

Healthcare System Dynamics

<http://HealthcareSystemDynamics.org>

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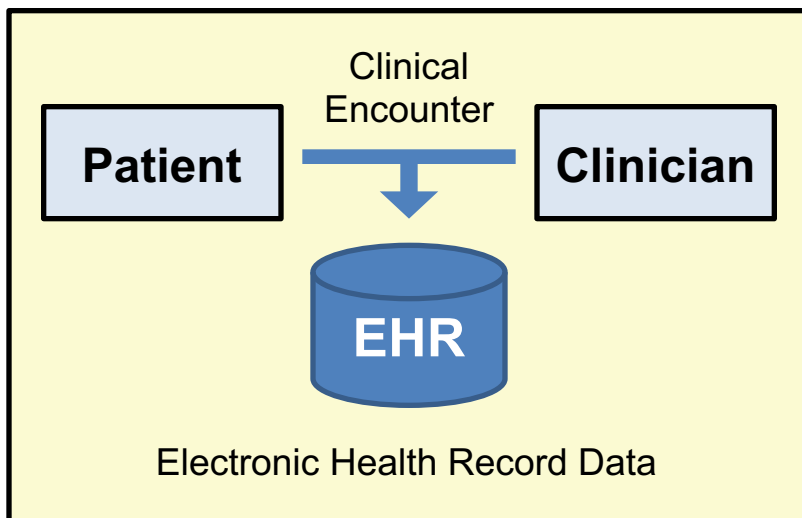
weber@hms.harvard.edu

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

Healthcare System Dynamics

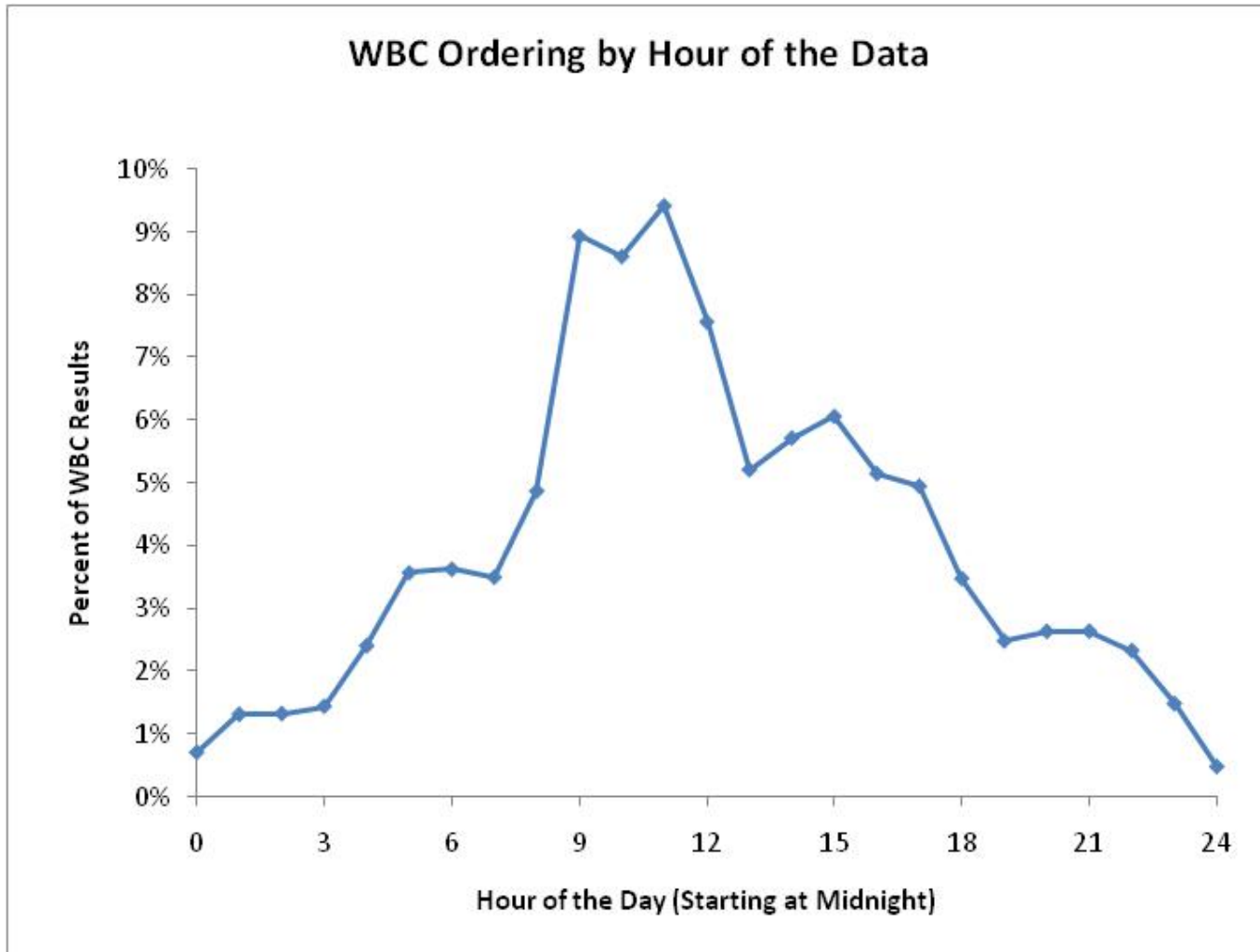
Clinical data reflect both patients' health AND their interactions with the healthcare system.

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

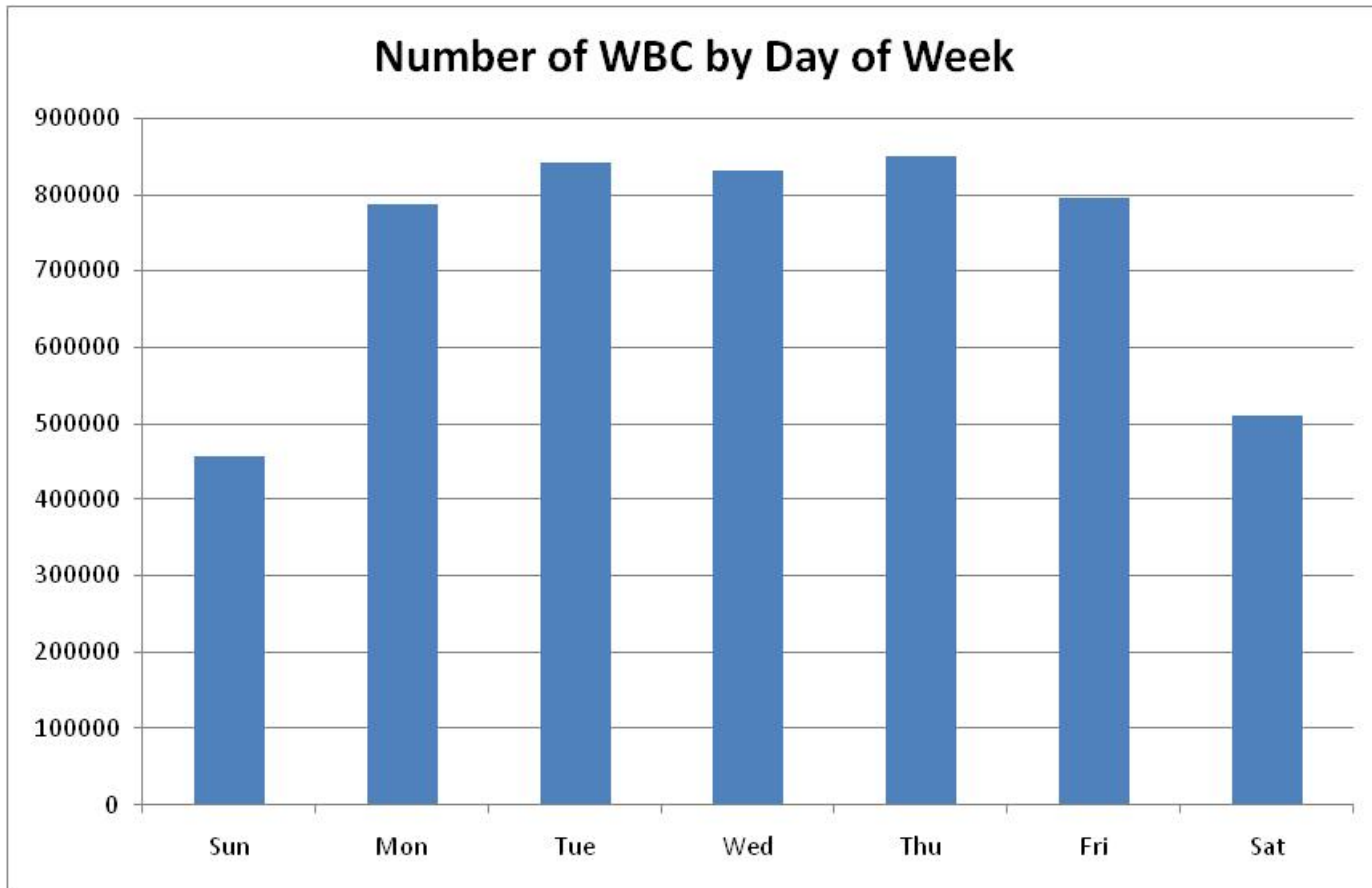


	Patient Pathophysiology	
Healthcare System Dynamics	Normal	Abnormal
Normal	Best Outcomes	Moderate Outcomes
Abnormal	Moderate Outcomes	Worst Outcomes

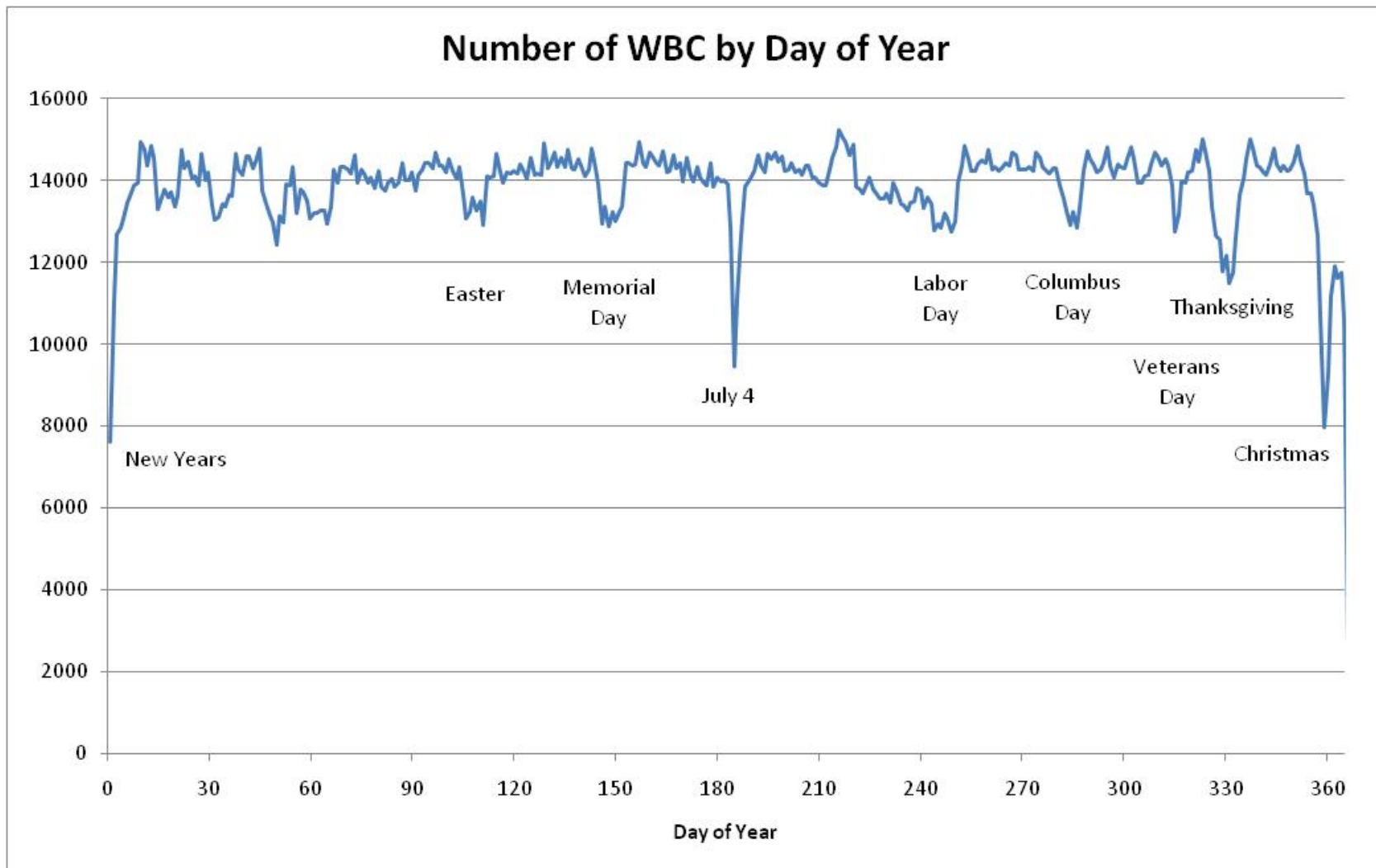
Daily HSD Cycles in Clinical Data



Weekly HSD Cycles in Clinical Data

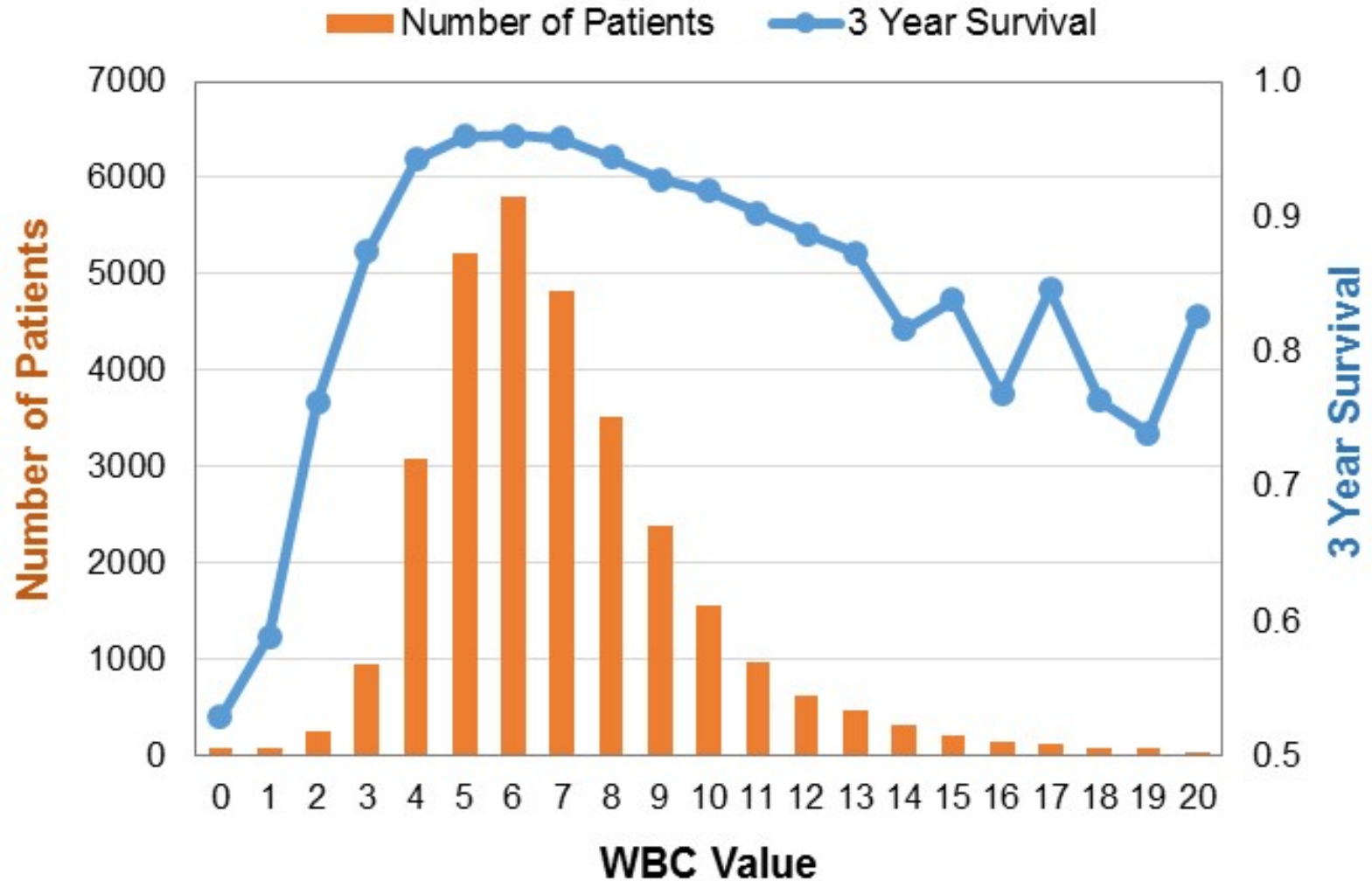


Yearly HSD Cycles in Clinical Data

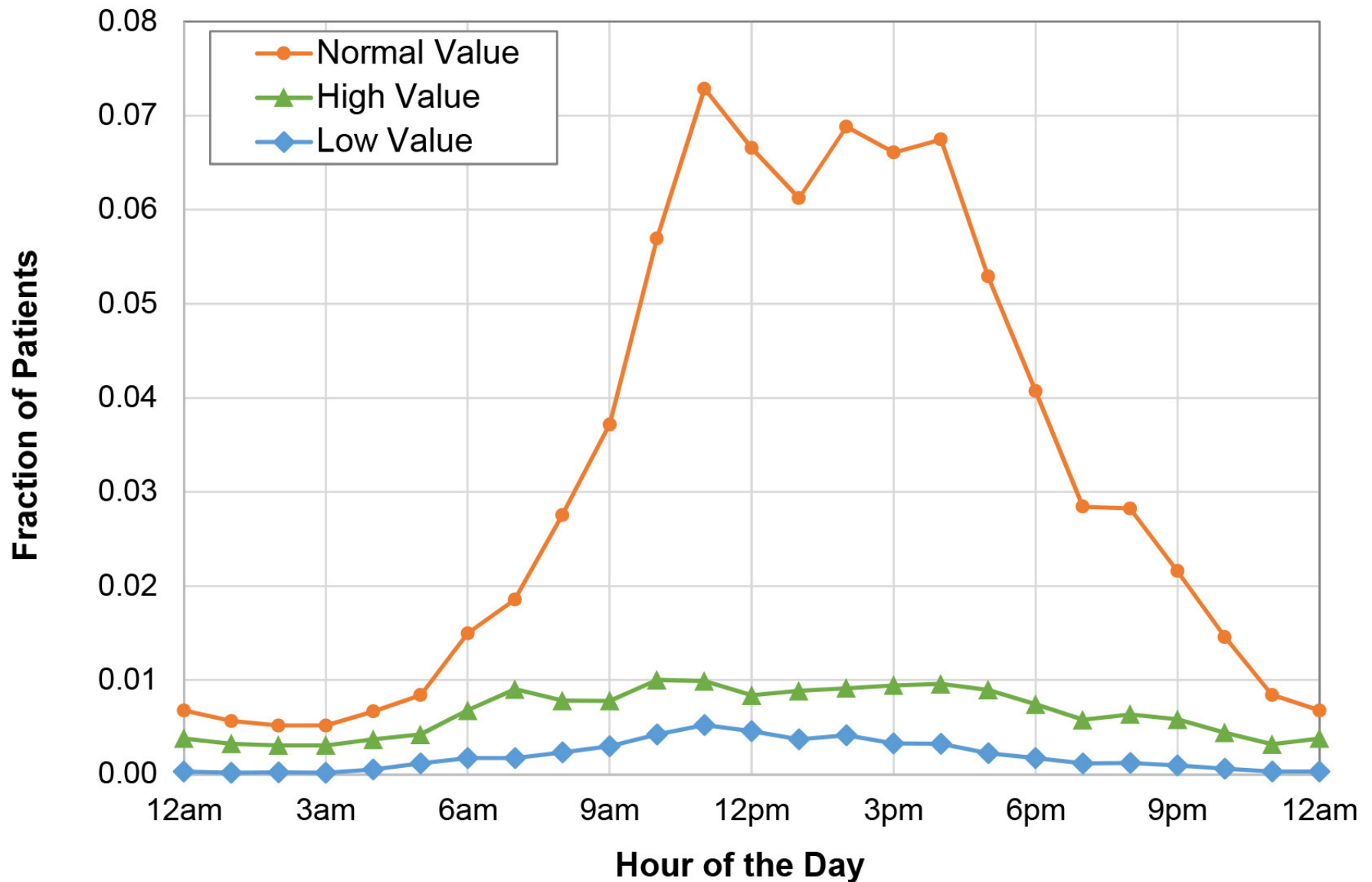


Using HSD To Predict Outcomes

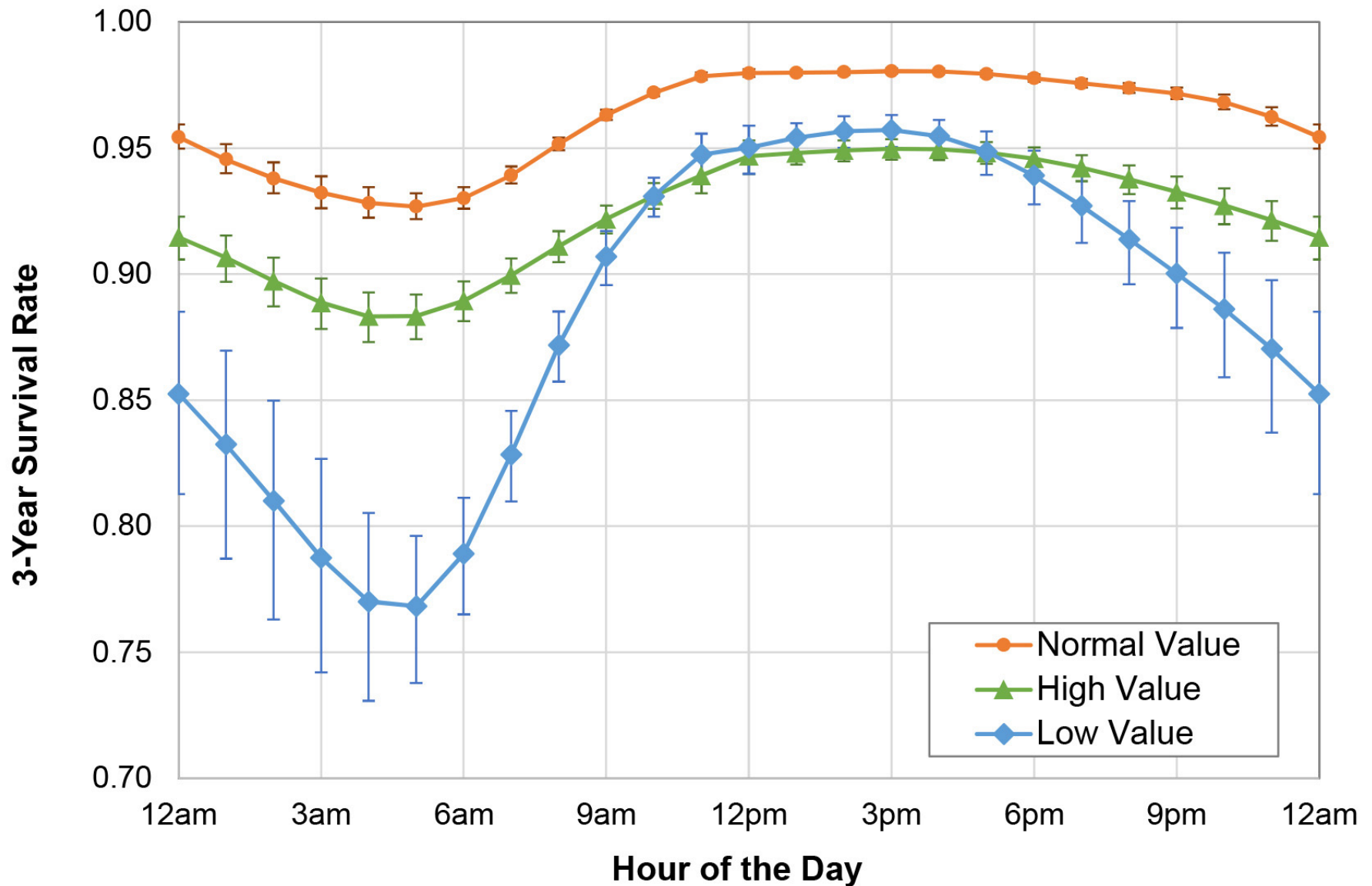
Survival 3 Years After a WBC Test



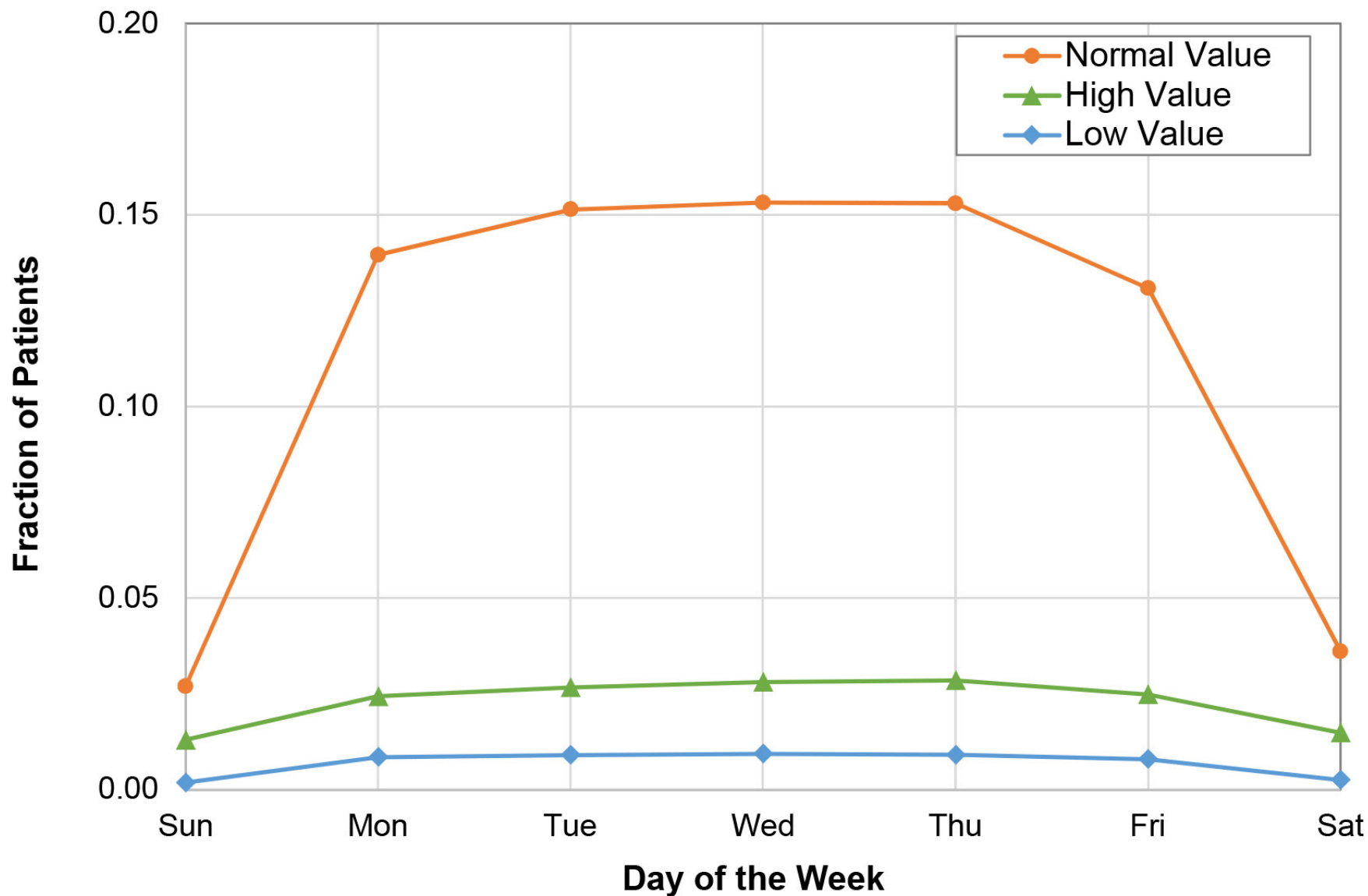
Fraction of Patients with WBC by Value and Hour



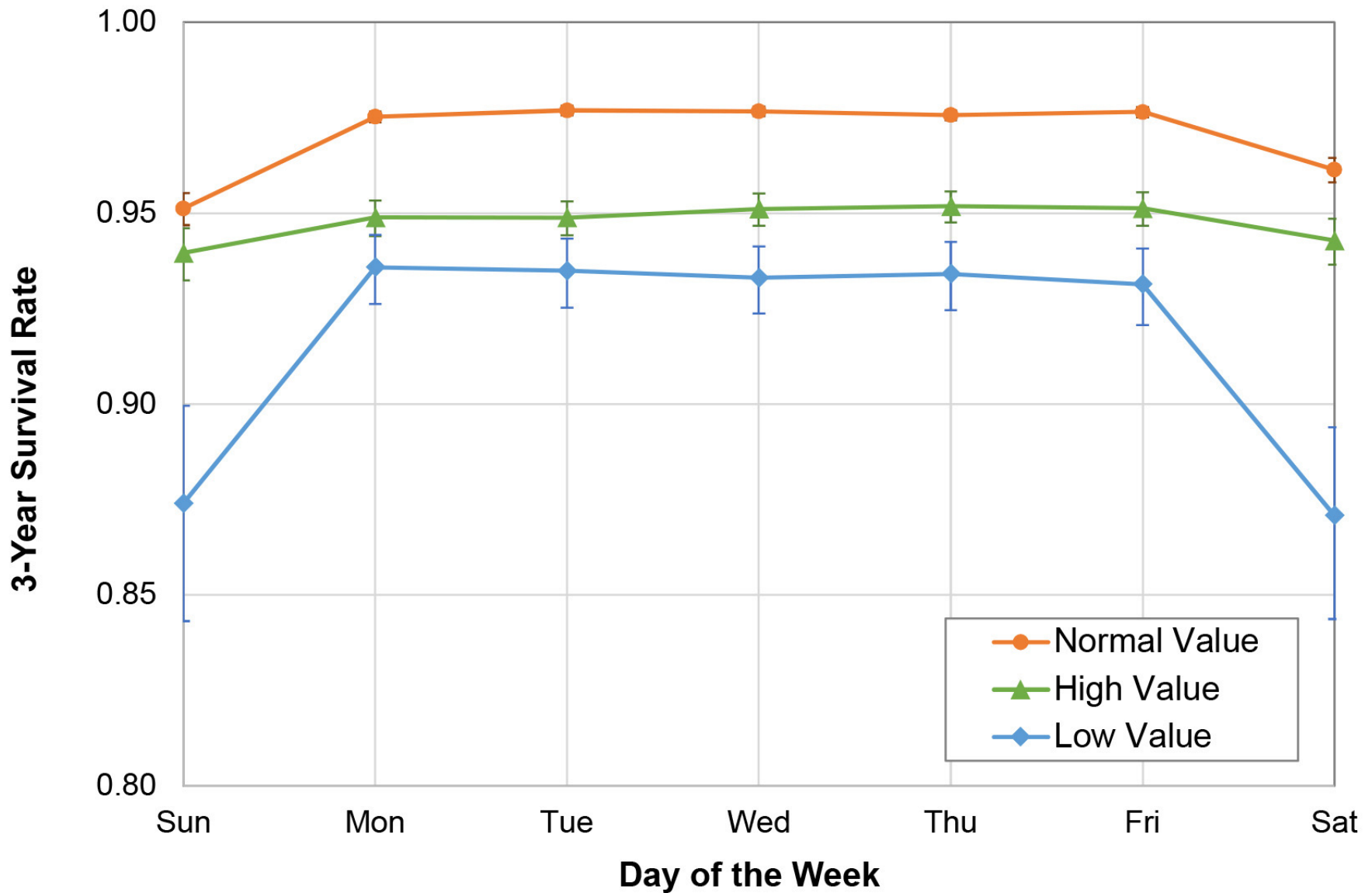
3-Year Survival After a WBC by Value and Hour



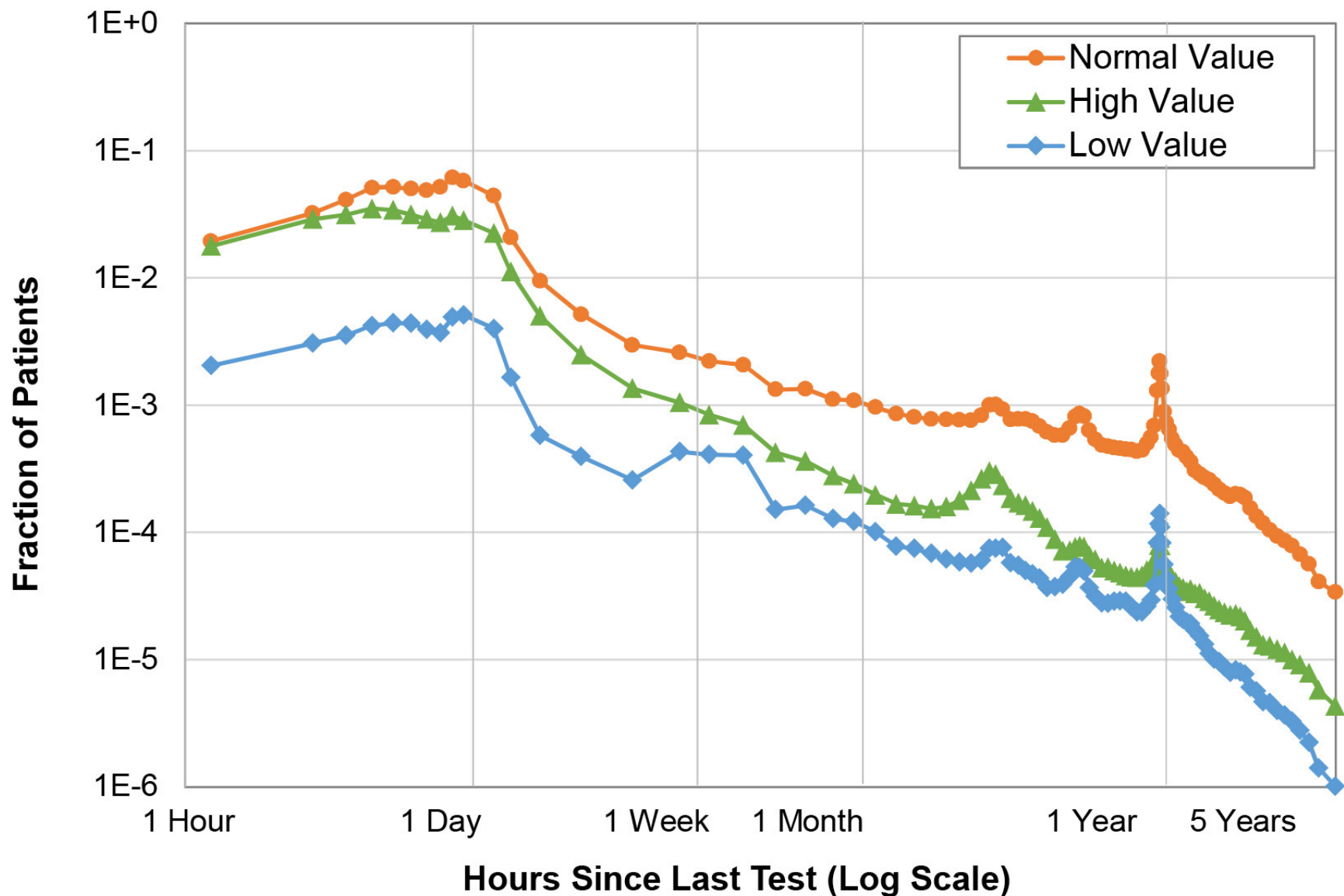
Fraction of Patients with WBC by **Value** and **Weekday**



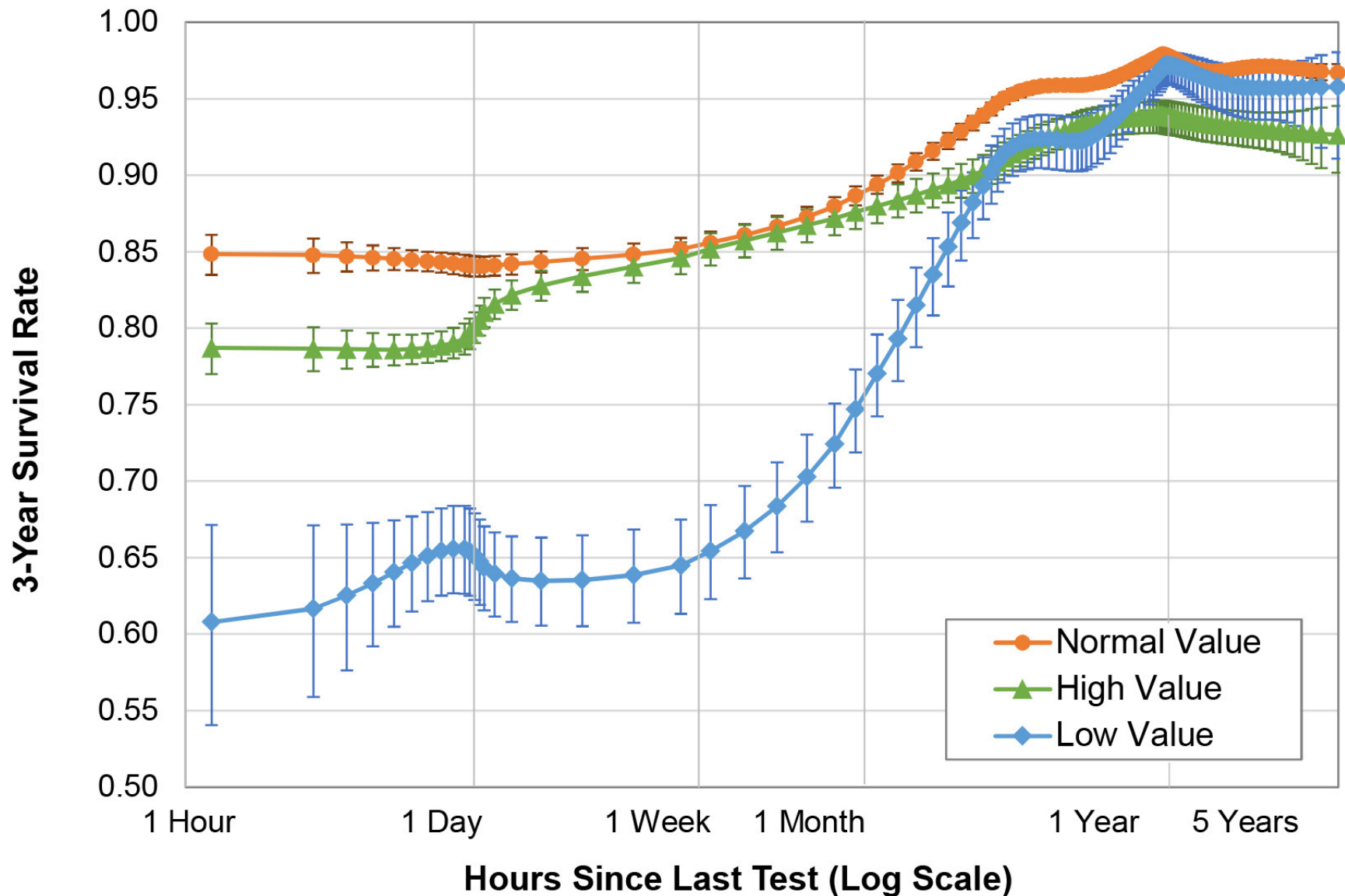
3-Year Survival After a WBC by Value and Weekday



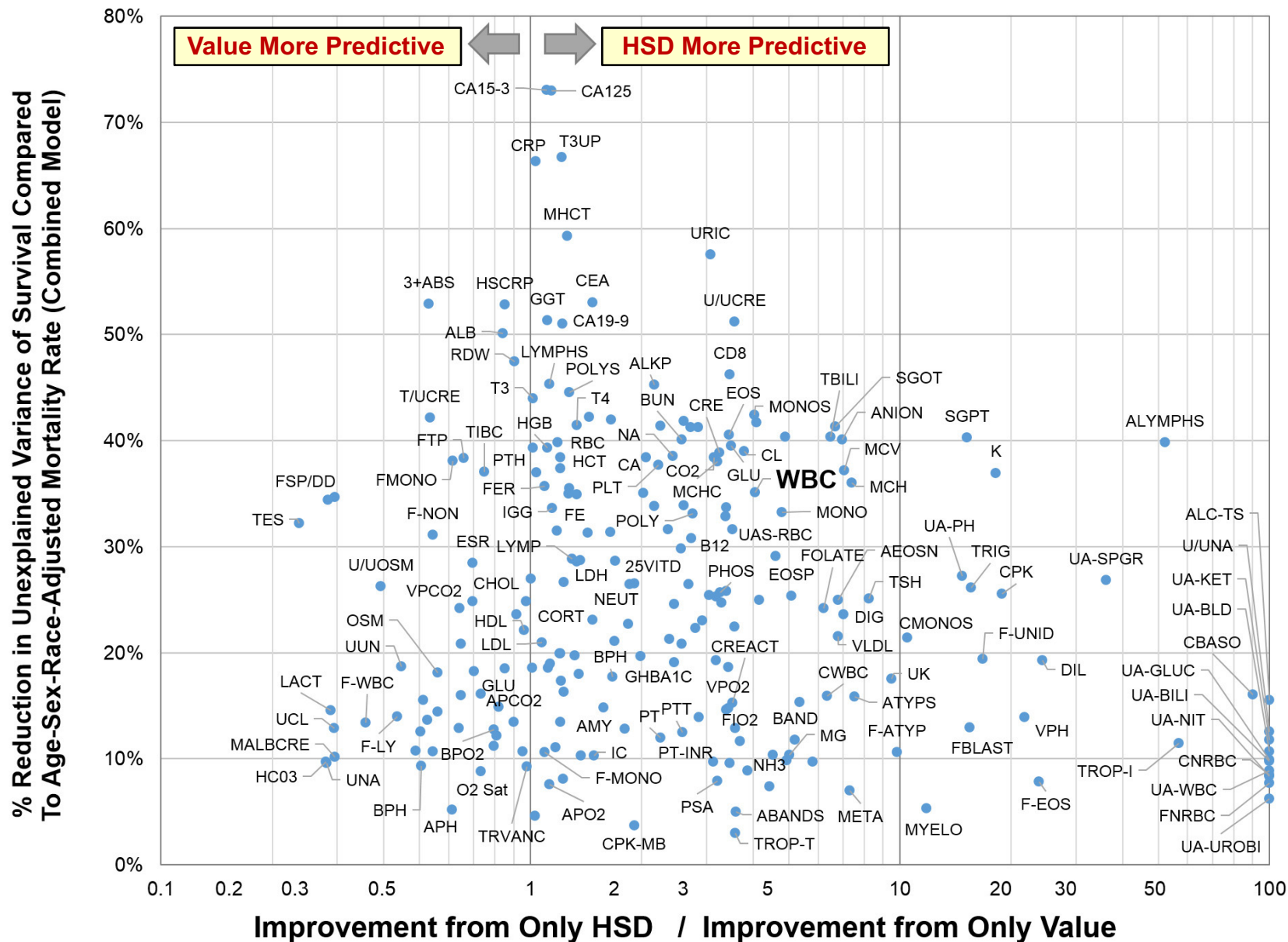
Fraction of Patients with WBC by Value and Interval



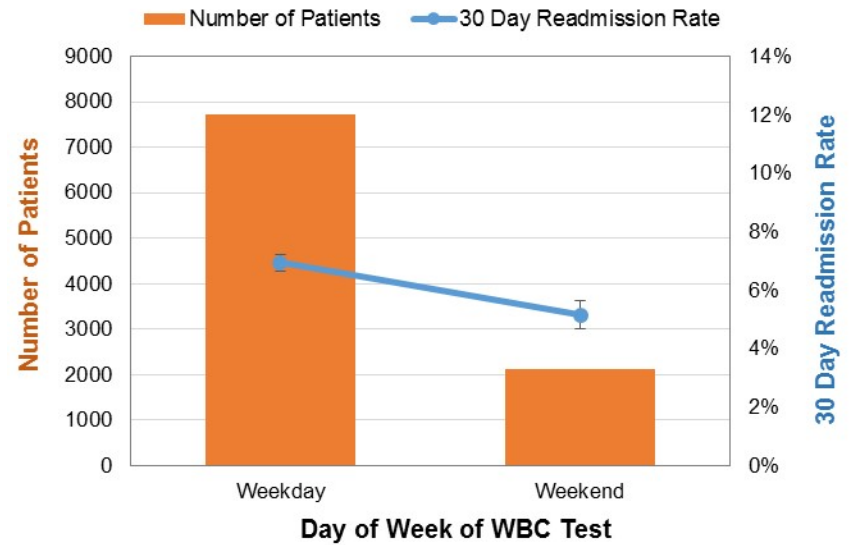
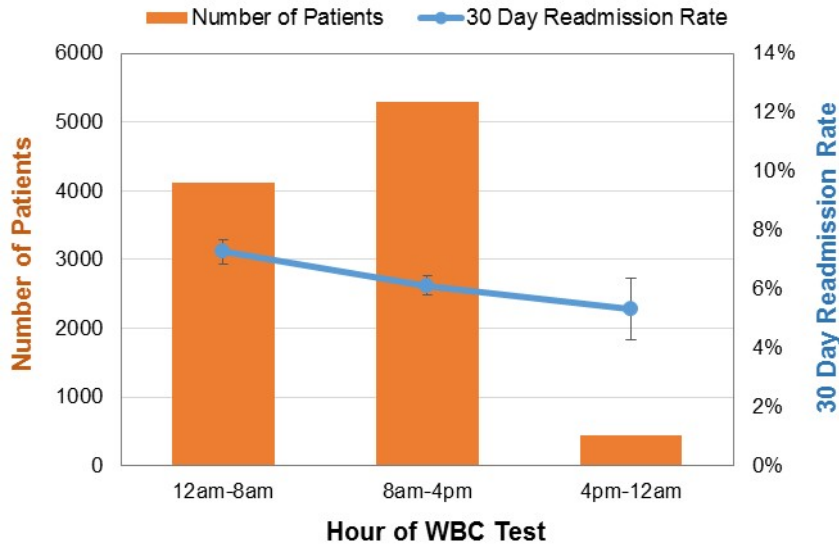
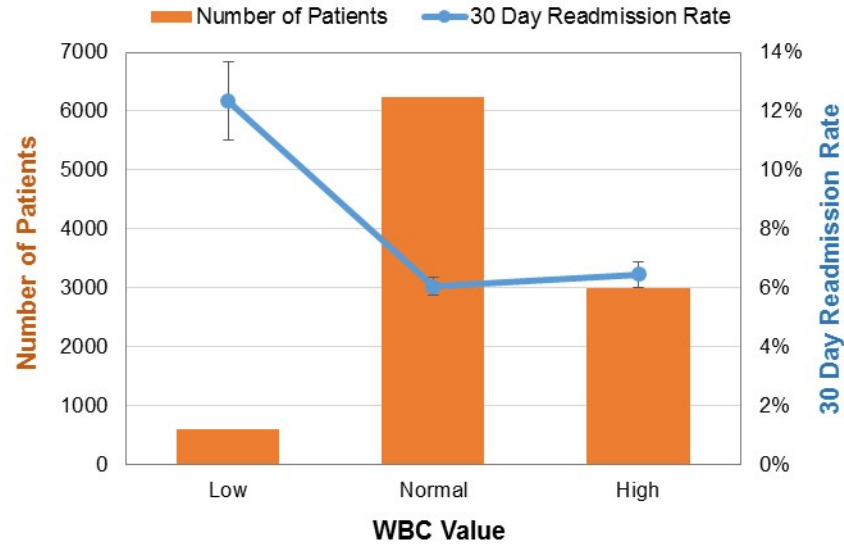
3-Year Survival After a WBC by **Value** and **Interval**



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

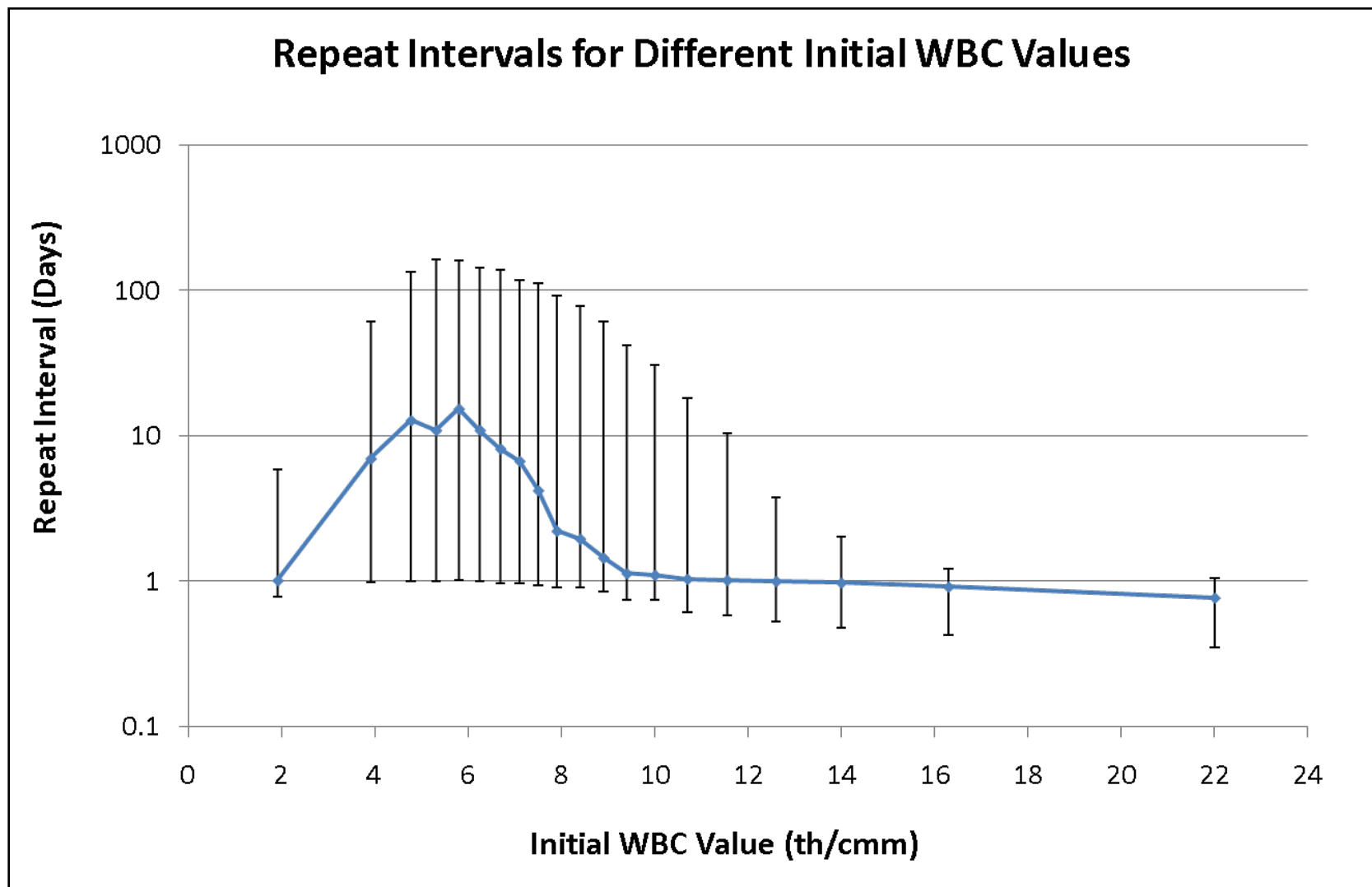


30 Day Readmission Rate After a WBC Test



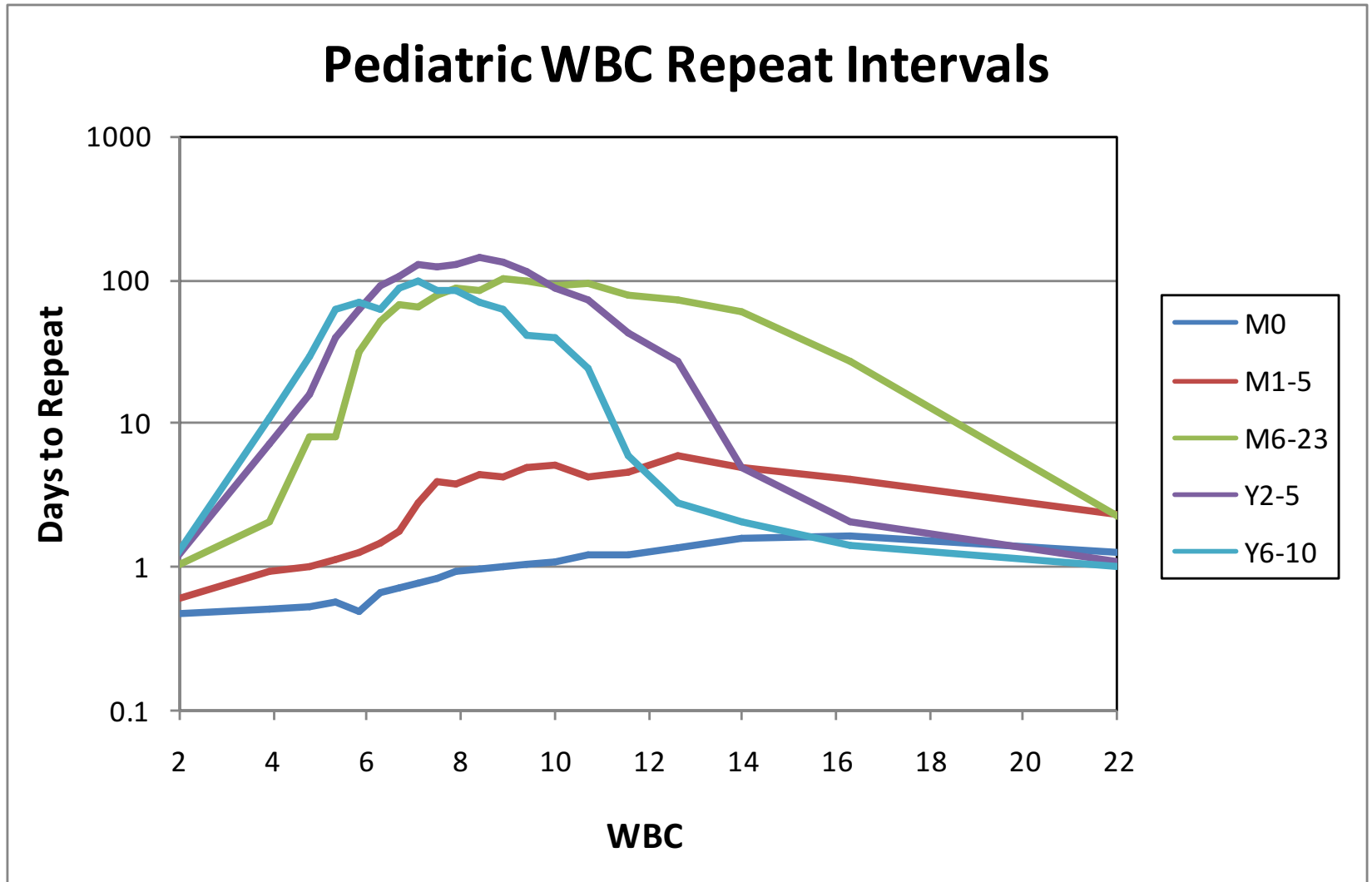
Using HSD To Derive Normal Ranges

Deriving Normal Ranges of Lab Test Values



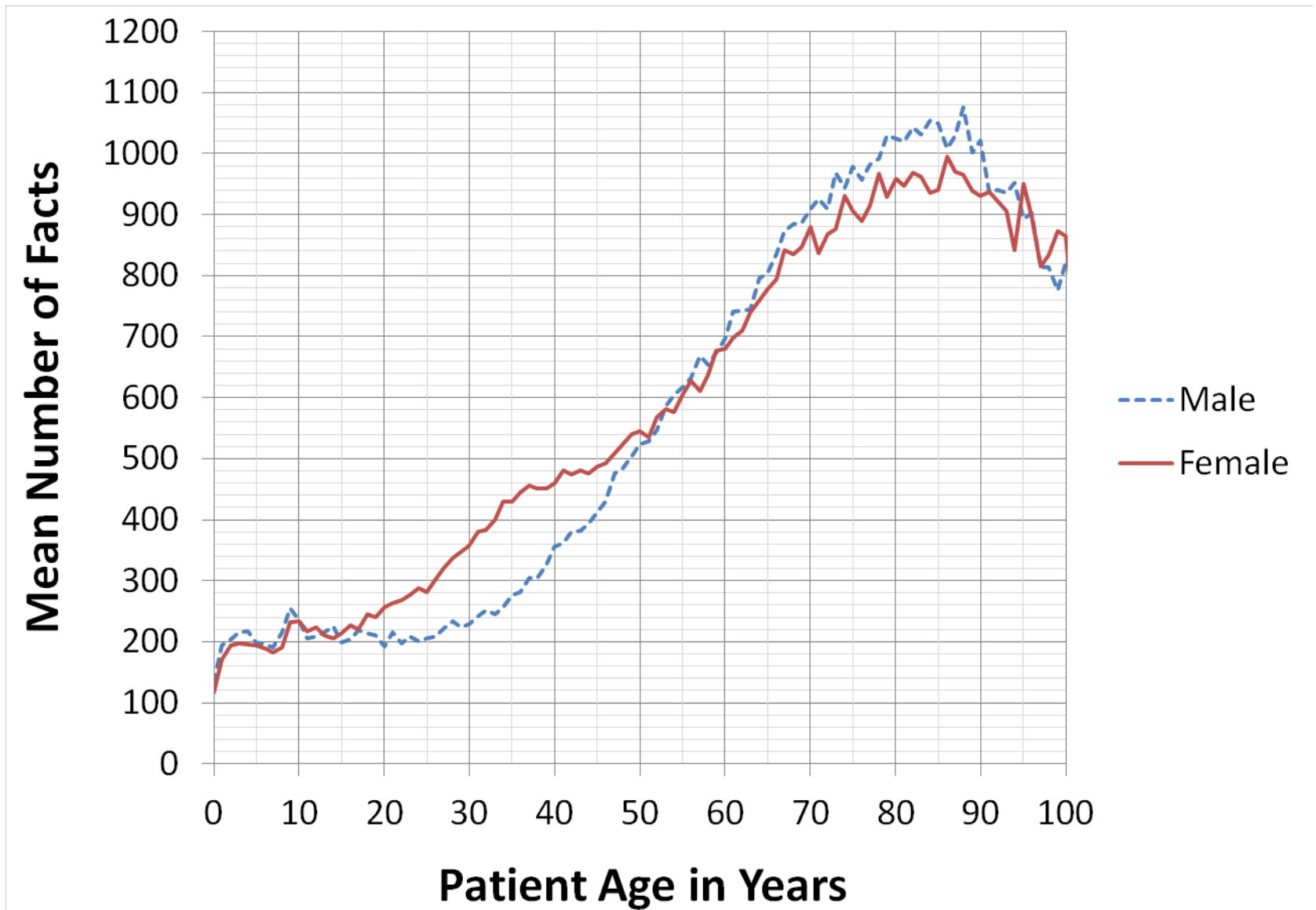
Weber GM, Kohane IS. Extracting physician group intelligence from electronic health records to support evidence based medicine. PLoS One. 2013 May 29;8(5):e64933.

Deriving Normal Ranges by Age Group

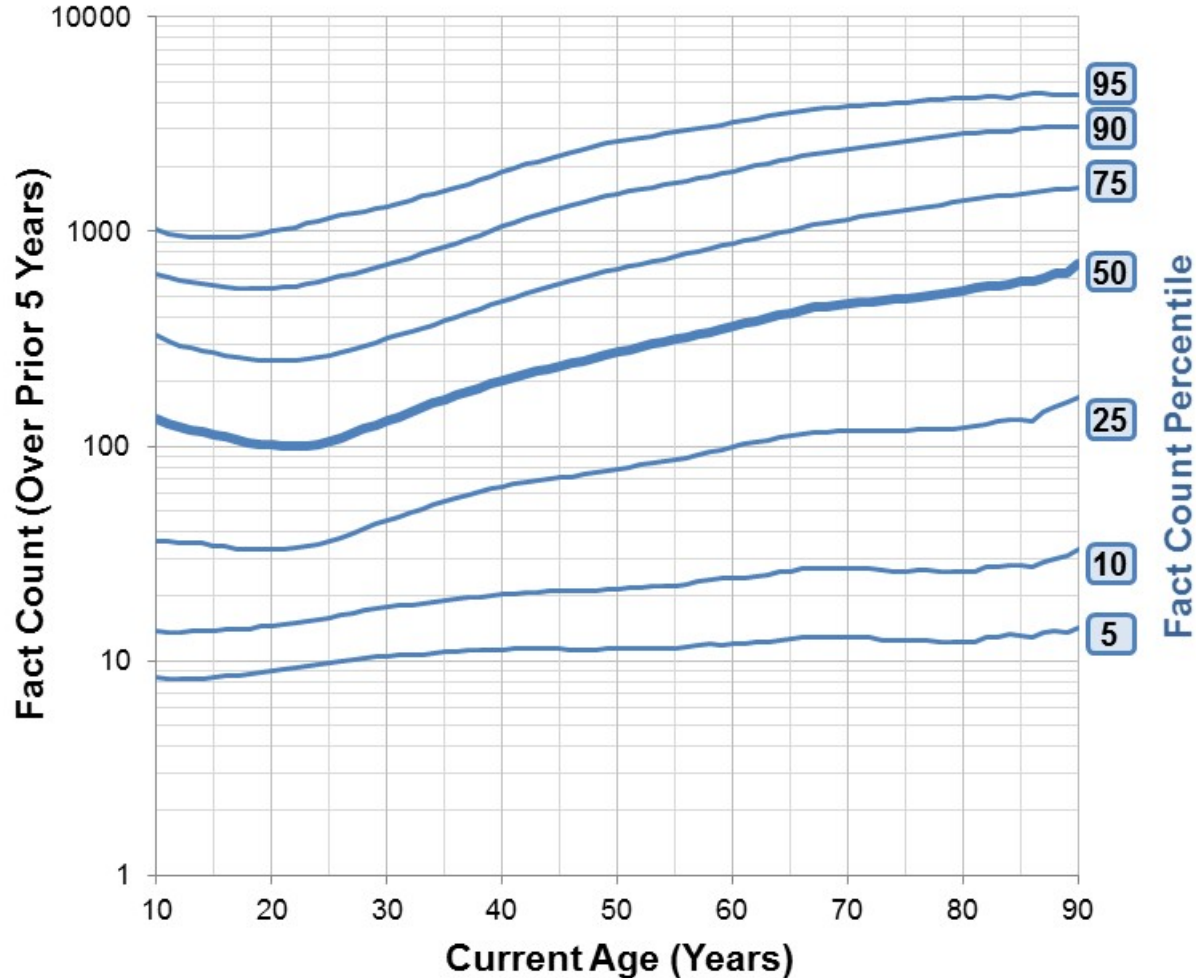


Predicting Survival Using “Fact Count”

Fact Count (over 8.5 years) by Age & Gender

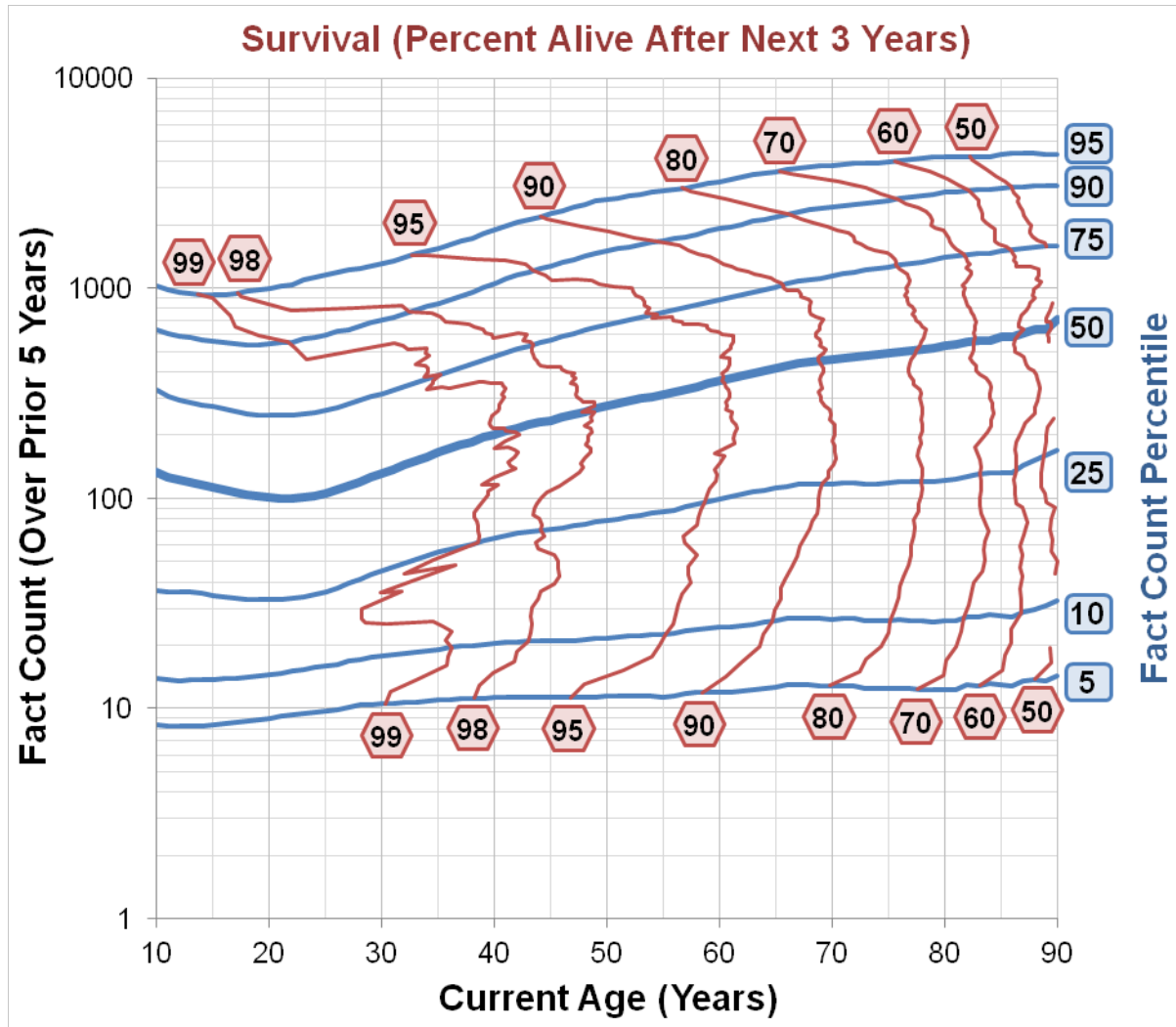


Fact Count Growth & Survival Chart (Male)



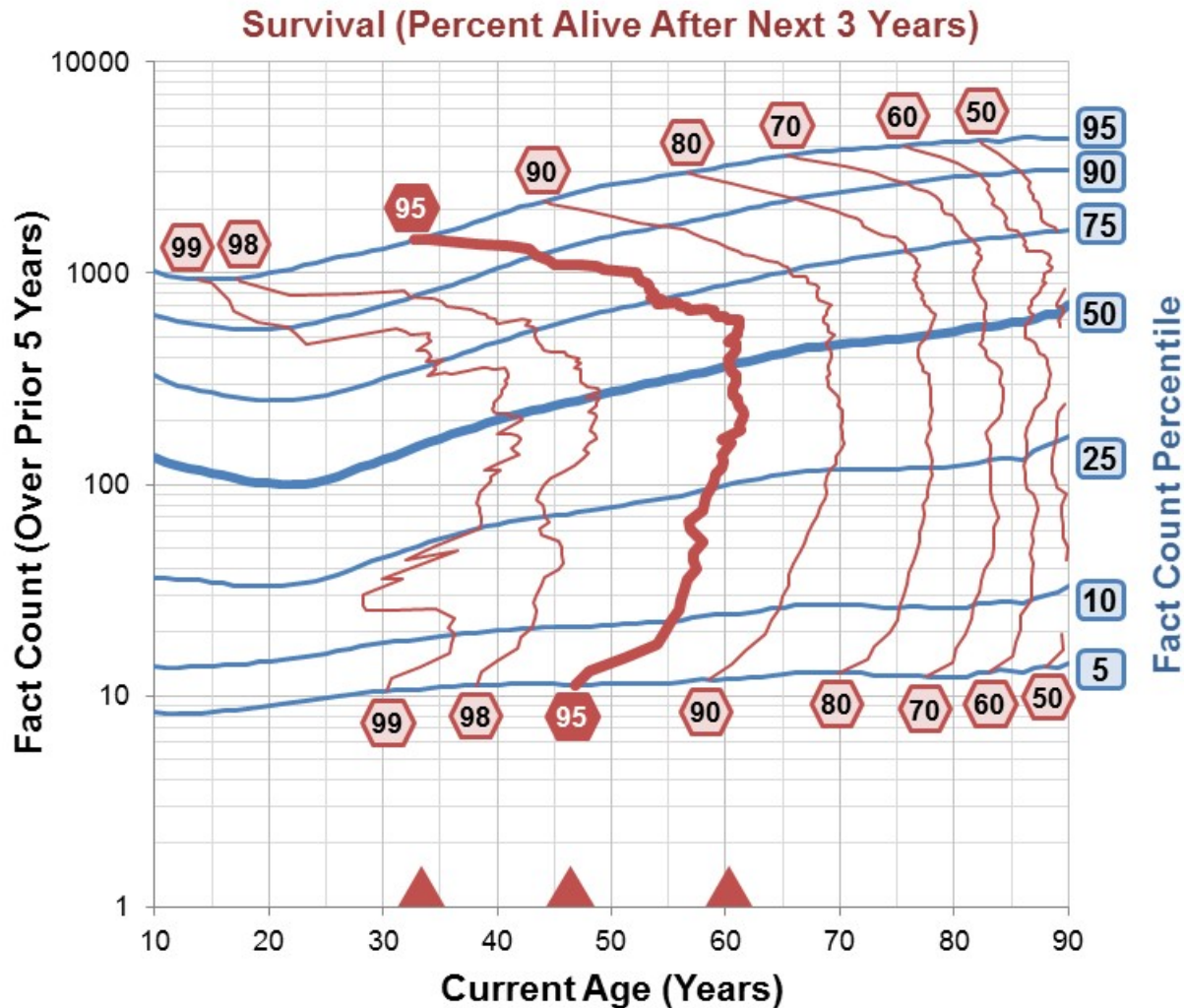
Horizontal blue curves with rectangular labels are five year fact count percentiles. Vertical red curves with hexagonal labels are three year survival curves. Data are from BWH and MGH from 7/28/2001 to 7/27/2009. All patients had at least one fact between 7/28/2005 and 7/27/2006. The “current” age is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

Fact Count Growth & Survival Chart (Male)



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.

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Adding HSD To i2b2

Adding HSD to i2b2 Using Sci2 Visualization Platform

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

Ontology for Visualizing HSD

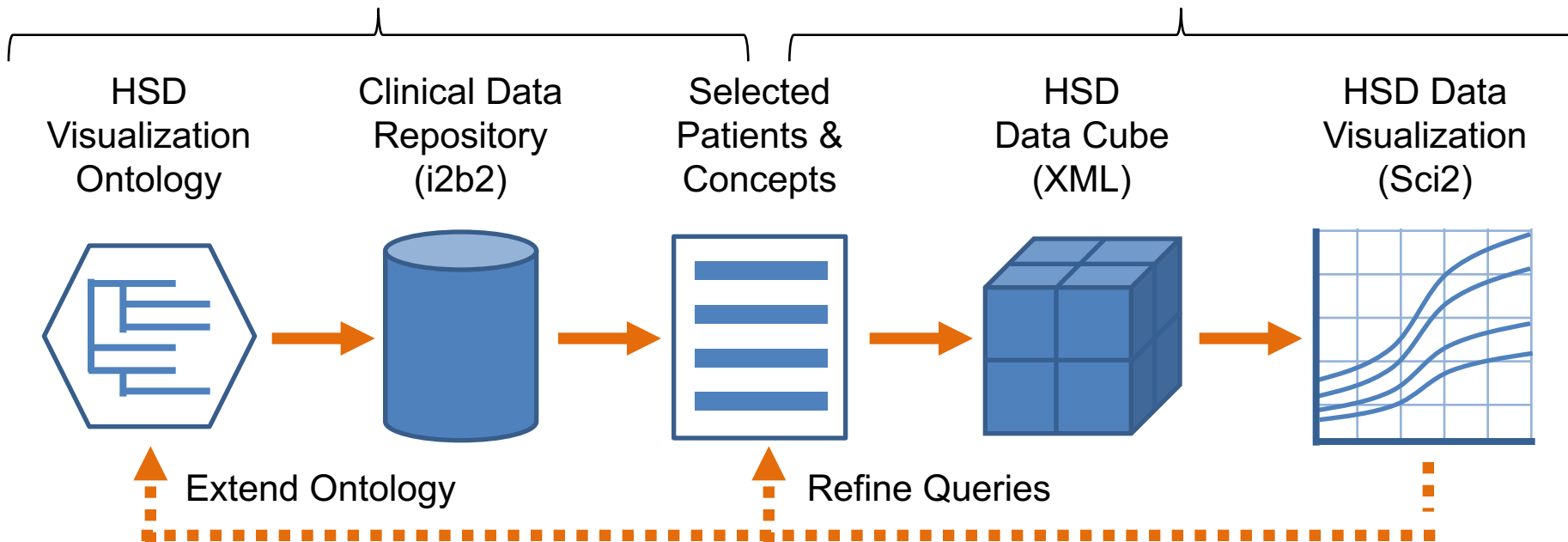
Informatics for Integrating Biology and the Bedside

<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

i2b2 Query & Analysis Tool Project: i2b2 Demo User: i2b2 User Find Patients | Analysis Tools | Message Log | Help | Change Password | Logout

Navigate Terms Find

- Demographics
- Diagnoses
- Healthcare System Dynamics
 - Fact Count
 - Fact Count
 - Fact Count Percentile
 - Fact Count Percentile
 - Time Periods
 - Months
 - January
 - February
 - March
 - April
 - May
 - June
 - July
 - August
 - September
 - October
 - November
 - December
 - Weekdays
 - Sunday
 - Monday
 - Tuesday
 - Wednesday
 - Thursday
 - Friday
 - Saturday
 - Laboratory Tests
 - Medications
 - Procedures
 - Visit Details

Query Tool

Query Name: Endocrine disorders - Fact Count Breakdown

Temporal Constraint: Treat all groups independently

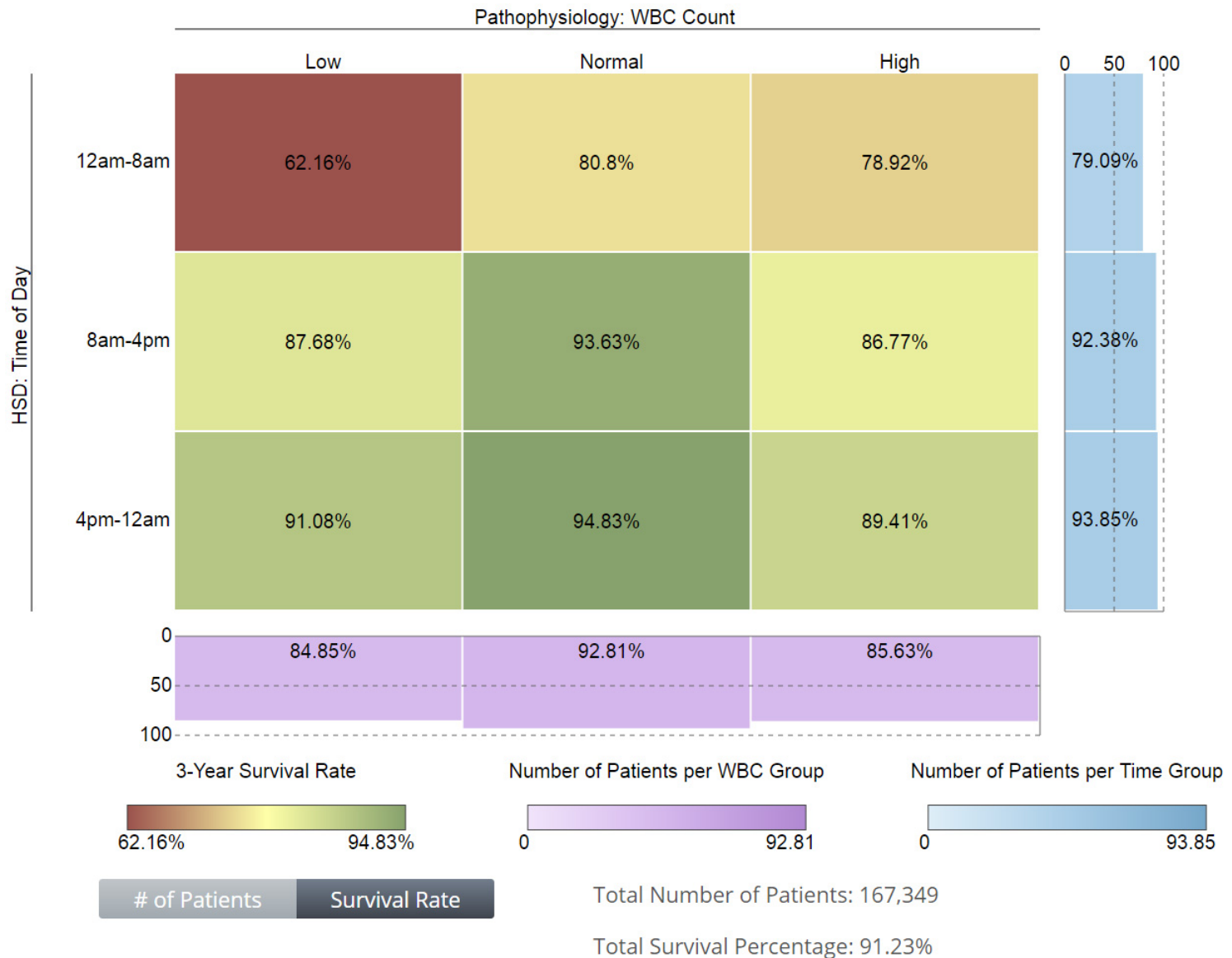
Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		
Endocrine disorders								

Run Query Clear Print Query 1 Group [New Group]

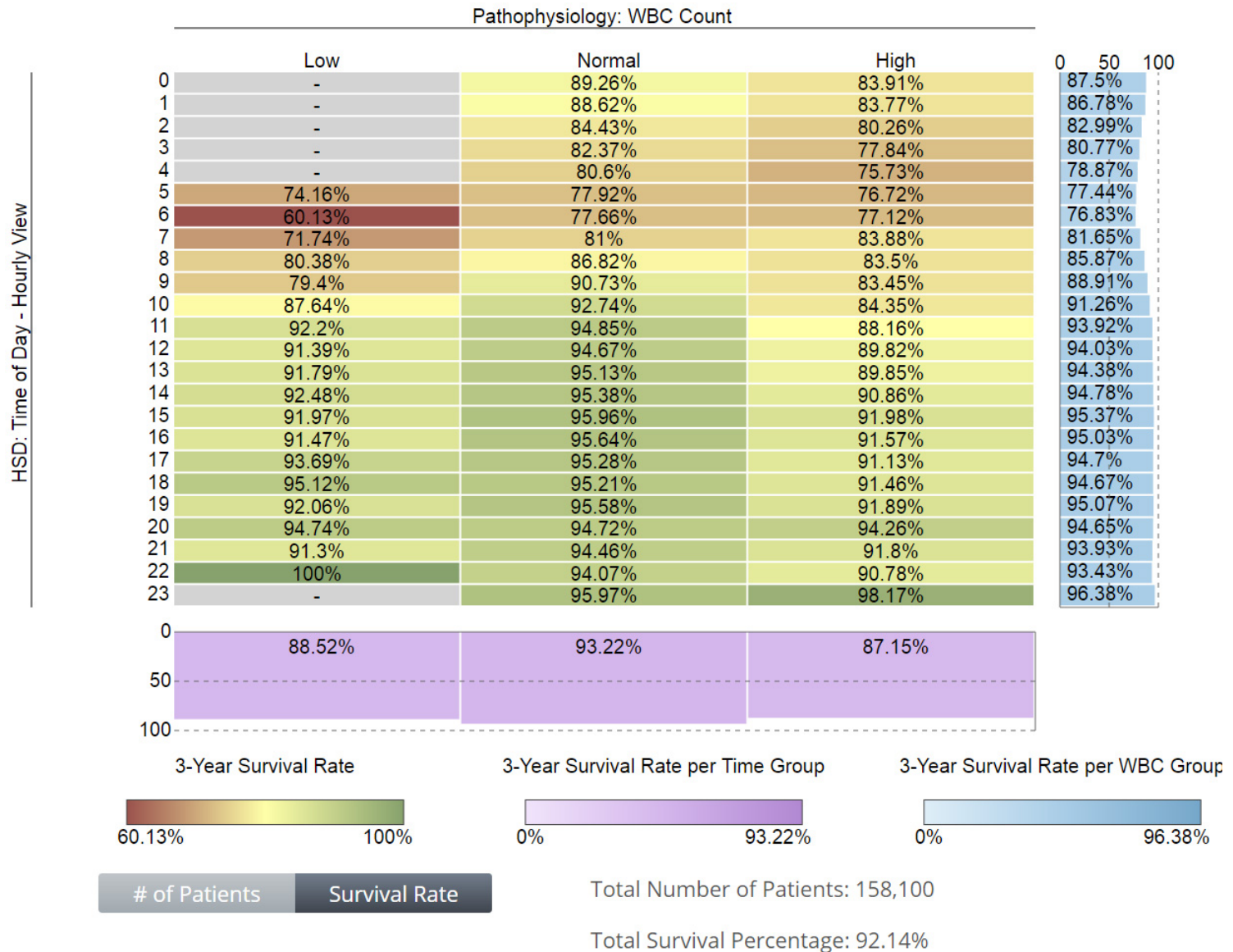
Show Query Status **Graph Results**

Percentile Range	Number of Patients
0th to 9th Fact C	5
10th to 19th Fact	3
20th to 29th Fact	3
30th to 39th Fact	3
40th to 49th Fact	3
50th to 59th Fact	3
60th to 69th Fact	4
70th to 79th Fact	3
80th to 89th Fact	8
90th to 99th Fact	8

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>
- Feedback, suggestions, questions, etc.
weber@hms.harvard.edu
- Participate in our upcoming Focus Groups