Enterprise Strategy to Change Healthcare Via Data Science: Nationwide Children's Hospital Case Study

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Topics for Today

- About Nationwide Children's Hospital
- Organizing a healthcare data science program
- Prioritizing healthcare data science projects
- Data science project case studies
  1. Preventing cardiopulmonary failure
  2. Prioritizing asthma ED patients for home/school intervention
  3. Prioritizing ACO members for case management recruitment

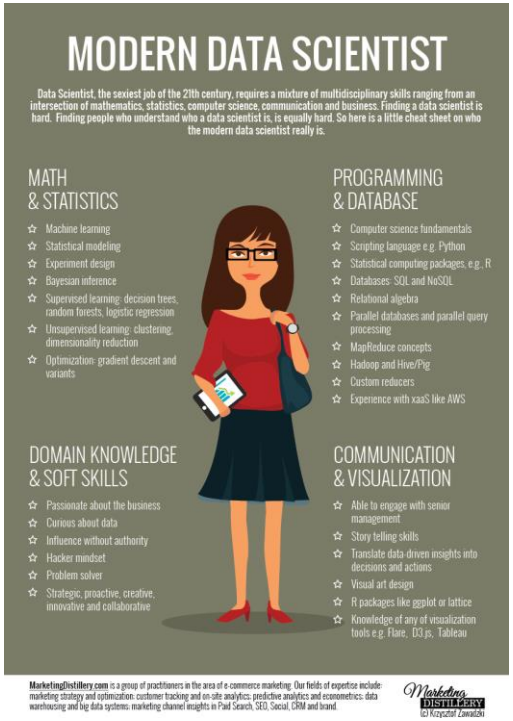
Nationwide Children's Hospital

One of America's largest pediatric health care and research centers

- More than 1.4 million patient visits
- Patients from 50 U.S. states and 52 foreign countries
- 102,991 donors have raised more than $107.2 million
- The Research Institute at NCH is one of the top 10 NIH-funded freestanding pediatric research facilities in the US
- Once again listed on the U.S. News & World Report's Best Children's Hospital Honor Roll

Organizing a Healthcare Data Science Program

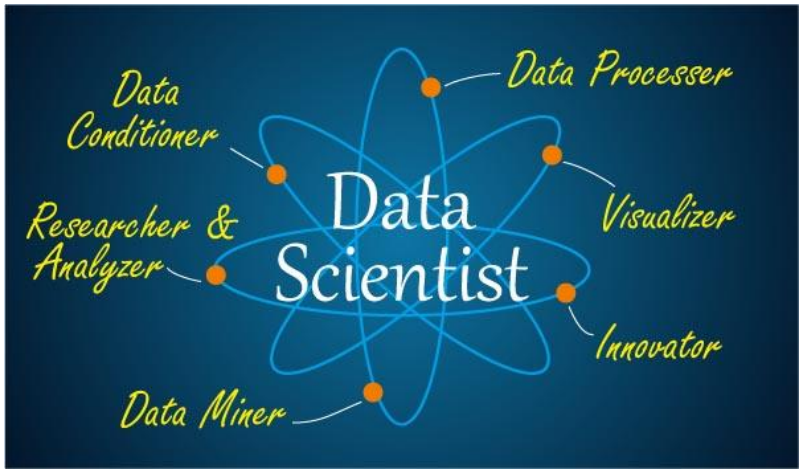
- Acquire initial data science resources
- Identify a network of collaborators who will:
  - Help identify the best opportunities for data science projects
  - Serve as subject matter experts during project execution



- Form steering committee of senior stakeholders to prioritize the use of data science resources

Important Data Science Skills

- Data manipulation
- Information retrieval
- Machine learning
- Natural language processing
- Project leadership
- Statistical modeling



Steering Committee Composition

- ACO
- Care Coordination
- CFO
- CIO
- CMIO
- CNO
- CRIO
- Data Resource Group
- IS R&D
- Quality Improvement
- Strategic Planning

Prioritizing Healthcare Data Science Projects

1. DS team works with collaborator network to identify project concepts
2. Steering committee prioritizes project concepts for development into 2-page project proposals
3. DS team develops 2-page proposals with individual collaborators
4. Steering committee evaluates and votes on project proposals resulting in a prioritization of projects for execution

Evaluation Criteria for Healthcare Data Science Projects

Category	Evaluation Criterion
Data	The required data is reasonably available
	A sufficient amount of data is available
	The quality (cleanliness, stability) of the available data is sufficient
	The available data can be acquired with reasonable effort
Modeling/ Implementation	Predictive modeling/algorithm development should not be too difficult
	User interface update frequency is reasonable
	Model implementation should not be too complex or too lengthy
Team/ Environment	The project has strong management support
	The project has a strong physician champion
	The project results will definitely be used to modify a care or business process
	The resources are available to successfully complete the project
Impact	The project will cause care to be more patient centered
	The project will improve performance metrics
	The project will help make effective use of scarce resources
	The project is alligned with enterprise strategic objectives
	The project will create opportunities for increased grant funding
Approach	The available resources are capable of successfully completing the project
	The proposed approach is both sound and feasible
	The proposed approach is innovative
	The probability of project success is reasonably high

Case Studies

1. Preventing cardiopulmonary failure
2. Prioritizing asthma ED patients for home/school intervention
3. Prioritizing ACO members for case management recruitment

Preventing Cardiopulmonary Failure

Develop an algorithm based on objective vital sign and oxygen support metrics that provides advance warning for cardiopulmonary failure events during the next 24 hours

Vital Sign & O_2 Metrics Utilized

- **HeartRate**
- **O_2Flow**
- **O_2Sat**
- **RespRate**
- **SysBP**
- **Temp**

Coded Vital Signs on {-2,-1,0,+1,+2} Scale

Item	Age	Item sub-score				
Heart Rate (beats/min)	**Coded Value**	**-2**	**-1**	**0**	**1**	**2**
	0 – 3 months	<90	90 – 109	110 – 150	151 – 180	>180
	3 – 12 months	<80	80 – 99	100 – 150	151 – 170	>170
	1 – 4 years	<70	70 – 89	90 – 120	121 – 150	>150
	4 – 12 years	<60	60 – 69	70 – 110	111 – 130	>130
	>12 years	<50	50 – 59	60 – 100	101 – 120	>120
Respiratory Rate (breaths/min)	**Coded Value**	**-2**	**-1**	**0**	**1**	**2**
	0 – 3 months	<20	20 – 29	30 – 60	61 – 80	>80
	3 – 12 months	<20	20 – 24	25 – 50	51 – 70	>70
	1 – 4 years	<15	15 – 19	20 – 40	41 – 60	>60
	4 – 12 years	<12	12 – 19	20 – 30	31 – 40	>40
	>12 years	<8	8 – 11	12 – 16	15 – 24	>24
Systolic Blood Pressure (mmHg)	**Coded Value**	**-2**	**-1**	**0**	**1**	**2**
	0 – 3 months	<50	50 – 59	60 – 80	81 – 100	>100
	3 – 12 months	<70	70 – 79	80 – 100	101 – 120	>120
	1 – 4 years	<75	75 – 89	90 – 110	111 – 125	>125
	4 – 12 years	<80	80 – 89	90 – 120	121 – 130	>130
	>12 years	<85	85 – 99	100 – 130	131 – 150	>150
Temperature ^{0}C	**Coded Value**	**-2**	**-1**	**0**	**1**	**2**
	All Ages	<95	95 – 96.8	96.8 – 101.3	101.3 – 104	>104
Oxygen Saturation (%)	**Coded Value**	**-2**	**-1**	**0**		
	All Ages	<85	85 – 95	>95		
Oxygen Flow (L/min)	**Coded Value**			**0**	**1**	**2**
	All Ages			none	<4 L/min	≥4 L/min

Assigned Points Based on Statistical Modeling of 2011-14 Data

Item	Age	Item sub-score				
Heart Rate (beats/min)	**Sub-Score**	**14.4**	**7.2**	**0**	**7.2**	**14.4**
	0 – 3 months	<90	90 – 109	110 – 150	151 – 180	>180
	3 – 12 months	<80	80 – 99	100 – 150	151 – 170	>170
	1 – 4 years	<70	70 – 89	90 – 120	121 – 150	>150
	4 – 12 years	<60	60 – 69	70 – 110	111 – 130	>130
	>12 years	<50	50 – 59	60 – 100	101 – 120	>120
Respiratory Rate (breaths/min)	**Sub-Score**	**12.8**	**6.4**	**0**	**6.4**	**12.8**
	0 – 3 months	<20	20 – 29	30 – 60	61 – 80	>80
	3 – 12 months	<20	20 – 24	25 – 50	51 – 70	>70
	1 – 4 years	<15	15 – 19	20 – 40	41 – 60	>60
	4 – 12 years	<12	12 – 19	20 – 30	31 – 40	>40
	>12 years	<8	8 – 11	12 – 16	15 – 24	>24
Systolic Blood Pressure (mmHg)	**Sub-Score**	**12.4**	**6.2**	**0**	**6.2**	**12.4**
	0 – 3 months	<50	50 – 59	60 – 80	81 – 100	>100
	3 – 12 months	<70	70 – 79	80 – 100	101 – 120	>120
	1 – 4 years	<75	75 – 89	90 – 110	111 – 125	>125
	4 – 12 years	<80	80 – 89	90 – 120	121 – 130	>130
	>12 years	<85	85 – 99	100 – 130	131 – 150	>150
Temperature ^{0}C	**Sub-Score**	**23.2**	**11.6**	**0**	**11.6**	**23.2**
	All Ages	<95	95 – 96.8	96.8 – 101.3	101.3 – 104	>104
Oxygen Saturation (%)	**Sub-Score**	**28.2**	**14.1**	**0**		
	All Ages	<85	85 – 95	>95		
Oxygen Flow (L/min)	**Sub-Score**			**0**	**4.5**	**9**
	All Ages			none	<4 L/min	≥4 L/min

Vitals Risk Index (VRI)

is

Sum of points

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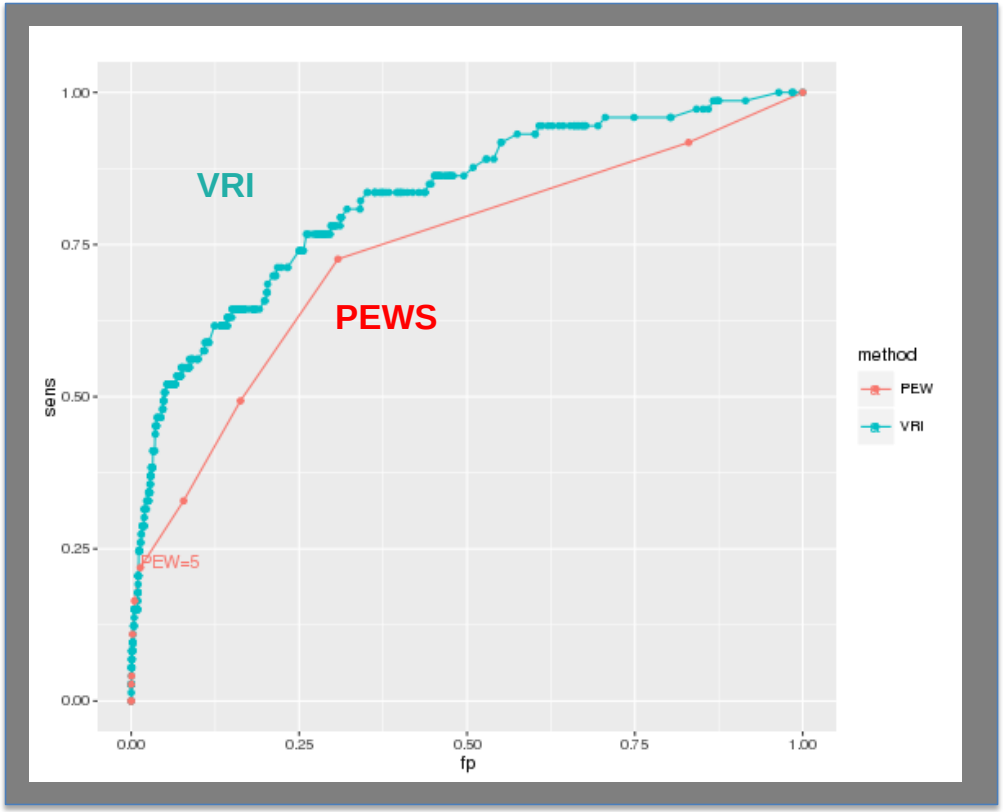
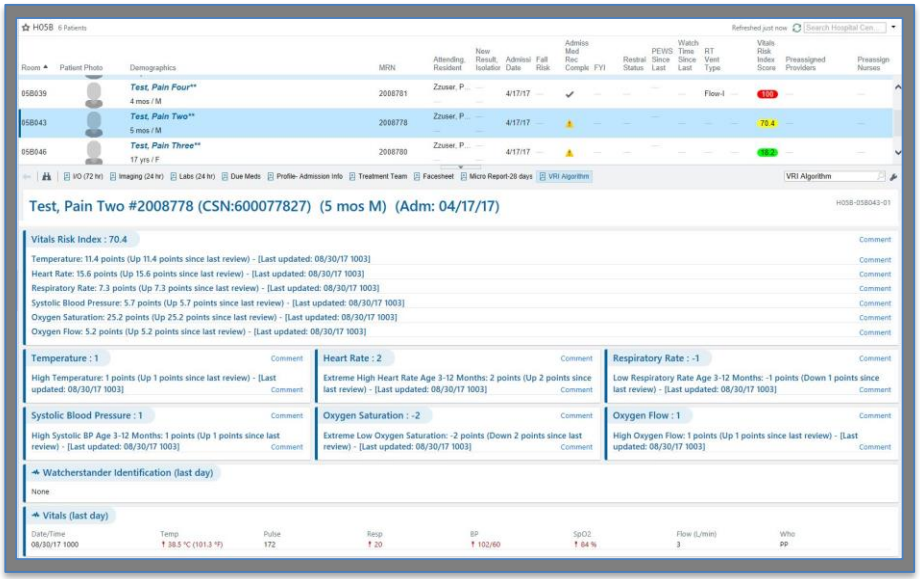
Validated VRI with Independent 2015-16 Data

- VRI outperforms PEWS for PEWS < 5
- VRI is 20% more sensitive than “PEWS ≥ 4” at the same specificity



VRI Implementation

- Just completing implementation of the VRI within the Epic EMR system



- Planned Validation – System will flag patients exceeding the VRI threshold for evaluation by a physician

- After validation, VRI will become a new trigger criterion for our Watchstander program (intervention to prevent cardiopulmonary failures & emergency transfers)

Prioritizing Asthma ED Patients for Home/School Intervention

- Project Objective: For a patient in the ED for asthma, estimate probability of a return, asthma-related ED visit within 1 year
- 1-year horizon selected to avoid complications of seasonality for shorter horizons
- Predictive model developed
- Model will soon be used to identify best candidates for 2 existing intervention programs:
  - Asthma Express (Home training)
  - In-School Intervention Program

Asthma ED Modeling Process

- Utilized multiple data types
  1. Emergency room encounters
  2. Patient demographic data
  3. Address-based geocoding data
  4. Asthma Action Plan
  5. Inpatient visits
  6. Primary care network

- Risk Factor Creation: Data types 4-6 were processed to create risk factors at the patient level that were relevant at the time of each ED encounter
- Employed logistic regression modeling approach with backward variable selection

Asthma ED Modeling Process (Continued)

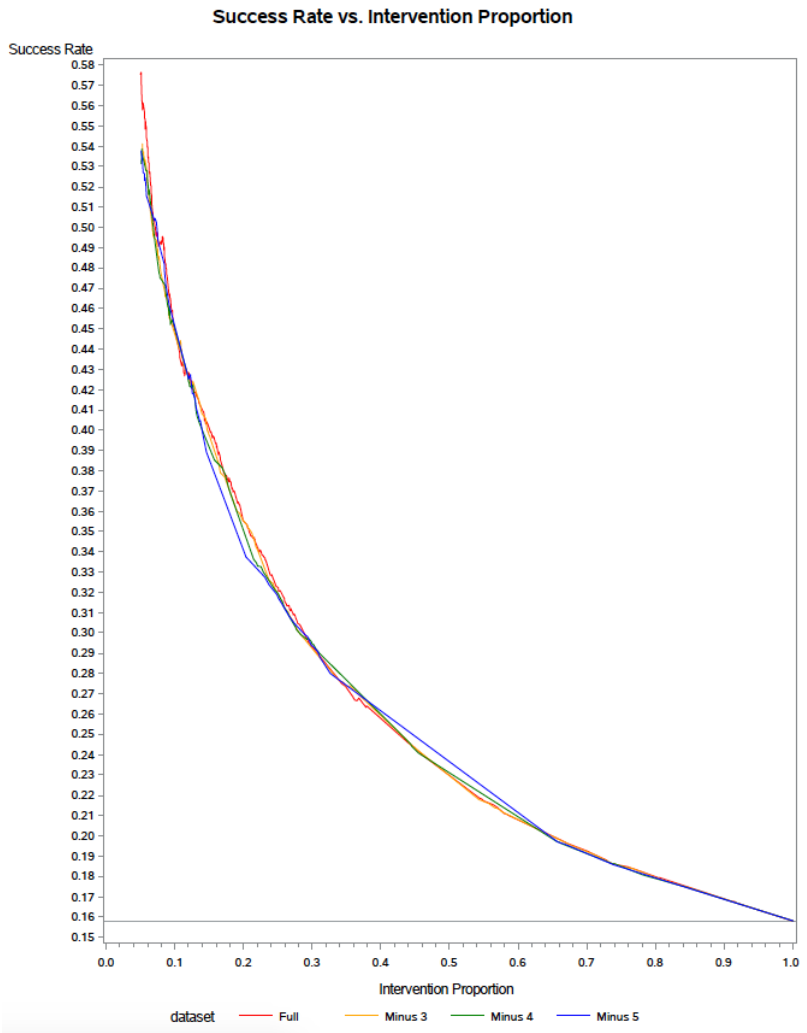
- Used 10-fold cross-validation repeated 10 times to set significance level (0.05) for variable retention in the predictive model in order to avoid over-training
- Applied variable selection procedure to full data set to obtain final list of model variables

- Finally, fit model with selected variables to full data set to obtain variable coefficients

Asthma ED Predictive Model

Likelihood of Return to ED within 1 Year

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
ageUnder5 1 vs 0	1.319	1.137	1.530
RacialEthnicMinority 1 vs 0	1.441	1.207	1.721
numERvisits	1.956	1.724	2.219
INPvisPrevYr 1 vs 0	1.524	1.227	1.894
numPCNvisitsAsthma	0.916	0.840	0.999
GZInhaledSteroidInd 1 vs 0	2.117	1.777	2.522
asthmaTypeColModSev 1 vs 0	1.574	1.263	1.962
LiveWithin5MilesNCH 1 vs 0	1.198	1.015	1.414
LiveWithin10MilesNCH 1 vs 0	1.334	1.089	1.635

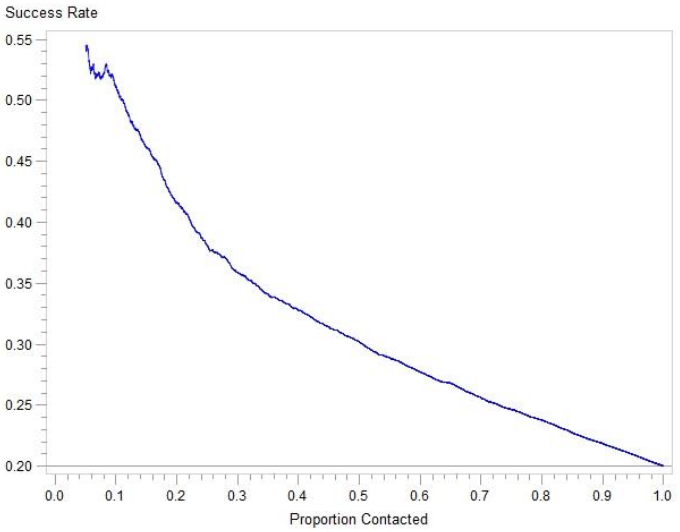


- 50% of first 10% identified by model will return to ED within 1 year vs. 16% in general population

Prioritizing ACO Members for Case Management Recruitment

- Project Scope: Develop a predictive models that may be employed to focus care navigation recruitment resources on children that are likely to enroll

- Progress: Likelihood to enroll model developed
  - May be used to initially achieve 55% enrollment rate in a population for which only 20% will enroll



Case Mgmt. Recruitment Model

- Created a laundry list of candidate predictive variables
- After statistical modeling including careful variable selection to avoid over-training, the variables retained in final predictive model are:
  - Patient age (-)
  - Days since last inpatient visit (-)
  - Resident of county in which hospital resides? (+)
  - Number of medications during the last year (+)
  - Ever a hospital or primary care network patient? (+)
  - Number of specialties during last year (+)
  - Ever had a previously successful case management episode? (+)
  - Insurance provider
  - Referral source

Future Projects

Area	Project Focus
Behavioral Health	Readmission
Behavioral Health	Suicide Prevention
Consumerism	Customer Segmentation
Consumerism	Patient Portal Engagement Model
Growth &Partnerships	External Validation /Competition
Integrating Clinical & Research	Cohort Investigator Deep Suggest
Operational Excellence	Track Emerging Technology
Operational Excellence	Revenue Cycle Management
Population Health	Deep Child
Quality & Safety	Utilization Management – High Cost Medications
Quality & Safety	Utilization Management – LOS Management
Quality & Safety	Adverse Event Prediction

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AMERICAN NURSES CREDENTIALING CENTER

2013 Parents 10 BEST CHILDREN'S HOSPITALS

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