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ORIGINAL ARTICLE

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# Low molecular weight heparin as an anticoagulation strategy for left-sided ablation procedures

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## Abstract

**Objective:** This quality improvement study was implemented to demonstrate consistent and reliable post procedure anticoagulation for patients undergoing left-sided ablations. We evaluated the safety and efficacy of anticoagulation practice during a transition from anticoagulation with overnight infusion of unfractionated heparin to a single subcutaneous injection of low molecular weight heparin.

**Methods:** Outcomes for patients who received unfractionated heparin from January 2014 to October 2014, were compared with outcomes of patients who received low molecular weight heparin from October 2014 to October 2015. Complications prepractice and postpractice change were documented and compared to establish confidence in the practice change and confirm the safety of the anticoagulation therapy management.

**Results:** There were no differences in the type or frequency of complications/adverse events demonstrated between the patients who had received unfractionated heparin for anticoagulation prophylaxis and those who received low molecular weight heparin. No thromboembolic events were reported or documented with either anticoagulation strategy. After confidence in the safety and efficacy of the practice change was established, a decision was made to discharge patients home the same day as there procedure, effectively reducing inpatient bed days and overall costs.

**Conclusion:** Administration of low molecular weight heparin provides predictable anticoagulation and equally safe as unfractionated heparin when administered to patients post left-sided ablation. A secondary gain has been reduction of procedural costs by elimination of the previously required inpatient observation stay.

KEYWORDS

ablation, anticoagulation, electrophysiology, low molecular weight heparin

## 1 | INTRODUCTION

Radiofrequency transcatheter ablation has become a routine procedure used to diagnose and treat many cardiac arrhythmias. While rare, thromboembolic events associated with radiofrequency ablation can have devastating and long-term consequences.[1] In the early era of catheter ablation, thromboembolic complications were reported to be as high as 2% but other reports have suggested that the rate is lower than 1%.[2–4]

To minimize the risk of thromboembolic events, patients have historically been anticoagulated with the administration of intravenous unfractionated heparin during the procedure followed by continuous intravenous infusion beginning 2 hours after obtaining hemostasis. It is particularly difficult to achieve therapeutic anticoagulation with unfractionated heparin as a result of a larger "interindividual variability" than other medications used for anticoagulation.[5] Unfractionated heparin also presents challenges in measuring the anticoagulant effect due to

  

the variability in reagents used to measure unfractionated heparin.[6] We sought to determine if the administration of low molecular weight heparin as a single dose was a safe alternative to unfractionated heparin infusion for anticoagulation postprocedure for left-sided ablations.

## 2 | MATERIALS AND METHODS

### 2.1 | Setting

This quality improvement study was performed in a free-standing, tertiary care pediatric hospital. The electrophysiology service at this institution includes 7 full-time electrophysiologists, 5 specialized nurses, and 3 technical associates. The service performs more than 260 catheter ablations annually. There is strong collaboration with the interventional service, cardiac anesthesiologists, nursing, and the multidisciplinary staff of the cardiac procedural unit.

### 2.2 | Development of a new anticoagulation protocol

Recommendations for alternative methods of anticoagulation were sought from the Cardiac Anticoagulation Management Program (CAMP), including the most appropriate medication, dose, timing of administration, and predicted time to therapeutic range. The CAMP program is a multidisciplinary team which includes physicians, pharmacists, a dedicated nurse practitioner, nursing leadership, nurse educators, and clinical nurse specialists. It was established with the primary purpose of providing centralized management of anticoagulation for cardiac patients and to devise strategies that would evolve clinical care with rapidly emerging trends in anticoagulation care.[7] CAMP provided an interdisciplinary perspective of the impact of this practice change on work flow and the patient's experiences.

After several months of interdisciplinary collaboration between the Electrophysiology service, CAMP, the cardiac procedural unit nurses and the cardiac step-down unit, a change in practice in our institution was initiated for anticoagulation after left-sided ablations beginning in October 2014. The change in practice was applied to ablations in the left atrium, the aortic root or pulmonary venous atrium in patients with atrial baffling.[8] Our practice was modified for patients requiring standard anticoagulation after left-sided ablations who would be transitioned to oral aspirin only upon discharge. These patients began receiving a single dose of 1 mg/kg (maximum dose of 80 mg) subcutaneous low molecular weight heparin 2 hour posthemostasis instead of a continuous overnight infusion unfractionated heparin.[9] This protocol was chosen to achieve a therapeutic anti Xa level 4–6 hours after subcutaneous injection while minimizing risks of bleeding.[10]

### 2.3 | Patient population and data analysis

To evaluate the safety and feasibility of this practice change, information was collected related to the timing of the low molecular weight heparin administration, occurrence of documented postprocedure rebleeds, and assessment of neurological symptoms from October 2014 through October 2015. The information was collected by the bedside registered nurse and the cardiology fellow using a standardized documentation tool. All patients continued to be admitted for observation overnight. To assess for neurological complications postablation, a standardized questionnaire outlining symptoms of headache, visual changes, new onset weakness or other concerning neurological symptoms was administered to each patient by the bedside nurse or cardiology fellow. In addition, a brief neurological examination was also documented by the bedside nurse or cardiology fellow which focused on facial asymmetries, new focal weaknesses or dysmetria the morning after the procedure. Any concerning signs or symptoms prompted emergent consultation with neurology. Those patients who had been discharged home received a follow-up phone call by a registered nurse and were assessed using the same standardized neurological questionnaire as those inpatients who had been observed overnight.

Patients who had undergone left-sided ablations and received unfractionated heparin for anticoagulation postprocedure during the 9-month period prior to the practice change were identified from hospital records. Outcomes and major procedural complications were recorded and compared to the low molecular weight heparin patients. Standard descriptive statistics were performed to compare the outcomes of both the low molecular weight heparin and unfractionated heparin patients for bleeding complications and neurological symptoms as described above.

## 3 | RESULTS

Information was collected on a total of 62 patients who received low molecular weight heparin after left-sided ablation and was compared to 60 patients who received unfractionated heparin. There were similar percentages of left-sided ablations for supraventricular tachycardia (SVT) in both groups (unfractionated heparin = 75% vs low molecular weight heparin = 77%) including ablations for Wolff-Parkinson-White syndrome (WPW) and concealed accessory pathways (Table 1). There

**TABLE 1** Low molecular weight heparin (LMWH) and unfractionated heparin (UFH) comparison

| Patient demographics and rebleed occurrence | UFH n = 60 | LMWH n = 62 |
|---|---|---|
| | Average (SD) N (%) | |
| Age | 16 (± 7.8) | 14 (± 6.1) |
| Male | 39 (63) | 37 (62) |
| Diagnosis | | |
| Wolff-Parkinson-White (WPW) syndrome | 14 (23) | 22 (35) |
| Concealed accessory pathway (AP) | 31 (52) | 26 (42) |
| Atrial tachycardia | 10 (17) | 7 (11) |
| Ventricular tachycardia | 4 (7) | 4 (6) |
| Other | 1 (2) | 3 (5) |
| Rebleeds | | |
| Total | 5 (8) | 5 (8) |
| Preanticoagulation | 1 (2) | 1 (2) |
| Postanticoagulation | 4 (6) | 4 (6) |
| Needing intervention beyond holding pressure | 0 | 0 |

Patient characteristics of the both the LMWH and UFH treatment groups.

**TABLE 2** Neurological symptoms after ablation

| Neurological symptoms after ablation | LMWH n = 62 |
|---|---|
| | N (%) |
| Total number of patients with neurological symptoms | 7 (11) |
| Headache | 6 (10) |
| Received acetaminophen | 5 (9) |
| Other symptoms including blurry vision | 2 (3) |
| Consult to neurology or need for imaging | 0 |

Neurological outcomes recorded using a standardized questionnaire and physical examination documented after the ablation.

was a higher percentage of patients with atrial tachycardia in the patients who received unfractionated heparin (unfractionated heparin- = 17% vs low molecular weight heparin = 11%) but fewer patients undergoing ablation for ventricular tachycardia (Table 1). The absolute number of patients with postprocedural rebleeds were identical in both groups (Table 1). Of the patients administered low molecular weight heparin that experienced post procedure rebleeds, all but one, occurred either before or within the typical required 4 hour postprocedure bed rest period. The single late rebleed occurred several hours after administration of low molecular weight heparin and was in a patient with arterial access.

There were 7 out of 62 patients (11%) administered low molecular weight heparin who complained of neurological symptoms postablation (Table 2). All neurological symptoms were minor such as headaches (rated on a scale 0–10) resolved by acetaminophen administration. There were no serious or persistent neurological symptoms that required either neurology consultation or acute brain imaging. Detailed neurological assessment data was not available for patients who received unfractionated heparin. Over the course of the evaluation period, average time to low molecular weight heparin administration was 2.5 ±0.6 hours, which decreased over the study period. After the practice change of administration of low molecular weight heparin and demonstration of its noninferiority to overnight infusions of unfractionated heparin, we extended the protocol to include the discharge of patients that received low molecular weight heparin. Historically, these patients would have been admitted to the cardiac step-down unit for unfractionated heparin infusion but now could be discharged after only a 4-hour observation period. Review of subsequent inpatient admissions for the 18 months after the secondary practice change demonstrated that 67% of post left-sided ablation patients were discharged home. Ongoing phone follow-up did not reveal any significant complications or late rebleeds. Patients with arterial access or at the discretion of the procedural attending continued to be admitted to the hospital for observation after administration of low molecular weight heparin. This change in practice resulted in savings of approximately 50 bed days in 2016 (Figure 1), resulting in savings of procedural costs and allowing these beds to be reallocated.

## 4 | DISCUSSION

While there is clear evidence for the importance of anticoagulation in adults undergoing RF catheter ablation for atrial fibrillation,[11] specific recommendations for pediatric patients are lacking. The primary endpoint of this quality improvement study was to demonstrate that administration of low molecular weight heparin was not inferior and did not have a higher complication rate than the historical practice of overnight unfractionated heparin infusions. There were no identified serious complications including stroke, significant rebleed requiring intervention or permanent disability during the evaluation period. As a result, administration of low molecular weight heparin has become the standard practice for the defined patient population and will allow for of the majority of these patients to be discharged home the same day as their procedure. The capacity to send patients home after the

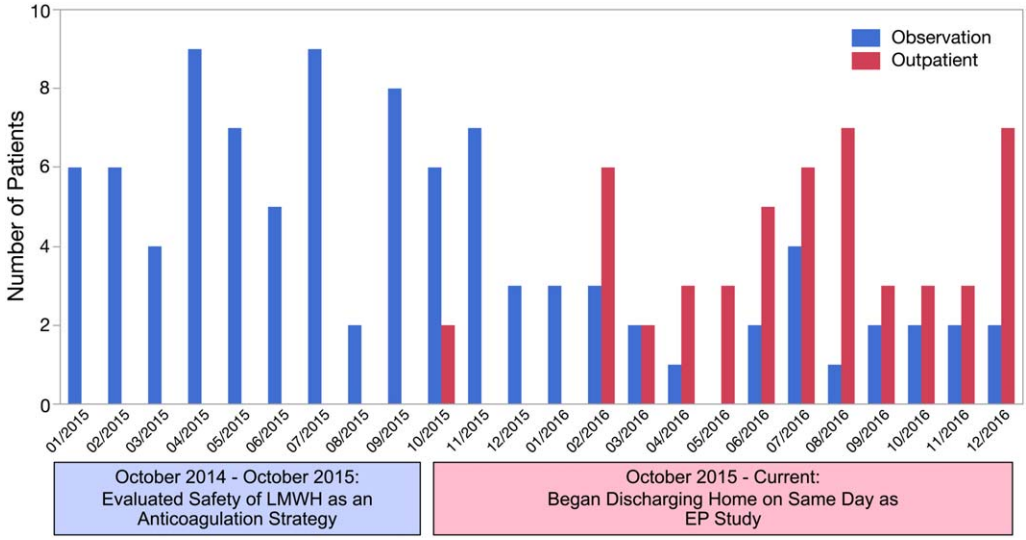


**FIGURE 1** Reduction in the number of admission for observation after practice change. The initial practice change of using low molecular weight heparin as an anticoagulation strategy occurred in October of 2014. Following this practice change, patients could then be discharged the same day of the procedure reducing the percentage of overnight admissions

majority of left-sided ablation procedures reduces cost and expands inpatient bed availability.

The limitations of this quality improvement initiative include the use of a small patient population (unfractionated heparin n = 60, low molecular weight heparin n = 62) in the setting of a low frequency of serious complications, which limits the statistical power of this observation. As a quality improvement project, this limitation will be addressed by ongoing data collection and monitoring of outcomes, but the reported results were deemed sufficient to support a provisional change in practice. Additional limitations include the retrospective acquisition of a comparator group of patients, and presentation of a single center experience, but given the size and stability of this active practice with respect to volume and outcome, these are not deemed likely to have biased the results in any way.

The practice of invasive electrophysiology continues to advance in terms of efficacy and safety.[12] The administration of low molecular weight heparin should be considered as a safe alternative to overnight UFH infusions for prevention of neurological complications in patients undergoing left-sided ablations.

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## CONFLICT OF INTEREST

The authors whose names are listed above certify that they have NO affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or nonfinancial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

## AUTHOR CONTRIBUTIONS

K.H. assisted with the implementation of the practice change, assisted in writing and reviewing the manuscript. M.E.L. assisted with the writing of the manuscript and assisted in data collection. C. P. performed the data analysis. S.C. performed the data collection. C.V. provided critical review of the manuscript. J.T. provided guidance and critical review of the manuscript. V.B. designed and implemented the practice change, assisted with the analysis and edited the manuscript.

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## REFERENCES

[1] Schaffer MS, Gow RM, Moak JP, Saul JP. Mortality following radiofrequency catheter ablation (from the Pediatric Radiofrequency Ablation Registry). Participating members of the Pediatric Electrophysiology Society. *Am J Cardiol.* 2000;86(6):639–643.

[2] Thakur RK, Klein GJ, Yee R, Zardini M. Embolic complications after radiofrequency catheter ablation. *Am J Cardiol.* 1994;74(3):278–279.

[3] Epstein MR, Knapp LD, Martindill M, et al. Embolic complications associated with radiofrequency catheter ablation. Atakr Investigator Group. *Am J Cardiol.* 1996;77(8):655–658.

[4] Cannon BC, Kertesz NJ, Friedman RA, Fenrich AL. Use of tissue plasminogen activator in a stroke after radiofrequency ablation of a left-sided accessory pathway. *J Cardiovasc Electrophysiol.* 2001;12(6):723–725.

[5] Jia Z, Tian G, Ren Y, Sun Z, Lu W, Hou X. Pharmacokinetic model of unfractionated heparin during and after cardiopulmonary bypass in cardiac surgery. *J Transl Med.* 2015;13(1):45.

[6] Raschke R, Hirsh J, Guidry JR. Suboptimal monitoring and dosing of unfractionated heparin in comparative studies with low-molecular-weight heparin. *Ann Intern Med.* 2003;138(9):720–723.

[7] Murray JM, Hellinger A, Dionne R, et al. Utility of a dedicated pediatric cardiac anticoagulation program: the Boston Children's Hospital experience. *Pediatr Cardiol.* 2015;36(4):842–850.

[8] Collins KK, Love BA, Walsh EP, Saul JP, Epstein MR, Triedman JK. Location of acutely successful radiofrequency catheter ablation of intraatrial reentrant tachycardia in patients with congenital heart disease. *Am J Cardiol.* 2000;86(9):969–974.

[9] Yee DL, O'Brien SH, Young G. Pharmacokinetics and pharmacodynamics of anticoagulants in paediatric patients. *Clin Pharmacokinet.* 2013;52(11):967–980.

[10] Dabbous MK, Sakr FR, Malaeb DN. Anticoagulant therapy in pediatrics. *J Basic Clin Physiol Pharmacol.* 2014;5(2):27–33.

[11] Di Biase L, Burkhardt JD, Santangeli P, et al. Periprocedural stroke and bleeding complications in patients undergoing catheter ablation of atrial fibrillation with different anticoagulation management: results from the Role of Coumadin in Preventing Thromboembolism in Atrial Fibrillation (AF) Patients Undergoing Catheter Ablation (COMPARE) randomized trial. *Circulation.* 2014;129(25):2638–2644.

[12] Seslar SP, Kugler J, Batra AS, et al. The Multicenter Pediatric and Adult Congenital EP Quality (MAP-IT) Initiative-rationale and design: report from the pediatric and congenital electrophysiology society's MAP-IT taskforce. *Congenit Heart Dis.* 2013;8(5):381–392.

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