Healthcare System Dynamics

http://HealthcareSystemDynamics.org

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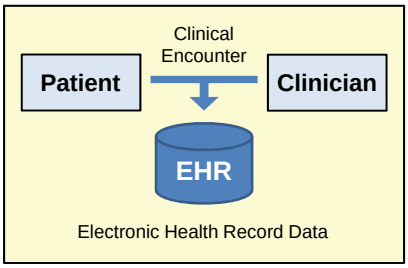
Big Data to Knowledge (BD2K), NIH/NCI U01 CA198934

Healthcare System Dynamics

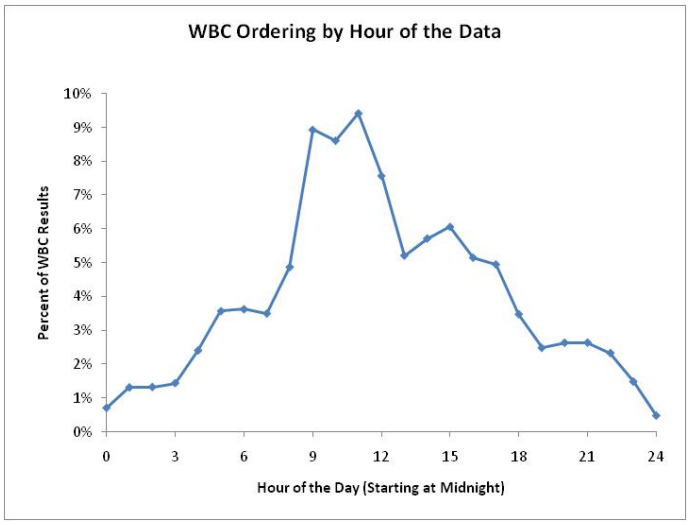
Clinical data reflect both patients' health AND their interactions with the healthcare system.

Patient Pathophysiology	Healthcare System Dynamics	Data Quality
Patient Demographics	Number of Observations	Data Entry Errors
Diagnoses	Time of Day of Observations	Dictation Mistakes
Laboratory Test Results	Time Between Observations	Data Compression Loss
Vital Signs	Cost of a Test or Treatment	Unstructured Data
Genetic Markers	Clinical Setting / Clinician Type	Missing Data

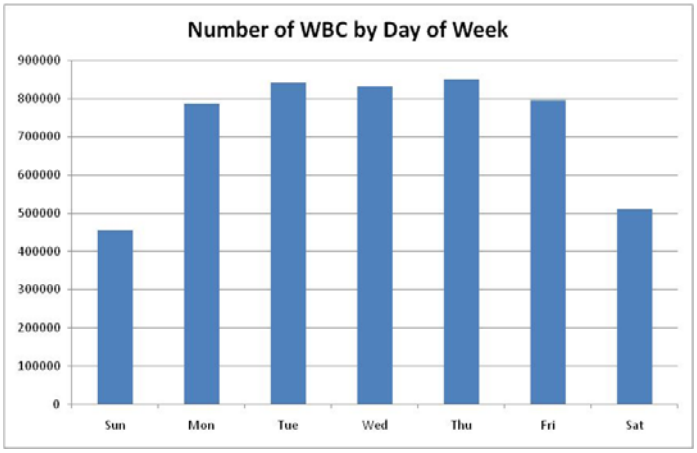


	Patient Pathophysiology	
Healthcare System Dynamics	Normal	Abnormal
Normal	Best Outcomes	Moderate Outcomes
Abnormal	Moderate Outcomes	Worst Outcomes

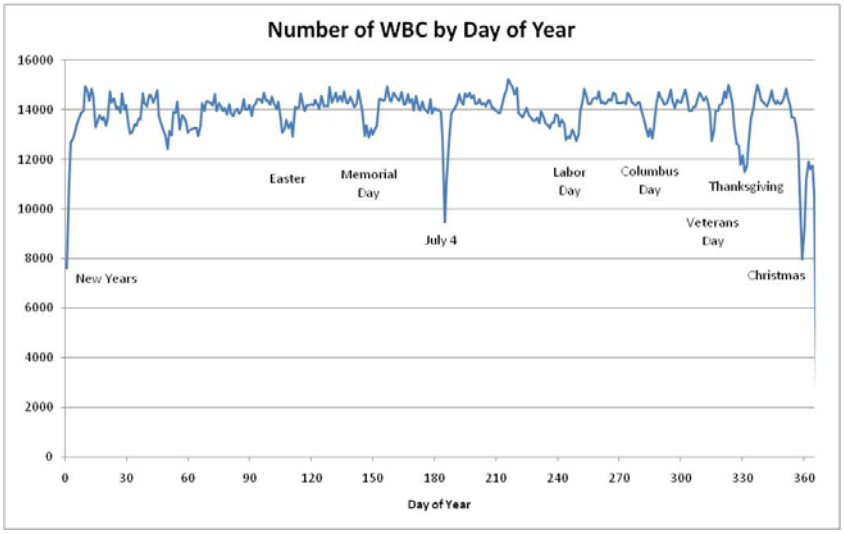
Daily HSD Cycles in Clinical Data



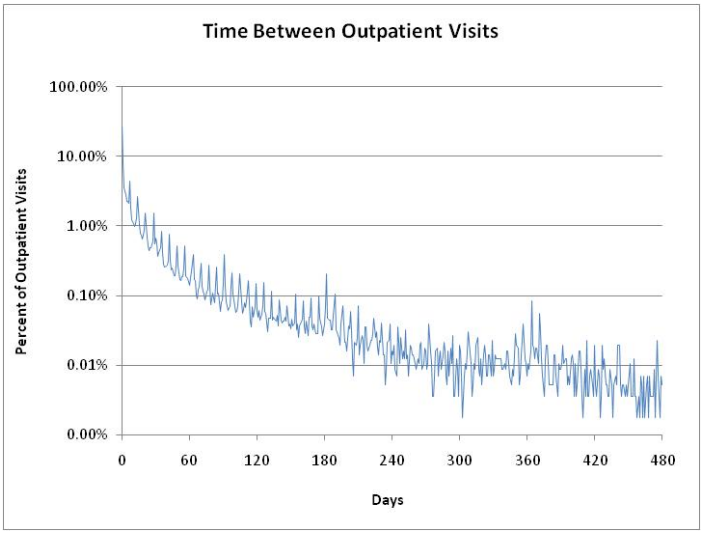
Weekly HSD Cycles in Clinical Data



Yearly HSD Cycles in Clinical Data

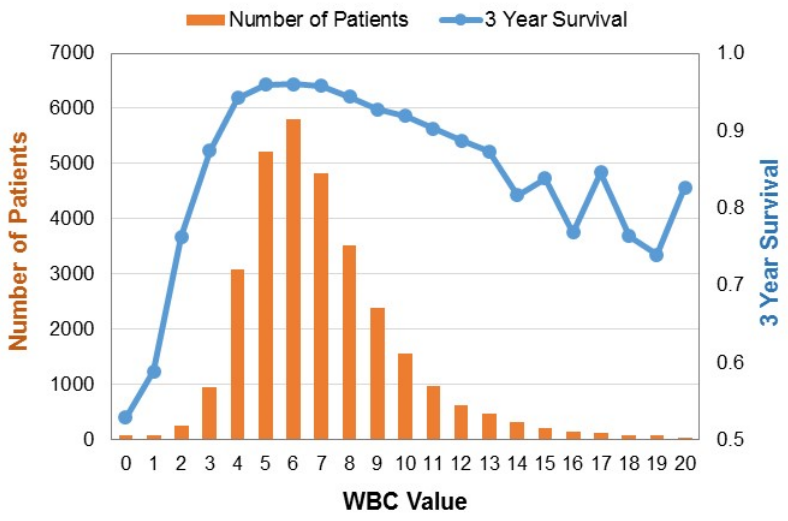


HSD Impact on **Time Intervals** between Visits

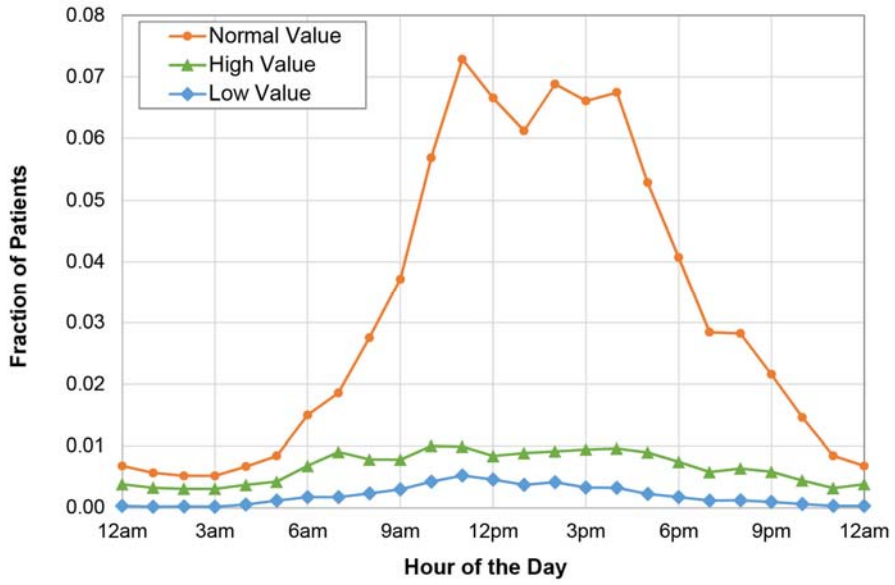


Using HSD To Predict Outcomes

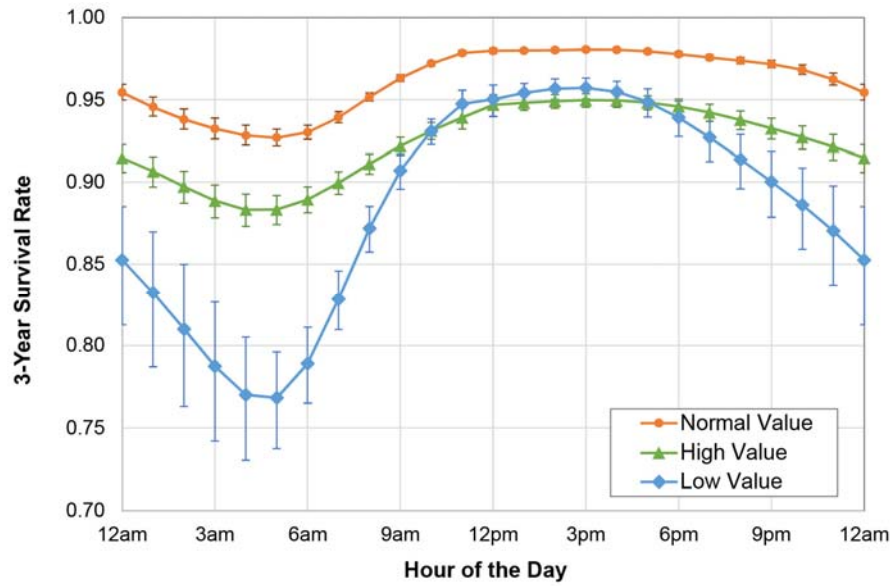
Survival 3 Years After a WBC Test



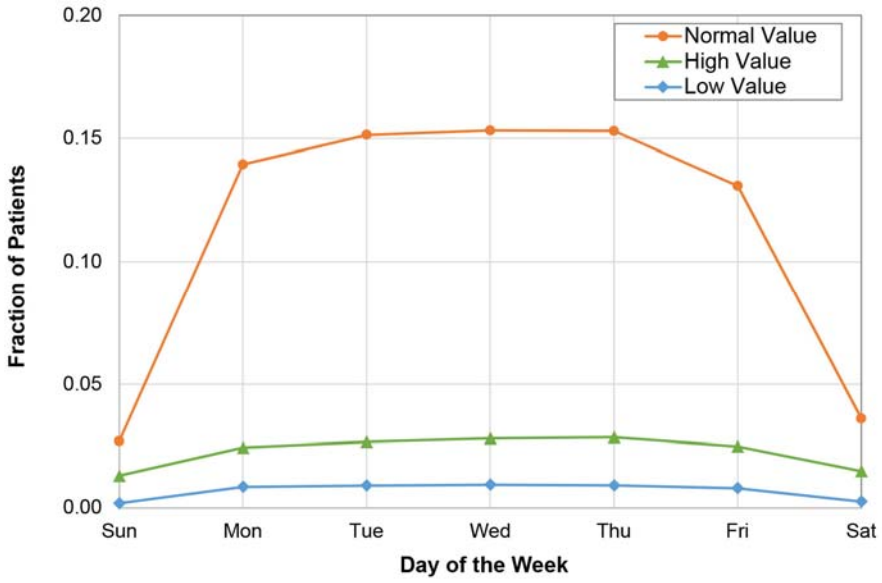
Fraction of Patients with WBC by **Value** and **Hour**



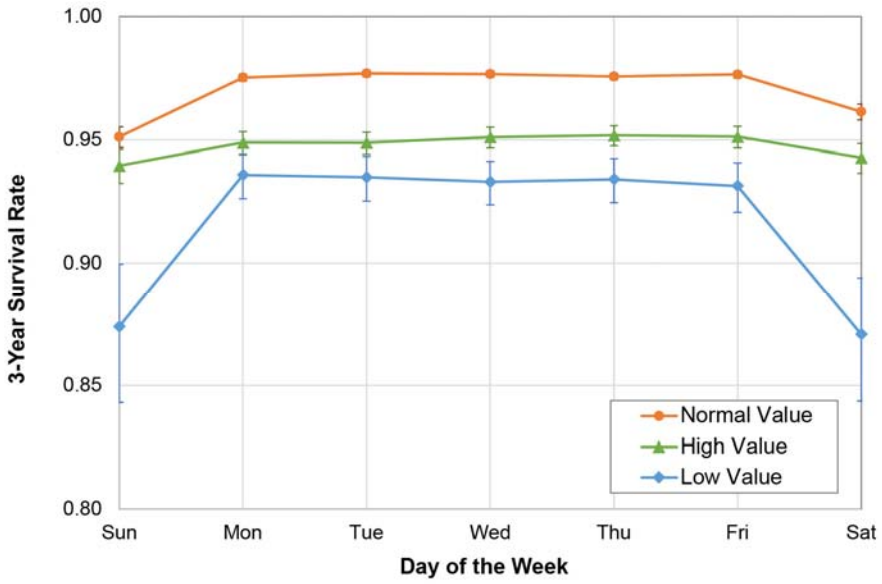
3-Year Survival After a WBC by **Value** and **Hour**



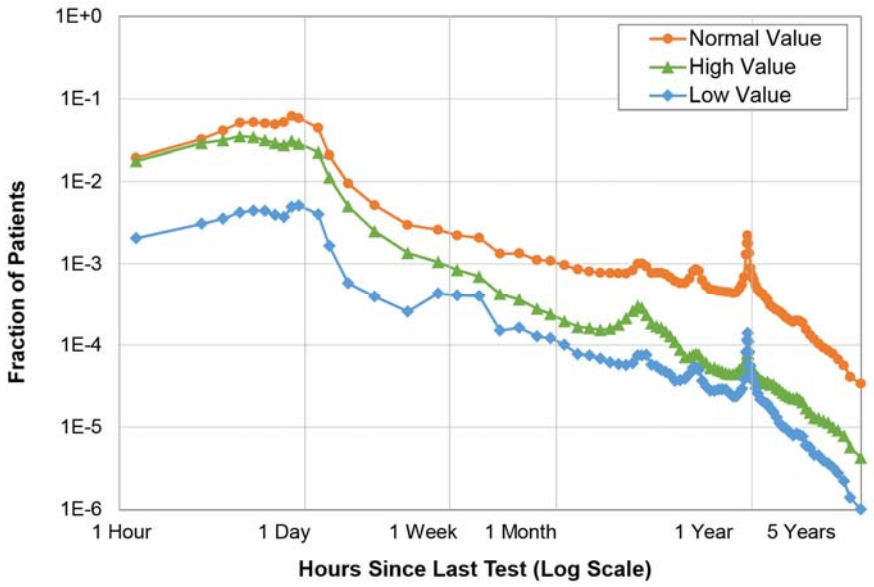
Fraction of Patients with WBC by **Value** and **Weekday**



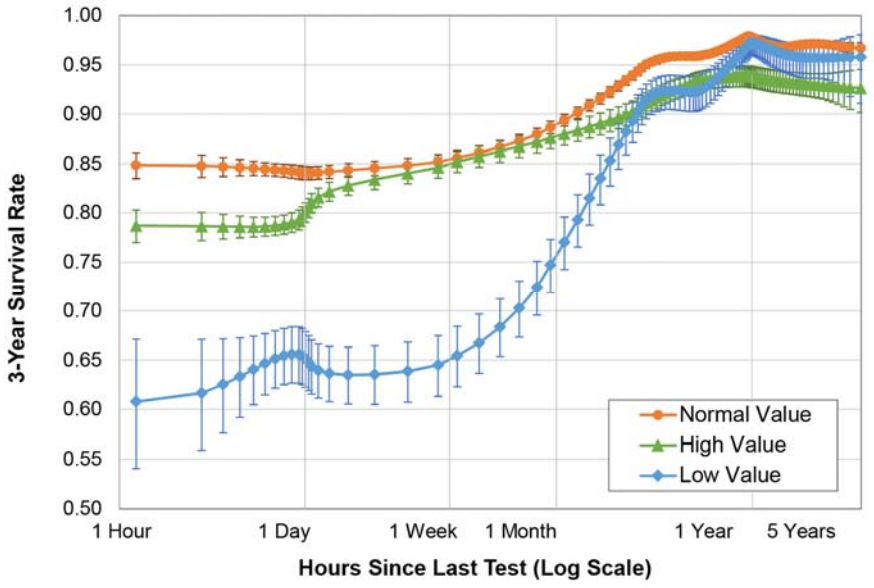
3-Year Survival After a WBC by **Value** and **Weekday**



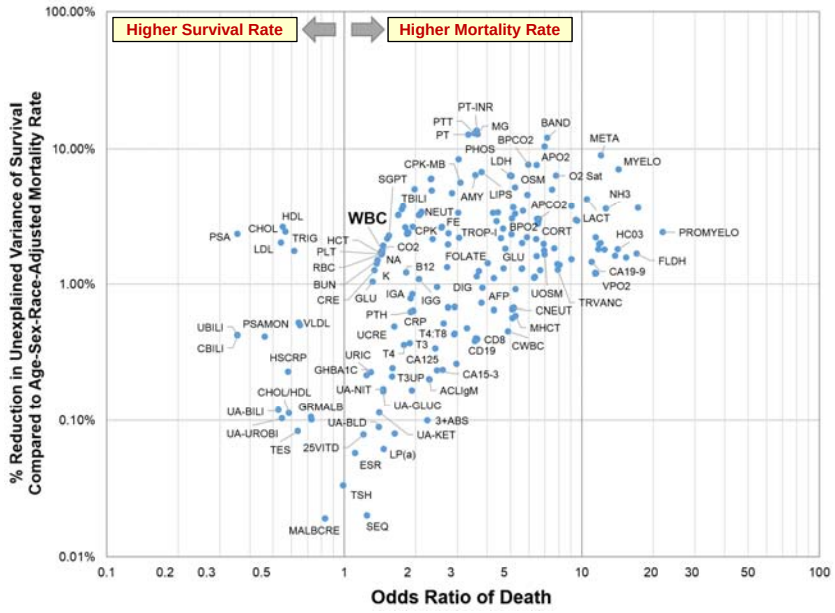
Fraction of Patients with WBC by **Value** and **Interval**



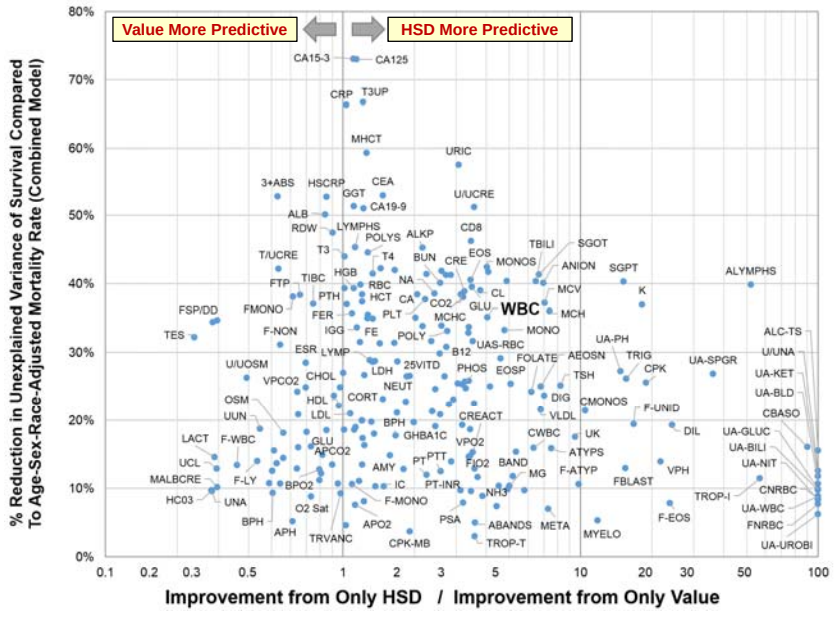
3-Year Survival After a WBC by **Value** and **Interval**



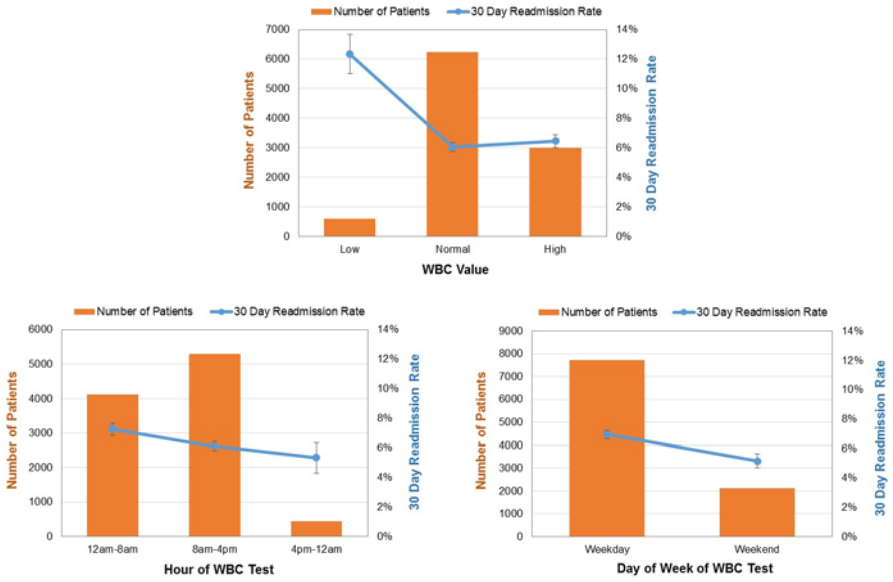
Predicting Survival from **Ordering** a Lab Test



Predicting Survival Using **Lab Value** & **HSD**

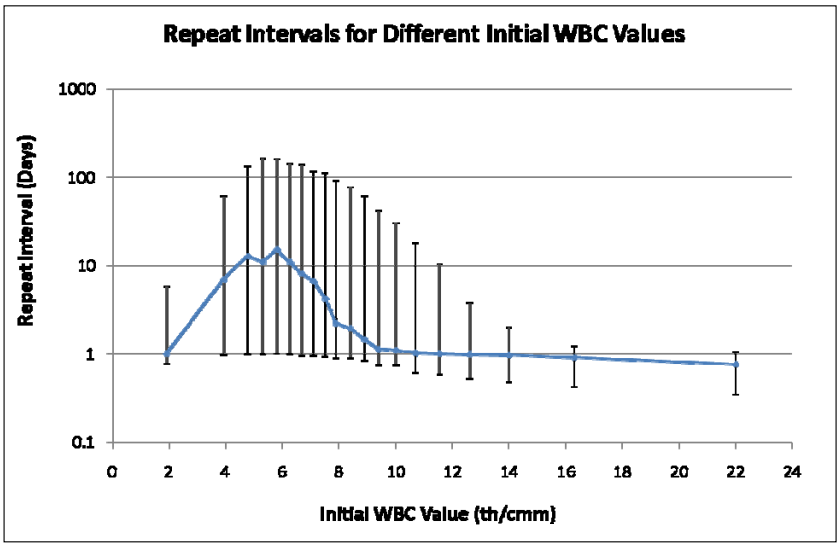


30 Day Readmission Rate After a WBC Test



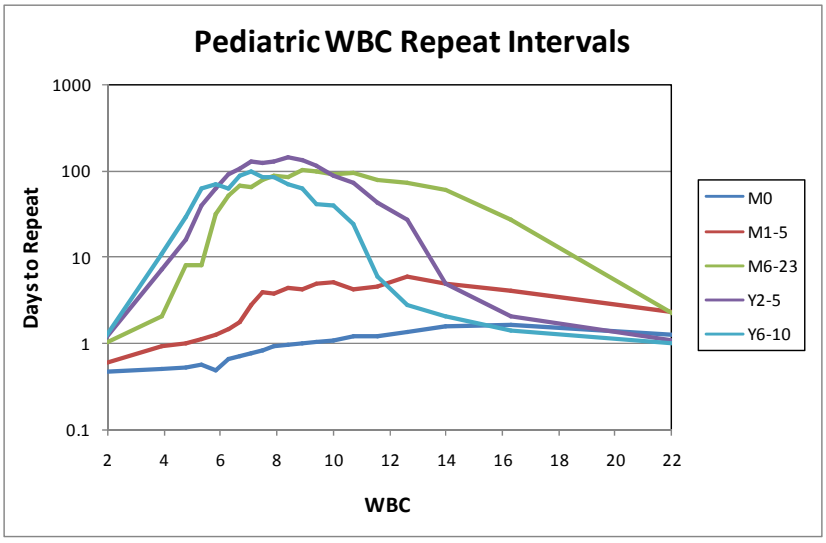
Using HSD To Derive Normal Ranges

Deriving Normal Ranges of Lab Test Values

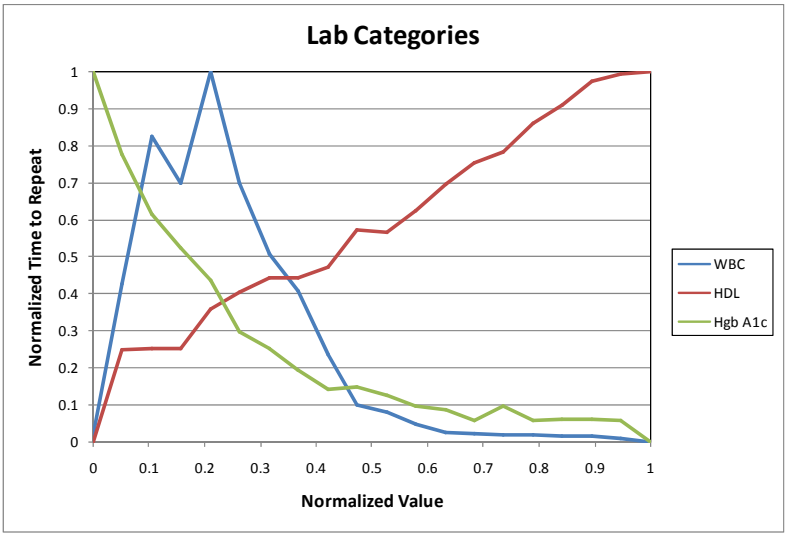


Weber GM, Kohane IS. Extracting physician group intelligence from electronic health records to support evidence based medicine. PLoS One. 2013 May 29;8(5):e64933.

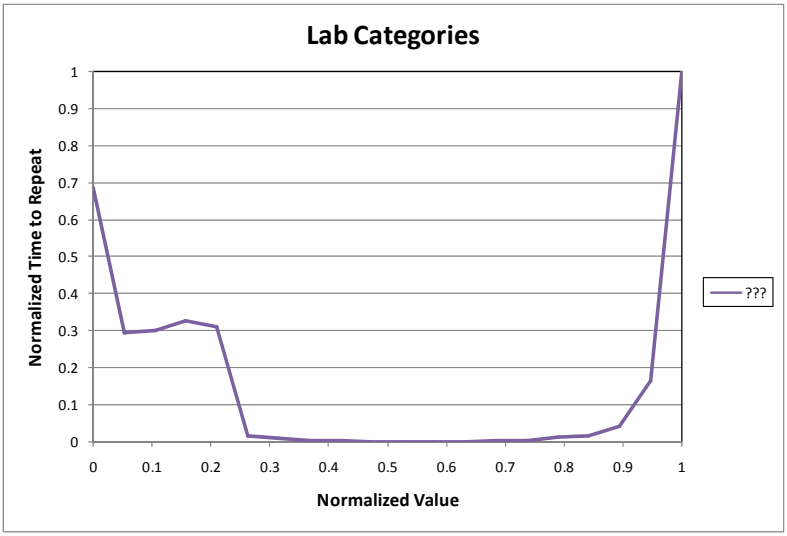
Deriving Normal Ranges by Age Group



Three Types of Laboratory Tests



Three Types of Laboratory Tests



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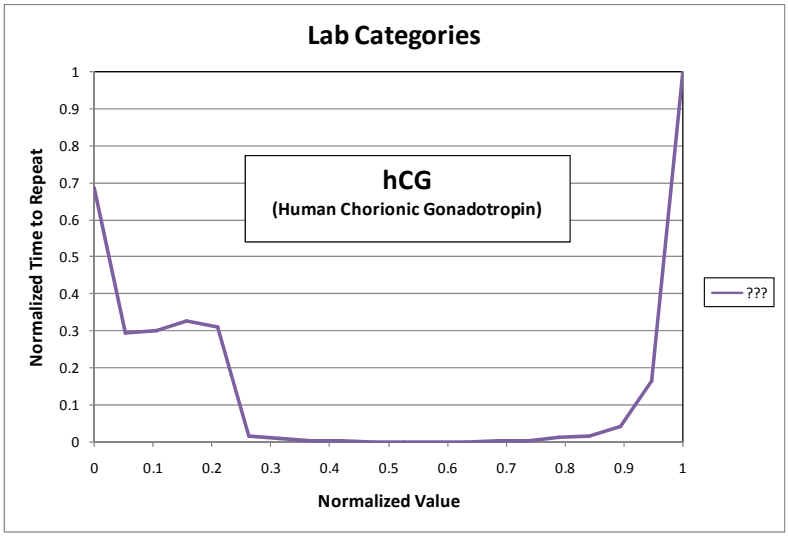
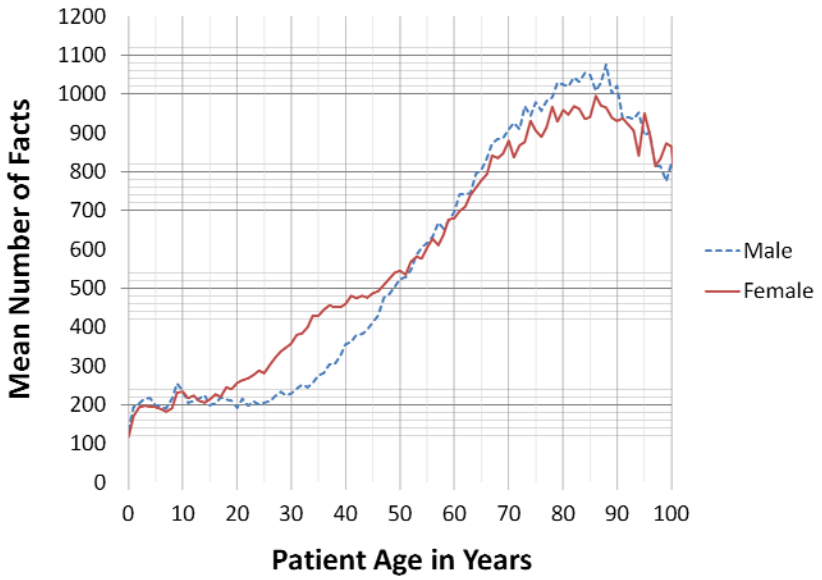
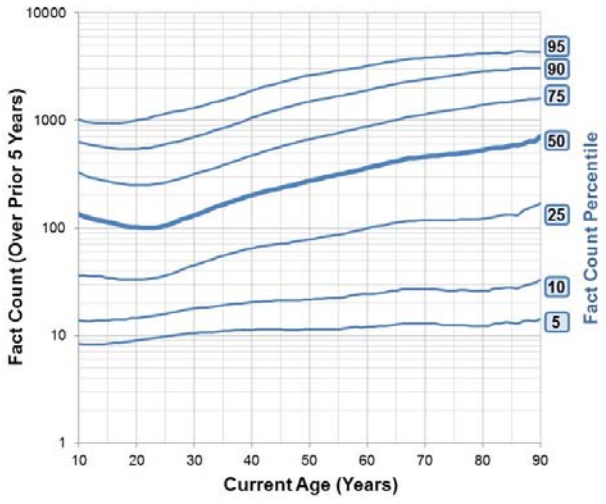


Predicting Survival Using "Fact Count"

Fact Count (over 8.5 years) by Age & Gender

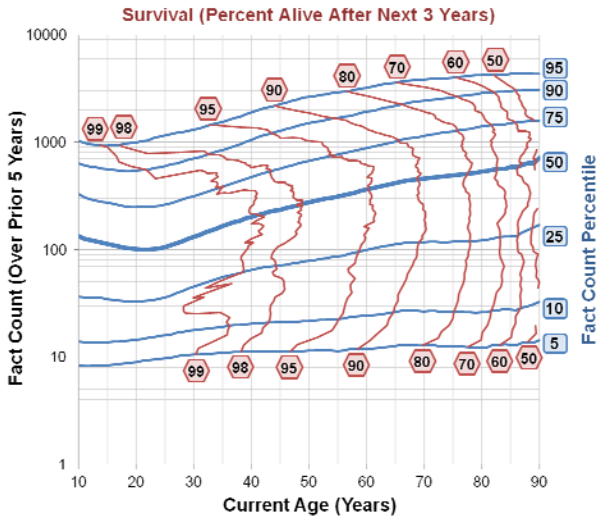


Fact Count Growth & Survival Chart (Male)



Horizontal blue curves with rectangular labels are five year fact count percentiles. Vertical red curves with hexagonal labels are three year survival curves. Data are from BWH and MGH from 7/28/2001 to 7/27/2009. All patients had at least one fact between 7/28/2005 and 7/27/2006. The "current" age is the patient age on 7/27/2006. This chart represents only male patients.

Fact Count Growth & Survival Chart (Male)



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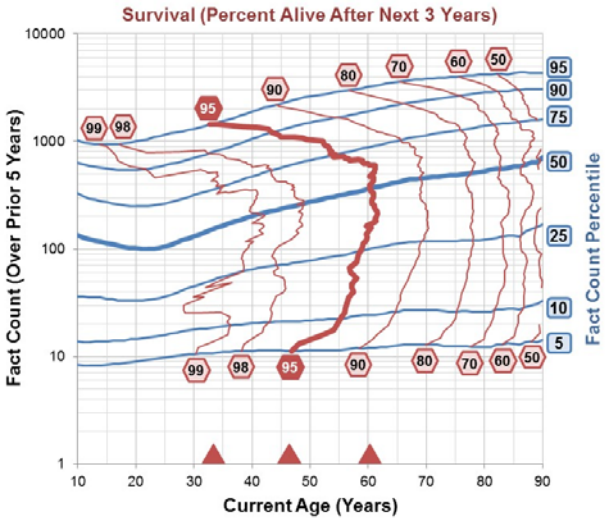
Fact Count Growth & Survival Chart (Male)



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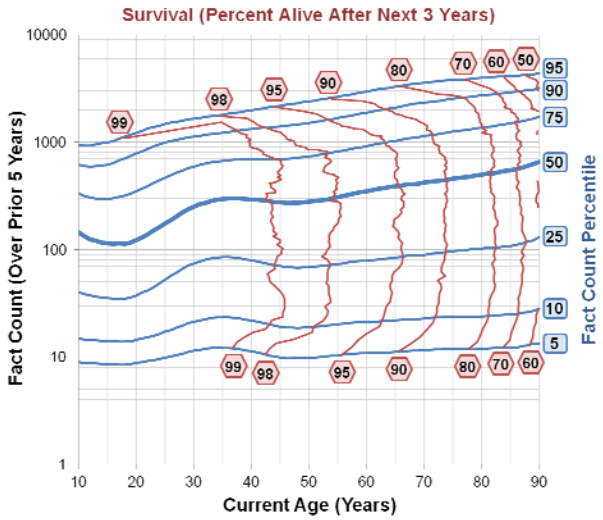
Fact Count Growth & Survival Chart (Female)



Horizontal blue curves with rectangular labels are five year fact count percentiles. Vertical red curves with hexagonal labels are three year survival curves. Data are from BWH and MGH from 7/28/2001 to 7/27/2009. All patients had at least one fact between 7/28/2005 and 7/27/2006. The "current" age is the patient age on 7/27/2006. This chart represents only female patients.

Adding HSD To i2b2

Adding HSD to i2b2 Using Sci2 Visualization Platform

Software and demos available at
http://HealthcareSystemDynamics.org

Ontology for Visualizing HSD

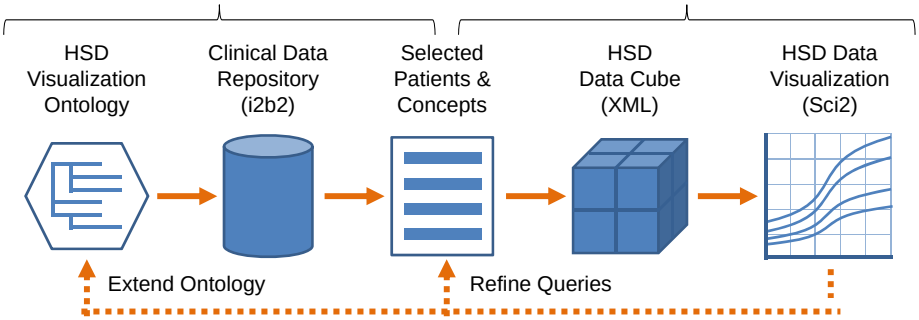
Informatics for Integrating Biology and the Bedside

https://www.i2b2.org

Interactive HSD Visualizations

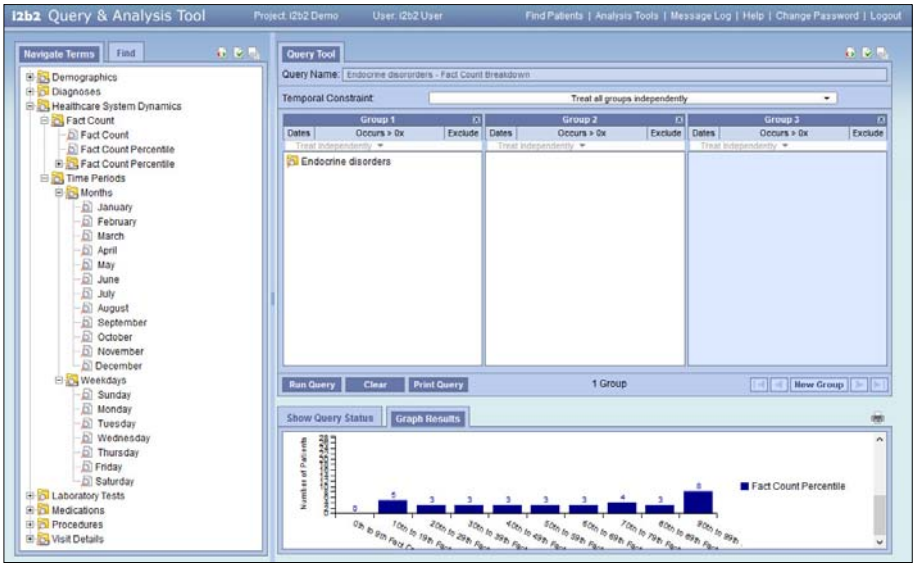
Science of Science (Sci2)

https://sci2.cns.iu.edu

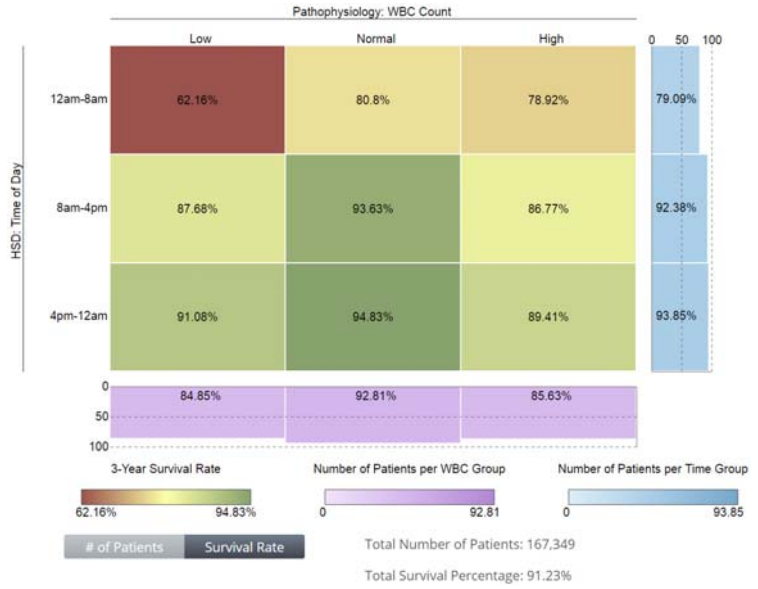


Learning from Visualization of HSD

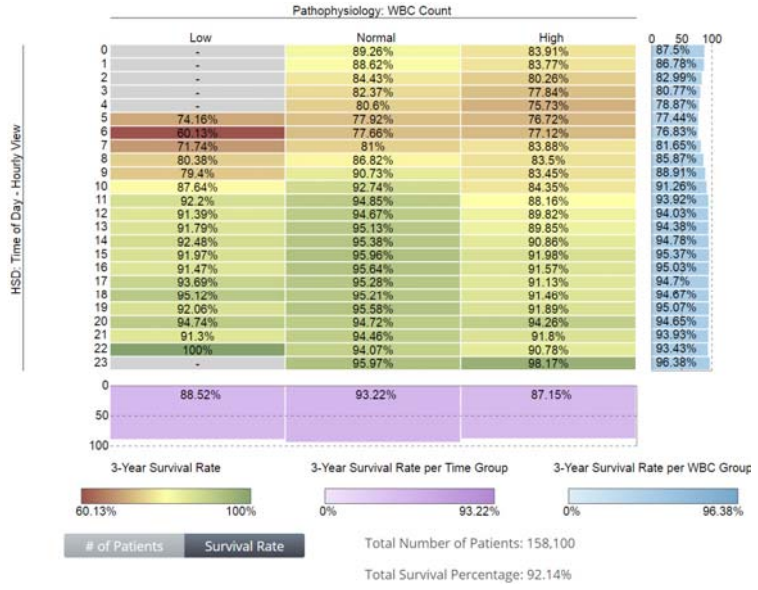
HSD Ontology for i2b2



Sci2 – WBC Survival by Time of Day Heatmap



Sci2 – WBC Survival by Time of Day Heatmap



We need your help!

- Try our i2b2 demo & download HSD ontology
  http://HealthcareSystemDynamics.org
- Participate in our upcoming Focus Groups
- Share with us references of similar work
- Feedback, suggestions, questions, etc.
  weber@hms.harvard.edu

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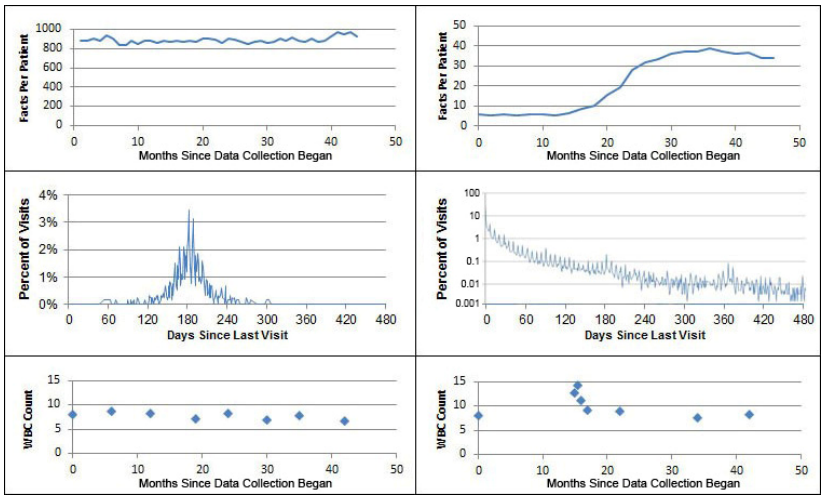
Big Data to Knowledge (BD2K), NIH/NCI U01 CA198934

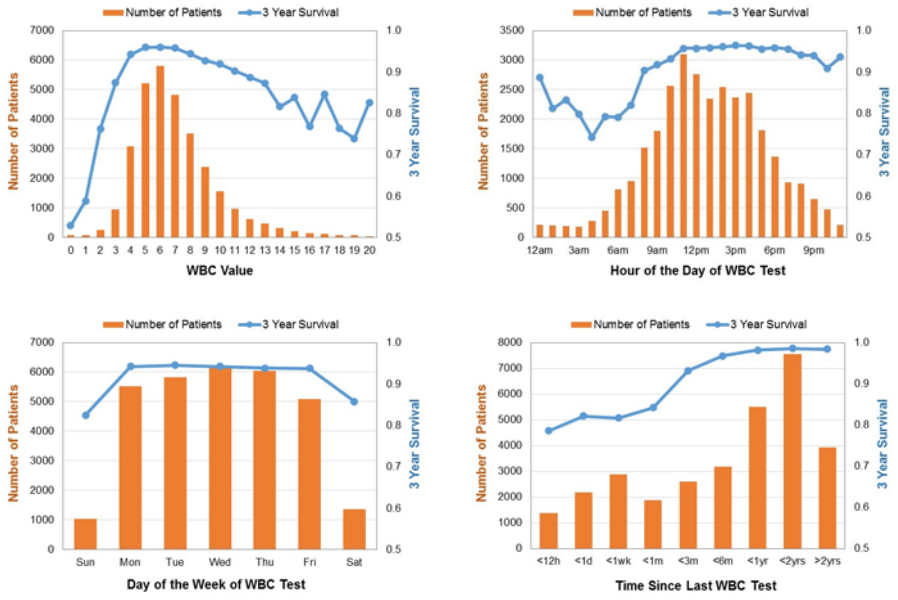
Extras

Clinical Trial vs EHR Data

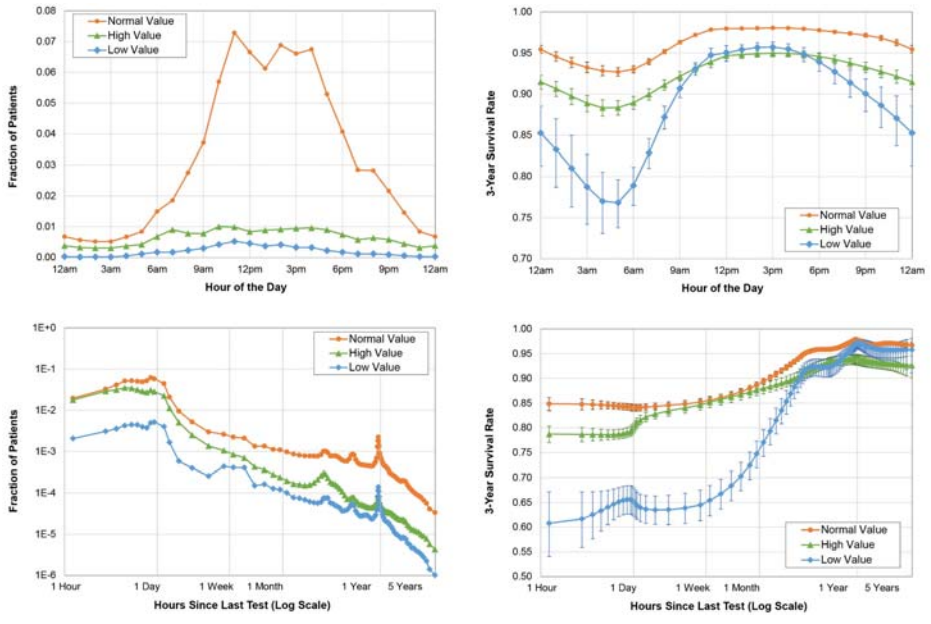
Clinical Trial (With 6 Month Visits) | Hospital Electronic Health Record



Survival by WBC Value and HSD Dimensions



Survival by WBC Value and HSD Dimensions



Survival 3 Years After a WBC Test

(White, Male, 50-69 Years; Using Last WBC Between 7/28/05 and 7/27/06)

		WBC Value				Patients
		Low	Normal	High	Any	
Result Time	12a-8a	46.56%	82.91%	65.90%	76.43%	3649
	8a-4p	79.61%	92.81%	81.71%	90.73%	14534
	4p-12a	81.99%	94.29%	85.74%	92.96%	4930
	Any	73.17%	91.79%	78.11%	88.95%	23113
Patients		1286	18775	3052	23113	

		WBC Value				Patients
		Low	Normal	High	Any	
Time Since Last WBC	< 1 Day	47.21%	85.04%	70.35%	78.92%	3501
	< 1 Year	72.88%	89.98%	79.22%	87.43%	13225
	> 1 Year	96.52%	97.83%	94.12%	97.59%	6387
	Any	73.17%	91.79%	78.11%	88.95%	23113
Patients		1286	18775	3052	23113	

Survival 3 Years After a WBC Test

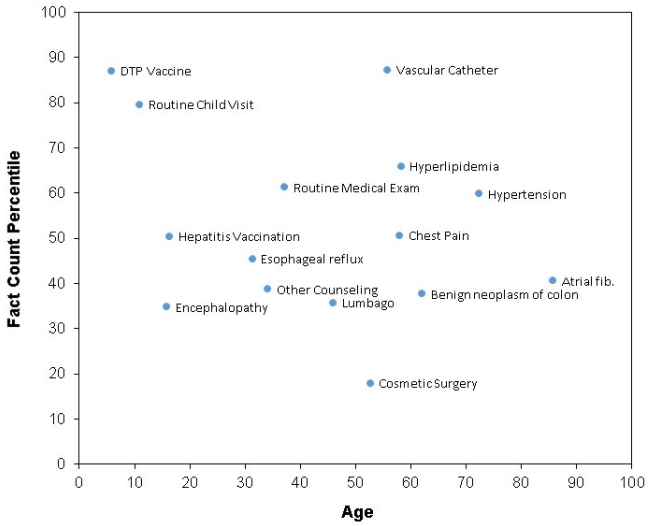
(White, Male, 50-69 Years; Using Last WBC Between 7/28/05 and 7/27/06)

Repeat Interval	Result Time	WBC Value				Patients
		Low	Normal	High	Any	
< 1 Day	12a-8a	43.33%	84.68%	63.24%	76.39%	1830
	8a-4p	54.55%	86.61%	79.40%	83.15%	1442
	4p-12a		77.30%	67.53%	72.49%	229
< 1 Year	12a-8a	47.83%	79.58%	66.67%	74.39%	1644
	8a-4p	76.96%	90.73%	80.80%	88.53%	8812
	4p-12a	81.65%	92.99%	86.01%	91.69%	2769
> 1 Year	12a-8a		95.65%	96.97%	96.00%	175
	8a-4p	97.30%	98.13%	91.98%	97.83%	4280
	4p-12a	92.68%	97.35%	96.67%	97.20%	1932
Any		73.17%	91.79%	78.11%	88.95%	23113
Patients		1286	18775	3052	23113	

Age-Fact Count Disease Profiles

Each point is the average age and fact count percentile of patients with a diagnosis

Cosmetic surgery vs. vascular catheter: same patient age, different health statuses



Prevalence Rank of Selected Diseases for Different Age and Fact Count Percentile Groups