Temporal Trends in Prevention of Venous Thromboembolism Following Primary Total Hip or Knee Arthroplasty 1996–2001*

Findings From the Hip and Knee Registry

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Background: The Hip and Knee Registry is an observational database comprising data on practices of US orthopedic surgeons during 1996 to 2001. We examined trends in the use of prophylaxis for venous thromboembolism (VTE) among patients who underwent primary total hip arthroplasty (THA) or total knee arthroplasty (TKA).

Methods: Data on 9,327 THA and 13,846 TKA patients were submitted between 1996 and 2001 by 464 orthopedic surgeons from 319 hospitals in 42 of the United States.

Results: During 1996 to 2001, 44% of THA patients and 38% of TKA patients were male, and 93% and 92% were white, respectively. The median age of THA and TKA patients increased from 66 to 68 years and 68 to 69 years, respectively, between 1996 and 2001 (p < 0.001), while the mean length of hospital stay decreased from 4.7 to 3.7 days and 4.5 to 3.7 days, respectively (p < 0.001). Use of spinal or epidural anesthesia increased from 34 to 46% for THA and 43 to 54% for TKA patients (p < 0.001). One or more types of thromboprophylaxis were administered to 99% of patients. The following were the most common types of thromboprophylaxis: elastic stockings (61% and 58%), warfarin (56% and 53%), low-molecular-weight heparin (38% and 40%), and intermittent pneumatic compression (35% and 32%) in THA and TKA patients, respectively. Aspirin was used for thromboprophylaxis in 4% of THA and 7% of TKA patients. One or more type of in-hospital prophylaxis matching the 2001 American College of Chest Physicians (ACCP) recommendations were administered to 89% of THA and 91% of TKA patients between 1996 and 2001. During this period, in-hospital use of ACCP prophylaxis recommendations increased from 88 to 94% following THA (p < 0.001). This increase was also observed for prophylaxis administered to TKA patients, although this did not reach statistical significance.

Conclusions: Recent trends in the management of patients undergoing THA and TKA in the United States, including shorter lengths of hospital stay and increased use of spinal/epidural anesthesia, present a challenge to orthopedic surgeons who wish to provide their patients with effective prophylaxis for VTE. Despite these challenges, nearly all surgeons participating in the Hip and Knee Registry are providing types of prophylaxis consistent with evidence-based consensus recommendations. Although there are concerns regarding increased bleeding risk due to the use of anticoagulants in patients receiving spinal/epidural anesthesia, there was a significant increase in the use of spinal/epidural anesthesia between 1996 and 2001. During this same period, the proportion of patients receiving spinal/epidural anesthesia who were also administered anticoagulants as prophylaxis increased significantly.

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Key words: deep vein thrombosis; pulmonary embolism; total hip arthroplasty; total knee arthroplasty; venous thromboembolism

Abbreviations: ACCP = American College of Chest Physicians; DVT = deep-vein thrombosis; FDA = Food and Drug Administration; LMWH = low-molecular-weight heparin; PE = pulmonary embolism; THA = total hip arthroplasty; TKA = total knee arthroplasty; UFH = unfractionated heparin; VTE = venous thromboembolism

The Hip and Knee Registry is a North American, voluntary, physician-directed registry examining outcomes in patients who undergo elective total hip arthroplasty (THA) or total knee arthroplasty (TKA).[1] The objectives of the Hip and Knee Registry are as follows: to examine trends in patient management; to link treatment approaches to patient outcomes; to provide orthopedic surgeons with quarterly confidential reports of their practice patterns and outcomes, including benchmarks to the aggregate experience of all surgeons participating in the registry; to provide data allowing more precise sample size estimation in the design of controlled trials; and to develop hypotheses to be tested in controlled clinical trials. The

information collected includes preoperative and postoperative data reported by both physicians and patients. Confidential summary reports, including regional and national benchmarks, along with individual physician summaries, are mailed to participating surgeons on a quarterly basis. Evidence from previous studies[2,3] suggests that feedback of practice data to physicians can lead to improvements in clinical practice.

The ability of prophylaxis to prevent deep-vein thrombosis (DVT) and reduce mortality due to pulmonary embolism (PE) has been affirmed by a National Institutes of Health Consensus Conference,[4] meta-analysis of controlled studies,[5,6] and evidence-based consensus recommendations.[7] When low-dose unfractionated heparin (UFH) is used postoperatively, patients who undergo major abdominal or thoracic surgery experience a two-thirds reduction in DVT and a 50% reduction in fatal PE. Currently available methods of thromboprophylaxis, including warfarin, intermittent pneumatic calf compression, and subcutaneous injection of either low-molecular-weight heparin (LMWH) or low-dose UFH, are both safe and cost-effective. Despite long-standing, convincing evidence of the benefits of thromboprophylaxis, surveys of physician practices conducted during the late 1980s demonstrated that physicians practicing in the United States were not prescribing prophylaxis for the majority of their high-risk patients.[8] However, subsequent surveys in the 1990s demonstrated a substantial increase in the use of thromboprophylaxis, particularly among orthopedic surgeons performing THA/TKA.[9–11]

The present observational study describes practices in the prevention of venous thromboembolism (VTE) among 464 US orthopedic surgeons during the years 1996 to 2001, in relationship to several variables, including changes in length of hospital stay and the frequency of use of spinal anesthesia. Informal observations have so far indicated a tendency toward a reduction in the lengths of hospital stay and an increase in use of spinal anesthesia. If correct, both of these trends would be expected to decrease the appropriate use of prophylaxis with anticoagulants due to logistic challenges and safety concerns. Our data provide a unique perspective on recent practices among a large group of orthopedic surgeons who practice in the United States.

Materials and Methods

This research is based on data from the Hip and Knee Registry, an ongoing observational database that currently provides a 6-year perspective on physician practices in the care of patients who undergo THA/TKA.

Physicians and Hospitals

Operations were performed by 464 orthopedic surgeons practicing at 319 hospitals located in 42 US states. Overall, 83% of surgeons practiced at nonteaching institutions.

Patient Selection

Participating surgeons were instructed to enroll consecutive patients who underwent THA or TKA. No other inclusion/exclusion criteria were specified in the registry. The present analysis was limited to the subset of enrolled patients who underwent primary (first operation for) THA or TKA.

Confidentiality

Measures for protecting the confidentiality of patients, physicians, and hospitals participating in this registry were reviewed and approved by the Institutional Review Board of the University of Massachusetts Medical School. Study patients were required to provide verbal informed consent. To reassure surgeons that their data were reasonably protected from disclosure in a civil proceeding, a Certificate of Confidentiality for this registry was obtained from the US Department of Health and Human Services.

Data Collection

A standardized data abstraction form was developed for this study by a scientific advisory board comprised of 16 orthopedic surgeons. Physicians were asked to complete a patient enrollment form that included questions about indications for surgery, types of anesthesia, antibiotics, and thromboprophylaxis. In addition, physicians were asked to complete a follow-up form on all study patients at 3 months and 1 year after surgery. The follow-up form contained questions relating to postoperative complications, including VTE and death. Completed data forms were mailed to a central study coordinating center at the University of Massachusetts Medical School for processing. Data quality control was monitored using standardized query logic. Out of range or illogical responses were queried to the surgeon on a quarterly basis. Corrections were faxed to the study coordinating center.

Data Analysis

Data were double-key entered into a computer database and analyzed using commercially available statistical software (SAS-PC; SAS Institute; Cary, NC). Differences in the distribution of categorically defined variables were evaluated by χ^2 tests. For continuous variables, comparisons were made using the Wilcoxon rank-sum or Kruskal-Wallis tests.

Results

Patient Characteristics

Between January 1996 and December 2001, 464 surgeons enrolled 23,173 patients in the registry, including 9,327 primary THA cases and 13,846 primary TKA cases. The sociodemographic characteristics of THA and TKA patients in the aggregated samples (1996 to 2001) were similar (Table 1). Male subjects comprised 40% of the study sample. Most (92%) were white. The primary risk factor for development of VTE in study patients was elective THA or TKA. Based on commonly accepted risk factors for VTE (Table 1), 70% of study patients had no additional risk factors for VTE, 24% had one additional risk factor, 5% had two additional risk factors, and 1% had more than three additional risk factors.

Hospital and Surgeon Characteristics

A number of variations were seen in the use of thromboprophylaxis according to the characteristics of partici-

Table 1—Patient Characteristics and Key Outcomes According to Type of Operation*

Characteristics	THA (n = 9,327)	TKA (n = 13,846)
Male sex	44	38
White race	93	92
Median age, yr	66.5	68.4
Mean length of stay, d	4.1	4.1
History of		
VTE	7.3	9.5
Myocardial infarction	7.5	8.6
COPD	5.5	5.5
Congestive heart failure	2.0	2.5
Stroke	3.6	5.0
Cancer	12	11
Postoperative events†		
DVT	1.3	1.0
PE	0.4	0.4
Death	0.04	0.07

*Data are presented as % unless otherwise indicated.
†Median follow-up 3 months.

pating surgeons, including the number of years in practice, annual volume of THA/TKA, and practice setting (Table 2). At enrollment, orthopedic surgeons participating in this study had been in practice for a median of 15 years following completion of surgical training, and 95% were board certified in orthopedic surgery. Only 28% of the study patients were hospitalized in teaching hospitals. Use of one or more of the types of in-hospital prophylaxis recommended by the American College of Chest Physicians (ACCP) consensus panel[7] was significantly lower in teaching compared with nonteaching hospitals (86% vs 91%, p < 0.001). In addition, the rate at which recommended types of thromboprophylaxis continued to be used after discharge from the hospital was significantly lower in teaching than in nonteaching hospitals (63% vs 68%, p < 0.001).

Surgical Practices and Types of Anesthesia

During the 6-year study period, the average lengths of hospital stay decreased by approximately 1 day: from 4.7 to

Table 2—Patients Who Received In-hospital Thromboprophylaxis Matching the ACCP Recommendations According to Surgeon Characteristics

Variables	THA, % (9,327 Patients/423 Doctors)	TKA, % (13,846 Patients/400 Doctors)
Years in practice		
< 5	94	97
6–15	91	91
16–25	85	89
> 25	89	91
Practice setting		
Academic	87	84
Community	89	92
Volume of operations		
≤ 50/yr	89	92
> 50/yr	88	90

3.7 days for THA, and from 4.5 to 3.7 days for TKA (p < 0.001; Fig 1). Over this same period, hospital discharge disposition showed little variation (Fig 2). There was a trend toward increasing use of spinal or epidural anesthesia from 35 to 46% for THA patients and from 43 to 54% for TKA patients (p < 0.001; Fig 3). During this period, the proportion of patients with spinal/epidural anesthesia who received thromboprophylaxis with LMWH also increased (p < 0.0001; Fig 3).

Types of Thromboprophylaxis

Rates of in-hospital use of common thromboprophylaxis methods are shown in Figure 4. Elastic compression stockings were the most commonly used thromboprophylaxis in both THA patients (61%) and TKA patients (58%). More than 99% of THA and TKA patients who received elastic stockings received them in combination with other modalities. Among methods of primary thromboprophylaxis, warfarin was the most common modality used, followed by LMWH. Rates of use of widely recognized thromboprophylatic methods after hospital discharge are shown in Figure 4. Elastic compression stockings, warfarin, and LMWH were the most commonly employed modalities.

Adequacy of In-hospital Thromboprophylaxis

At least one type of thromboprophylaxis was provided during hospital stay for 99% of patients who underwent THA or TKA (Table 3). The types of prophylaxis used were consistent with the 2001 ACCP recommendations[7] in 89% and 91% of patients who had undergone THA and TKA, respectively (Table 3). LMWH was administered to 38% of THA patients and 40% of TKA patients, while warfarin was administered to 56% of THA patients and 53% of TKA patients. Temporal trends in the in-hospital use of one or more types of thromboprophylaxis matching the 2001 ACCP recommendations[7] are shown in Figure 5.
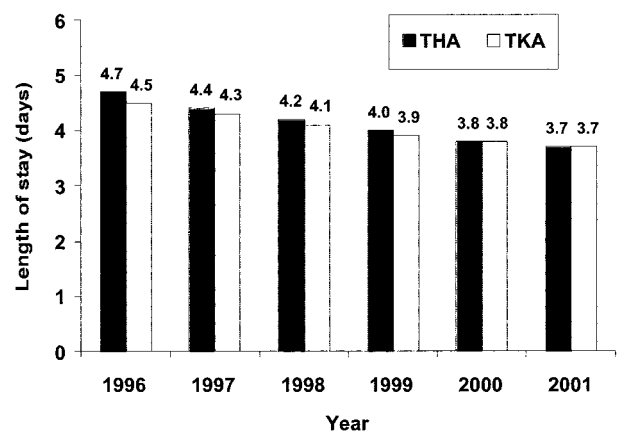

FIGURE 1. Temporal trends in average length of hospital stay for patients enrolled in the Hip and Knee Registry during the years 1996 to 2001.
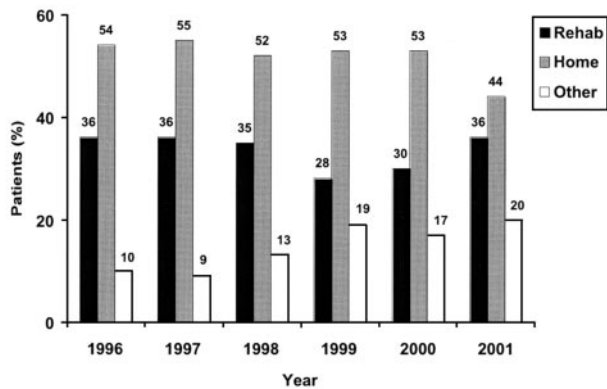
FIGURE 2. Temporal trends in hospital discharge disposition following THA during the years 1996 to 2001. Rehab = rehabilitation.

Adequacy of Thromboprophylaxis After Hospital Discharge

At least one type of thromboprophylaxis was prescribed following hospital discharge for 97% of patients who underwent THA or TKA (Table 3). One or more types of thromboprophylaxis consistent with the 2001 ACCP recommendations[7] was provided for approximately two thirds of patients who had undergone THA or TKA, respectively
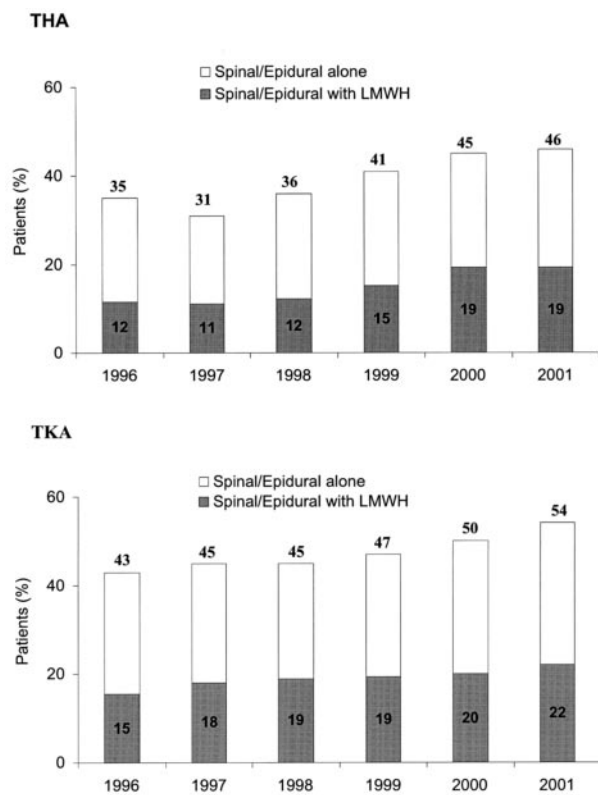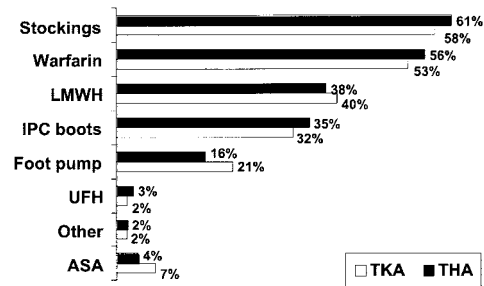

FIGURE 3. Annual percentage of patients enrolled in the Hip and Knee Registry who received spinal or epidural anesthesia according to use of LMWH prophylaxis during the years 1996 to 2001.
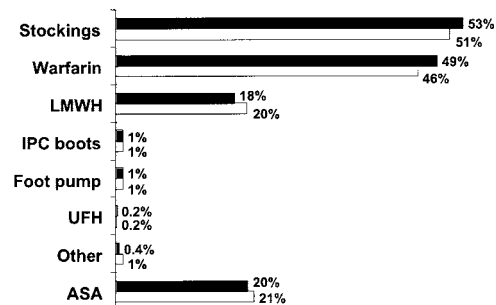

FIGURE 4. Use of prophylaxis for VTE in the hospital and following discharge. IPC = intermittent pneumatic compression; UFH = unfractionated heparin; ASA = aspirin.

(Table 3). After hospital discharge, LMWH was administered in 18% of THA patients and 20% of TKA patients, while warfarin was administered in 49% of THA and 46% of TKA patients, respectively. Temporal trends in the postdischarge use of one or more types of thromboprophylaxis matching those recommended in the ACCP guidelines are shown in Figure 5.

Duration of Thromboprophylaxis

There was a wide variation in practice in the duration of thromboprophylaxis (Table 4). For example, 50% of THA patients and 46% of TKA patients received thromboprophylaxis for > 21 days. In addition, there was an increasing

Table 3—Type of Prophylaxis for VTE

Type	THA, %*	TKA, %†
In-hospital		
Any	99.7	99.7
Adequate*	88.9	90.9
Aspirin (alone)	0.9	1.6
After discharge		
Any	97.2	97.5
Adequate‡	67.0	66.0
Aspirin (alone)	7.3	6.5

*LMWH or warfarin.
†LMWH, intermittent pneumatic compression, or warfarin.
‡2001 ACCP consensus recommendations.[7]

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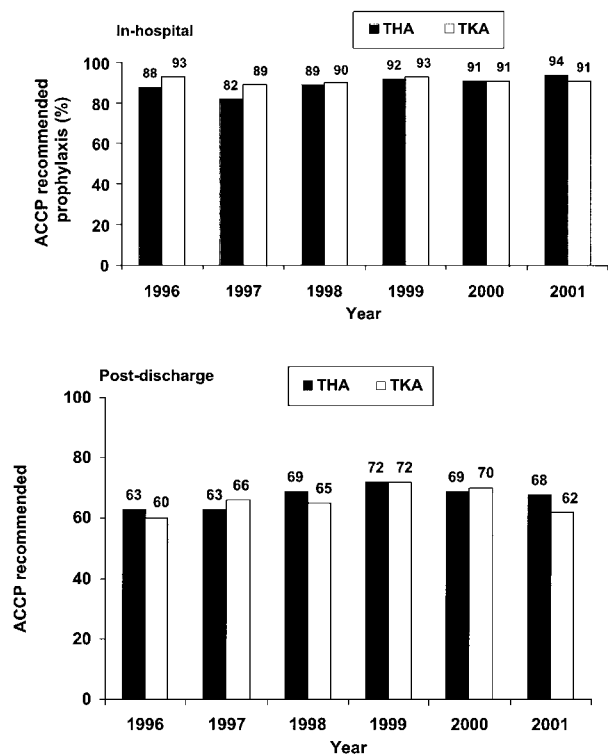
FIGURE 5. Temporal trends in hospital and postdischarge use of types of thromboprophylaxis matching the ACCP recommendations[7] during the years 1996 to 2001.

trend for THA and TKA patients to receive thromboprophylaxis for > 21 days between 1996 and 2001 (Fig 6).

Venous Thromboembolism

Clinically recognized VTE (1.1%) and PE (0.4%) were rare in the early (1 to 3 months) postoperative follow-up period. Death was also rare in this period, with an incidence of 0.1%, equating to 1 in 1,000 patients. Only one TKA patient who died was reported to have had a clinically recognized PE. She had been treated with intermittent pneumatic compression boots in the hospital with aspirin after hospital discharge. During the 1- to 3-month period after hospital discharge, the follow-up rate for these patients was 43%. Thus, estimates of the rates of clinically apparent PE and death may underestimate the true rates, because of incomplete follow-up data.

DISCUSSION

Several methods of thromboprophylaxis have proven safe and effective in well-designed, controlled clinical

Table 4—Duration of Prophylaxis for VTE

Duration, d	THA, %	TKA, %
< 8	11	13
8–21	39	41
> 21	50	46

trials. However, there are little data to demonstrate whether surgeons are employing these methods in patients cared for outside the controlled trial environment or outside of academic medical centers with a particular interest in the prevention of VTE. Furthermore, to our knowledge, there are no published data on changes over time in practice patterns to demonstrate whether surgeons are modifying their thromboprophylactic practices in response to the publication of evidence-based consensus recommendations,[7] US Food and Drug Administration (FDA) "black-box" warnings,[12] or commercial promotion of the findings of new controlled trials comparing the efficacy and optimal application of new and established prophylactic methods.

The main goal of this study was to document 6-year temporal trends in "real-world" physician practice patterns in the use of well-known approaches to thromboprophylaxis in patients undergoing elective THA or TKA. The 2001 ACCP consensus recommendations[7] were used as the primary benchmark for the definition of adequate thromboprophylaxis.

Despite the widely recognized limitations of voluntary, disease-specific, registry databases,[13] a wide variety of observational multicenter registry databases have been developed for a number of chronic diseases.[14–18] The publications from these registries are contributing in unique and important ways to understanding the real-world clinical practices and outcomes in a number of chronic diseases.[14–18]

The vast majority of surgeons participating in the Hip and Knee Registry enrolled THA and TKA patients who received types of thromboprophylaxis that were consistent with the 2001 ACCP recommendations.[7] Interestingly, patients whose surgeons were in practice for < 5 years more frequently received thromboprophylaxis that matched the 2001 ACCP recommendations for THA and TKA patients (94% and 97%, respectively), while this compliance rate dropped to 85% in THA and 91% in TKA for the patients of surgeons who had been in practice for > 5 years. This may be a result of some more experienced
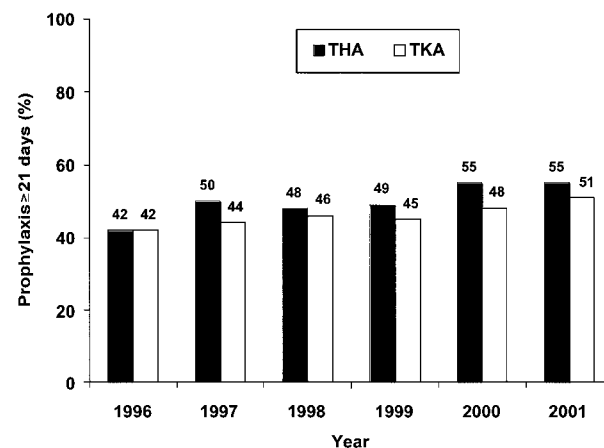

FIGURE 6. Temporal trends in use of prophylaxis for VTE for a period of at least 21 days during the years 1996 to 2001.

surgeons being reluctant to begin using new anticoagulant regimens due to a fear of bleeding, higher cost of the new anticoagulants, or a lack of knowledge of current consensus recommendations for thromboprophylaxis, perhaps due to the increasing challenge of keeping up with the literature that may increase in proportion to the number of years since completion of residency training.[19,20]

It is also interesting that surgeons in academic hospitals tended to use both in-hospital and postdischarge thromboprophylaxis regimens that did not match the 2001 ACCP recommendations[7] in significantly more cases than surgeons in community hospitals. This result contrasts with data from a previous study[11] in a Medicare patient population in the Massachusetts area that showed that more THA patients in academic hospitals received thromboprophylaxis than in nonteaching hospitals. In addition, other studies[8,21] in the same area have shown that patients were more likely to receive thromboprophylaxis in academic hospitals than nonteaching hospitals. A possible hypothesis to explain this is that the community-based surgeons were younger compared to the academic-based surgeons and/or those community-based surgeons with a higher interest in VTE prophylaxis may have been more likely to participate in this registry than those with little interest.

During the period 1996 to 2001, data from the Hip and Knee Registry show that THA and TKA patients stayed in the hospital for progressively shorter periods of time following surgery. However, the disposition of patients following hospital discharge (*eg*, home, rehabilitation hospital, nursing home) remained relatively uniform during this time period.

More than 90% of THA and TKA patients received one or more types of thromboprophylaxis that matched the 2001 ACCP recommendations.[7] Mechanical methods were commonly used for thromboprophylaxis in both THA and TKA patients. A little more than one half of THA and TKA patients received elastic stockings both in the hospital and postdischarge, although this was nearly always done in combination with other modalities. In addition, intermittent compression boots were used in approximately one third of patients in the hospital, and foot pumps were used in nearly one quarter of patients in this setting. Intermittent compression pumps and boots were rarely used in the outpatient setting, probably due to practical and cost considerations. On the whole, these results are not surprising, as the 2001 ACCP guidelines[7] state that the use of elastic stockings or intermittent pneumatic compression as adjuvant prophylaxis may provide additional protection for THA patients, and intermittent pneumatic compression is recommended as an alternative method of thromboprophylaxis in TKA patients. The increasing use of foot compression as VTE prophylaxis is notable because, while this method has been recommended by European consensus panels, it has not been recommended by US consensus panels. Despite the weak evidence of its efficacy, the foot pump was widely used by surgeons in both THA and TKA patients. Foot pumps were more commonly used in TKA than in THA cases, which is surprising because published studies on the efficacy of foot pumps are based on THA, and there are little or no data to support the use of foot pumps in TKA patients.

Of the pharmacologic methods of thromboprophylaxis used, warfarin was most frequently used for both THA and TKA patients, followed by LMWH. The most surprising observation was that 4% of THA patients and 7% of TKA patients received aspirin as thromboprophylaxis in the hospital, and 20% and 21% received aspirin after hospital discharge, respectively, despite the fact that aspirin has been judged to be significantly less effective than either LMWH or warfarin by major consensus panels.[7,22]

Studies[2,8] performed in the late 1980s suggested that surgeons were not using adequate methods of prophylaxis for DVT following major operations, including THA and TKA. Thus, the present study provides encouraging news that > 90% of patients received types of prophylaxis consistent with evidence-based consensus recommendations. Furthermore, the temporal trend in practices is toward increasing use of highly effective types of prophylaxis (Fig 5). While the generalizability of our findings may be limited by the fact that our data were limited to orthopedic surgeons who volunteered to participate in this registry, it is encouraging that other independent studies[9–11] performed within the same time frame have demonstrated substantially similar practices among US orthopedic surgeons.

The 6-year time frame of this study (1996 to 2001) provides a unique opportunity to observe trends in practices among orthopedic surgeons during a time period in which a number of important uncertainties about the best approach to VTE prevention were clarified by publication of well-designed clinical trials. However, while observed trends favor the hypothesis that orthopedic surgeons have, by and large, absorbed the messages of recent clinical trials, the observed temporal associations between changes over time in clinical practices and the publication dates of key trials are at best modest (Figs 3, 5).

Important new findings related to VTE prophylaxis published during the time frame of this study include two studies[23,24] published in 1996 that reported high rates of venographically confirmed thrombosis after hospital discharge and a significant reduction in VTE in response to prolonging VTE prophylaxis for up to 1-month following THA. In our study, there was an increase, from 42% in 1996 to 50% in 1997, in the proportion of THA patients who received VTE prophylaxis for ≥ 21 days. Although to our knowledge there have been no published studies documenting the value of prolonged VTE prophylaxis following TKA, use of longer prophylaxis following TKA increased slightly (from 42 to 44%) during the same time period. These trends continued after 1998. In 2001, slightly more than one half of patients received VTE prophylaxis for ≥ 21 days following THA or TKA, respectively.

On December 15, 1997, the FDA issued a black-box warning of possible increased bleeding risk in patients receiving spinal-epidural anesthesia while receiving LMWH for prevention of VTE.[12] As shown in Figure 3, the proportion of THA patients who received spinal-epidural anesthesia decreased from 35 to 31% between

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1996 and 1997 and then continued to rise steadily after 1998 to 46% in year 2001. Despite the FDA warning, the proportion of patients who received LMWH in combination with spinal-epidural anesthesia for THA or TKA remained fairly constant during the years 1996 and 2001 (Fig 3). While the use of spinal-epidural anesthesia appears to have decreased in 1997, the FDA warning was released too late that year to have had an effect on clinical practice. Use of LMWH prophylaxis in the presence of spinal-epidural anesthesia was not affected by the 1997 FDA warning and continued to increase in proportion to annual increases in the use of spinal-epidural anesthesia during the years 1998 to 2001 (Fig 3).

After the release of the FDA warning, a number of studies were published documenting the low absolute risk of bleeding into the spinal column and pointing out avoidable errors in the timing of the administration of anticoagulants, particularly the importance of careful timing of the removal of spinal catheters. Independent review of all available cases of spinal bleeding reported from hospitals across the United States suggested that avoidable errors were present in virtually every case.[25–28] The publication of evidence-based guidelines for the safe use of spinal catheters in the presence of an anticoagulant[28] may explain the finding that the use of LMWH did not decrease in patients who received spinal-epidural anesthesia. Temporal trends in the period 1997 through 2001 suggest that surgeons and anesthesiologists remained confident that LMWH and spinal-epidural anesthesia can be combined safely provided that evidence-based protocols are followed.

Although no audit was performed to document physician diligence in identifying and reporting adverse events, including VTE and postoperative death, a study by White et al[11] reported a 2.1% rate of VTE over a 3-month period following THA that is similar to the 1 to 2% rate of VTE observed in the present study (Table 1). In addition, White et al[11] observed low rates of postoperative complications in a representative sample of residents of California aged > 65 years who underwent THA, which are similar to those rates found in the present study.[11] Thus, the low rate of postoperative complications presented herein, including low rates of clinically recognized VTE and death, are consistent with independent observations and thus may not be attributable solely to ascertainment bias or unavailability of follow-up.

Several potentially important limitations of the design and performance of this study must be clearly stated and used to caution the interpretation of the findings. Although the study protocol requested either enrollment of consecutive patients or an unbiased sample of patients undergoing THA or TKA in each surgeon's practice, no audit of physician compliance to the study protocol was performed. Nevertheless, it is reassuring that the socioeconomic and demographic characteristics of study patients are similar to those in independent reports on THA/TKA patients in the United States.[29–31] Possible limitations to generalizing the results of the present study to the overall US population include the low proportion of nonwhites and possible variation in the manner of identi-

fying and recording complications. Also, the strength of conclusions from the 3-month follow-up is weakened by the low rate of return of follow-up case report forms (43%). Furthermore, there was no independent method by which to assess physician diligence in identifying and reporting adverse events, particularly VTE and postoperative death.

Conclusions

Recent trends in the management of THA and TKA in the United States, including shorter lengths of acute hospital stay and increased use of spinal or epidural anesthesia, present a challenge to surgeons who wish to provide their patients with effective thromboprophylaxis. Despite these challenges, nearly all surgeons participating in the Hip and Knee Registry are providing types of thromboprophylaxis consistent with evidence-based expert consensus recommendations. Despite recent concerns about an increased bleeding risk due to the use of anticoagulants in patients who receive spinal or epidural anesthesia, orthopedic surgeons participating in the Hip and Knee Registry increased their use of spinal or epidural anesthesia during the years 1996 through 2001. Despite the FDA black-box warning,[12] the proportion of patients with spinal or epidural anesthesia who received anticoagulant prophylaxis also increased during this period.

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