Prophylactic Antithrombotic Therapy for Patients With Systemic Lupus Erythematosus With or Without Antiphospholipid Antibodies

Do the Benefits Outweigh the Risks? A Decision Analysis

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Background: A high incidence of both arterial and venous thromboembolic events has been reported in patients with systemic lupus erythematosus (SLE), but the risks and benefits of primary prophylactic antithrombotic therapy have not been assessed. We measured the clinical benefit of 3 antithrombotic regimens in patients with SLE without antiphospholipid antibodies, with anticardiolipin antibodies, or with lupus anticoagulant.

Methods: A Markov decision analysis was used to evaluate prophylactic aspirin therapy, prophylactic oral anticoagulant therapy, and observation. Input data were obtained by literature review. Clinical practice was simulated in a hypothetical cohort of patients with SLE who had not experienced any previous episode of arterial or venous thromboembolic events. For each strategy, we measured numbers of thromboembolic events prevented and major bleeding episodes induced, and quality-adjusted survival years.

Results: Prophylactic aspirin therapy was the preferred strategy in all settings, the number of prevented thrombotic events exceeding that of induced bleeding episodes. In the baseline analysis (40-year-old patients with SLE), the gain in quality-adjusted survival years achieved by prophylactic aspirin compared with observation ranged from 3 months in patients without antiphospholipid antibodies to 11 months in patients with anticardiolipin antibodies or lupus anticoagulant. Prophylactic oral anticoagulant therapy provided better results than prophylactic aspirin only in patients with lupus anticoagulant and an estimated bleeding risk of 1% per year or less.

Conclusions: Prophylactic aspirin should be given to all patients with SLE to prevent both arterial and venous thrombotic manifestations, especially in patients with antiphospholipid antibodies. In selected patients with lupus anticoagulant and a low bleeding risk, prophylactic oral anticoagulant therapy may provide a higher utility.

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MATERIALS AND METHODS

Decision analysis explicates the logic of a choice among alternative strategies. To analyze a decision, one defines possible strategies, describes plausible and important clinical events associated with each strategy, and specifies the probability of each event. One estimates the value of each possible state of health resulting from each strategy and calculates the average expected value of pursuing each strategy. The axioms of decision analysis dictate that the strategy with the greatest expected value is preferred. We describe the structure of this analysis in general below.

ASSUMPTIONS

The absence of published information required assumptions on several points. These assumptions are listed below.

1. We assumed that the daily dosage of aspirin was 100 to 325 mg. For patients taking oral anticoagulants: (2) we assumed the targeted international normalized ratio to be between 2.0 and 3.0; (3) we considered only the risks of major hemorrhagic events (intracranial, retroperitoneal, or those that resulted in hospital admission or transfusion), some of them leading to death; and (4) we assumed the risk of major bleeding to be constant while patients are receiving anticoagulant therapy, ignoring the potentially higher risk of bleeding at treatment initiation and possible variation of this risk with age (analysis restricted to patients aged 20 to 60 years). (5) For patients receiving oral anticoagulant therapy and surviving a major bleeding event without having previously suffered a thromboembolic event (arterial and/or venous), we assumed that prophylactic oral anticoagulant therapy was discontinued permanently, or (6) for patients recovering from venous and/or arterial embolic events who suffer a nonfatal hemorrhage, that anticoagulant therapy was discontinued for 1 month and then was resumed. (7) Patients sustaining long-term morbidity from an event (eg, arterial embolism) were still subject to the risks of future events (eg, bleeding), and (8) finally, we did not take into consideration long-term morbidity from deep venous thrombosis (the postthrombotic syndrome) and from nonfatal pulmonary embolism (secondary pulmonary arterial hypertension).

DECISION TREE

The choice between the 3 competing strategies is depicted by the square shaded node on the left in Figure 1, A. These strategies include (1) observation, in which prolonged oral anticoagulant therapy is started in patients having suffered and survived a clinically apparent thromboembolic event; (2) prophylactic aspirin, in which aspirin is started before the occurrence of any thromboembolic event and is switched for oral anticoagulants if a thromboembolic event occurs; and (3) prophylactic oral anticoagulant therapy, in which oral anticoagulant therapy is started before the occurrence of any clinically apparent thromboembolic event.

We used a Markov process to model repetitive clinical events beyond the patient’s and physician’s control. In a Markov process, patients move between various health states depending on the chance events modeled in the decision tree and the probability of those events. States of health are long-term (eg, morbidity after systemic embolism), or short-term (eg, discontinuation of anticoagulant therapy after the occurrence of a major bleeding episode). Patients may move from one health state to another with each “tick of the clock” or cycle. In this model, each cycle is 1 month long, to allow switching to another therapy (eg, from prophylactic oral anticoagulant therapy to observation) in case of occurrence of an adverse event. We calculated the average value (expected utility) of each strategy by tracking how much time is spent in each health state and the consequences of being in that health state (eg, quality-adjustment factor). The states are listed in Figure 1, A.

At the beginning of the Markov process, patients are well and are in one of the following states: taking oral anticoagulant therapy (well while taking anticoagulants), taking oral aspirin (well while taking aspirin), or not taking any prophylactic therapy (well without antithrombotics). In each case, 3 groups of events are possible: thromboembolic events (venous and/or arterial), major bleeding events, and death from demographic and morbidity-related causes (Figure 1, B and C). Patients face the risk of these same events during each cycle but at different probabilities, depending on the initial strategy. In each cycle, more than 1 event may occur (eg, long-term morbidity after arterial thromboembolism and long-term morbidity after bleeding). Thus, in each cycle, 1 of the 9 mutually exclusive outcomes will occur, resulting in a new distribution across the health states shown in Figure 1, A.

PROBABILITIES AND RATES USED IN THE ANALYSIS

Table 1 summarizes the rates and probabilities used in the analysis derived from published systematic reviews and meta-analyses. Estimates that could not be derived by an explicit approach were obtained by either individual studies or consensus statements. The range of estimates used in sensitivity analyses are included. (Additional information is available from the authors upon request.)

ANALYSIS OF OUTCOMES

In this analysis, we measured the outcome of each strategy (1) by tracking the number of thromboembolic events prevented and the number of major bleeding events induced in the 3 strategies and (2) in terms of quality-adjusted life years (QALYs). The QALY addresses both longevity and quality of life. As life expectancy is calculated by the Markov process, it is adjusted for the loss of quality experienced by the patient with each strategy. Quality of life is diminished by reducing functional capabilities in both the short and long term. A month spent in the patient’s baseline state of health is assigned 1 full quality-adjusted month, and months in which the patient has morbidity (such as hemiplegia) are given values between 0 and 1. Table 2 lists the baseline long-term quality-of-life adjustments used in the analysis.
thromboembolic events prevented by this option exceeded that of major bleeding episodes induced in all risk scenarios. In addition, the overall number of disabling events (related to hemorrhage and thrombosis) associated with this strategy was smaller than in the other strategies. The number of arterial and venous thromboembolic events prevented by prophylactic oral anticoagulant therapy overwhelmed that of major bleeding events compared with observation, only for patients with a high thrombotic tendency (LA+). However, this option was associated with more disabling events than prophylactic aspirin.

For the clinical scenario of a 40-year-old patient with a low thrombotic tendency (aPLA−), prophylactic aspirin provided the greatest quality-adjusted life expectancy (29 QALYs). This represented an additional 3 months of quality-adjusted survival compared with observation (28.7 QALYs), and 2.5 years compared with prophylactic oral anticoagulant therapy (26.3 QALYs). As expected, when the thrombotic tendency increased, the gain in QALYs provided by prophylactic aspirin increased compared with the observation. For a 40-year-old patient with an intermediate risk of arterial or venous thromboembolism (positive for anticardiolipin antibodies), the expected number of QALYs provided by prophylactic aspirin was 24.6. This represented a gain of 11 months compared with observation (23.7 QALYs), and of 17 months compared with prophylactic oral anticoagulant therapy (23.2 QALYs). Finally, in the setting of high thromboembolic risk (LA+), prophylactic aspirin–related survival was 21.7 QALYs, representing a gain of 11 months compared with observation (20.8 QALYs),
and 9 months compared with prophylactic oral anticoagulant therapy (21 QALYs).

**SENSITIVITY ANALYSIS**

The previously described results depend largely on the baseline values used in the model, but estimates of these variables vary in the published literature. After sensitivity analyses were performed on all variables in the model, 3 critical variables emerged, in addition to the venous and/or arterial embolic risk profile: the incidence of treatment-related complications (major bleeding), treatment efficacy, and patient age. In patients with a high thrombotic tendency (LA+), prophylactic oral anticoagulant therapy became the preferred strategy when the rate of major hemorrhage was below 1% per year, or when the efficacy of oral anticoagulant therapy in preventing thromboembolism was above 51% (“threshold” values). Table 3 depicts the threshold values of these 2 variables in different clinical settings. Table 4 represents the gain in QALYs achieved by prophylactic aspirin therapy compared with observation for different age groups. Primary prophylaxis with aspirin remained the preferred strategy over the whole range from 20 to 60 years of age.

The effect of varying 2 variables simultaneously (2-way sensitivity analysis) can be assessed. Figure 3 and Figure 4 represent 2-way sensitivity analyses. In Figure 3 the horizontal axis represents the rate of thromboembolic events, whereas the vertical axis represents efficacy of aspirin. In Figure 4 the horizontal axis represents the rate of major bleeding with aspirin, whereas the vertical axis represents efficacy of aspirin. Thus, any point in these graphs represents a specific pair of values for different rate of thromboembolism (Figure 3) or aspirin-related complications (Figure 4) and for different treatment efficacy (vertical axis). For combinations falling in the upper left region (low rate of complications and high efficacy), prophylaxis with aspirin becomes the preferred treatment strategy.
efficacy), prophylactic aspirin therapy is preferred to observation. On the opposite, for values falling toward the lower right region (high rate of complications and low efficacy), the observation strategy is preferred. All points falling on one of the lines yielded the same QALYs for the 2 strategies.

**COMMENT**

The benefit of primary prophylaxis with aspirin outweighs its risks in patients with SLE. This benefit is proportional to the thrombotic tendency, becomes quite substantial in patients with a high thrombotic tendency (LA+) and a low bleeding risk. The latter (≤1% per year) has only been approached in the setting of some anticoagulant clinics and in patient groups that might differ from those with SLE. Thus, a 20-year-old LA+ patient without comorbidity might be a good candidate for oral anticoagulant therapy. Moreover, the advantage of this option might be further increased by reducing the international normalized ratio to 1.5 to 2.0. However, there are insufficient data to support the latter recommendation at the present time.

Our results favor primary antithrombotic prophylaxis (aspirin or oral anticoagulants), despite the fact that we consistently biased our analysis against these 2 strategies. Specifically, we underestimated the efficacy of both aspirin and oral anticoagulants and used rather high estimates for the bleeding risks. However, these figures may, over time, underestimate the bleeding risks, especially that of oral anticoagulant therapy, because patients with SLE may have multiple medications and comorbidities that may increase the hemorrhagic tendency. Moreover, this risk has to be viewed in the perspective of a long-term treatment.

These results are important in daily practice because of the uncertainty of physicians in charge of these patients. Indeed, current therapeutic approaches are based mainly on clinicians’ best judgment. Of course, our analysis cannot replace longitudinal trials and certainly should not be used as a formal guideline. However, clinical studies designed to assess the risk of thromboembolic complications and the efficacy of various treatments in asymptomatic patients will probably not be available in the near future. In the meantime, our model may represent a useful tool for clinicians to facilitate decision making. Given the reported prevalence of SLE or SLE-like disease in the United States (40 to 50 cases per 100,000 persons), around 240,000 Americans have suspected or definite SLE and might benefit from prophylaxis if they have not experienced previous thrombotic events. The low cost of aspirin prevented us from performing a formal cost-effectiveness analysis. However, it can be anticipated that such a strategy would even be cost-saving because of the high costs induced by thromboembolic complications.

The limitations of our study also warrant comments. First, the efficacy of aspirin has not been established in the setting of SLE, and our estimates were obtained from randomized trials and overviews in general medical patients. However, we performed sensitivity analyses in which efficacy was varied over wide ranges, which did not affect the ranking of strategies. Second, our classification of the thrombotic risk relying on the presence of anticardiolipin antibodies and LA does not take into consideration more refined patient characteristics, such as prothrombin or β₂-glycoprotein I binding.

![Figure 2. Balance between the number of embolic events prevented and bleeding events induced by different types of prophylaxis compared with observation during a 5-year period. ATE indicates arterial thromboembolic events; VTE, venous thromboembolic events; aPLA−, patients without antiphospholipid antibodies; aCL+, patients with anticardiolipin antibodies; and LA+, patients with lupus anticoagulant.](http://archinte.jamanetwork.com/pdfaccess.ashx?url=/data/journals/intemed/11967/)

| Table 3. Threshold Values of Variables Affecting the Choice Among Treatment Strategies* |
|---------------------------------|-----------------|-----------------|-----------------|
| **Strategy**                     | **Variable**     | **Lupus Anticoagulant, %** | **Anticardiolipin Antibodies, %** | **Patients Without aPLA, %** |
| Observation vs prophylactic aspirin | Rate of bleeding (aspirin) | 2.3 | 1.5 | 0.4 |
|                                  | Efficacy (aspirin) | 3.0 | 3.7 | 16.0 |
| Observation vs prophylactic OAC  | Rate of bleeding (OAC) | 3.0 | 1.9 | 0.5 |
|                                  | Efficacy (OAC)    | 29.0 | 47.0 | NT |
| Prophylactic aspirin vs prophylactic OAC | Rate of bleeding (OAC) | 1.0 | 0.8 | 0.4 |
|                                  | Rate of bleeding (aspirin) | 1.9 | 2.2 | 2.6 |
|                                  | Efficacy (OAC)    | 51.0 | 67.0 | NT |
|                                  | Efficacy (aspirin) | 7.0 | NT | NT |

*aPLA indicates antiphospholipid antibodies; OAC, oral anticoagulation; and NT, no threshold.*
antibodies,\textsuperscript{4,5,34} associated inherited thrombophilia,\textsuperscript{8,35} or evidence of a prothrombotic state as assessed by activation markers such as abnormal levels of prothrombin fragment \(1+2\).\textsuperscript{3} Third, comorbidities that are frequent in SLE may influence both thrombotic and hemorrhagic risks; for example, concomitant use of nonsteroidal anti-inflammatory drugs may potentiate gastrointestinal tract side effects of aspirin.\textsuperscript{36,37} Conversely, a highly inflammatory state might increase the thromboembolic risk.

In conclusion, SLE is a complex disease with a wide spectrum of thrombotic and hemorrhagic tendency. Our decision analysis model handles part of this complexity and suggests that primary prophylaxis with aspirin is beneficial to all patients with SLE who have not yet experienced any thrombotic event. Under special circumstances, prophylactic oral anticoagulant therapy might provide a higher benefit. Ideally, this hypothesis should be confirmed in randomized controlled trials, which, however, would be difficult to set up because of the complexity of the issues.

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\begin{table}[h]
\centering
\caption{Quality-Adjusted Survival Gains Provided by Prophylactic Aspirin Compared With Observation in Patients With Low (Patients Without aPLA), Intermediate (Patients With aCt), and High (Patients With LA) Thrombotic Tendency*}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Clinical Setting & Age at Treatment Initiation, y & 20 & 30 & 40 & 50 & 60 \\
\hline
Patients without aPLA & 6.4 & 4.7 & 3.0 & 2.1 & 1.1 & \\
Patients with aCt & 14.7 & 12.6 & 11.0 & 7.5 & 4.9 & \\
Patients with LA & 14.0 & 12.7 & 11.0 & 8.6 & 6.0 & \\
\hline
\end{tabular}
\* Quality-adjusted survival gains are given in months. aPLA indicates antiphospholipid antibodies; aCt, anticardiolipin antibodies; and LA, lupus anticoagulant.
\end{table}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3}
\caption{Two-way sensitivity analysis showing the threshold curve between observation and prophylactic aspirin. The horizontal axis represents the rate of major bleeding, and the vertical axis, efficacy of aspirin. For values below the curve, observation is the preferred strategy; for example, a patient with a 4% annual rate of arterial or venous thromboembolism will benefit from prophylactic aspirin if treatment efficacy is 5%. Conversely, a patient with a 1% annual rate of arterial or venous thromboembolism will achieve greater benefit with observation if treatment efficacy is 20%.}
\end{figure}

\begin{figure}[h]
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\includegraphics[width=\textwidth]{figure4}
\caption{Two-way sensitivity analysis showing several threshold curves between observation and prophylactic aspirin therapy. The horizontal axis represents the rate of major bleeding, and the vertical axis, efficacy of aspirin. For values below each curve (patients with lupus anticoagulant [LA+], or anticardiolipin antibodies [aCL+] or patients without antiphospholipid antibodies [aPLA+]), observation is the preferred strategy.}
\end{figure}

\begin{thebibliography}{1}
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\end{thebibliography}


