Prophylactic Anticoagulation in Nephrotic Syndrome: A Clinical Conundrum

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ABSTRACT

It has long been recognized that nephrotic syndrome is associated with an increased risk for thromboembolic complications, including deep venous thrombosis, renal vein thrombosis, and pulmonary embolism. This risk varies with the nature of the underlying disease and seems to be greatest for membranous nephropathy. Other factors, including the level of serum albumin, previous thromboembolic episodes, and a genetically determined predisposition to thrombosis, may also be involved. Prevention of thromboembolic events with oral anticoagulants in nephrotic syndrome requires a careful case-by-case analysis of the risks for thromboembolic events balanced by the risks for anticoagulant induced bleeding. Markov-based decision analysis using literature-based assumptions regarding these risks has suggested that prophylactic anticoagulants may be indicated in certain circumstances. Such decisions need to take into account the nature of the underlying disease, the severity of the nephrotic syndrome (as assessed by serum albumin concentration), preexisting thrombophilic states, and the overall likelihood of serious bleeding events consequent to oral anticoagulation (as assessed by the international normalized ratio for prothrombin time). The optimal duration of prophylactic anticoagulation is unknown but very likely extends to the duration of the nephrotic state per se.

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Richard J. Glassock

Little doubt exists that certain forms of renal disease are associated with an increased risk for thrombosis or embolism (“thrombophilia”) compared with the general population.1,2 Most noteworthy among these disorders are the various forms of primary and secondary nephrotic syndrome,1,2 systemic lupus erythematosus with “lupus anticoagulant”,3 granulomatous vasculitis (Wegener’s granulomatosis),4 and Behçet syndrome.5 In the recent past, the greatest attention to thromboembolic risk and its management has been given to the nephrotic syndrome. Among the numerous causes of the nephrotic syndrome, only a relatively few conditions are consistently associated with a decidedly increased risk for thromboembolism; these include membranous nephropathy (primary and secondary), membranoproliferative glomerulonephritis, minimal-change disease, and perhaps renal amyloidosis.1,6 However, the reported risk for thromboembolism in these disorders varies widely, depending in part on how the cases were ascertained, how the diagnosis of a thrombotic event was established, or what the severity of the nephrotic state per se was. Both venous and systemic or pulmonary arterial thrombosis have been noted to occur with increased frequency in nephrotic syndrome.1,7 Among the venous thromboses associated with nephrotic syndrome, both acute and chronic renal vein thrombosis (RVT) and deep venous thrombosis (DVT) of the lower extremities may develop (separately or together), both of which may be associated with pulmonary embolism.1,8–11 DVT is said to develop in approximately 15% of patients with the nephrotic syndrome, either with or without an accompanying RVT.12 RVT, unilateral or bilateral, has been reported to develop in approximately 25 to 30% of patients with the nephrotic syndrome as a result of primary renal disease, with the greatest risk seen in membranous glomerulonephritis (37%), membranoproliferative glomerulonephritis (26%), and minimal-change disease (24%).1,8–11 The com-
The combined burden of DVT and RVT in patients with membranous nephropathy and the nephrotic syndrome has been estimated to be as high as 45% in some reports. The risk for DVT and/or RVT seems to be higher when the serum albumin concentration is <2.0 to 2.5 g/dl. For example, Bellomo and Atkins found venous thromboembolic events to occur in 40% of patients with membranous nephropathy and nephrotic syndrome with a serum albumin concentration of <2.5 g/dl but only 2.7% in those with a serum albumin concentration of >2.5 g/dl. The reported development of DVT and/or RVT among nephrotic renal diseases varies widely. In cross-sectional studies of membranous nephropathy, the reported risk for RVT has ranged from 1.9 to 60%.

To some extent, this extreme variation is the result of differing methods to establish the diagnosis of RVT and gradations in the severity of the underlying disease. In many cases, the RVT is asymptomatic and discovered only upon “routine” screening studies or diagnosed after a thromboembolic event. Ventilation-perfusion lung abnormalities that are suggestive of pulmonary embolism (or in situ thrombosis) can be found in 10% of asymptomatic patients without RVT or DVT and in approximately 20% of those with RVT alone accompanying nephrotic syndrome. Higher values for pulmonary embolism (or in situ thrombosis in nephrotic syndrome have been reported when pulmonary angiography is used for diagnosis. Thus, general agreement exists that nephrotic syndrome, especially as a result of membranous nephropathy, membranoproliferative glomerulonephritis, and minimal-change disease, is a risk factor for thromboembolic disease, although the precise level of this risk is not fully agreed on. A very low serum albumin level seems to be a surrogate measure of increased risk, but thromboembolism can occur even when serum albumin is only modestly reduced.

The underlying mechanisms of the “thrombophilia” of the nephrotic syndrome are multiple but seem to related to an imbalance of prothrombotic factors (e.g., increased fibrinogen levels, increased factor VIII levels, increased platelet adhesiveness) and antithrombotic factors (e.g., reduced antithrombin III levels, reduced protein C and S levels or activity) and impaired thrombolytic activity (decreased plasminogen levels, elevated plasminogen activator inhibitor-1 levels or albumin deficiency–related impairment of the interaction of plasminogen–fibrin). Volume depletion, diuretic and/or steroid therapy, venous stasis, immobilization, or immune complex activation of the clotting cascade may also participate in the “thrombophilia” of the nephrotic syndrome. It remains a mystery why only certain conditions have such a strong (but variable) association with RVT. The recent discovery of the association of anti-enolase autoantibodies with membranous nephropathy offers a tantalizing clue, because these autoantibodies could interfere with fibrinolysis. The coexistence of another “thrombophilic” state, such as hereditary resistance to the activation of protein C (Leiden trait), with nephrotic syndrome could be another factor involved in the generation of thrombotic events in selected patients.

The treatment of overt thrombotic or embolic events in patients with nephrotic syndrome is relatively straightforward. Anticoagulation with sequential high or low molecular weight heparin and oral warfarin is the recommended therapy with the greatest experience. The duration of treatment needed to prevent recurrent events is unknown but is probably equal to the duration of the nephrotic state per se. “Breakthrough” thrombosis in anticoagulated patients is distinctly uncommon.

Prophylactic oral anticoagulation of asymptomatic patients who have nephrotic syndrome and are believed to be at elevated risk for a thromboembolic event is another matter altogether. The issue of prophylactic anticoagulation in nephrotic syndrome, such as caused by membranous nephropathy, is complicated further by suggestions that asymptomatic patients who are thought to be “at risk” for RVT should be routinely screened for covert RVT, using spiral computed tomography (CT), and then anticoagulated for secondary prophylaxis of a pulmonary embolic event if the test is positive. The sensitivity and specificity of CT for the diagnosis of covert RVT is 90 and 100%, respectively, using renal venous angiography as the gold standard. Magnetic resonance angiography may also be useful, but this technique has not been as well studied as CT. Doppler ultrasonography has test characteristics (high false positive [40%] and false negative [15%] rates) that make it less desirable as a screening tool. A major weakness of uncritical advocacy for routine screening for DVT is that a negative test does not predict whether (or when) a negative study is likely to convert to a positive study. Furthermore, the risk for developing an overt pulmonary embolus in an untreated patient with a covert RVT detected by “screening” is not well understood. Some studies have suggested that the risk for a pulmonary embolus is approximately twice as high with the presence of covert chronic RVT (20%) compared with its absence (10%), but long-term prospective studies are lacking. Clinical clues (other than an overt thromboembolic episode in the absence of an obvious DVT) for the presence of an occult RVT are relatively few but include ipsilateral renal enlargement, pelvicaliceal abnormalities, and ureteric notching from collateral veins as determined by intravenous urography. A renal biopsy with prominent leukocyte margination (stasis) in the glomerular capillaries and interstitial edema may also suggest RVT. Chronic RVT is most often asymptomatic, whereas acute RVT may produce flank pain and hematuria. Therefore, it remains uncertain whether routine screening for RVT (with CT scanning) is needed in asymptomatic patients with nephrotic syndrome, although a case might be made for this approach in patients who are at high risk, such as patients with membranous glomerulonephritis and severe nephrotic syndrome with a serum albumin level of <2.0 to 2.5 g/dl. A positive study (expected in between 2 and 60% of patients, averaging approximately 30%) would be a possible indication for anticoagulation, depend-
ing on the risks for bleeding or other con-
traindications to anticoagulation (e.g., a
central nervous system lesion). A nega-
tive study would be unhelpful with a de-
cision to anticoagulate, because the pa-
tient could subsequently develop an
asymptomatic RVT or DVT. It is appar-
ent that routine screening for covert RVT
is not considered standard of practice be-
cause this has not been a requirement for
admission to randomized, controlled tri-
als of nephrotic syndrome, including
membranous glomerulonephritis.

The excess “burden” of thrombosis that
is seen in nephrotic syndrome (par-
ticularly in membranous nephropathy)
may contribute to the morbidity and
mortality of this condition. For example,
Bellomo and Atkins\textsuperscript{12} found a yearly
mortality rate from thromboembolism
of approximately 10% in membranous
nephropathy. These events tended to oc-
cur “early” (within the 6 mo) after diag-
nosis.\textsuperscript{12} It is noteworthy that a much
lower rate of thromboembolism has been
observed in randomized therapeutic
trials in idiopathic membranous
nephropathy. A survey of all such trials re-
ported between 1979 and 2001 revealed
an extraordinarily low rate of thrombo-
embolism (one case in \( >500 \) randomly
assigned patients who were followed for
\( >2000 \) patient-years).\textsuperscript{23–29} Subtle selec-
tion forces operating at the enrollment
level may have contributed to this find-
ing. Natural history studies of untreated
patients have also noted a low prevalence
of thromboembolism in membranous
nephropathy.\textsuperscript{30}

What, then, should be the position of a
nephrologist who is confronted with a
patient who has nephrotic syndrome
with no overt symptoms or signs sug-
gestive of a thromboembolic disorder with
respect to the initiation of prophylactic
oral anticoagulation? Unfortunately, no
randomized, controlled trials have been
conducted to provide evidence to guide
and inform this decision-making pro-
cess. What does exist are analyses of hy-
pothetical scenarios using Markov mod-
eling and decision analysis, which uses
assumptions (estimated from the litera-
ture) regarding the risk and benefit of
such prophylactic oral anticoagulation in
patients with nephrotic syndrome (most
often with membranous nephropathy as
the underlying disorder). Sarasin and
Schifferli\textsuperscript{31} reported on such an analysis
in 1994. They assumed an incidence of
RVT of 0.5% per month of observation.
For DVT, they assumed an incidence of
1% per month for acute symptomatic
disease. They assumed that a pulmonary
embolus would occur in 30% of patients
with RVT and in 50% of patients with
DVT. These assumptions may be some-
what higher than the true risk, which is
not very well known. They are also much
higher than the observed rate of pulmo-
nary embolism in patients with membra-
nous nephropathy enrolled in random-
ized clinical trials of therapy of
membranous nephropathy cited previ-
ously. The risk for hemorrhagic compli-
cations of oral anticoagulation was
defined to range between 0.05 and 1.4%
per month depending on the presence of
other risk factors, such as advanced age,
history of stroke or gastrointestinal
bleeding, or other serious comorbidity.
These values have been extrapolated
from patients who have received oral an-
ticoagulation for nonrenal indications.

More recent studies have suggested that
the risk for serious bleeding complica-
tions from oral (warfarin) anticoagula-
tion has been decreasing but remains
higher in the elderly (10.5 events/100 pa-
tient-years) compared with younger pa-
tients (6.0 events/100 patient-years).\textsuperscript{32}

Hemorrhagic events are also associated
with the intensity of oral anticoagulation
(as assessed by the international normal-
ized ratio [INR] for prothrombin time).
Hemorrhagic events are infrequent when
the INR is well maintained within a rec-
ommended “therapeutic” range (4.8/100
patient-years for an INR of 2.0 to 2.9) but
increase substantially when the INR in-
creases above the “therapeutic” range
(9.5/100 patient-years for an INR of 3.0
to 4.4 and \( >40/100 \) patient-years for INR
\( >4.4 \)).\textsuperscript{32} A therapeutic target of an INR
between 1.8 and 2.0 has been suggested as
optimal for prevention of recurrent
DVT.\textsuperscript{12}

Using these assumptions and a
Markov-based decision analysis model
incorporating utilities (morbidity and
mortality), Sarasin and Schifferli\textsuperscript{31} con-
cluded that a policy of routine prophy-
latric oral anticoagulation of patients with
the nephrotic syndrome as a result of id-
iopathic membranous glomerulonephri-
tis would result in a gain of 2.5 mo of
quality-adjusted life expectancy for a 50-
year-old patient who remained on antico-
agulation for 2 yr. However, observation
without anticoagulation would be pre-
ferred if the risk for venous thrombosis
were a factor of two times lower than the
estimates and/or the risk for bleeding
were twice that assumed. Obviously
these analyses do not apply to secondary
membranous glomerulonephritis (e.g.,
malignancy related, lupus membranous
glomerulonephritis related), to other
forms of glomerular disease associated
with the nephrotic syndrome, to patients
with a history of thromboembolism, or
to patients with a genetic disorder that
predisposes to thrombosis (e.g., the Lei-
den trait). Sarasin and Schifferli\textsuperscript{31} also
noted that patients with nephrotic syn-
drome other than that as a result of
membranous glomerulonephritis have
risk levels of thrombosis that yield differ-
ent results on Markov decision analysis
much closer to a “toss up” and much
more sensitive to minor changes in the
underlying assumptions. A somewhat
similar decision analysis was conducted
by Bellomo and Atkins\textsuperscript{12} in 1993. They
assumed that hemorrhagic complica-
tions from oral anticoagulation (at INR
levels of approximately 2.0) would occur
at a rate of approximately 17 per 100 pa-
tient-years (approximately three times
higher than rates currently observed)
and that the combined risk for thrombo-
embolic events was approximately 40%.
The further assumed that “break-
through” thromboembolism would oc-
cur in approximately 10% of patients
who are anticoagulated. Using these as-
sumptions, they estimated that 54 mor-
bid events would occur per 100 patient-
years (40 thromboembolic events
requiring therapeutic anticoagulation,
11 hemorrhagic events, and three
“breakthrough” thromboembolic events
in anticoagulated patients) in a strategy
involving therapeutic anticoagulation af-
ter a thromboembolic event had tran-
spired. Using similar estimates, they estimated that 37 morbid events per 100 patient-years (26 hemorrhagic events and 10 breakthrough thromboembolic events in anticoagulated patients) in a strategy involving routine prophylactic anticoagulation. Thus, the rate of morbid events is 32% lower with a prophylactic rather than a therapeutic strategy using these estimates. A “sensitivity” analysis was not conducted to determine what level of assumptions (risk for thrombosis and risk for hemorrhagic complications from anticoagulation) would generate a toss-up decision between the therapeutic and prophylactic strategies, but if the theoretical risk for thromboembolism is half that used in this analysis, then the “benefit” of a prophylactic compared with a therapeutic strategy is nullified. Despite repeated calls for a randomized clinical trial of prophylactic anticoagulation to validate or deny the conclusions derived from decision analyses, none has yet been conducted. A possible argument against “routine” prophylactic anticoagulants in idiopathic membranous nephropathy is that none of the randomized therapeutic trials in membranous nephropathy reported between 1979 and 2001 required that enrolled patients be routinely treated with prophylactic anticoagulants.23–28 Because ethical considerations demand that participants in such trials receive standard of care, one would have to conclude that prophylactic anticoagulation of patients with membranous nephropathy (and by inference other patients with nephrotic syndrome) has not yet reached a uniform level of standard of care.

This does not mean that prophylactic anticoagulants are not indicated in management. Patients who have severe nephrotic syndrome, regardless of underlying cause, and a history of a thromboembolic event (a DVT or a pulmonary embolus) should be offered prophylactic anticoagulants if no contraindications exist. Patients with severe nephrotic syndrome (serum albumin <2.0 to 2.5 g/dl) should also be considered candidates for prophylactic anticoagulation if they have other risk factors for thrombosis (e.g., congestive heart failure; prolonged immobilization; morbid obesity; abdominal, orthopedic, or gynecologic surgery). Patients with a family history of “thrombophilia” (who might have a genetic predisposition to thrombosis) might also be considered for prophylactic therapy. The utility of screening for such genetic causes of thrombophilia has not been tested in a cohort of patients with the nephrotic syndrome. The value of prophylactic aspirin therapy has also not been rigorously tested in nephrotic syndrome.

The decision to screen (with CT) asymptomatic patients with nephrotic syndrome for covert RVT should be undertaken with caution. A clearly positive test will mandate anticoagulation for secondary prophylaxis of a pulmonary embolus, and there are no randomized, controlled trials to suggest that this “screen and treat” strategy is both safe and effective. A negative study is not helpful with respect to the decision to recommend prophylactic anticoagulation. Personally, I find little reason to recommend routine screening for RVT in patients with the nephrotic syndrome. Studying patients with nephrotic syndrome and overt DVT or pulmonary emboli for occult RVT seems to me to be very unnecessary because anticoagulation will be offered to the patient irrespective of the findings. In my inspection of the relevant literature, I can also find no justification for prolonged prophylactic anticoagulation for patients with unilateral or bilateral covert chronic RVT discovered by screening to improve the nephrotic syndrome or to slow the rate of progression to ESRD. No evidence exists that anticoagulation has any clear-cut beneficial effects on these parameters.

In summary, a “selective” or individualized rather than a “routine” approach to prophylactic anticoagulation seems justified in nephrotic syndrome. A case can be made for prophylactic anticoagulation in patients with severe nephrotic syndrome (serum albumin concentration <2.0 to 2.5 g/dl) as a result of membranous nephropathy when no contraindication to the use of long-term warfarin anticoagulation exists. It is unclear whether a “cutoff” of an albumin concentration of <2.0 or 2.5 g/dl is most appropriate. The INR during maintenance therapy should be targeted to 1.8 to 2.0, and the treatment should be continued for as long as the patient is nephrotic (unless, of course, a serious hemorrhagic event ensues). The desirability of prophylactic anticoagulation of an individual patient would be enhanced if a history of a thromboembolic event is obtained or if other factors that favor thrombosis are identified. Screening for genetic causes of thrombophilia might be indicated if a family history of recurrent thrombosis is present, but the value of this approach and its cost-effectiveness have not yet been evaluated in the nephrotic syndrome. However, the clinical conundrum that is the subject of this clinical commentary can be truly resolved only by a properly designed randomized clinical trial. I can only echo the numerous calls for this conundrum-resolving exercise, none of which has been heeded to date.

DISCLOSURES
None.

REFERENCES