

# Factors and Labor Cost Savings Associated with Successful Pediatric Imaging without Anesthesia: a Single-Institution Study

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## BACKGROUND

In pediatric imaging, particularly MRI, sedation is often necessary to obtain diagnostic quality imaging and avoid motion artifact. Prior studies have suggested an increased risk of neurocognitive delay from repeated anesthesia exposure in childhood. We aim to quantify patient and imaging-specific factors associated with successful pediatric scans without anesthesia and to evaluate labor cost savings associated with our institutional Scan Without Anesthesia Program (SWAP).

## METHODS

Patients who participated in SWAP between Oct 2019 - Apr 2022 were identified from Child Life Specialist records. Chart review was conducted to obtain sociodemographic and clinical information. Radiology database was used to obtain scan duration, modality/body part of examination, and administration of contrast. Mann-Whitney U and Chi-Square tests were used for univariate analysis of factors associated with success. Backward elimination multivariate logistic regression was used to evaluate independent contributions to success. Associated hospital labor cost savings were estimated using the average hourly rate of labor costs for each specialist compiled through public records with hourly rates based on a job code’s mid-tier rate.

SWAP has success rate of 95% and confers significant cost savings. Older age, absence of developmental delay, and female sex are associated with successful outcome.

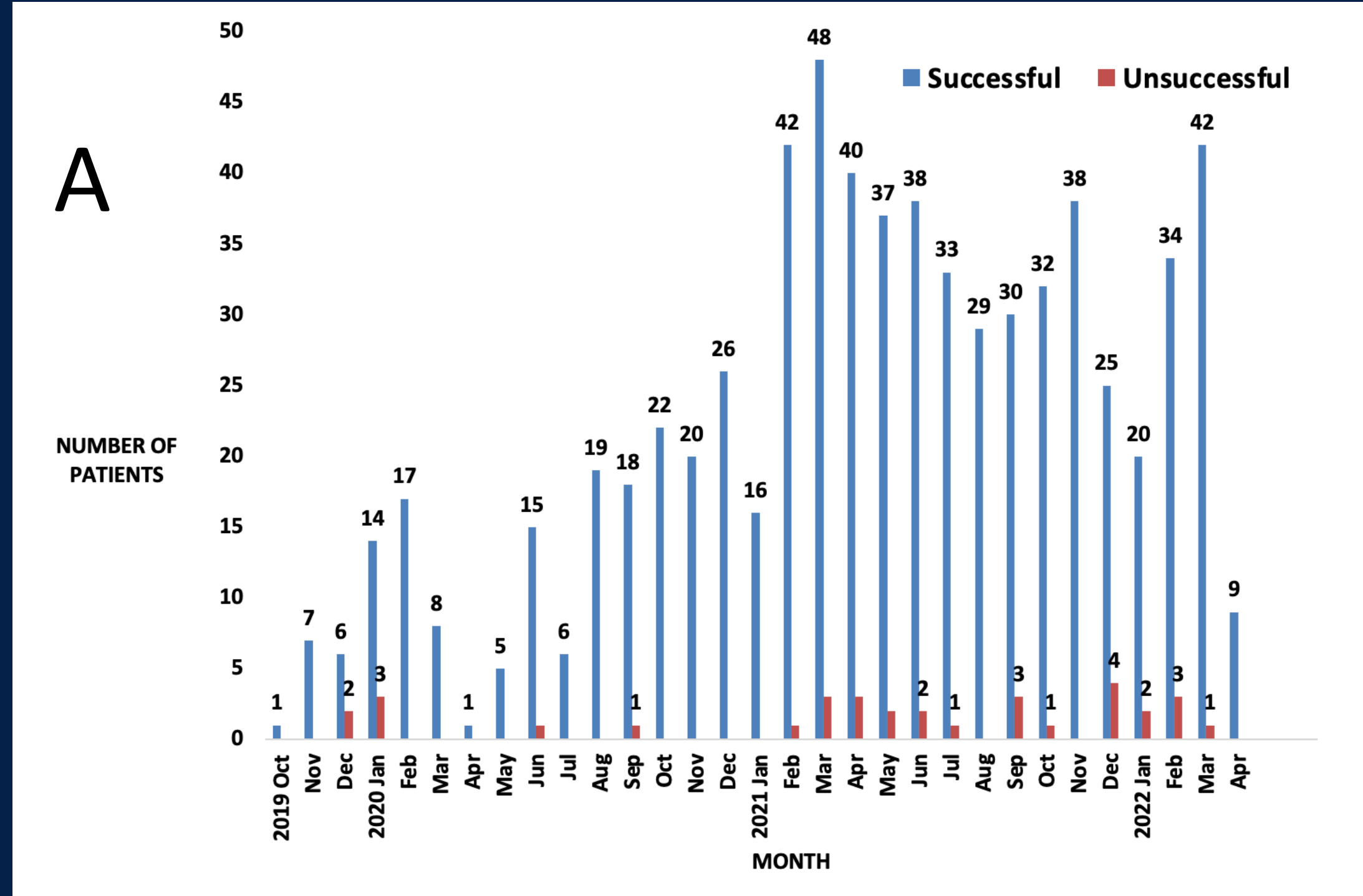


Figure A. Number of successful and unsuccessful SWAP scans by month between Oct 2019 - Apr 2022. The number of patients imaged under SWAP per month has increased over the duration of the program, due to greater awareness of the program and increased efficiency of throughput. Figure B. Between Oct 2019 - Apr 2022, patients who were successfully and unsuccessfully scanned had a median age of 8 (IQR 3-11) and 3 (IQR=0.4-6) years, respectively. No patients older than 11 years had unsuccessful scans. The higher number of total patients in the <1 year age category reflects large number of feed-and-swaddle patients imaged for immediate perinatal indications or term- corrected MRI for preterm infants.

## Patient-specific factors investigated

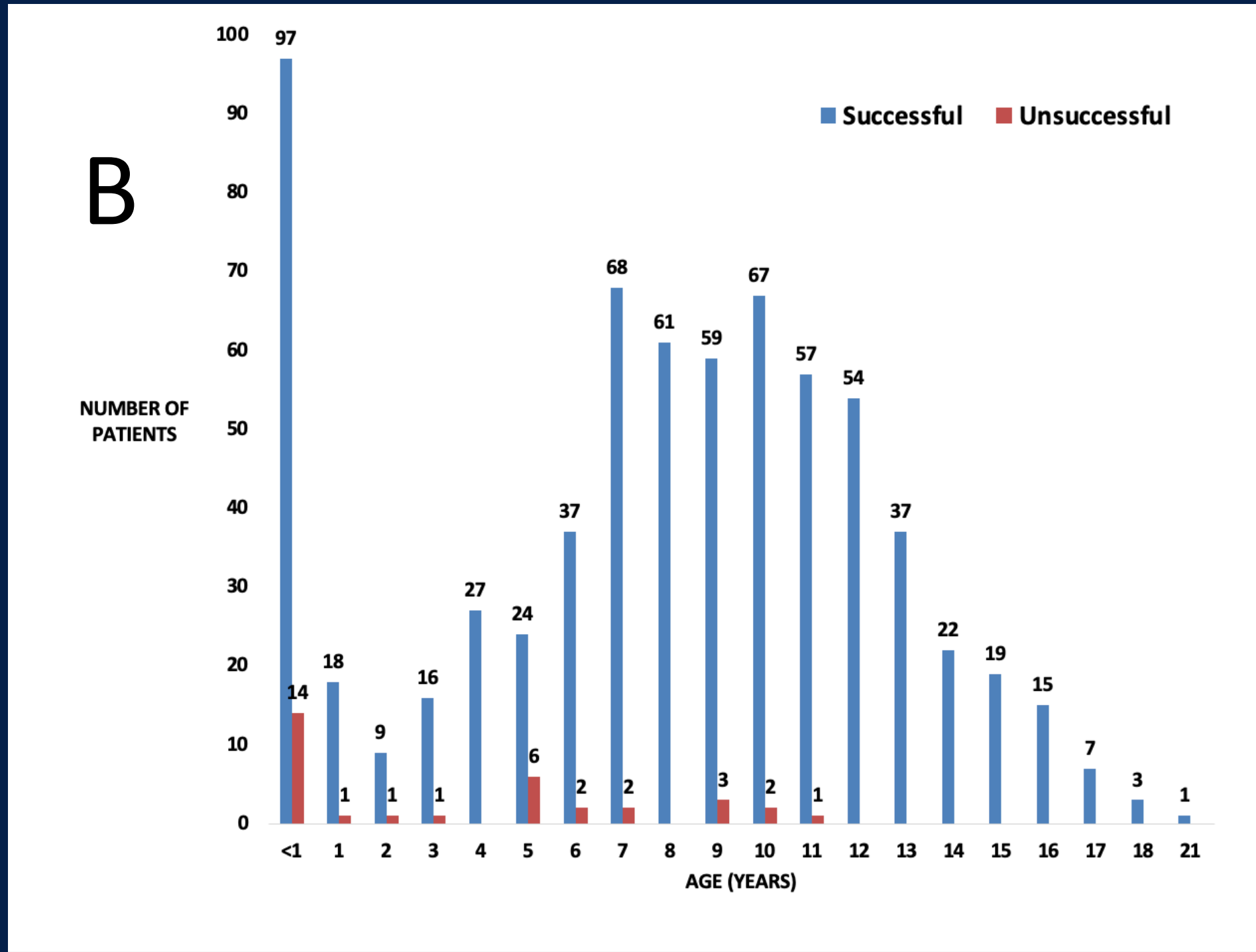
|                                 | Successful (N=698) | Unsuccessful (N=33) | Rate of success | P-value         |
|---------------------------------|--------------------|---------------------|-----------------|-----------------|
| Age (Yrs) [Median (IQR)]        | 8 (5.0-11.0)       | 3 (0.4-6.0)         |                 | <0.01           |
| Sex                             |                    |                     |                 | <0.01           |
|                                 | Female             | 375 (53.7%)         | 9 (27.3%)       | 375/384 (97.7%) |
|                                 | Male               | 323 (46.3%)         | 24 (72.7%)      | 323/347 (93.1%) |
| Preferred Language              |                    |                     |                 | 0.44            |
|                                 | English            | 611 (87.5%)         | 27 (81.8%)      | 611/638 (95.8%) |
|                                 | Spanish            | 80 (11.5%)          | 6 (18.2%)       | 80/86 (93.0%)   |
|                                 | Other Language*    | 7 (1.0%)            | 0 (0%)          | 7/7 (100%)      |
| Self-reported Race/ethnicity    |                    |                     |                 | 0.82            |
|                                 | Asian              | 53 (7.6%)           | 4 (12.1%)       | 53/57 (93.0%)   |
|                                 | Black              | 23 (3.3%)           | 1 (3.0%)        | 23/24 (95.8%)   |
|                                 | Hispanic           | 198 (28.4%)         | 11 (33.3%)      | 198/209 (94.7%) |
|                                 | Multietnic         | 44 (6.3%)           | 1 (3.0%)        | 44/45 (97.8%)   |
|                                 | Non-Hispanic White | 261 (37.4%)         | 13 (39.4%)      | 261/274 (95.3%) |
|                                 | Other**            | 74 (10.6%)          | 2 (6.1%)        | 74/76 (97.4%)   |
|                                 | Unknown            | 45 (6.4%)           | 1 (3.0%)        | 45/46 (97.8%)   |
| History of Developmental Delay  |                    |                     |                 | <0.01           |
|                                 | Absent             | 492 (70.5%)         | 16 (48.5%)      | 492/508 (96.9%) |
|                                 | Present            | 206 (29.5%)         | 17 (51.5%)      | 206/223 (92.4%) |
| Subtypes of Developmental Delay |                    |                     |                 | 0.77            |
|                                 | Speech Delay       | 81 (39.3%)          | 9 (52.9%)       | 81/90 (90.0%)   |
|                                 | Gross Motor Delay  | 26 (12.6%)          | 2 (11.8%)       | 26/28 (92.9%)   |
|                                 | Global Delay       | 34 (16.5%)          | 2 (11.8%)       | 34/36 (94.4%)   |
|                                 | Unspecified Delay  | 35 (17.0%)          | 3 (17.6%)       | 35/38           |
|                                 | Other Delay***     | 30 (14.6%)          | 1 (5.9%)        | 30/31           |

\* Includes American Sign Language, Chinese-Cantonese, Chinese-Mandarin, Punjabi, and Igbo  
\*\* Includes self-reported Other/ American Indian or Alaskan Native/ Other Pacific Islander  
\*\*\* Includes fine motor, cognitive, and multi-domain delay

## Imaging-specific factors investigated

|                                     | Successful (N=698) | Unsuccessful (N=33) | Rate of success | P-value         |
|-------------------------------------|--------------------|---------------------|-----------------|-----------------|
| Contrast Enhanced                   |                    |                     |                 | 0.04            |
|                                     | Yes                | 294 (42.1%)         | 8 (24.2%)       | 294/302 (97.4%) |
|                                     | No                 | 404 (57.9%)         | 25 (75.8%)      | 404/429 (94.2%) |
| Scan Duration* (min) [Median (IQR)] | 54 (40-74)         | 54 (39-93)          |                 | 0.31            |
| Modality of Study                   |                    |                     |                 | 0.07            |
|                                     | MRI                | 585 (83.8%)         | 28 (84.8%)      | 585/613 (95.4%) |
|                                     | CT                 | 98 (14.0%)          | 3 (9.1%)        | 98/101 (97.0%)  |
|                                     | Other*             | 15 (2.5%)           | 2 (6.1%)        | 15/17 (88.2%)   |

\*Scan duration available in 679 patients with successful scans and 23 patients with unsuccessful scans  
\*Includes interventional radiology, ultrasound-guided biopsy, nuclear medicine studies



## Multivariate logistic regression model

|                     | Odds Ratio (95% CI) | P-value |
|---------------------|---------------------|---------|
| Age                 | 1.22 (1.12-1.34)    | <0.01   |
| Developmental Delay | 0.47 (0.23-0.96)    | 0.04    |
| Female Sex          | 2.56 (1.15-5.68)    | 0.02    |

## Labor costs from hospital perspective for anesthesia or SWAP assuming standard 1.5-hour MRI

| With Anesthesia                        | FTE* | Hourly Rate | Hours per Prep | Hours per Procedure | Hours per Post | Total Hours per Case | Labor Expense | Benefit Markup | Total Cost per Case |
|----------------------------------------|------|-------------|----------------|---------------------|----------------|----------------------|---------------|----------------|---------------------|
| Tech: 9021 RADLG TECHNO PRN            | 1.00 | \$72.13     | 0.00           | 1.50                | 0.00           | 1.50                 | \$108.20      | 1.34           | \$144.98            |
| RN: 9139 CLIN NURSE II                 | 1.00 | \$89.49     | 0.50           | 0.50                | 0.50           | 1.50                 | \$134.24      | 1.34           | \$179.87            |
| Child Life: 7873 CHILD LIFE SPEC 1 EX  | 1.00 | \$39.46     | 0.25           | 0.25                | 0.00           | 0.50                 | \$19.73       | 1.34           | \$26.44             |
| Anesthesiologist:                      | 1.00 | \$177.06    | 0.50           | 1.50                | 0.50           | 2.50                 | \$442.65      | 1.34           | \$593.15            |
| TOTAL LABOR COST                       |      |             |                |                     |                |                      |               |                | \$944.45            |
| Scan Without Anesthesia Program (SWAP) | FTE* | Hourly Rate | Hours per Prep | Hours per Procedure | Hours per Post | Total Hours per Case | Labor Expense | Benefit Markup | Total Cost per Case |
| Tech: 9021 RADLG TECHNO PRN            | 1.00 | \$72.13     | 0.00           | 1.50                | 0.00           | 1.50                 | \$108.20      | 1.34           | \$144.98            |
| RN: 9139 CLIN NURSE II                 | 1.00 | \$89.49     | 0.50           | 0.50                | 0.25           | 1.25                 | \$111.86      | 1.34           | \$149.90            |
| Child Life: 7873 CHILD LIFE SPEC 1 EX  | 1.00 | \$39.46     | 0.50           | 1.50                | 0.00           | 2.00                 | \$78.92       | 1.34           | \$105.75            |
| Anesthesiologist:                      | 1.00 | \$177.06    | 0.00           | 0.00                | 0.00           | 0.00                 | \$0.00        | 1.34           | \$0.00              |
| TOTAL LABOR COST                       |      |             |                |                     |                |                      |               |                | \$400.63            |

| SWAP Long-term Investments                                               | Fixed Cost |
|--------------------------------------------------------------------------|------------|
| Standard MRI audio/visual goggle system                                  | \$41,000   |
| Advanced MRI audio/visual goggle system with functional paradigm options | \$81,000   |

- Full time equivalent



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## RESULTS

Of 731 patients, 698 had successful and 33 had unsuccessful scans (95% success rate). In univariate analysis, older age, female sex, absence of developmental delay, and administration of contrast were significantly associated with successful scans. Multivariate analyses revealed that older age, female sex, and absence of developmental delay were significant independent factors lending toward success. Imaging-related factors were not associated with outcome in multivariate analysis. Estimated labor cost savings were \$139,367.80 per year for the medical center.

## DISCUSSION

SWAP had an overall success rate of 95%. Older age, absence of developmental delay, and female sex were independently significantly associated with successful outcome. Cost analysis reveals substantial labor cost savings to the institution compared with imaging under anesthesia.

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