Utilization and Complications of Catheter Ablation Therapy for Cardiac Arrhythmias in Congenital Heart Disease: An Analysis of the National Inpatient Sample (NIS) Database

Analysis for RCOP NIS Cardio6

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## Preamble:

* **Reference Papers:**
  + [Rozen et al. 2020](https://www.ahajournals.org/doi/10.1161/JAHA.119.015721)
  + [Alhassan et al. 2023](https://www.ahajournals.org/doi/10.1161/JAHA.122.029339)
  + [Hosseini et al. 2017](https://linkinghub.elsevier.com/retrieve/pii/S2405500X17303924)
* **Study Objective**: Describe the utilization and outcomes of catheter ablation therapy for cardiac arrhythmias in patients with congenital heart disease (CHD)
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions for patients aged 18 years or older with CHD who underwent catheter ablation with atrial fibrillation, atrial flutter, supraventricular tachycardia, or ventricular tachycardia as the primary diagnosis. Excluded patients who underwent pacemaker implantation, implantable cardioverter-defibrillator insertion, or open surgical ablation during the same hospitalization to avoid confounding effects from these procedures.
* **Primary Outcomes**:
  + At least 1 Complication
  + In-hospital all-cause mortality
  + Length of stay (days)
  + Inflation-adjusted total charge ($)
* **Secondary Outcomes**:
  + Pericardial complications (Hemopericardium, Pericardial Effusion, Cardiac Tamponade, Pericardiocentesis, Acute Pericarditis)
  + Cardiac complications (Myocardial Injury, Myocardial Arrest, Myocardial Infarction, Postprocedural Heart Failure, Requiring Open Heart Surgery, Postcardiotomy Syndrome)
  + Vascular complications (Hemorrhage/Hematoma, Hemo-transfusion, Accidental Puncture, Vascular Injury, Fistulas/Aneurysms, Injury Requiring Surgical Repair)
  + Respiratory complications (Pneumothorax/Hemothorax, Diaphragmatic Paralysis, Postoperative Respiratory Failure)
  + Gastrointestinal complications (Esophageal Perforation, Esophageal Injury)
  + Neurological Complications
* **Statistical Analysis**: Multiple logistic regression model was used to evaluate predictors of complication rates including:
  + Demographics: Age, sex, race, residential income, insurance type, and admission type (elective vs. non-elective).
  + Medical History: Hypertension, obesity, obstructive sleep apnea, diabetes mellitus, chronic pulmonary disease, chronic kidney disease
  + Ablation-Related Factors: Indication for Ablation
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **N = 2,370** |
| --- | --- |
| Age, y, n (%) |  |
| 18–44y | 430 (18) |
| 45–59y | 620 (26) |
| 60–74y | 965 (41) |
| ≥75y | 355 (15) |
| Sex, n (%) |  |
| Female | 930 (39) |
| Male | 1,440 (61) |
| Race, n (%) |  |
| White | 1,845 (80) |
| Black | 190 (8.2) |
| Hispanic | 190 (8.2) |
| Other | 95 (4.1) |
| Residential income, n (%) |  |
| $1 - $51,999 | 500 (22) |
| $52,000 - $65,999 | 635 (27) |
| $66,000 - $87,999 | 555 (24) |
| $88,000 or more | 635 (27) |
| Expected primary payer, n (%) |  |
| Private | 915 (39) |
| Medicaid | 250 (11) |
| Medicare | 1,130 (48) |
| Other | 70 (3.0) |
| Hospital region, n (%) |  |
| Midwest | 545 (23) |
| Northeast | 615 (26) |
| South | 830 (35) |
| West | 380 (16) |
| Hospital bedsize, n (%) |  |
| Large | 1,530 (65) |
| Medium | 595 (25) |
| Small | 245 (10) |
| Hospital location and teaching status, n (%) |  |
| Rural | 75 (3.2) |
| Urban, non-teaching | 160 (6.8) |
| Urban, teaching | 2,135 (90) |
| Admission type, n (%) |  |
| Elective | 875 (37) |
| Non-elective | 1,495 (63) |
| Charlson comorbidity index, Mean (SD) | 1.92 (1.83) |
| Indication for ablation, n (%) |  |
| Atrial Fibrillation | 1,045 (44) |
| Atrial Flutter | 805 (34) |
| Supraventricular Tachycardia | 305 (13) |
| Ventricular Tachycardia | 215 (9.1) |
| Hypertension, n (%) | 1,215 (51) |
| Obesity, n (%) | 630 (27) |
| Obstructive sleep apnea, n (%) | 545 (23) |
| Diabetes Mellitus, n (%) | 620 (26) |
| Chronic pulmonary disease, n (%) | 470 (20) |
| Chronic kidney disease, n (%) | 345 (15) |

## Outcomes Table:

| **Characteristic** | **N = 2,370** |
| --- | --- |
| Death, n (%) | 15 (0.6) |
| Length of stay (days), Median (IQR) | 3.0 (2.0 – 6.0) |
| Adjusted total charges, Median (IQR) | 138,056 (99,076 – 202,284) |
| Pericardial Complications, n (%) | 175 (7.4) |
| Cardiac Complications, n (%) | 50 (2.1) |
| Vascular Complications, n (%) | 70 (3.0) |
| Respiratory Complications, n (%) | 15 (0.6) |
| Gastrointestinal Complications, n (%) | 20 (0.8) |
| Neurological Complications, n (%) | 15 (0.6) |
| At Least 1 Complication, n (%) |  |
| At Least 1 Complication | 275 (12) |
| No Complications | 2,095 (88) |

## Baseline Table of Patients With and Without Any Complications:

| **Characteristic** | **At Least 1 Complication** N = 275 | **No Complications** N = 2,095 | **p-value***1* |
| --- | --- | --- | --- |
| Age, y, n (%) |  |  | 0.17 |
| 18–44y | 30 (11) | 400 (19) |  |
| 45–59y | 65 (24) | 555 (26) |  |
| 60–74y | 115 (42) | 850 (41) |  |
| ≥75y | 65 (24) | 290 (14) |  |
| Sex, n (%) |  |  | 0.027 |
| Female | 145 (53) | 785 (37) |  |
| Male | 130 (47) | 1,310 (63) |  |
| Race, n (%) |  |  | 0.68 |
| White | 230 (84) | 1,615 (79) |  |
| Black | 15 (5.5) | 175 (8.6) |  |
| Hispanic | 15 (5.5) | 175 (8.6) |  |
| Other | 15 (5.5) | 80 (3.9) |  |
| Residential income, n (%) |  |  | 0.30 |
| $1 - $51,999 | 45 (17) | 455 (22) |  |
| $52,000 - $65,999 | 85 (31) | 550 (27) |  |
| $66,000 - $87,999 | 45 (17) | 510 (25) |  |
| $88,000 or more | 95 (35) | 540 (26) |  |
| Expected primary payer, n (%) |  |  | 0.74 |
| Private | 95 (35) | 820 (39) |  |
| Medicaid | 25 (9.1) | 225 (11) |  |
| Medicare | 150 (55) | 980 (47) |  |
| Other | 5 (1.8) | 65 (3.1) |  |
| Hospital region, n (%) |  |  | 0.83 |
| Midwest | 70 (25) | 475 (23) |  |
| Northeast | 65 (24) | 550 (26) |  |
| South | 105 (38) | 725 (35) |  |
| West | 35 (13) | 345 (16) |  |
| Hospital bedsize, n (%) |  |  | 0.22 |
| Large | 195 (71) | 1,335 (64) |  |
| Medium | 70 (25) | 525 (25) |  |
| Small | 10 (3.6) | 235 (11) |  |
| Hospital location and teaching status, n (%) |  |  | 0.12 |
| Rural | 10 (3.6) | 65 (3.1) |  |
| Urban, non-teaching | 0 (0) | 160 (7.6) |  |
| Urban, teaching | 265 (96) | 1,870 (89) |  |
| Admission type, n (%) |  |  | 0.17 |
| Elective | 125 (45) | 750 (36) |  |
| Non-elective | 150 (55) | 1,345 (64) |  |
| Charlson comorbidity index, Mean (SD) | 2.16 (2.37) | 1.89 (1.75) | 0.92 |
| Indication for ablation, n (%) |  |  | 0.010 |
| Atrial Fibrillation | 170 (62) | 875 (42) |  |
| Atrial Flutter | 40 (15) | 765 (37) |  |
| Supraventricular Tachycardia | 40 (15) | 265 (13) |  |
| Ventricular Tachycardia | 25 (9.1) | 190 (9.1) |  |
| Hypertension, n (%) | 155 (56) | 1,060 (51) | 0.41 |
| Obesity, n (%) | 75 (27) | 555 (26) | 0.91 |
| Obstructive sleep apnea, n (%) | 60 (22) | 485 (23) | 0.82 |
| Diabetes Mellitus, n (%) | 65 (24) | 555 (26) | 0.65 |
| Chronic pulmonary disease, n (%) | 70 (25) | 400 (19) | 0.24 |
| Chronic kidney disease, n (%) | 35 (13) | 310 (15) | 0.69 |
| *1*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | |

## Multivariable Logistic Regression:

### At least 1 Complication:

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Age, y |  |  |
| 18–44y | — |  |
| 45–59y | 0.54 (0.18 to 1.63) | 0.27 |
| 60–74y | 0.43 (0.13 to 1.40) | 0.16 |
| ≥75y | 0.22 (0.05 to 0.94) | 0.042 |
| Sex |  |  |
| Female | — |  |
| Male | 1.61 (0.88 to 2.95) | 0.12 |
| Race |  |  |
| White | — |  |
| Black | 1.14 (0.29 to 4.53) | 0.85 |
| Hispanic | 0.99 (0.29 to 3.32) | 0.98 |
| Other | 0.73 (0.18 to 3.07) | 0.67 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.66 (0.28 to 1.55) | 0.34 |
| $66,000 - $87,999 | 1.12 (0.40 to 3.17) | 0.83 |
| $88,000 or more | 0.62 (0.26 to 1.49) | 0.29 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.79 (0.25 to 2.48) | 0.68 |
| Medicare | 1.26 (0.52 to 3.03) | 0.60 |
| Other | 1.38 (0.17 to 11.4) | 0.76 |
| Admission type |  |  |
| Elective | — |  |
| Non-elective | 1.18 (0.63 to 2.21) | 0.60 |
| Ablation type |  |  |
| Atrial Fibrillation | — |  |
| Atrial Flutter | 3.32 (1.44 to 7.62) | 0.005 |
| Supraventricular Tachycardia | 1.31 (0.49 to 3.46) | 0.59 |
| Ventricular Tachycardia | 1.00 (0.35 to 2.90) | >0.99 |
| Hypertension |  |  |
| No | — |  |
| Yes | 0.99 (0.47 to 2.11) | 0.99 |
| Obesity |  |  |
| No | — |  |
| Yes | 0.98 (0.45 to 2.10) | 0.95 |
| Obstructive sleep apnea |  |  |
| No | — |  |
| Yes | 1.09 (0.49 to 2.42) | 0.84 |
| Diabetes Mellitus |  |  |
| No | — |  |
| Yes | 1.57 (0.77 to 3.19) | 0.22 |
| Chronic pulmonary disease |  |  |
| No | — |  |
| Yes | 0.73 (0.38 to 1.41) | 0.35 |
| Chronic kidney disease |  |  |
| No | — |  |
| Yes | 1.23 (0.43 to 3.51) | 0.70 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |