

## How to reduce head CT orders in Children with Hydrocephalus using Lean Sigma Methodology: Experience in a Major Academic Children's Center

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## Johns Hopkins Children's Center

- Tertiary care children's center with dedicated pediatric emergency department and 11 subspecialty floors
- Main imaging modality for hydrocephalus especially in the ED setting is head CT



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## Problem Statement & Goal

- Radiation should be limited as much as possible especially in children. Many children with hydrocephalus need serial imaging for diagnosis and for follow-up increasing life time cumulative radiation exposure
- The goal of this project is to reduce head CT orders by 50% within 6 months in children with known or suspected diagnosis of hydrocephalus from all referring departments, 24/7

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## Forming the TEAM!

- Division of Pediatric Radiology and Pediatric Neuroradiology took the initiative to reduce the head CT orders
- Stake holders involved in the care and imaging of hydrocephalus were invited:
  - Pediatric Neurosurgeons,
  - Pediatric Emergency Department (PED) physicians,
  - Chief technologists of CT, US, and MRI,
  - Pediatric Radiology nurses and scheduling staff,
  - Administrator of our department and an analyst

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# Forming the TEAM!

- Weekly meetings were held
  - Current/baseline process discussed
  - Scope and goal of the project outlined
  - Buy in and commitment from all stake holders established after hearing each group member's input
  - Project title, problem statement and project goal were set
- This process formed the project charter

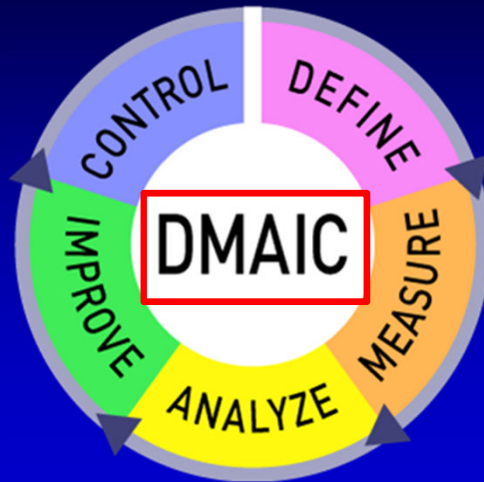
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# Project Charter

<b>Project Name:</b> Reduce Head CT studies in Children with Hydrocephalus	<b>Champion:</b> Thierry Huisman
<b>Green Belt:</b> Aylin Tekes	<b>Master Black Belt:</b> Richard Hill
<b>Problem Statement:</b> Radiation is dangerous especially in children. There is an increasing rate of head CT orders in children with hydrocephalus. Many children with hydrocephalus need repeat imaging adding additional risk for cumulative radiation, which may lead to cancer.	<b>Project Goal:</b> Reduce the rate of head CT orders for hydrocephalus by 50 percent in 6 months (project start date: 1/24/2014)
<b>Project Y:</b> None	<b>Scope:</b> All children with hydrocephalus, 0-18 years of age, presenting to Emergency Department, in patient, and out patients services
<b>Team Members:</b> Aylin Tekes, Pediatric Radiology and Pediatric Neuroradiology, Attending Physician. Project Leader Thierry Huisman, Pediatric Radiology and Pediatric Neuroradiology, Director, Physician Champion Jean Ogborn, Pediatric Emergency Department, Attending Physician, Member George Jallo, Pediatric Neurosurgery, Director, Member Eric Jackson<, Pediatric Neurosurgery, Attending Physician, Member Marty Bledsoe, Radiology Department Administrator Elyce Wolfgang, Pediatric Radiology Manager, Member Bea Mudge, Department of Radiology, CT Manager Bob De Jong, Department of Radiology, US Manager Linda Ellwood, Radiology Patient Care Coordinator, Member Bina Patel, Pediatric MRI Manager, Member Diane Novak, MRI manager, Member Mollie Young, Child Life Specialist, Member	<b>Benefits:</b> 1. Eliminate radiation in evaluation of hydrocephalus 2. Reduce MRI time in the evaluation of hydrocephalus 3. Reduce cost for MRI with limited charge 4. Reduce shunt survey orders
	<b>Timeline:</b> Define/Measure: 1/24/2014-2/1/2014 Analyze/Improve: 3/10/2014-5/30/2014 Control: 7/1/2014-10/1/2014

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## Let the Lean Sigma Roll!



Inserted picture from : [blog.sesa-systems.ca](http://blog.sesa-systems.ca)

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## Define

- Define alternative imaging modalities for head CT
  - Ultrafast Brain MRI (UFB-MRI), Head US, Routine Brain MRI (B-MRI)
- Define source database for data collection
  - Radiology Informatics Systems (RIS)
- Define search terms
  - Hydrocephalus
  - 0-18 years of age
  - Known or suspected diagnosis of hydrocephalus

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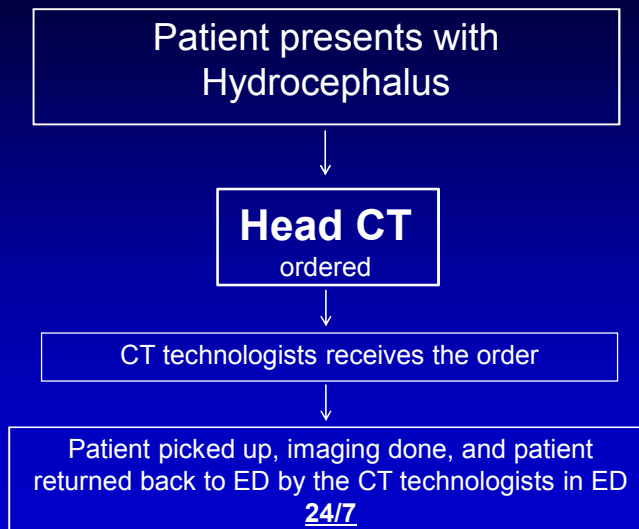
## Define

- Define reliable/reproducible measurements to analyze the process
  - Rate of head CT, Head US, UFB-MRI and B-MRI
  - Rate of above mentioned exams per time of practice (routine day time, after hours practice and weekends)
  - Rate of above mentioned orders per ordering department (ED, IP, OP)
  - Rate of above mentioned orders per rank of ordering physician (resident versus attending)

ED: emergency department, IP: inpatient, OP: outpatient

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## Baseline Ordering Process



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## Baseline Data

Our baseline analysis shows that  
~70% of head CTs are ordered from ED  
~90% UFB-MRIs are performed on outpatients

Modality	ER		Inpatient		Outpatient	
	# Cases	%	# Cases	%	# Cases	%
CT	47	(71.2%)	13	(19.7%)	6	(9.1%)
UFB-MRI	2	(2.9%)	1	(2.7)	34	(91.9%)
Routine MRI	3	(7.9%)	15	(39.5%)	20	(52.6%)
Head US	2	(2.9%)	47	(69.1%)	19	(27.9%)
N=205	54	(25.8%)	76	(36.4%)	79	(37.8%)

Baseline Data: 10/28/2013--1/27/2014

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## Baseline Data

- In addition, our analysis showed that
  - ~50% of head CT cases were done after hours and during the weekends
  - ~ 60% of all cases were ordered by residents

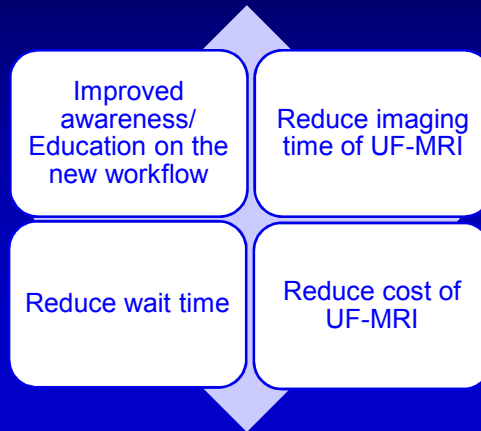


What interventions could improve our process?

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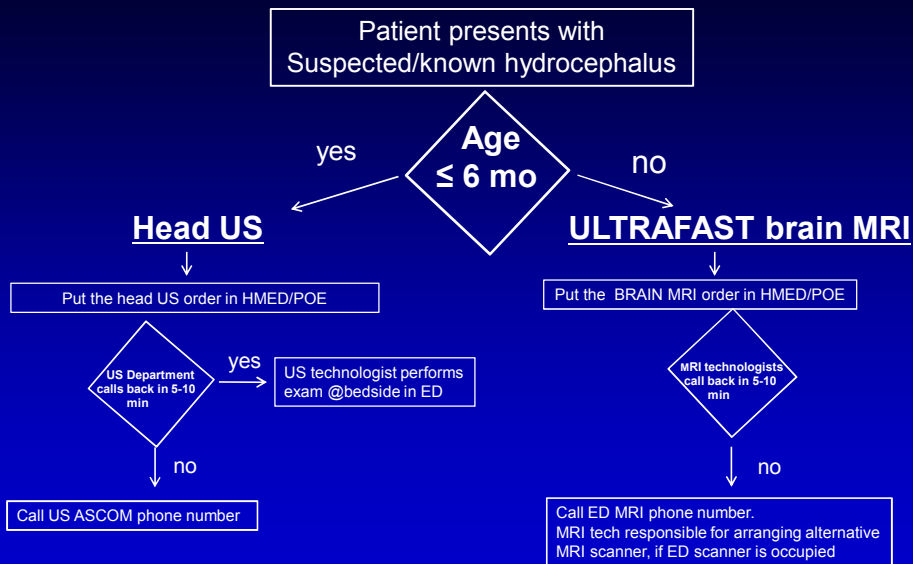
# Interventions

Stake holders gathered around the table, created a radiation free improved imaging work flow for hydrocephalus. Then, interventions were grouped under 4 major action plans



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# Improved workflow for reducing head CT



Patients that have programmable shunts: MRI technologist calls on call neurosurgery resident pager, 24 /7 before they initiate the scan.

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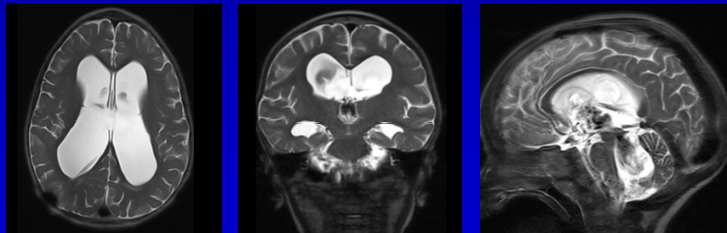
## Interventions: Improved Awareness/ Education on the new workflow

- Educate/inform all referring departments with the change/improvement in workflow for pediatric hydrocephalus imaging:  
(Stake holders: Pediatric Neuroradiologists, PED physician, and Pediatric Neurosurgeons)
  - Main target PED and Pediatric Neurosurgery
    - In-person visit to these departments during their internal meetings
    - e-mail to divisional representatives
    - e-mail chief pediatrics residents and fellows

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## Interventions: Reduce imaging time of UFB-MRI

- Reduce imaging time:  
(Leaders: Chief pediatric MRI tech and PED MRI manager, Pediatric Neuroradiologist)
  - Revise UFB-MRI protocol to reduce imaging time ~ 5 min
  - **NO SEDATION, NO ANESTHESIA!**



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## Interventions: Reduce imaging time of UFB-MRI

- Update all MRI scanners with the new protocol
- Inform/educate all MRI technologists with the change in workflow with in person meetings and e mails including all shifts!
- In-service/meeting with the US technologists: review Head US imaging protocol

## Interventions: Reduce wait time

- Reduce patient wait time  
(Leaders: MRI technologists, PED physician, Pediatric Neurosurgery)
  - MRI technologist responds to the order within 5 min
  - MRI technologist page Pediatric Neurosurgery when the patient in the MR scanner
  - Purchase a shunt programmer for PED, arrange in-service for PED staff for a need by basis use

## Interventions: Reduce cost of UFB-MRI

- Reduce the cost of UFB-MRI for the patient (Radiology Administration and Finance)
  - Create a “charge modifier” to reduce the cost for the patient
  - “charge modifier” reduced professional fee by 20%



Following the implementation of interventions  
Pilot phase data were collected on a monthly basis

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## Improve

We have well surpassed our goal of 50% reduction in head CT orders consistently during 3 pilot phases!

Note the increase in UFB-MRI as the Head CT decreases

Modality	Baseline		Phase I		Phase II		Phase III	
Head CT	62	(30.2%)	5	(8.1%)	6	7.0%	7	7.6%
UFB-MRI	37	(18.0%)	31	(50.0%)	49	57.0%	45	48.9%
B-MRI	38	(18.5%)	9	(14.5%)	10	11.6%	8	8.7%
Head US	68	(33.2%)	17	(27.4%)	21	24.4%	32	34.8%

This is an all inclusive data set including all orders coming from all departments 24/7

Baseline (n=205)	10/28/2013 - 1/27/2014
Phase I (n=62)	3/10/2014 - 3/31/2014
Phase II (n=86)	4/1/2014 - 4/29/2014
Phase III (n=92)	5/1/2014 - 5/31/2014

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# Improve

- The improvements during the pilot phases can be appreciated even more when we focus on the major referral, Pediatric Emergency Department

	Baseline	Phase 1	Phase 2	Phase 3
Head CT	45	3	2	5
UFB-MRI	2	11	15	17

Number of cases presented

Baseline (n=205)	10/28/2013 - 1/27/2014
Phase I (n=62)	3/10/2014 - 3/31/2014
Phase II (n=86)	4/1/2014 - 4/29/2014
Phase III (n=92)	5/1/2014 - 5/31/2014

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# Results/Benefits

- Quality
  - 24/7 service!
  - Provided for all PED, inpatient and outpatient setting
- Efficiency
  - Statistically significantly reduced head CT's from baseline to post intervention phases (Z-test, p-Value: 0.00004)
  - Improved service over the after hours and weekends
- Financial
  - Reduced patient cost with a charge modifier for UFB-MRI

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# Control

- Pediatric Emergency Department changed ordering systems to use EPIC ASAP in 8/2014
  - Revised the “hydrocephalus order package” for EPIC ASAP
    - Added “pop-up” information on the order package that summarizes the workflow and use of each modality
- Getting prepared for the new the academic year as the project moves into the control phase
  - Reach out to Pediatric Neurosurgery, PED, and chief pediatrics residents to have them inform the incoming interns/residents/fellows for the ongoing workflow for pediatric hydrocephalus imaging
- Continue collecting monthly data and repeat the analysis to ensure stability

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# Control

We continued to collect data on a monthly basis after the pilots

	Baseline	Pilot 1	Pilot 2	Pilot 3	Control 1	Control 2	Control 3
Head CT	45	3	2	5	5	11	7
UFB-MRI	2	11	15	17	14	10	11
B-MRI	3	4	3	3	4	0	1
Head US	2	1	1	2	0	1	0

Throughout all phases, the goal of 50% reduction in head CT orders have been surpassed.

Number of Head CT's demonstrated increase in the first 2 months of control phase, which was also the beginning of the academic year. Note the decrease in the 3<sup>rd</sup> control phase.

Baseline	10/28/2013 - 1/27/2014
Pilot 1	3/10/2014 - 3/31/2014
Pilot 2	4/1/2014 - 4/30/2014
Pilot 3	5/1/2014 - 5/31/2014
Control 1	7/1/2014 - 7/31/2014
Control 2	8/1/2014 - 8/31/2014
Control 3	9/1/2014 - 9/30/2014

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## Opportunity for Spread

- Eliminating radiation in pediatric imaging
  - “Fast abdominal MRI” protocols
    - Imaging of appendicitis: “Fast abdominal MRI” to replace the current “common practice” of abdominal CT.
  - “Fast joint MRI” protocols, especially for elbow:
    - Elbow has 6 ossification centers that gradually ossify 1-11 years of age: if the ossification center is not ossified at the time of injury, plain radiographs are not sufficient to address injury to the cartilage.

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## Conclusion

- We were able to surpass our goal of reducing head CT orders by 50% in children with hydrocephalus using the Lean Sigma methodology 24/7 from all referring departments.
- Regular meetings, a strongly committed team and frequent communication between stake holders were crucial in achieving our goal.
  - The project has been handed off to the process owner.

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