

# The Evaluation of Surgical Stapling in Robotic Thoracic Procedures – Clinical Outcomes and Resources Utilization

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IW PAN MPH, PhD,  
Medtronic, plc, Boston, MA, USA

## INTRODUCTION

Few case studies have shown the favorite results of hybrid/bedside staplers used in robotic procedures.<sup>1,2</sup>

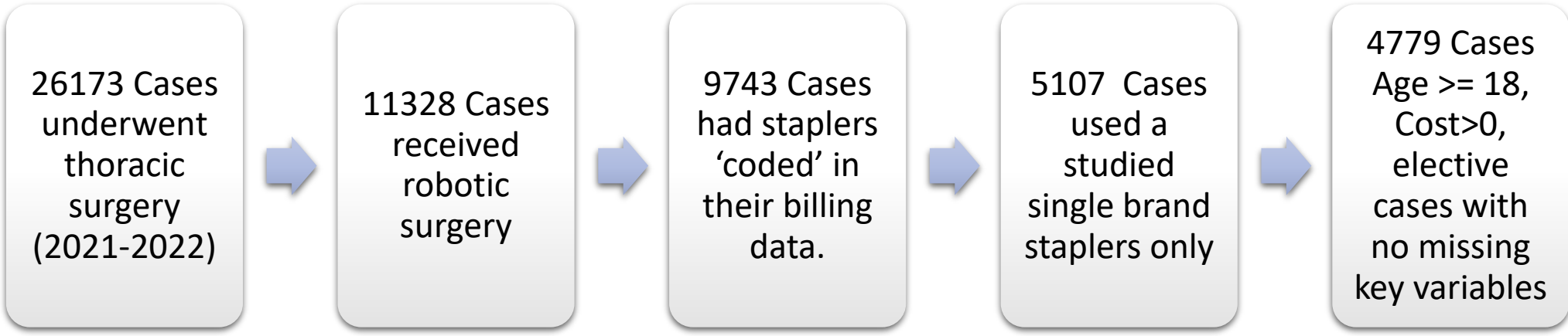
## OBJECTIVE

This study aims to evaluate the effectiveness of bedside staplers compared with robotic staplers on thoracic robotic surgical procedure.

## METHOD

Data Sources:  
PINC AI™ Healthcare Data, 2021-2022

Cohort Selection: Figure 1



Definition of staplers

- Bedside stapler (BS): Medtronic staplers (Signia™, Tri-stapler™, and other Medtronic staplers)
- Robotic stapler (RS): Intuitive SUREFORM™ staplers.

Baseline variables

Include both patient and hospital characteristics.

Outcomes variables

*Clinical outcomes:* used ICD 10 diagnosis and procedure codes, CPT codes to identify blood transfusion, bleeding, air leak, pneumothorax, bronchopleural fistula according to existing literature<sup>3-5</sup>  
*Healthcare resources utilization:* operating room (OR) time in minutes, total inpatient costs in 2022 US dollars, and lengths of stay (LOS)

Statistical analysis

**Baseline variable balance between two groups was evaluated by** Chi-square or Fisher exact test, and t-test or ANOVA.  
**Multivariable general linear mixed models (GLMMs) with respective gamma or binomial distribution and log-link function** were used to obtain adjusted outcomes variations between BS and RS.  
**Sensitivity analysis:** was done by propensity scores matching methods<sup>6</sup> to test the robustness of results obtained from GLMMs.

## RESULTS

- ❑ Majority of robotic lobectomy used RS (84.2%). (Table1)
- ❑ Patients who use RS are likely to increase the risk of bleeding by 2.5% compared to BS. Also, BS has equivalent clinical outcomes compared with RS in blood transfusion, air leak, and pneumothorax (Table 2 & 3)
- ❑ BS users were likely to save \$4,331 USD per thoracic inpatient procedure, compared to RS (p<0.001) (Table 4)
- ❑ BS users were likely to save 19 minutes per thoracic procedure compared to RS (p<0.001) (Table 4)
- ❑ No significant difference in length of stay between BS and RS. (Table 4)
- ❑ Sensitivity analysis showed similar results compared BS to RS. Table 3 & 4)

Table 1: Baseline characteristics in two groups

| Covariates                           | BS (%) | RS (%) | P-value |
|--------------------------------------|--------|--------|---------|
| Total (N= 4779)                      | 15.53  | 84.17  |         |
| Age >=65                             | 68.33  | 66.11  | 0.240   |
| Male                                 | 45.15  | 41.05  | 0.037   |
| Non-Hispanic White                   | 63.61  | 70.75  | <0.001  |
| Medicare                             | 65.63  | 65.32  | 0.374   |
| Lung cancer                          | 77.36  | 80.43  | 0.055   |
| Lobectomy                            | 55.93  | 61.28  | 0.006   |
| CCI >= 3                             | 67.12  | 63.34  | 0.049   |
| Moderate/Major /Extreme APR severity | 59.43  | 53.60  | 0.003   |
| South Region                         | 71.02  | 41.14  | <0.001  |
| Hospital in Urban                    | 95.69  | 94.05  | 0.078   |
| Bedside >=500                        | 69.54  | 59.03  | <0.001  |
| Teaching hospitals                   | 70.35  | 66.63  | 0.047   |
| High volume hospitals                | 60.78  | 64.70  | 0.041   |
| High volume surgeons                 | 66.58  | 73.30  | <0.001  |
| Thoracic surgeons                    | 40.57  | 57.74  | <0.001  |
| Discharge year 2022                  | 51.48  | 52.54  | 0.596   |

Table 2: Unadjusted outcomes by type of staplers

| Clinical outcomes         | RS (N=4037)<br>N(%) | BS (N=742)<br>N(%)  | P-value |
|---------------------------|---------------------|---------------------|---------|
| Blood transfusion         | 1.7%                | 2.3%                | 0.27    |
| Bleeding                  | 5.4%                | 4.0%                | 0.14    |
| Air leak                  | 16.5%               | 16.7%               | 0.84    |
| Pneumothorax              | 12.8%               | 11.3%               | 0.27    |
| Bronchopleural fistula    | 0.12%               | 0.27%               | 0.34    |
| Resources utilization     | Mean(STD)           | Mean(STD)           | P-value |
| Inpatient cost (2022 USD) | \$28,020 (\$22,655) | \$24,083 (\$13,620) | <0.001  |
| OR time (minutes)         | 230 (97)            | 216 (84)            | <0.001  |
| Length of Stay (Days)     | 4 (4.1)             | 4 (3.2)             | 0.15    |

Table 3: Summary of GLMMs -- Adjusted clinical outcomes and sensitivity analysis

| Adjusted Rates (%)<br>Reference: BS | Main Model – GLMMs <sup>1</sup> |        |                     |                    | Sensitivity analysis - PSM |        |                     |                     |
|-------------------------------------|---------------------------------|--------|---------------------|--------------------|----------------------------|--------|---------------------|---------------------|
|                                     | RS (%)                          | BS (%) | Odds ratio (95% CI) | P-value            | RS (%)                     | BS (%) | Odds Ratio (95% CI) | P-value             |
| Blood Transfusion                   | 1.8                             | 2.0    | 0.87(0.49, 1.54)    | 0.64               | 3.1                        | 2.3    | 1.36(0.72, 2.58)    | 0.336               |
| Bleeding                            | 5.6                             | 3.1    | 1.93(1.24, 3.00)    | 0.003 <sup>2</sup> | 9.6                        | 4.0    | 2.51(1.62, 3.90)    | <0.001 <sup>2</sup> |
| Air leak                            | 16.9                            | 14.7   | 1.22(0.95, 1.56)    | 0.112              | 20.1                       | 16.7   | 1.25(0.96, 1.63)    | 0.094               |
| Pneumothorax                        | 13.0                            | 10.5   | 1.29(0.99, 1.67)    | 0.059              | 13.9                       | 11.3   | 1.28(0.93, 1.72)    | 0.137               |

<sup>1</sup>Bronchopleural fistula did not include the multivariable GLMMs due to no or rare incidence in some subgroups; <sup>2</sup>p-value < 0.05 showed statistical significance.

Table 4: Summary of GLMMs – Adjusted resources utilization and sensitivity analyses

| Adjusted Resources Utilization | Main Model: GLMMs |           |                            |                     | Sensitivity analysis: PSM |           |                            |                     |
|--------------------------------|-------------------|-----------|----------------------------|---------------------|---------------------------|-----------|----------------------------|---------------------|
|                                | RS (MEAN)         | BS (MEAN) | Mean Differences (95% CI)  | P-value             | RS (MEAN)                 | BS (MEAN) | Mean Differences (95% CI)  | P-value             |
| Inpatient cost (2022 USD)      | \$28,085          | \$23,753  | \$4,331 (\$3,362, \$5,301) | <0.001 <sup>1</sup> | \$29,547                  | \$24,083  | \$5,464 (\$3,885, \$7,043) | <0.001 <sup>1</sup> |
| OR time (minutes)              | 231               | 212       | 19.1(12.3, 25.7)           | <0.001 <sup>1</sup> | 237.4                     | 215.7     | 21.6(11.7, 31.6)           | <0.001 <sup>1</sup> |
| LOS (days)                     | 3.7               | 3.7       | -0.01(-0.23, 0.21)         | 0.932               | 3.9                       | 3.9       | 0.07(-0.3, 0.4)            | 0.705               |

Abbreviation in all tables: RS: robotic staplers; BS: bedside staplers; OR: operating room; STD: standard deviation; GLMMs: general linear multivariate models; CI: confidence interval; PSM: propensity score matching;


This study showed conflicting results from the previous study<sup>7</sup> for following reasons:

1. PSM may not be an appropriate study design when controls cannot be completely matched to cases. In the prior study, out of 528 robotic cases, only 358 cases were matched. It left 47% of bedside staplers unmeasurable compared to robotic staplers.
2. The prior study used ENDOWRIST; the current study used SUREFORM as the comparison group.

3. Prior study included manual/powered staplers but did not provide details about the staplers, brand, or products. It may include products from JNJ, Medtronic, and/or other brands. This study included Medtronic staplers only in BS group.
4. The current study did not include conversion rate as an outcome because two studies (Servais et al., 2022 & Herrera et al., 2022)<sup>8-9</sup> suggested that the conversion rate may not indicate worse outcomes.

## CONCLUSIONS


Bedside Stapler is more effective and cost-saving than robotic staplers in thoracic robotic procedures



**Less Bleeding**

Bedside staplers (Medtronic)


Less than 2.5% of bleeding rate than robotic staplers (SUREFORM); Medtronic 3.2% vs SUREFORM 5.7%



**Less Operating Room Time**

Bedside staplers (Medtronic)

19 minutes less than robotic staplers (SUREFORM)



**Reduced inpatient costs**

Bedside staplers (Medtronic)

\$4,331 USD less than robotic staplers (SUREFORM) per admission

## REFERENCES

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## CONTACT INFORMATION

I-Wen Elaine Pan: elaine.pan@medtronic.com