

Clinical Impact of an Anticoagulation Screening Service at a Pediatric Tertiary Care Facility

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Abstract

Background: As thromboembolic events increase in pediatrics, so does the need for formal anticoagulation practice and management. In 2003, Children's Hospital Boston implemented an inpatient anticoagulation screening service. **Objective:** The objective for this project was to describe the impact of the anticoagulation screening service at a tertiary care pediatric center. **Design/Methods:** We screened 1,340 inpatient records for recommended dose of anticoagulant, indication, monitoring, and clinician responsible for followup care. Ninety-four percent were screened in real-time; 6 percent were evaluated by retrospective review. A survey of staff knowledge was performed. **Results:** Interventions declined from 7 percent of cases (24/338) screened in FY 2004 to 3 percent (12/399) in FY 2006 ($P = 0.01$). The percentage of patients discharged on anticoagulation therapy increased from 46 percent (154/338) in FY 2004 to 62 percent (248/399) in FY 2006 ($P < 0.001$). A discharge plan was present for an average 96 percent of patients. **Conclusion:** An inpatient anticoagulation screening service optimizes compliance with recommendations for safe anticoagulation practice across many services in a large pediatric hospital.

Introduction

Anticoagulation practice in the setting of pediatrics is predominantly extrapolated from the adult literature,^{1, 2, 3, 4} yet anticoagulation therapy continues to increase in this population. This rise is attributed to longer survival rates of acute and chronically ill children, due in part to advances in medical technology.^{2, 5} Despite the upsurge in pediatric thromboembolic events, they are still 100 times less frequent in the pediatric setting compared to the adult setting, which contributes to a lack of evidence-based guidelines in the literature for pediatric prophylaxis.⁶ Most available information is focused on the treatment of thrombosis rather than prevention.⁷ Despite the fact that the safety and effectiveness of anticoagulant medications, such as enoxaparin, have not yet been fully established in pediatrics, they are widely used. As the prevalence of pediatric thromboembolic events increases along with the use of anticoagulants, the need to augment formal anticoagulation practice and management intensifies.

Background

Although only a few pediatric anticoagulation services exist in the United States and Canada,⁸ Children's Hospital Boston (CHB) recognized that anticoagulation practice is a high-risk area, and this triggered a review of practice to ensure safe patient care. In 2002, an interdisciplinary

team of nurses, hematologists, and pharmacists was established to examine the roles and care processes for patients receiving anticoagulation therapy at CHB.

This team devised a protocol to assess the need for enoxaparin dosing guidelines at CHB. A pilot study was completed as the first step for development of the guideline and to (1) determine whether an anticoagulation service would help to identify pediatric patients at high risk for bleeding, (2) analyze anti-Xa levels, and (3) evaluate the potential impact of the modified guidelines for patients at risk of complications. The retrospective review included a review of medical records of patients aged 18 years or younger that had been identified by pharmacy as receiving enoxaparin for treatment of a venous thrombotic event (VTE) between January 2000 and September 2002. Adverse events identified during the pilot study included: hemangioma, oropharyngeal bleed, bleeding at the central venous line, hematoma bruising, epistaxis, stroke, GI bleed, and a new cranial bleed into a tumor. Analysis of enoxaparin levels (as anti-Xa levels) suggested that draft conservative guidelines would have indicated a change from following the American College of Chest Physicians nomogram in nine unique admissions.¹ This retrospective cohort review also revealed variability in monitoring practices for patients receiving anticoagulation treatment for VTEs.⁹

Based on the pilot study results, the team concluded that a work-force redesign was necessary. An inpatient anticoagulation screening service was established and comprised a hematology attending, a dedicated pediatric nurse practitioner (PNP), and a consulting pharmacist. The screening service was designed to promote the safe management of anticoagulation therapy, with the goals of intercepting potential errors by ensuring correct indication, dosing, and monitoring and support of patients discharged on anticoagulation therapy with education, discharge planning, and followup.

A PNP was hired, and the anticoagulation service began in August of 2003. All inpatients ordered for an anticoagulant (warfarin, enoxaparin, and subcutaneous heparin) were included as part of the screening service, excluding cardiac patients receiving warfarin. Patients on the cardiology and cardiothoracic surgery services at our center who receive warfarin are followed by the cardiovascular program but not routinely by the anticoagulation service. Therefore, they were excluded from this screening program and subsequent analysis, unless their cardiologist had asked for hematology/anticoagulation consultation.

The purpose of this analysis was to examine the impact of the mandatory screening service on anticoagulation practice within a pediatric tertiary setting and to describe the influence of the service on improving the consistency of anticoagulation management. An evaluation of selected dimensions of prescribing and monitoring practices was conducted.

Methods

Anticoagulation Screening Service Practice

This report covers the period between October 2003 and May 2007. Since the screening of patients was implemented as a quality improvement measure for CHB, Institutional Review Board approval was not indicated. Patients and their records were screened Monday through

Friday by the anticoagulation service PNP. Screening on weekends and holidays occurred on the following business day. The CHB departments of pharmacy and information services developed a “clot buster report,” a comprehensive listing of all inpatients receiving anticoagulation, to facilitate identification of patients requiring screening. Medical records were reviewed to assess compliance with three major aspects of care: (1) recommended indication for anticoagulation, (2) recommended dose, and (3) recommended monitoring of levels. Results of the screening were documented in each patient’s medical record using a templated form. Concerns identified during the screening process triggered notification of the primary service, and all issues were addressed by the anticoagulation service PNP or the hematology attending. Additional information was gathered (e.g., unit, service, education needed, adverse event), coded, and entered into a Microsoft Excel[®] database. Data were analyzed quarterly, with results reported as a part of the routine process for departmental reporting of quality indicators.

The results shown below are reported on a per-patient-screened basis. If the patient was not discharged between orders, a new order did not generate a new screening episode. A small number of patients (< 1 percent of total) had length of stay > 30 days on anticoagulation and generated a new screen on a monthly basis.

Reduced Variation in Prescribing Practices

In 2004, the Pharmacy and Therapeutics Committee embarked on the implementation of an enoxaparin order template. This order template included recommendations for age-appropriate dosing, with considerations related to renal status and ordering per actual body weight vs. ideal body weight. Our actual practice in morbid obesity was to start with the mean of the ideal and measured body weight for initial dosing. The template also included appropriate monitoring measures and frequency. The screening service encouraged the use of this template and provided education to prescribers.

Enhanced Staff Education

In October 2003, following the introduction of the screening service, the PNP developed a survey to assess the education needs of registered nurses throughout the hospital. Surveys were distributed on the inpatient medical service and orthopedic inpatient nursing unit (day + evening shift nursing census averaged 98); 64 surveys (65 percent) were completed. The results were used to develop a training program. Initially offered to registered nurses on the inpatient units, this education is now offered on an ongoing basis to all clinical staff. Training methods consist of individualized consultations, lecture, and hands on demonstration. The training focuses on the following topics: warfarin/enoxaparin education (e.g., precautions, consistent vitamin K intake, subcutaneous injections), appropriate lab monitoring and techniques, and education on subcutaneous catheter devices.

To evaluate the effectiveness of training, an identical survey was redistributed in 2007 to the same areas, with a 57 percent response rate among a staff of 98. The results of this second survey revealed increased knowledge with regard to the management of patients receiving enoxaparin.

Patient Education, Discharge Planning, and Outpatient Followup

Based on our initial work on the service, adherence to recommended treatment was identified as a problem for patients discharged on anticoagulants. These findings led to the development of an outpatient followup program by the PNP to provide ongoing education and to closely monitor adherence. Participation in monitoring after discharge is at the discretion of the treating team. Referrals to the outpatient monitoring program are usually made by the primary inpatient service treating the patient. The PNP and RN for the service coordinate patient education, identify appropriate facilities for lab monitoring, and develop an outpatient anticoagulation discharge plan that is documented and forwarded to the primary care provider.

Outpatient lab monitoring and dose adjustments are completed in accordance with CHB hematology guidelines. Since October 2003, 30 to 50 patients per month have participated in this outpatient lab monitoring program. These patients could include, but are not limited to, patients who require deep vein thrombosis prophylaxis, prosthetic valve protection (only when specifically referred by their cardiologist, not as a routine), and patients with a history of thromboembolic events.

Results

Between October 2003 and May 2007, 1,428 patients were identified as having an order for an anticoagulant. Of those, 1,340 patients (94 percent) were screened during their admission by the anticoagulation service. Predominant anticoagulants used were enoxaparin, warfarin, and subcutaneous heparin. Dosing interventions (i.e., modifications of dosing inconsistent with recommendations and failure to comply with recommendations to hold anticoagulation) have steadily and significantly declined from 7 percent of cases screened in fiscal year 2004 (24/338) to 3 percent of cases screened in fiscal year 2006 (12/399) ($P = 0.01$). During the first 8 months of fiscal year 2007, 1.7 percent of cases screened (4/234) required dosing interventions ($P = 0.003$ vs. fiscal year 2004). Results are highlighted in Figure 1.

The percentage of patients discharged home on anticoagulation therapy has continued to increase from

46 percent (154/338) in fiscal year 2004 to 62 percent (248/399) in fiscal year 2006 ($P < 0.001$). During the first 8 months of fiscal year 2007, 145 patients (55 percent, $P = 0.02$ vs. fiscal year 2004) were discharged on anticoagulation therapy. The presence of a discharge plan for these patients averaged 96 percent (range, 91 to 99 percent). Anticoagulation discharges are highlighted in Figure 2.

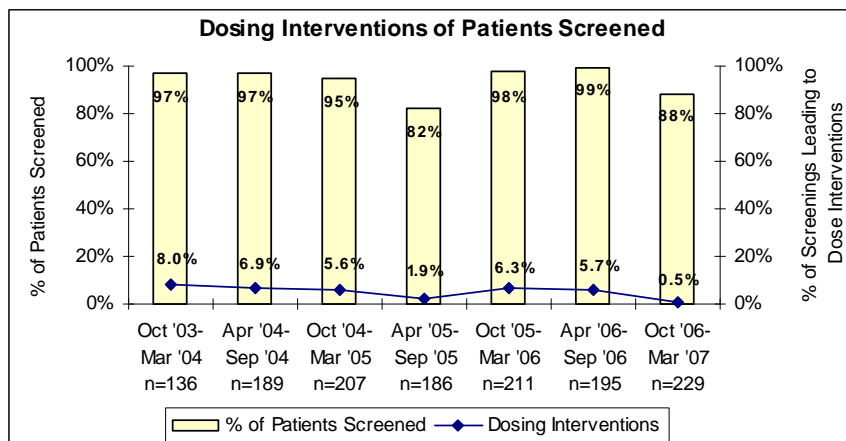


Figure 1. Dosing interventions of patients screened.

Data collection regarding readmission of patients within 3 months of the original diagnosis for bleeding, recurrent thrombosis, or extension of thrombus was initiated in the second year of the program. Readmission rates apply to those patients readmitted to CHB only.

At present, there is no evidence to suggest that any patients that were on

anticoagulation treatment were admitted to an outside hospital during the period listed. Because the anticoagulation team follows the majority of these patients, it would be unusual for them to be unaware of a hospital admission. Since October 2004, 0.98 percent of patients (7/716) were readmitted. Of these, two were readmitted for bleeding, one related to trauma, and one attributed to the patient's underlying diagnosis. Five patients were readmitted for recurrent thrombosis or extension of thrombus. On review of data obtained from the CHB Safety Events Reporting System, adverse event rates in FY 2005 and FY 2006 have been low, with a total of eight cases (four per year) and two for the first 8 months of FY 2007.

When the enoxaparin order template (a paper form available on the hospital intranet) was implemented during the fourth quarter of FY 2004, 28 percent (21/74) of initial orders were written using this template. Although the use of the enoxaparin template was encouraged by our service, it was not mandatory. In 2007, a hospital-wide automated medical record was introduced, and the template is now required for prescribing enoxaparin. Results of the knowledge survey are summarized in Table 1.

Discussion

As anticoagulation therapy has evolved, decisions about patient management have increased.¹⁰ CHB is a teaching hospital, and many clinicians in training rotate into the pediatric setting. The results of this quality improvement project should help in the further refinement of dosing and anticoagulation practice within the hospital.

The anticoagulation screening service has enhanced compliance with recommendations, education, and appropriate followup. In addition, patients who experience a thromboembolic event are routinely seen by the inpatient hematology team after a request for consultation by the patients' attending physician and are followed by the screening service. All patients with a thromboembolic event who are followed as part of the outpatient lab monitoring program are seen by the PNP 1 to 2 weeks following discharge and then at 3-month intervals. Monitoring of coagulation studies after discharge is based on the specific anticoagulant, as follows:

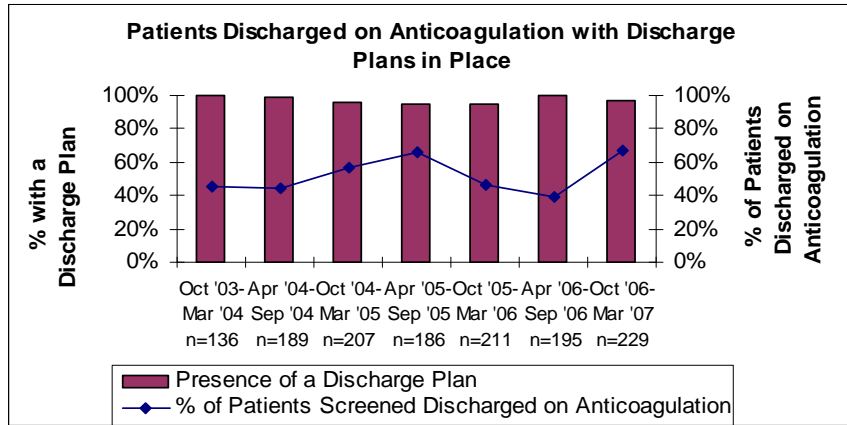


Figure 2. Patients discharged on anticoagulation with discharge plans in place.

- Warfarin is monitored with INR/PT (international normalized ratio/prothrombin time) by our initial dosing protocol; once consistently therapeutic, from week to week, the intensity of monitoring is tapered to monthly.
- Anti-Xa levels are monitored 7 to 10 days after discharge and then on a monthly basis. The responsibility for outpatient followup is shared with the hematologist. Each patient is followed until anticoagulation therapy is discontinued. Patients who complete therapy but continue to have morbidity issues related to their diagnosis and/or continue to have thrombotic risk factors are followed long term.
- One patient population monitored closely is the pediatric patient transitioning to adolescence. Continued followup of patients in this particular age group is needed due to the increase in thrombotic risk factors that occur during this period.^{11, 12}

There is no available literature describing the rate of readmissions for pediatric patients with an adverse event due to anticoagulation therapy. The screening service began collecting readmission data for CHB during the second year of the program; readmissions were defined as patients readmitted within 3 months of the original diagnosis for bleeding or recurrent thrombosis or extension of thrombus.

A review of all readmissions since October 2004 that occurred within 3 months of original diagnosis was completed by the anticoagulation service in collaboration with the primary teams. They found 7 readmissions out of a total of 716 admissions. The review revealed that due to the complexity of six of these cases, clinical outcomes could not be linked to monitoring practices, and it was unlikely that anything further could have been done to prevent the bleeding and reoccurrence/extension of the thrombus. In one case, anticoagulation dosing by the primary

Table 1. RN needs assessment survey^a

Questions answered correctly	Num/Denom ^b (%)		% Change
	2003	2007	
Total number of respondents	64	56	-12.5
What is enoxaparin?	51/64 (80)	55/56 (98)	22.5
Identify two indications?	49/128 (38)	65/112 (58)	52.6
Dosing appropriate for treatment based on recommendations?	1/64 (1.6)	35/56 (63)	3800
Identify side effects	38/64 (59)	51/56 (91)	54.2
Identify appropriate time to draw anti-XA level	29/64 (45)	55/56 (98)	117.8
Identify recommended level	7/64 (11)	33/56 (59)	436.4
Identify correct name of lab test	32/64 (50)	47/56 (84)	68

a The survey was made available to 98 registered nurses each time.

b Numerator represents total number of correct indications identified; denominator represents total number of potential indications.

service was not consistent with that routinely recommended by the anticoagulation service, suggesting that readmission might have been preventable. The PNP provided education regarding the benefits of twice-daily dosing to the primary service that prescribed the anticoagulant.

While few successful pharmacist-run inpatient anticoagulation programs have been documented,¹⁰ there are no reported inpatient PNP-led pediatric programs. The CHB anticoagulation screening service is the first of its kind that we are aware of in the pediatric setting. It has proven to be a valuable resource for patients, families, and clinicians. Although the need for interventions has steadily declined since the introduction of the anticoagulation screening service, this team continues to be a critical means of optimizing compliance with recommendations and standardizing practice for a low-volume, high-risk therapy. In addition to individualized consultation and education, the team has introduced updated guidelines, policies, and templates to guide practice. The screening service continues to be a vehicle for ongoing assessment of anticoagulation practices to identify potential opportunities for improvement and to determine whether education and/or broader interventions are necessary for system-wide improvement.

Conclusion

The findings of this review suggest that an inpatient anticoagulation screening service can increase compliance with recommendations for management of anticoagulation across many services in a large academic pediatric hospital. The screening service at CHB has continued to evolve and has overcome the natural challenges associated with launching a service designed to evaluate practice variation and to continuously assess “best practice.” This program is recognized as a clinical and educational resource for patients and staff. Given the emerging emphasis on anticoagulation practices by external regulatory agencies, the success of the anticoagulation screening service at CHB may serve as a model for other centers.

Limitations

This descriptive paper cannot provide definitive evidence for improved safety; that will require explicit evaluation of outcomes (clots and complications). Readmission rates are for our hospital only, so that if patients with clots or bleeding were admitted solely to another facility, we would not have counted them.

Further evaluation is needed to confirm the long-term effectiveness of interventions introduced by the service to standardize practice and improve patient safety. The relative costs and benefits associated with improved compliance with team recommendations for anticoagulation management will require future analyses. Future goals for this program will focus on broadening the base of evidence to guide management practices for the treatment of pediatric thrombosis and thrombophilia.

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