Jia Ying Circle

# Improving Procedures Of Children MRI Under Sedation - Benefits From Quality Control Circle

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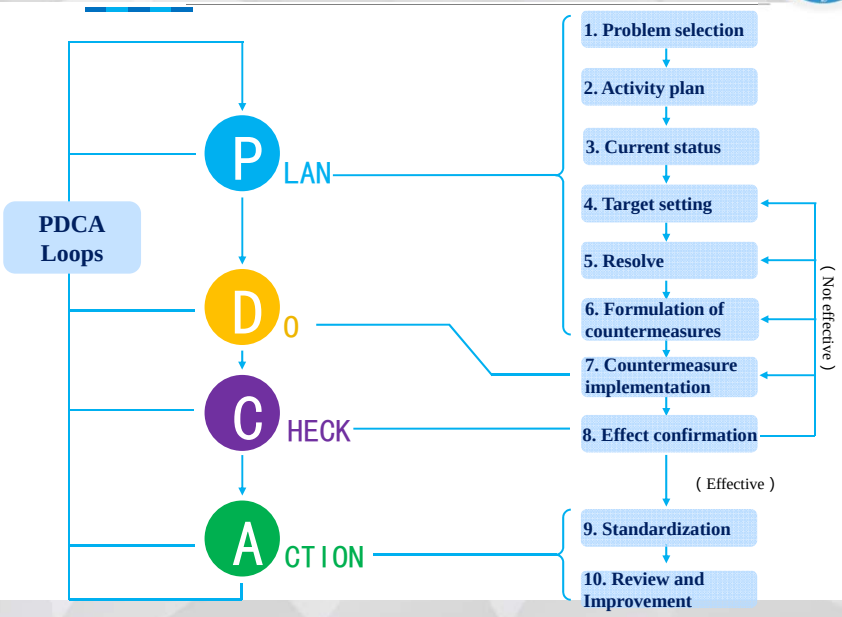
Activity time: 2016.12-2017.06

## Process Flow Chart



## Problem Selection

Chinese **preterm infants** ranks **second**

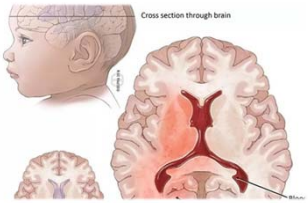
**2 million** premature babies per year

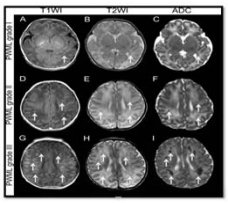
Increasing **200,000** per year

Over **10%** newborns are premature baby in China

High risk of **life long disability and death**

## Problem Selection






**50%** of preterm infants have **brain damage**

**Safe, high-resolution MRI--------**

**First Choice**

## Problem Selection- International Guidelines

**American Academy of Pediatrics**

CLINICAL REPORT

American Academy of Pediatrics

Guidelines for Monitoring and Management of Pediatric Patients Before, During, and After Sedation for Diagnostic and Therapeutic Procedures: Update 2016

01 Children <6 month Feed and rap

02 Children >6 month 1-2 week preparation

03 Children with certain disease sedated by consult with anesthesiologist

04 Success rate after sedation --- between 80%-96%

## Problem Selection-Definition

**Definition of failure of examination**

- MRI sequence can be numerous and independent
- Interruption of inspections, poor image quality---- Fail Diagnosis. This is defined as failure of examination

$$\text{Children's MRI failure rate} = \frac{\text{Incomplete sequences number}}{\text{Total sequence number}} \times 100\%$$

## Problem Selection

### Significance

**For Hospital**

- Avoid medical waste
- Highlight high precision
- Expanding leadership

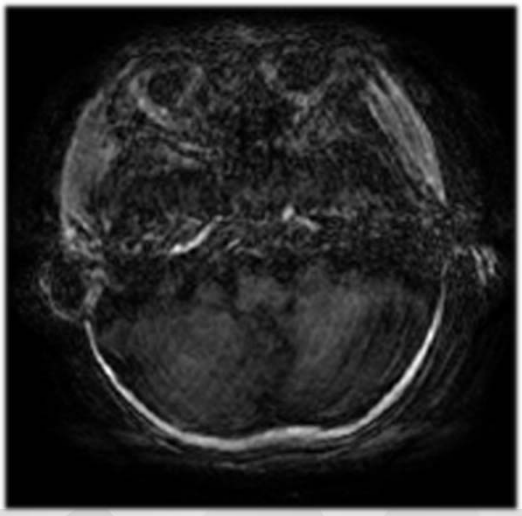
**For medical staff**

- Improve machine efficiency
- Improve image quality
- Assisted clinical research

**For the patient**

- Shorten diagnosis and treatment time
- Reduced repeated sedation
- Improve diagnosis and treatment efficiency

## Problem Selection-Example Case



# Activity Plan

| WHAT | | WHEN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | WHO | WHERE | HOW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | | 2016.12 | | 2017.01 | | | | 2017.02 | | | | 2017.03 | | | | | 2017.04 | | | | 2017.05 | | | | | 2017.06 | | | | | | Person in charge | | Tools |
| Step | Week | 3w | 4w | 1w | 2w | 3w | 4w | 1w | 2w | 3w | 4w | 1w | 2w | 3w | 4w | 5w | 1w | 2w | 3w | 4w | 1w | 2w | 3w | 4w | 5w | 1w | 2w | 3w | 4w | | | | | |
| P | Select Problem | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Jia & Guo | Meeting room of radio-logy Dep-artm-ent | Brain storming |
| | Activity plan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Jin & Li | | Gantt chart |
| | Current status | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Alicia & Tao | | Checklist Pareto Diagram |
| | Target setting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Chen & Hou | | Formula Formulation & Column Diagram |
| | Resolve | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Ren & Jun | | Fishbone Diagram |
| | Solution Formulation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Jiao | | Brain storming |
| D | Counter measure | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Zhao & Yan | | PDCA |
| C | Efficency | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Wang | | Checklist Pareto Diagram |
| | Standardlization | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Jia &Guo | | Standard formulation |
| A | Check and improvement | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Cong &Hen | | Diagrams |

P 40%

D 30%

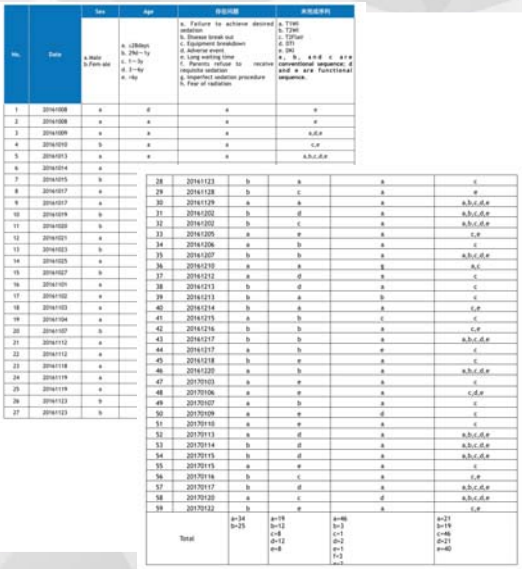
C 20%

A 10%

# Current Status

- ◆Total of 101 patients
- ◆Each patient had 5 sequences
- ◆Total of 505 sequences.
- ◆59 incomplete cases
- ◆147 incomplete sequences :
  - 86 conventional sequence
  - 61 functional sequence

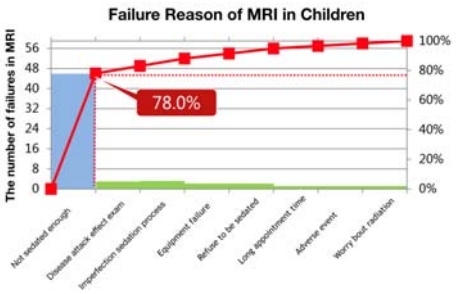
**Result: Children's MRI failure rate = 29.1%**



# Current Status

| Problems | Frequency | Ratio | Accumulated percentage |
|---|---|---|---|
| Fail to achieve expected sedation effects | 46 | 78.0% | 78.0% |
| Attack of diseases influencing the examination | 3 | 5.1% | 83.1% |
| The imperfection of the sedation process | 3 | 5.1% | 88.1% |
| Equipment failure | 2 | 3.4% | 91.5% |
| Family members refusing the sedation | 2 | 3.4% | 94.9% |
| Long appointment time | 1 | 1.7% | 96.6% |
| The adverse effect induced by sedation drugs | 1 | 1.7% | 98.3% |
| Worries of potential radiation | 1 | 1.7% | 100.0% |
| Totals | 59 | 100.0% | - |

Before Activity




Pareto Diagram

According to 80/20 rule, the main problem is：
**Failure to achieve the desired sedation depth**

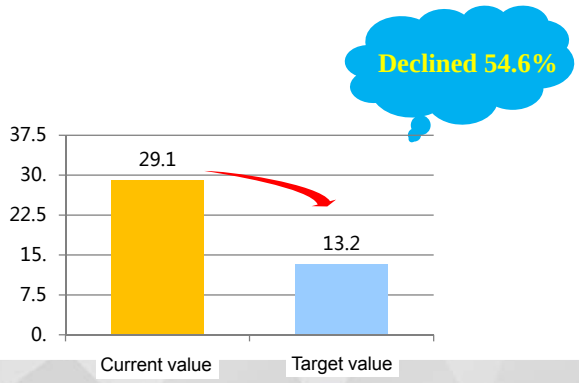
# Target Setting

## Target value

= current status value - （current status value × key improve value × Circle capability）

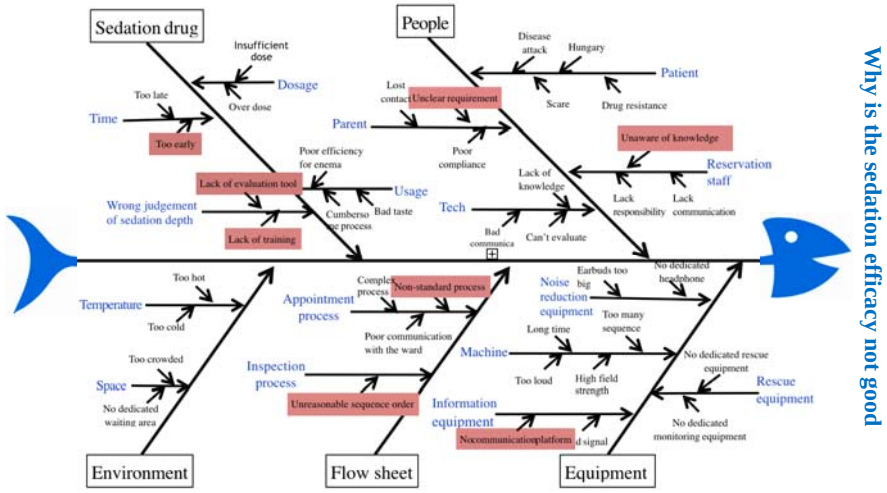
= 29.1% - (29.1% × 78.0% × 70.0% )

**= 13.2%**



# Analysis

**Analysis**




Why is the sedation efficacy not good

# Analysis-Causes Verification

| No. | Date | Sex (a. Male b. Female) | Age (a. ≤28days b. 29d~1y c. 1~3y d. 3~6y e. >6y) | Incomplete sequences (a. T1WI b. T2WI c. T2Flair d. DTI e. DKI a、b and c are conventional sequence; d and e are functional sequence.) | Causes (a. Family members unaware of the sedation requirements b. Registration staff do not understand the precautions clearly c. Lack of specified communication platform d. Sedated too early before the examination e. Lack of evaluation tools f. Lack of professional training g. Unstandardized process h. Noisy environment) |
|---|---|---|---|---|---|
| 1 | 20170206 | a | b | a、b、c、d、e | a |
| 2 | 20170206 | b | a | c | b |
| 3 | 20170207 | b | b | a、b、c、d、e | e |
| 4 | 20170207 | a | a | a、b、c、d、e | f |
| 5 | 20170208 | a | a | a、b、c、d、e | h |
| 6 | 20170208 | b | b | c | f |
| 7 | 20170209 | a | a | a | e |
| 8 | 20170212 | b | d | e | f |
| 9 | 20170212 | a | d | e | a |
| 10 | 20170213 | a | d | e | b |
| 11 | 20170212 | a | d | e | d |
| 12 | 20170215 | b | a | c | c |
| 13 | 20170216 | b | b | e | g |
| 14 | 20170217 | a | d | e | h |
| 15 | 20170217 | a | a | c | e |
| 16 | 20170218 | a | b | a、b、c、d、e | h |
| 17 | 20170220 | a | b | c | f |
| 18 | 20170221 | b | d | a、b、c、d、e | e |

Scene

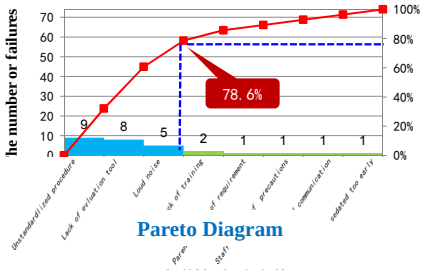
Object

Reality

## Analysis- Causes Verification

| Checking items | Frequency | Ratio | Accumulated Percentage |
|---|---|---|---|
| **Unstandardized appointment process** | **9** | **32.1%** | **32.1%** |
| **Lack of sedation evaluation tools** | **8** | **28.6%** | **60.7%** |
| **Noisy environment** | **5** | **17.9%** | **78.6%** |
| Lack of training | 2 | 7.1% | 85.7% |
| Parents unaware of the sedation requirements | 1 | 4.5% | 89.3% |
| Registration staff unaware of precautions | 1 | 3.6% | 92.9% |
| Lack of communication platforms | 1 | 3.6% | 96.4% |
| Sedated too early | 1 | 3.6% | 100% |
| Total | 28 | 100% | |

**Truth Verification**




**Pareto Diagram**

## Countermeasures

**1 A standard appointment procedure for children's MRI exam**

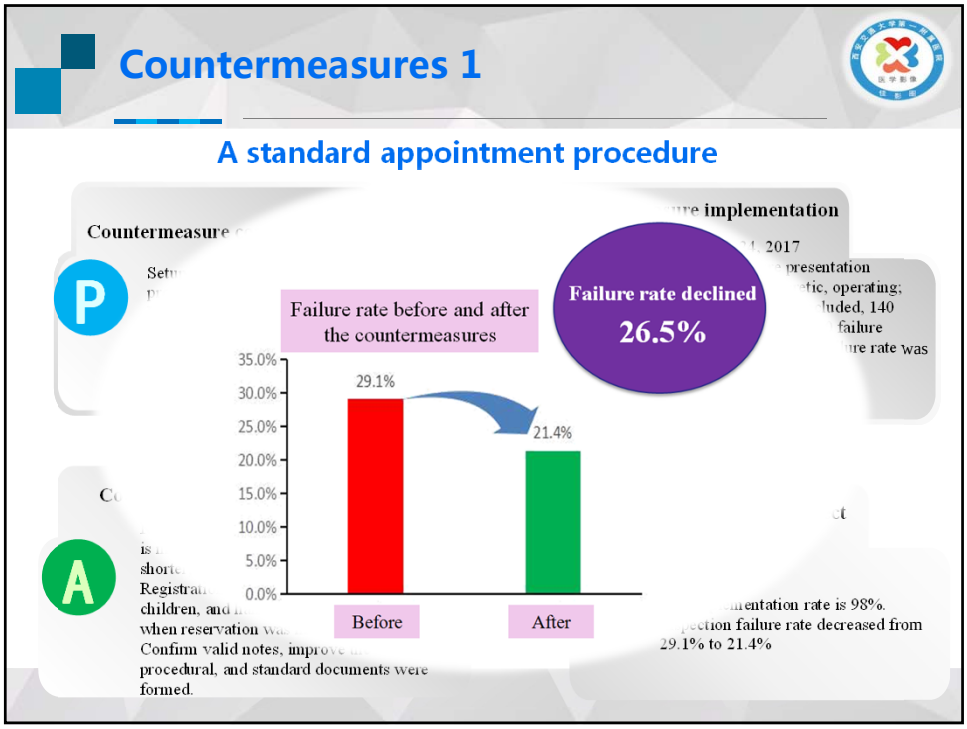
1.1 Establishing an MRI registration appointment procedure for children
1.2 Develop precautions list for children MRI exam

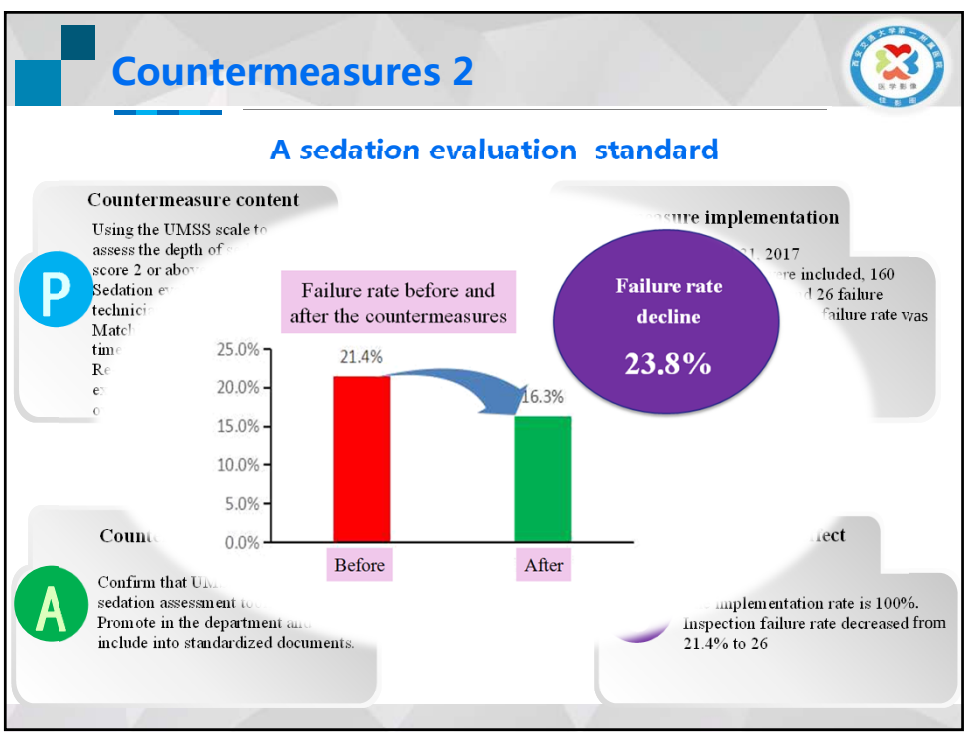
**2 A sedation evaluation standard for children's MRI exam**

2.1 Utilizing the University of Michigan Sedation Scales (UMSS)
2.2 Sedation evaluation training and first aid training
2.3 Evaluate after sedation and follow-up

**3 Noise influence reduction**

3.1 Utilizing noise reduction tools and dedicated coil
3.2 Adjust sequence order
3.3 Repair motion artifacts


Countermeasures 1
A standard appointment procedure
Countermeasure
P
A
Failure rate before and after the countermeasures
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
29.1%
21.4%
Before
After
Failure rate declined
26.5%
implementation
2017
presentation
tic, operating;
luded, 140
failure
ure rate was
mentation rate is 98%.
ection failure rate decreased from
29.1% to 21.4%
Confirm valid notes, improve
procedural, and standard documents were
formed.


Countermeasures 2
A sedation evaluation standard
Countermeasure content
P
A
Failure rate before and after the countermeasures
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
21.4%
16.3%
Before
After
Failure rate decline
23.8%
implementation
2017
re included, 160
26 failure
failure rate was
Confirm that UM
sedation assessment
Promote in the department
include into standardized documents.
implementation rate is 100%.
Inspection failure rate decreased from
21.4% to 26

## Countermeasures 3

### Noise influence reduction

**Countermeasure content**

P

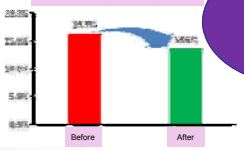
Use noise reduction tools
Adjust the sequence order
Repair motion artifacts

**Countermeasure implementation**

D

April 24 to May 12, 2017
A total of 31 children were included, 155 sequences were scanned, and 21 failure sequences were obtained. The failure rate was 13.6%.

Failure rate before and after the countermeasures




**Failure rate decline 16.6%**

**Countermeasures**

A

In practice, adjusted the sequence order individually.
Promote to peers.

**Countermeasure effect confirmation**

C

The implementation rate is 100%.
Inspection failure rate decreased from 16.3% to 13.6%

## Countermeasures 3

### Noise influence reduction

Sound proof earmuffs

Sleeping state

Dedicated coil

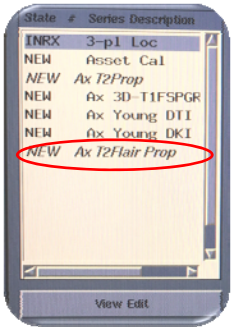
**Use noise reduction tools and special coils**

# Countermeasures 3

## Noise influence reduction

**Adjust sequence order**

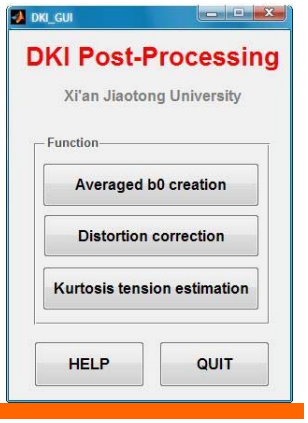
3-pl Loc
Asset Cal
Ax T2Prop
Ac T2Flair Prop
3D-T1FSPGR
Young DTI
Young DKI




**Move the loudest sequence T2 Flair to the last to scan**

# Countermeasures 3

## Noise influence reduction




**Motion correction software**

**Repair motion artifacts**

# Effect Confirmation

## Inspection summary

| Problems | Frequency | Ratio | Accumulated percentage |
|---|---|---|---|
| Failure to achieve desired sedation | 21 | 47.7% | 47.7% |
| Disease break out | 5 | 11.4% | 59.1% |
| Equipment breakdown | 5 | 11.4% | 70.4% |
| Adverse event | 4 | 9.1% | 79.5% |
| Long appointment time | 4 | 9.1% | 88.6% |
| Parents refuse to receive requisite sedation | 3 | 6.8% | 95.5% |
| Imperfect sedation procedure | 1 | 2.3% | 97.7% |
| Fear of radiation | 1 | 2.3% | 100.0% |

**91 cases × 5 sequences each = 455 sequences in total**
**44 incomplete cases in total**
**40 conventional sequences + 22 functional sequences = 62 unfinished sequences**
**Failure rate in children's MRI = 13.6%**

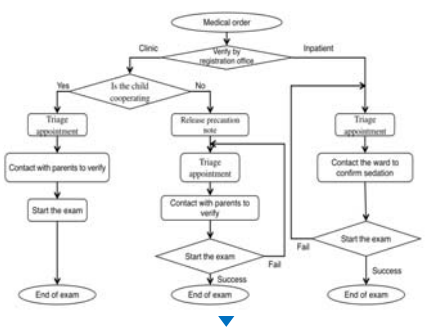
# Effect Confirmation - Tangible Achievement

(1) Target compliance rate = |(13.6%-29.1%)|/|(13.2%-29.1%)|×100%
**Compliance rate = 97.5%**
The basic failure rate reaches the target value after the intervention.

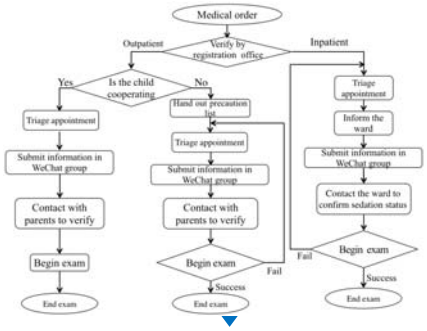
(2) Decline rate = |(13.6%-28.5%)|/28.5×100%
**Decline rate = 53.3%**
This activity has made great progress and the progress rate has reached 53.3%.

## Effect Confirmation-Tangible Achievement

**Flow chart**




Before

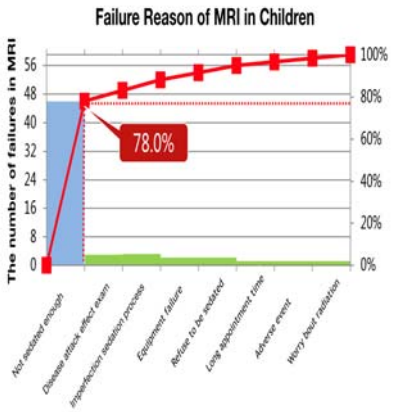



After

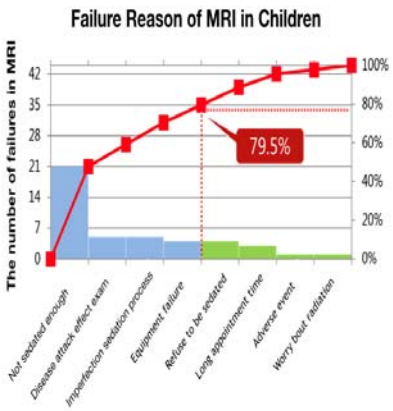
## Effect Confirmation-Tangible Achievement

**Pareto diagram**

Before

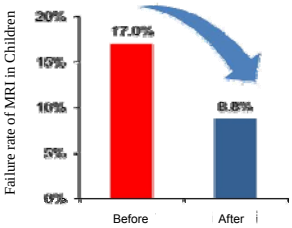



After

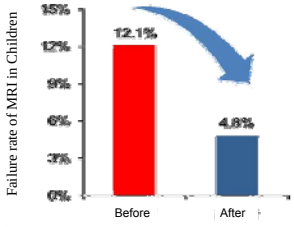


# Effect Confirmation-Tangible Achievement

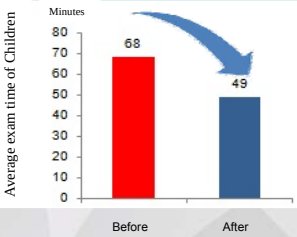
**Comparison of failure rates of conventional sequences before and after activity**
**The drop was 48.2%.**



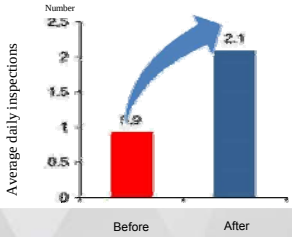

**Comparison of failure rates of functional sequences before and after activity**
**The drop was 60.3%.**




**The average time needed for each child before and after the activity was 27.9%.**




**Comparison of average daily inspections before and after the activity,**
**An increase of 124.7%。**

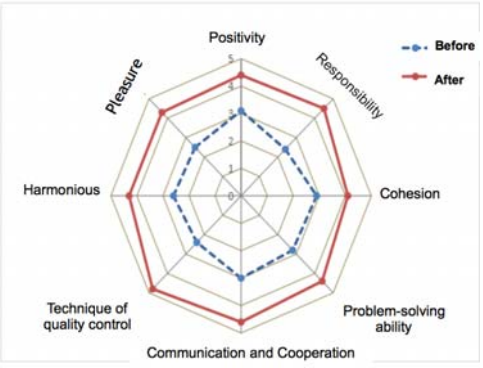



# Effect Confirmation- Intangible Outcomes

**Intangible achievement score sheet**

| Evluating items | Before | | After | | Progress | Positive / Negative |
|---|---|---|---|---|---|---|
| | Totals | Averages | Totals | Averages | | |
| Positivity | 50 | 3.1 | 70 | 4.4 | 1.3 | ↑ |
| Responsibility | 38 | 2.4 | 72 | 4.5 | 2.1 | ↑ |
| Cohesive force | 46 | 2.9 | 66 | 4.1 | 1.2 | ↑ |
| Problem-solving ability | 44 | 2.8 | 70 | 4.4 | 1.6 | ↑ |
| Communication and Cooperation | 48 | 3 | 74 | 4.6 | 1.6 | ↑ |
| Technique of quality control | 38 | 2.4 | 76 | 4.8 | 2.4 | ↑ |
| Harmony degree | 42 | 2.6 | 68 | 4.3 | 1.7 | ↑ |
| Pleasure | 40 | 2.5 | 68 | 4.3 | 1.8 | ↑ |

**Radar chart of intangible achievement**



## Effect Confirmation- Additional Benefits

### Patient

**Shorten hospitalization days**

Avoid repeated inspections 0.2 times/day * Reduce hospitalization days 2/ Total number of inspections 4 times/day = 0.1 day

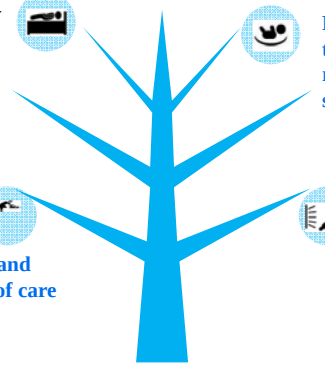
**Reduce the disturbance to children's circadian rhythm by sedation or sleep preparation**

**Reduce the costs**

100 yuan/person/day * 0.5 day = 50yuan/person

**Reducing the psychological stimuli of children due to environmental changes**

**Save parent's time and reduce the burden of care**
24 hr/person



## Effect Confirmation- Additional Benefits

### Medical staff

Avoid duplicate inspections
Improve work efficiency
Reduce working hours
**2 hr/person**

Improve image quality
Improve diagnostic accuracy and report quality

Improve doctor-patient relationship

## Effect Confirmation- Additional Benefits

Save electricity and equipment maintenance costs
Save electricity costs 200 yuan/day, equipment maintenance costs 100 yuan/day, total 300 yuan/day; annual savings: 300 yuan/day * 250 working days =¥ 75,000 /yr

Accelerate the progress of inspections and report issuance.
Improve the marginal benefits of human and equipment investment

Enhance the cohesion

Improve the utilization rate of machines, increase the number of inspections, and increase income
Daily income increase : (2.09-0.93) times/day * 600 yuan/time = 696 yuan/day;
Annual income increase: 696 y/day * 250 work days =0.1705 million/yr

Accelerate scientific research output

**Department of radiology**

## Effect Confirmation-Additionai Benefits

**Society**

**Public Service Activities – Reported by Media**
**- Expanding Social Influence**

## Review and Improvement

### Circle activity review summary

| Events | Advantage | Disadvantages |
|---|---|---|
| Theme selection | Significant clinical significance, and assisted scientific research. | Continue to carry out, use more data to support and establish a better inspection specification. |
| Plan activities | Reasonable time schedule and clear division of labor. | In the first quality circle activity, the actual progress and plan are slightly in error. |
| confirmation | sequences. | the ability to solve problems, and develop a feasible countermeasure for the exterior of the section. |
| standardization | The unfinished research sequence and the rate of unplanned re-examination of children were reduced. -- | Collaborate further with peers to expand the range of countermeasures and improve results. |
| Circle operation | Countermeasures are feasible and standardization documents can be formed. | Observe continuous effects and correct problems instantly. |
| Remaining problem | 1.The sedation-related issues related to factors outside our department and cannot be resolved temporarily;<br>2. This is our first time run QCC circle, the continuing effect remains to be inspect. | |

**Remaining issues:**
**1. MRI in children is still dominated by sedative medication-assisted sleep**
**2. The pediatric MR examination industry standards and specifications are yet to be established**

## Outlook--Be Better

- **Explore pre-examination criteria**
- **Improve compliance and safety**

- **Promote optimization clinical path**
- **Explore children's MRI examination program in China**

西安交通大學 第一附属医院
THE FIRST AFFILIATED HOSPITAL OF XI' AN JIAOTONG UNIVERSITY
THANK YOU!
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