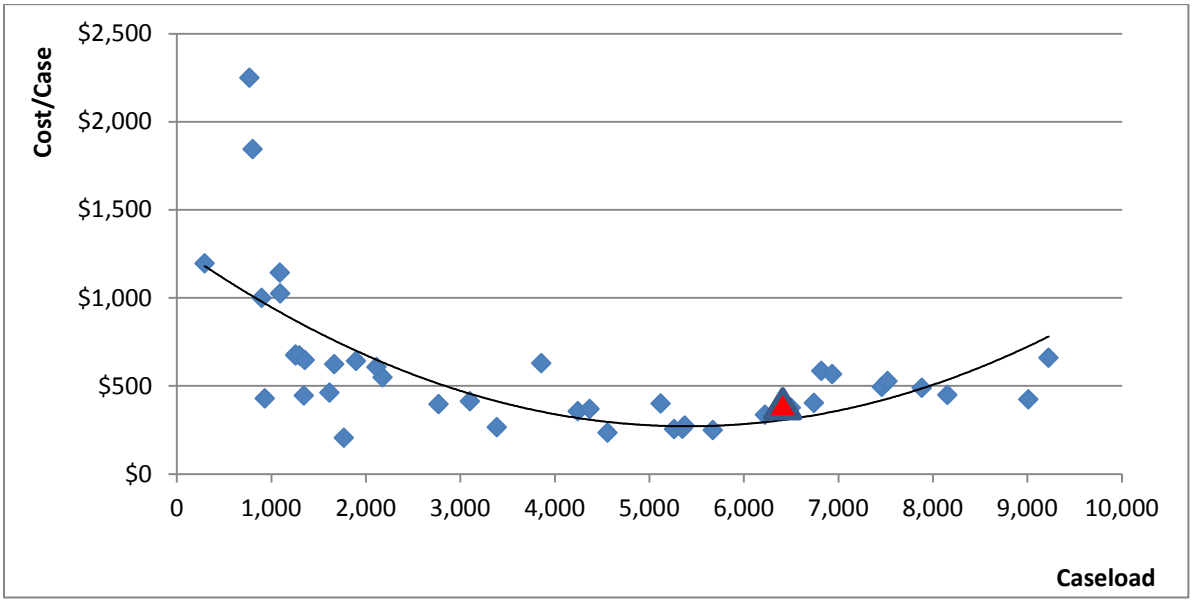
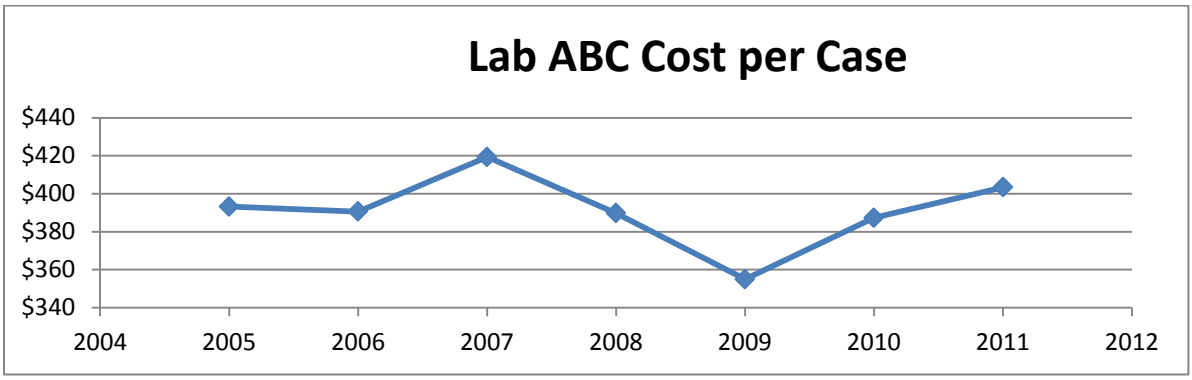


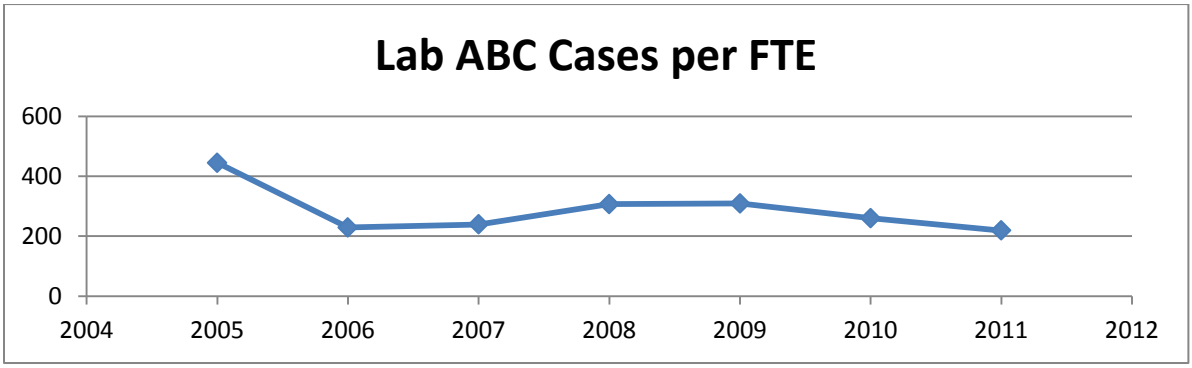


Toxicology Analysis ante mortem

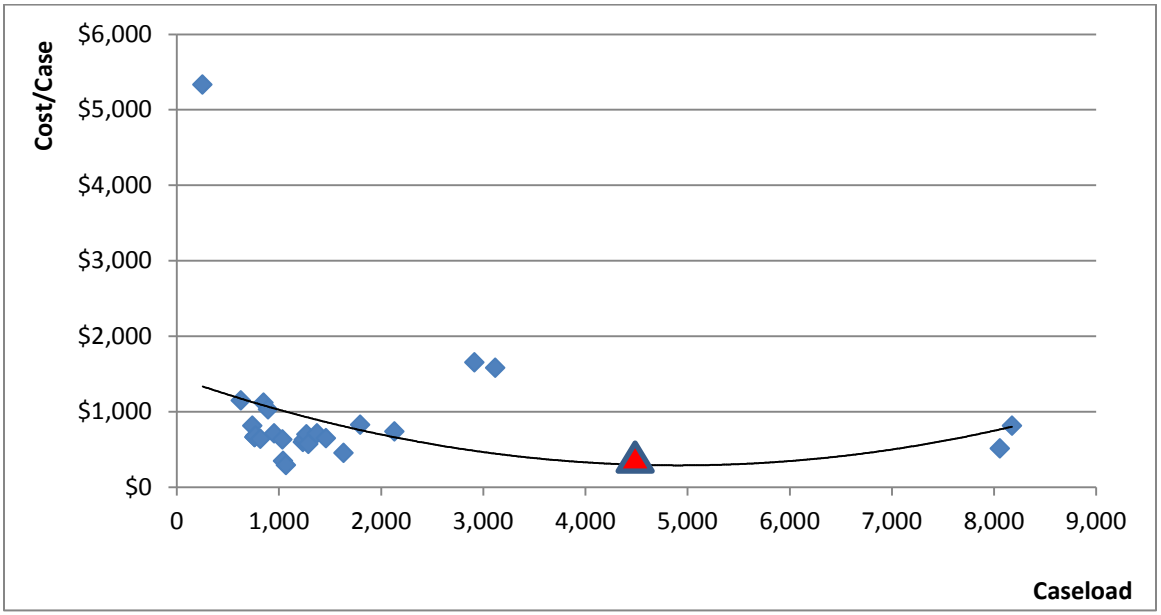


Foresight Project 2011-2012, West Virginia University, Morgantown, WV, USA

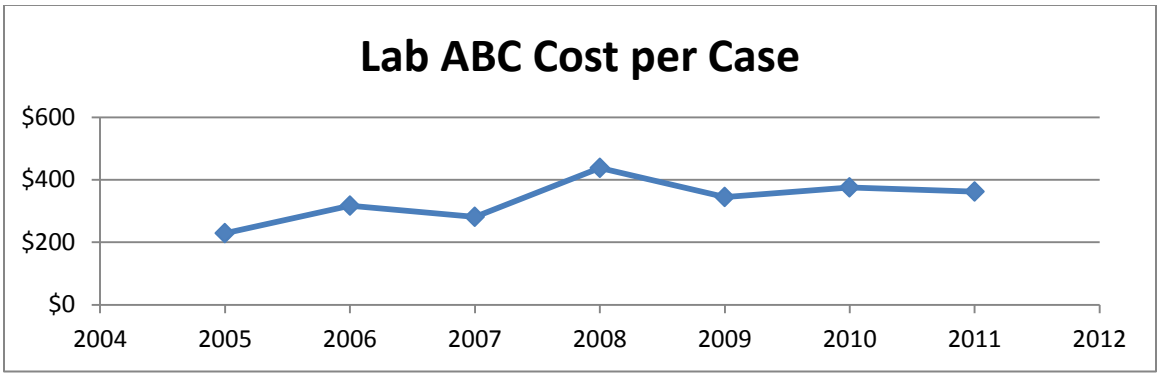


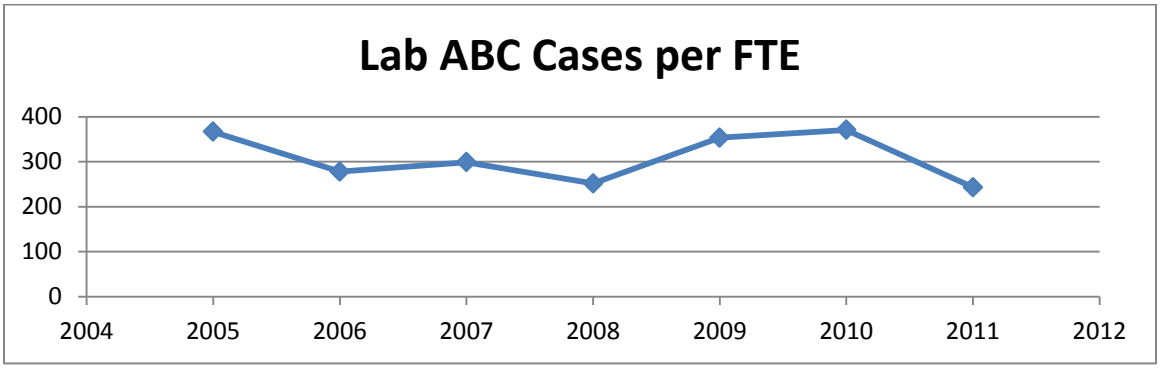


Toxicology Analysis post mortem

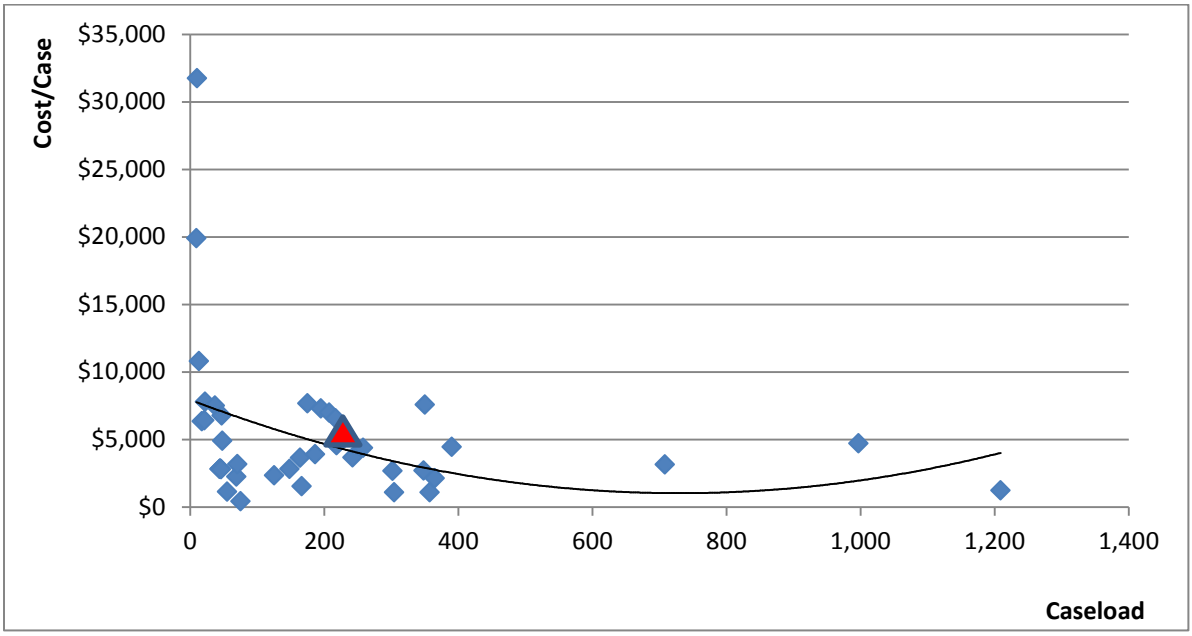


Foresight Project 2011-2012, West Virginia University, Morgantown, WV, USA

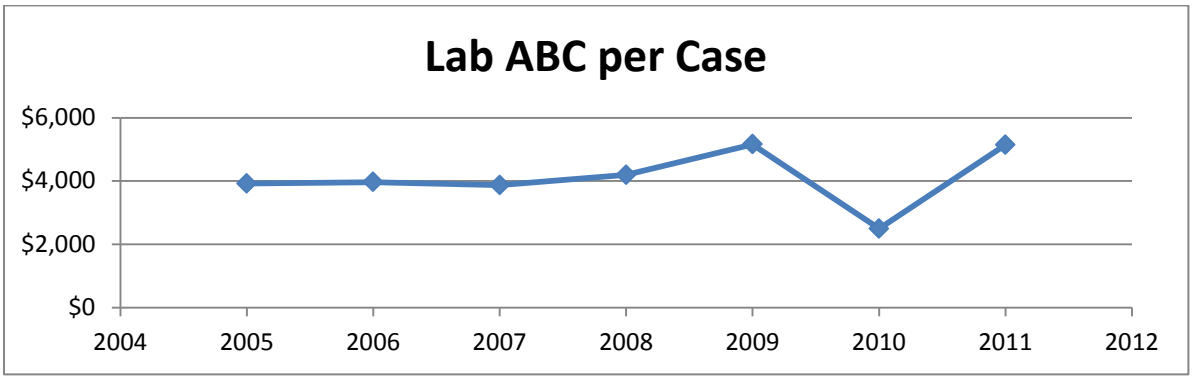


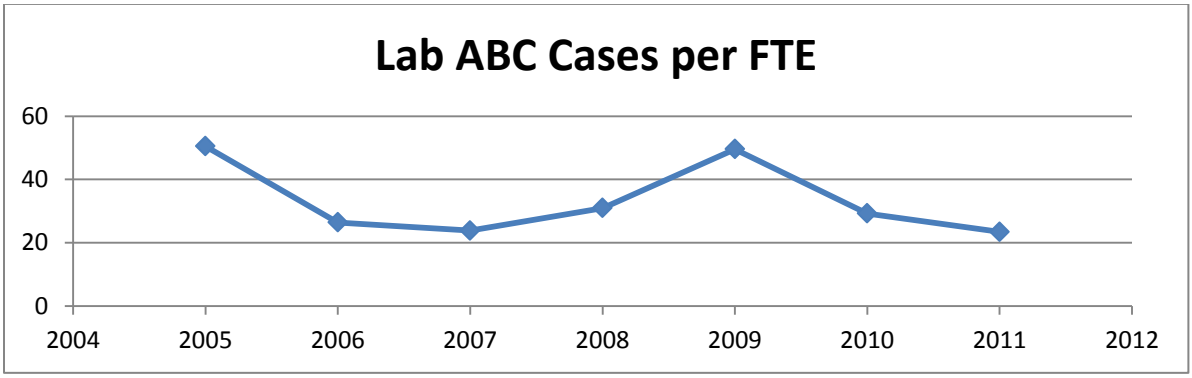


Trace Evidence Analysis



Foresight Project 2011-2012, West Virginia University, Morgantown, WV, USA





For more detail on Project FORESIGHT and its output see:

FORESIGHT: A Business Approach to Improving Forensic Science Services, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 2, 2009, Max M. Houck, Richard A. Riley, Paul J. Speaker, & Tom S. Witt, pages 85-95

Abstract: Managers of scientific laboratories see themselves as scientists first and managers second; consequently, they tend to devalue the managerial aspects of their jobs. Forensic laboratory managers are no different, but the stakes may be much higher given the importance of quality science to the criminal justice system. The need for training and support in forensic laboratory management has been recognized for many years, but little has been done to transition the tools of business to the forensic laboratory environment. FORESIGHT is a business-guided self-evaluation of forensic science laboratories across North America. The participating laboratories represent local, regional, state, and national agencies. Economics, accounting, finance, and forensic faculty provide assistance, guidance, and analysis. The process involves standardizing definitions for metrics to evaluate work processes, linking financial information to work tasks, and functions. Laboratory managers can then assess resource allocations, efficiencies, and value of services—the mission is to measure, preserve what works, and change what does not. A project of this magnitude for forensic laboratories has not been carried out anywhere.

Key Performance Indicators and Managerial Analysis for Forensic Laboratories, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 1, 2009, Paul J. Speaker, pages 32-42

Abstract: Forensic laboratories generate a great deal of data from casework activities across investigative areas, personnel and budget allocations, and corresponding expenditures. This paper investigates ways in which laboratories can make data-driven managerial decisions through the regular extraction of key performance indicators from commonly available data sources. A laboratory's performance indicators can then be compared to peer laboratory performance to search for best practices, determine in-house trends, manage scarce resources, and provide quantitative support for the

justification of additional resources.

The Decomposition of Return on Investment for Forensic Laboratories, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 2, 2009, Paul J. Speaker, pages 96-102

Abstract: For forensic laboratories, a detailed understanding of return on investment (ROI) is necessary for routine assessment, consideration of new legislative alternatives, and cost-benefit analysis for decision making. Converting performance data to ratio measures provides useful comparisons between an individual laboratory and the standards for excellence for the industry; these measures also permit an evaluation across time. Unfortunately, these same ROI measures are subject to abuse when overemphasis on a single measure leads to unintended consequences. In this paper, the ROI measure is broken down into various parts that can be tracked on a regular basis to reveal how a laboratory achieves its results. The tradeoffs between return and risk, efficiency, analytical process, and market conditions are outlined. The end product is a series of easily monitored metrics that a laboratory director may examine on a regular basis for continuous improvement.

Benchmarking and Budgeting Techniques for Improved Forensic Laboratory Management, *Forensic Science Policy & Management: An International Journal* Volume 1, Issue 4, 2010, Paul J. Speaker & A. Scott Fleming, pages 199-208

Abstract: Forensic laboratories are not immune from downturns in the worldwide economy. Recession and economic slowdowns, when coupled with the public's heightened sense of the capabilities of forensic science, put stress on the effectiveness of forensic laboratories. The resources available to forensic laboratories are limited, and managers are under greater pressure to improve efficiency and effectiveness. To this end, the use of internal and external financial and accounting metrics to plan, control, evaluate, and communicate performance is examined. Using data from the QUADRUPOL and FORESIGHT studies, we illustrate the use of external benchmarking through a calculation of laboratory return on investment and the internal development and use of a budget to enhance laboratory performance in light of limited resources.

Forensic Science Staffing: Creating a Working Formula, *Forensic Science Policy & Management: An International Journal* Volume 2, Issue 1, 2011, Joyce Thompson Heames & Jon Timothy Heames, pages 5-10

Abstract: The key issue facing forensic labs is "the classic economic problem—how to allocate limited resources with increasing demand for services, while maintaining high quality standards" (Speaker 2009). Employees are the biggest expense and most valuable resource that forensic labs possess, thus the question arises as to how to maximize human resource functions to best allocate resources through personnel. As the search is on to look for better practices to improve the operations as well as technical expertise of labs, human capital management is crucial to that objective. The purpose of this article is to process map some of the staffing issues facing forensic science labs, whether public or private, and to identify metrics from the FORESIGHT study (Houck et al. 2009) that might help lab directors create a working formula to better manage staffing (e.g., recruiting and selection) issues.

Managing Performance in the Forensic Sciences: Expectations in Light of Limited Budgets, *Forensic Science Policy & Management: An International Journal* Volume 2, Issue 1, 2011, Hilton Kobus, Max Houck, Paul J. Speaker & Richard Riley, pages 36-43

Abstract: For forensic service providers worldwide, the demand for high-quality services greatly outpaces available resources to meet those requests. The gap between the demand for services and the resource-restricted supply of those services has implications for managing performance: the effectiveness and efficiency of forensic science. The effectiveness of forensic science is directly related to the quality of the scientific analysis and the timeliness with which that analysis is provided, while efficiency is associated with attempts to minimize costs without negatively impacting quality. An inevitable result of the demand and supply gap is a backlog that results in downstream effects on timeliness, service, and quality. One important strategy to respond to the demand-supply imbalance is continual process improvement. Collaborative benchmarking as a basis for process improvement is another approach. This paper discusses the disjunction between perceived and actual value for forensic services and the rationale for providers to evaluate, improve, and re-tool their processes

toward continual improvement given limited resources.

Strategic Management of Forensic Laboratory Resources: From Project FORESIGHT Metrics to the Development of Action Plans, *Forensic Science Policy & Management: An International Journal* Volume 2, Issue 4, 2011, Jonathan Newman, David Dawley, & Paul J. Speaker, pages 164-174

Abstract: The project FORESIGHT stated objectives begin with the development of metrics applicable to the activity of forensic science laboratories. These metrics enable a laboratory to assess how they fit within the forensic science industry and offer a glance at the levels of performance that they might be able to achieve. FORESIGHT's mission goes on to state the intent for laboratories to use those measurements to "preserve what works, and change what does not" (Houck et al. 2009, p. 85). This paper addresses the strategic implications of those additional aspects of the FORESIGHT mandate with a view of the strategic planning process for a forensic science laboratory. The keys to the development of an ongoing strategic planning and execution process are outlined, and then the actions of one laboratory, Ontario's Centre of Forensic Sciences, are examined to demonstrate the move from metrics to action. While there cannot yet be made a claim of "best practices," this Canadian example offers some guidance to "better practices" in the quest for continual improvement in the provision of forensic science services.

The Power of Information, *Forensic Magazine* April 10, 2012, Tom S. Witt & Paul J. Speaker

Abstract: When it comes to cost, the Foresight model was designed to overlook nothing. When we talk about the cost of doing something, we look at everything from equipment, telecommunications, heating, lighting, facility rent … everything. If a participant doesn't have access to the data, we can estimate those costs from other labs in our studies. We come up with an all-inclusive figure that tells participants what it costs to process a case. This leads to informed decisions. Take trace evidence cases, for example. You might find that processing one trace evidence case costs the same as processing two, three, or even four traditional DNA cases. While trace evidence is wonderful and powerful, if DNA alone will get you where you need to be, this cost factor will heavily affect your decision-making process. Foresight is not about cutting where it matters. It's about using resources wisely so that labs can do more and enhance the services they provide. Once you know the key metrics, you can make informed

decisions.

Is Privatization Inevitable for Forensic Science Laboratories?, *Forensic Science Policy & Management: An International Journal* Volume 3, Issue 1, 2012, William McAndrew, pages 42-52

Abstract: Given the recent global recession, many national governments have been forced to implement austerity measures, and the forensic science industry has not been immune from such changes. Proposals to privatize some or all aspects of forensic science services have been bantered about for decades, but the recent economic climate has brought this idea back to the forefront of public debates. Although privatization has been shown to have many benefits in the provision of other goods and services, the idea of privatizing forensic services has been harshly criticized by scholars and practitioners. This paper explores some of those criticisms through the lens of economics, and arguments are offered regarding why market approaches in forensic science may be more successful than might have originally been imagined under certain conditions. On the other hand, recognition of those economic forces and reaction by forensic laboratories to address inefficiencies may provide the effective delivery of forensic services that forestalls privatization efforts.

The Balanced Scorecard: Sustainable Performance Assessment for Forensic Laboratories, *Science and Justice* Volume 52, 2012, Max Houck, Paul J. Speaker, Richard Riley, & A. Scott Fleming, pages 209-216.

Abstract: The purpose of this article is to introduce the concept of the balanced scorecard into the laboratory management environment. The balanced scorecard is a performance measurement matrix designed to capture financial and non-financial metrics that provide insight into the critical success factors for an organization, effectively aligning organization strategy to key performance objectives. The scorecard helps organizational leaders by providing balance from two perspectives. First, it ensures an appropriate mix of performance metrics from across the organization to achieve operational excellence; thereby the balanced scorecard ensures that no single or limited group of metrics dominates the assessment process, possibly leading to long-term inferior performance. Second, the balanced scorecard helps leaders offset short term performance pressures by giving recognition and weight to long-term laboratory

needs that, if not properly addressed, might jeopardize future laboratory performance.

Efficiency and the Cost Effective Delivery of Forensic Science Services: In-Sourcing, Out-Sourcing, and Privatization, *Forensic Science Policy & Management: An International Journal* Volume 3, Issue 2, Chris Maguire, Max Houck, Robin Williams, & Paul J. Speaker, pages 62-69

Abstract: Given the recent global recession, many national governments have been forced to implement austerity measures, and the forensic science industry has not been immune from such changes. Proposals to privatize some or all aspects of forensic science services have been bantered about for decades, but the recent economic climate has brought this idea back to the forefront of public debates. Although privatization has been shown to have many benefits in the provision of other goods and services, the idea of privatizing forensic services has been harshly criticized by scholars and practitioners. This paper explores some of those criticisms through the lens of economics, and arguments are offered regarding why market approaches in forensic science may be more successful than might have originally been imagined under certain conditions. On the other hand, recognition of those economic forces and reaction by forensic laboratories to address inefficiencies may provide the effective delivery of forensic services that forestalls privatization efforts.

Enhancing Employee Outcomes in Crime Labs: Test of a Model, *Forensic Science Policy and Management: An International Journal* Volume 3, Issue 4, 2012, David Dawley.

Abstract: This paper developed and tested a model identifying determinants of employee turnover intentions and desirable performance behaviors, including helping others and engaging in knowledge sharing. Data collected from 798 employees at ten FORESIGHT laboratories suggest that job satisfaction and embeddedness are the primary antecedents of turnover intentions and knowledge sharing, and that embeddedness is a stronger predictor variable of both outcomes. Embeddedness is driven by the employees' understanding of the lab's strategic vision. Moreover, job satisfaction and embeddedness are positively associated with helping behavior. Finally, we identified job autonomy as a primary determinant of job satisfaction. We discuss practical implications of these findings for managers.

Forensic Science Service Provider Models: Data-Driven Support for Better Delivery Options, *Australian Journal of Forensic Sciences* Volume 45, Issue 2, 2013, Paul J. Speaker.

Abstract: There are a variety of models for the delivery of forensic science analysis in service to the justice system. In answer to the question as to whether there is a 'best' option for the delivery of forensic science services, New Zealand's Institute of Environmental Science and Research (ESR) has been offered as a model which demonstrates a comparative advantage over the delivery of forensic services in more traditional models. The support for that assertion rests in the ability of the ESR to react at the speed of business and avoid bureaucratic drag found too often in the public sector. This efficiency argument addresses one dimension of the search for 'best' delivery. The second dimension involves the discovery of the optimal scale of operation to take efficiency and turn it into cost effectiveness.