ORIGINAL ARTICLE

The management of deep vein thrombosis: the Autar DVT risk assessment scale re-visited

Ricky Autar

Deep vein thrombosis (DVT) is a precursor of potentially fatal pulmonary embolism (PE). The Autar DVT scale (1994) was developed to assess patient risk and enable the application of the most effective prophylaxis. The scale is composed of seven categories of risk factors derived from Virchow's triad. The DVT scale was re-evaluated on 150 patients across three distinct clinical specialities to allow for generalisation of the findings. Five reproducibility studies achieved total percentage agreement of between 91 and 98%, κ values within 0.88–0.95 and intra-class correlation coefficients of 0.94–0.99, confirming the consistency of the instrument. A receiver operating characteristic (ROC) curve was constructed to determine the optimal predictive accuracy of the scale and a cut-off score of 11 yielded approximately 70% sensitivity. Partially completed data from two patients were excluded from the sensitivity analysis of the DVT scale. Out of the 148 (78%) 115 patients were correctly predicted. However, the predictive accuracy of the DVT scale was partially masked by the 50% of patients who were recipient of some proven venous thromboprophylaxis.

Editor's comment
The risk of thromboembolism in orthopaedic patients continues to be significant. This study adds to the evidence supporting the efficacy of risk assessment tools and in particular the Autar DVT risk assessment chart. In such a complex area as thromboprophylaxis, evidence about the nature and specifics of risk assessment is never going to be conclusive and completely trustworthy. However, this work adds positively to previous research.

PD

KEY WORDS: deep vein thrombosis, risk assessment, thromboprophylaxis, thromboembolism

Ricky Autar
PhD, MSc, BA(Hons) RGN, RMN, Dip N, RNT, Cert ED
Principal Lecturer, De Montfort University, Leicester, UK.

Correspondence to:
Ricky Autar
Principal Lecturer,
De Montfort University,
School of Nursing and Midwifery, Charles Frears Campus, 266, London Road, Leicester LE2 1RQ, UK.
Tel.: +116-201-3945;
E-mail: rautar@dmu.ac.uk

INTRODUCTION

Deep vein thrombosis (DVT) is a silent killer (Autar 1996a). It is a serious threat to recovery from surgery and is the third most common vascular disease, after ischaemic heart disease and stroke (Anands et al. 1998, Turpie 1997). Data from epidemiological studies suggests that the annual frequency of DVT in the general population is approximately 160 per 100,000 (Anderson et al. 1991, Linblad et al. 1991, Nordstrom et al. 1992). DVT crosses all clinical specialities (Table 1). DVT is mostly preventable and national and international consensus groups on venous thromboprophylaxis (International Consensus Statement 1997, 2001, NIH 1986, THRiFT 1992, 1998) have all recommended that hospital patients should be assessed for clinical risk factors and an overall risk of thromboembolism. Patients should then receive prophylaxis according to their risk categories.

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Table 1 Risk level by patient group (International Consensus Statement 1997)

Speciality	Incidence of DVT (weighted mean) %
General surgery	25
Orthopaedic surgery	45–51
Urology	9–32
Gynaecological surgery	14–22
Neurosurgery including strokes	22–56
Multiple trauma	50
General medical	17

The Autar DVT scale (1994, 1996b) was developed to proactively identify patients at risk, so that the recommended prophylaxis could be promptly initiated. Developed through an action research process and founded on Virchow's triad of risk factors in the genesis of DVT, the Autar DVT scale (1994) comprised seven subscales (Figure 1).

BACKGROUND

The original DVT scale was developed and tested on a trauma/orthopaedic unit for its consistency, predictive validity and practical utility. The scale and a postal questionnaire were used for data collection on 21 patients. DVT risk scale was used by paired registered nurses to independently

Name:

Unit No:

Ward:

Age:

Type of admission:

Diagnosis

AGE SPECIFIC GROUP (years) — **score**

10-30	0
31-40	1
41-50	2
51-60	3
61+	4

BUILD / BODY MASS INDEX (BMI)
Wt(kg/ Ht (m)^2

Build	BMI	score
Underweight	16-18	0
Average/ Desirable	20-25	1
Overweight	26-30	2
Obese	31-40	3
Very obese (morbid)	41+	4

MOBILITY — **score**

Ambulant	0
Limited (uses aids, self)	1
Very limited (needs helps)	2
Chair bound	3
Complete bed rest	4

SPECIAL RISK CATEGORY — **score**
Oral Contraceptives:

20-35 years	1
35+ years	2
Pregnancy/ Puerperium	3

TRAUMA RISK CATEGORY

Score item(s) ***only preoperatively***. — **score**

Head injury	1
Chest injury	1
Spinal injury	2
Pelvic injury	3
Lower limb injury	4

SURGICAL INTERVENTION: *Score only one appropriate surgical intervention*. — **score**

Minor surgery < 30 mins	1
Planned major surgery	2
Emergency major surgery	3
Thoracic	3
Abdominal	3
Urological	3
Neurosurgical	3
Orthopaedic (below waist)	4

HIGH RISK DISEASES: *Score the appropriate item(s)* — **score**

Ulcerative colitis	1
Anaemia: Sickle Cell	2
Haemolytic	2
Polycythaemia	2
Chronic heart disease	3
Myocardial infarction	4
Malignancy	5
Varicose veins	6
Cerebrovascular accident	6
Previous DVT	7

ASSESSMENT PROTOCOL

Score range	Risk Categories
≤ 6	No risk
7-10	Low risk
11-14	Moderate risk
≥ 15	High risk

SCORING:
Identify appropriate items, add and record below:
Assessor
Date
Score

Fig. 1 Autar DVT risk assessment scale (1994).

record for seven consecutive days the risk of each of the 21 patients. A correlation coefficient (r) achieved a value of 0.94 confirming the consistency of the DVT risk calculator. Most patients assessed for DVT risk fell in the high risk category and choosing a cut-off score of 16, the DVT scale achieved 100% sensitivity and 81% specificity. Overall, 83% of the patients were correctly classified. However, despite the promising results recorded, the study was limited in its ability to generalise findings and represent a population in diverse clinical specialities.

The objectives of the study were to re-evaluate the DVT risk scale as a predictive index in diverse clinical areas and review its practical application.

METHODS

This study is essentially quantitative and longitudinal. DVT is a continuing problem and risk persists long after discharge home (Scurr et al. 1988, Scurr 1990). Patients studied were therefore followed up for DVT for a minimum period of three months. Wasson et al. (1985) recommend that instruments be tested in more than one setting to eliminate unusual, practice-specific relationships between the predictor, DVT scale, and the outcome, end point DVT. For this reason, the orthopaedic, medical, and surgical specialities with varying levels of risk by patient group (Table 1) were targeted. The Autar DVT scale was originally designed to have universal application.

The goal of this study was to obtain a large enough sample to show statistical significance, yet be expedient and economical at the same time.

To calculate the power and sample size, a priori analysis was undertaken, using the computer software G*Power programme (Erdfelder et al. 1996) and selecting Cramer's V statistic to determine the power of χ^2. Choosing the conventional alpha input of 0.05, a minimum considered acceptable power $(1-\beta)$ of 0.80 as default, G*Power calculated a sample of 149 patients were required for the study.

Fifty patients were recruited from each of the three clinical specialities, irrespective of gender. Gender as a predictor of DVT is not a significant factor (Coon 1976, Nordstrom et al. 1992). Any gender-related risk would originate from additional risk factors such as oral contraceptive, hormone replacement therapy, pregnancy, and puerperium.

Data were collected by nurses on the ward to which the patient was admitted. The pairing of nurses allowed for the calculation of a kappa statistic to evaluate the consistency of the risk calculator with respect to inter-rater reliability. Every effort was made to ensure that the sample was representative of the clinical population. The occurrence of DVT was fairly homogenous within the population at large. This homogeneity added weight to the claim of generalisability. If the individual subjects are very much alike in all variables, a smaller sample suffices (Crookes & Davies 1998). There was little variability in the characteristics of the populations. The fifty subjects on the trauma/orthopaedic wards were prototypical of subjects with hip fractures, as cardiovascular disorders were to those on the medical wards (Clagett et al. 1992). Most of the patients on the surgical ward had undergone major abdominal surgery.

Patients exhibited a wide variability of DVT risk scores, ranging from the very highest score of 27 to the lower of 1 for the no risk category. Variability was evident in the sample representation of the various risk categories (Table 2).

All patients recruited to the study had to be risk assessed within 24 h of admission. The choice of 24 h admission was considered timely for optimum predictive accuracy when patients were very dependent due to their acute clinical condition or surgical intervention with accompanying fibrinolytic shutdown (Kakkar & Stringer 1990, Merli & Martinez 1987). Fibrinolytic shutdown is an acute reaction syndrome, favouring thrombi formation (Marsh 1981). Thrombi of clinically significant proportion are present as early as the first 24 h of admission (Brown & Neuman 1995). In trauma and orthopaedic patients DVT often occurs preoperatively (Roberts et al. 1990). Therefore, DVT risk assessment should be undertaken as early as possible and for those patients who would be having surgery within the 24 h deadline, they would be risk assessed immediately on their return from theatre. In the immediate postoperative period, both hypercoaguable state and stasis are at their peak (Nicolaides 1990). All patients admitted primarily for treatment of acute DVT were excluded from the sample.

Two data collection tools were applied to re-evaluate the Autar DVT scale. The chart was the primary data gathering tool. To assess patients for risk of DVT, the paired registered nurses who collected the data simply circled the appropriate risk factors and aggregated the score.

Table 2 Sample representation of risk categories

Risk categories	Number of patients	%
High	19	13
Moderate	37	25
Low	51	34
No risk	43	28
Total	150	100

A postal Likert-type questionnaire was used to measure the practical utility of the DVT scale. The postal questionnaire comprised 29 items conveniently split into two sections. Section one addressed the biographical data of the participating nursing staff, in relation to their professional experience and competence. This biographical data was used as a basis for explaining similarities and differences in responses to the items in section two. In section two, specific questions evaluated the clarity of the independent variables in the subscales and the practical application of the DVT risk calculator. Both closed and open questions were used, so that the strength of one would offset the weakness of the other (Parahoo 1997).

RESULTS

Reliability of the DVT scale

Data gathered independently and simultaneously by paired registered nurses from the 150 patients were analysed to evaluate the inter-rater and overall reliability of the DVT risk assessment scale. Estimates of reliability computed by different procedures for the same instrument are not identical (Polit 1996). Therefore, to communicate the inter-rater variability in the data captured for the establishment of the consistency of the DVT scale, three measures of equivalence were applied: total percentage agreement ($T\%$), kappa statistic (κ), and intra-class correlation coefficients (ICC). Percentage agreement was calculated using the following equation

$$\frac{\text{Number of agreement}}{\text{Number of agreement and disagreement}} \times 100 = (T\%).$$

One major criticism of $T\%$ agreement is that it does not take into account the varying contribution of chance agreements to observed agreement rate. Some of the agreement between raters can be accounted for by chance alone. To offset the limitation of $T\%$ agreement, kappa statistic (Cohen 1960) was applied to the same data. The advantage of the κ coefficient over percentage agreement is its correction or adjustment for the amount of agreement expected to occur by chance. It is symbolically expressed as

$$K = \frac{P_o - P_e}{1 - P_e},$$

where P_o is the observed proportion of agreement, P_e is the chance expected proportion of agreement, the numerator $P_o - P_e$ is the proportion of observer agreement, explicitly corrected for the proportion of chance or expected agreements, and the denominator $1 - P_e$ is similarly a correction for chance agreement.

As the number of observations recorded for each subject was the same, ICCs were also computed for all the five clinical areas (SPSS 2001). ICC estimates the average among all possible pairs of observation (Bland & Altman 1996). The high percentage agreement of the analysis of reliability ranging between 85% and 98%, κ values within 0.88–0.95, and ICCs values of 0.94–0.99 confirmed the rater-reliability of the DVT scale (Table 3).

Sensitivity and specificity of the DVT scale

The prime factor to consider in the selection of a predictive index is its accuracy. Wheeler et al. (1994) identify four components of test accuracy which are:

- Sensitivity
- Specificity
- Positive predictive value (PPV)
- Negative predictive value (NPV).

All four measurements were applied to evaluate the predictive accuracy of the DVT scale.

Sensitivity is conditional on the disease being present and specificity on being absent.

To estimate the sensitivity and specificity of the Autar DVT scale, data pooled from the 150 patients were analysed. Two patients who could not be followed up after discharge from hospital were excluded from the sensitivity and specificity data analysis. The criteria for evaluating the sensitivity and specificity of the DVT scale were a confirmed diagnosis of DVT and treatment with secondary anticoagulant therapy. Twenty-eight such subjects met the criteria (Table 4).

The score values of all patients with and without DVT are shown in Table 5.

A cut-off score range of $\geqslant 15$ captured only 25% of patients with DVT but lowering the score

Table 3 Reliability studies on orthopaedic, medical and surgical wards

Wards	No. of patients	No. of agreement	T% agreement	κ values	ICCs
Ward A: Orthopaedic	26	22	85	0.95	0.99
Ward B: Orthopaedic	24	23	96	0.94	0.94
Ward C: Medicine	25	23	92	0.94	0.99
Ward D: Medicine	25	23	92	0.88	0.99
Ward E: Surgery	50	49	96	0.94	0.99
Total	150	140	–	–	–

Table 4 Prevalence of DVT in the three clinical specialities

Speciality	No. of patients	No. with DVT	%
Orthopaedic trauma	50	8	16
Medical	50	12	24
Surgical	48	8	17
Total	148	28	19

Table 5 Score values of patients with and without DVT

% DVT present (*n*)	DVT risk score	% DVT absent (*n*)
0 (0)	1	2 (2)
0 (0)	2	2 (2)
0 (0)	4	7 (8)
7 (2)	5	12 (14)
7 (2)	6	10 (12)
3.5 (1)	7	5 (6)
11 (3)	8	9 (11)
3.5 (1)	9	11 (13)
0 (0)	10	13 (15)
11 (3)	11	9 (11)
11 (3)	12	4 (5)
14 (4)	13	7 (8)
7 (2)	14	1 (1)
7 (2)	15	2.5 (3)
7 (2)	16	2.5 (3)
3.5 (1)	17	2 (2)
0 (0)	19	1 (1)
3.5 (1)	20	2 (2)
3.5 (1)	26	0 (0)
0 (0)	27	1 (1)
100 (28)		**100 (120)**

range to $\geqslant 11$ captured 68% of patients with the condition.

The four possible indicators of accuracy were therefore influenced by the chosen cut-off values and initially an absolute cut-off range of $\geqslant 15$ was applied. True positives (TP) are those which are predicted positive and have the disease. Seven patients were correctly classified as true positives. False positives (FP) are those who are incorrectly predicted to have the disease when they do not. Twelve patients were false positives. Those who are predicted negative and who do not have the disease are the true negatives (TN) and 108 patients were correctly classified. False negatives (FN) are those subjects who are predicted negative for the disease but contracted it. Twenty-one false negatives were recorded.

Test accuracy is defined as the number of true positive and true negative divided by the number of patients studied (Wheeler et al. 1994). Overall, the DVT scale correctly predicted 115 patients (7 TP + 108 TN/148 = 78%) and misclassified 33 patients (22%).

The sensitivity and specificity of the absolute cut-off value is illustrated in the contingency Table 6.

The sensitivity and specificity of the DVT scale are dependent on the threshold used and calculating only one pair of sensitivity and specificity results provides only a very brief glimpse of a test performance. On account of this limitation, the cut-off values of the four risk categories in the Autar DVT scale assessment protocol were also calculated (Table 7).

The choice of an 11–14 score range optimised the predictive potential of the DVT scale and a sensitivity of 68% was recorded. However, only 19 patients (13%) in the high risk score range were identified (Table 6).

Although sensitivity and specificity provide information about the accuracy of the test, they do not add to the meaning of positive and negative test results. While sensitivity and specificity

Table 6 Sensitivity and specificity of absolute scores in DVT

	DVT present	DVT absent	Total
Score $\geqslant 15$	A 7 TP	B 12 FP	19
Score $\leqslant 14$	C 21FN	D 108 TN	129
Total	28	120	148

Sensitivity : $\frac{a}{a+c} \times 100 = \frac{7}{7+21} \times 100 = 25\%$

Specificity : $\frac{d}{b+d} \times 100 = \frac{108}{12+108} \times 100 = 90\%$

Table 7 Sensitivity and specificity for the four cut-off values

Cut-off scores	High risk $\geqslant 15$	Moderate risk 11–14	Low risk 7–10	No risk $\leqslant 6$
Sensitivity	7/28 = 25%	(12+7)/28 = 68%	(5+12+7)/28 = 86%	(4+5+12+7)/28 = 100%
Specificity	12/120 = 10%	(12+25)/120 = 31%	(45+25+12)/120 = 68%	(120/120) = 100%
1-Specificity	0.90	0.69	0.32	0.0

Table 8 Predictive values of DVT scale for absolute score range

Score values	DVT present	DVT absent	Total	Predictive values
⩾15	7 TP	12 FP	19	PPV: 37%
⩽14	21 FN	108 TN	129	NPV: 84%
Total	28	120	148	

are conditioned by the knowledge of the disease state, predictive values are conditioned by the nature of the test result (Essex-Sorlie 1995).

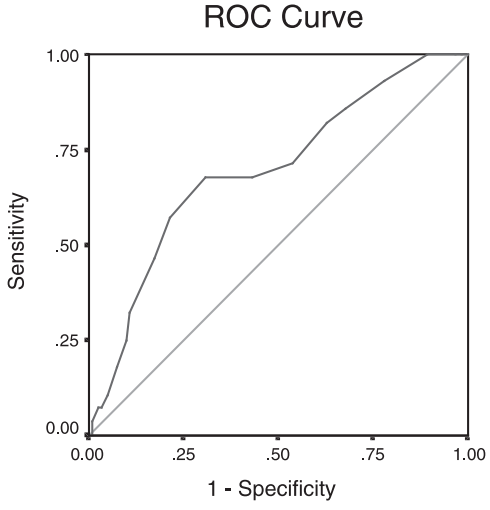
Predictive values were therefore used to measure the frequency with which the DVT scale correctly identified those at risk. Positive predictive values (PPV) are the proportion of those testing positive or predicted at risk of DVT, who actually develop DVT. Negative predictive values (NPV) are the proportion of those predicted negative that do not have DVT. PPV and NPV for the absolute score are shown in Table 8.

Two factors influenced the predictive values of the instrument: prevalence of DVT and sensitivity and specificity of the tool. 'As prevalence falls, positive predictive value must fall alongside it, and negative predictive value must rise' (Sackett et al. 1991, p. 88). A fall in PPV (37%) due to low prevalence of DVT (19%) was associated with a concomitant rise in NPV (84%). Importantly, the PPV of the DVT scale was masked by 50% of the patients who were recipient of some form of known primary venous thromboprophylaxis. Interestingly, 39% (11/28) of the patients developed a DVT at home when active prophylaxis was discontinued (Autar 2002).

Receiver operating characteristics

To further optimise the predictive accuracy of the DVT scale, a receiver operating characteristic (ROC) curve was constructed. A ROC (Figure 2) is simply a plot of the true positive rate against the false positive rate for the given thresholds (Zweig & Campbell 1993). Using version 11 of the SPSS package (2001), scores on the 148 patients were analysed to plot the ROC.

The area under the ROC curve for the above plot was calculated to be approximately 70%.



Area Under the Curve

Test Result Variable(s): SCORE

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.696	.056	.001	.587	.806

The test result variable(s): SCORE has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

Fig. 2 Receiver operating characteristics (ROC).

This means that a randomly selected patient from the DVT group has a higher DVT risk assessment score than one from the group without DVT. However, it does not mean that a DVT occurs with a probability of 0.70 or that DVT is associated with a positive result 70% of the time. Data extrapolation from Table 6 and the ROC curve affirmed that the score of 11 was the optimum cut-off point and reduced the amount of false negatives.

Practical application of the DVT scale

A response rate of 88% (22/25) from the paired data collection nurses was recorded for the postal questionnaire survey undertaken and used to evaluate the practical application of the DVT scale. The DVT scale was very favourably evaluated across the three clinical directorates. Its design facilitated its application in all the specialities without necessitating any modification to the chart. Items that were not applicable to a particular speciality were simply not rated. The DVT scale was described as user friendly. There was consensus that it enabled the respondents to individualise DVT risk assessment in less than 3 min. It purported to complement clinical judgement and ''reminds us of patients who otherwise might be overlooked'', thus making assessment visible.

Name:
Unit No:
Ward:

Age:
Type of admission:
Diagnosis

AGE SPECIFIC GROUP(years)	score
10-30	0
31-40	1
41-50	2
51-60	3
61-70	4
71+	5

BUILD / BODY MASS INDEX (BMI)
Wt(kg/ Ht (m)^2

Build	BMI	score
Underweight	16-18	0
Average/ Desirable	20-25	1
Overweight	26-30	2
Obese	31-40	3
Very obese (morbid)	41+	4

MOBILITY	score
Ambulant	0
Limited (uses aids, self)	1
Very limited (needs helps)	2
Chairbound	3
Complete bedrest	4

SPECIAL RISK CATEGORY	score
Oral Contraceptives:	
20-35 years	1
35+ years	2
Hormone replacement therapy	2
Pregnancy/ puerperium	3
Thrombophilia	4

TRAUMA RISK CATEGORY

Score item(s) *only preoperatively*.	score
Head injury	1
Chest injury	1
Spinal injury	2
Pelvic injury	3
Lower limb injury	4

SURGICAL INTERVENTION: Score only one appropriate surgical intervention.

	score
Minor surgery < 30 mins	1
Planned major surgery	2
Emergency major surgery	3
Thoracic	3
Gynaecological	3
Abdominal	3
Urological	3
Neurosurgical	3
Orthopaedic (below waist)	4

CURRENT HIGH RISK DISEASES: Score the appropriate item(s)	score
Ulcerative colitis	1
Polycythaemia	2
Varicose veins	3
Chronic heart disease	3
Acute myocardial infarction	4
Malignancy (active cancer)	5
Cerebrovascular accident	6
Previous DVT	7

ASSESSMENT INSTRUCTION

Complete within 24 hours of admission.

Scoring: Ring out the appropriate item(s) from each box, add score and record total below;

Total score:

Assessor:
Date:

ASSESSMENT PROTOCOL

Score range	Risk categories
≤ 10	Low risk
11-14	Moderate risk
15 ≥	High risk

Please record any other clinical observations that may supplement this DVT risk assessment.

VENOUS THROMBOPROPHYLAXIS

Low risk: Ambulation+ Graduated Compression Stockings.
Moderate risk:Graduated Compression stockings+ Heparin + Intermittent Pneumatic Compression Stockings.
High risk:Graduated Compression Stockings+ Heparin+ Intermittent Pneumatic Compresssion.
International Consensus Group recommendation, 2001.
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Fig. 3 New (2002) Autar DVT risk assessment scale.

DISCUSSION AND CONCLUSION

New findings mandate some changes to the clinimetric properties of the original DVT scale, so as to enhance its overall predictive performance. In the light of the results changes were made to the DVT subscales (Figure 3).

Age specific group

DVT increases exponentially with advancing age (Rosendaal 1997). Older people now comprise two-thirds of all patients in acute hospital settings, partly due to the demographic shift but also due to lack of alternative settings for health and social care (DoH 2001). A DVT increase in occurrence of 20% is reported in the 40–60 year old age range. This doubles between the age of 60 and 70 years and in patients over 70 the figure trebles (Borrow & Goldson 1981, Caprini & Natonson 1989). Despite a low risk score placing them in the no risk category, two medical patients in the 70–80 age range developed a DVT and advanced age was the only significant risk factor. In the age specific subscale, the 51–60 and 61+ age groups were assigned risk scores of 3 and 4, respectively. Relative to the incidence of DVT rising sharply in the different age groups, it is judged that elderly patients in the 70–80 age group be recognised as a higher risk group and assigned a risk score of 5.

Special risk category

HRT

Opinion has been divided on the association between hormone replacement therapy (HRT) and venous thromboembolic diseases (THRiFT 1998). At the time of the initial study (Autar 1994) and the launch of this investigation, the causal association between HRT and DVT was questionable (Carter 1992, Moore 1976, Notelovitz & Ware 1982).

However, two more recent studies (Daly et al. 1996, Jick et al. 1996) have demonstrated a positive causal relationship between HRT and DVT. Perez-Gutthann et al. (1997) conducted a case control study and concluded an overall twofold increase of relative risk of venous thromboembolic diseases associated with the current use of HRT. Most recently, a randomised controlled trial (Lowe et al. 2000) confirmed a two- to fourfold increase of DVT rate in women taking HRT.

There is now compelling evidence that a causal relationship between HRT and DVT exists. HRT is now a new addition to the special risk subscale and is assigned a risk score of 2.

Thrombophilia

Thrombophilia represents a group of abnormalities in which patients have recurrent thrombotic events because of genetic defect(s). Ninety to ninety-two per cent of patients with thrombophilia present with DVT (Marlar & Mastovich 1990). In order to reflect the magnitude of this problem, thrombophilia as an independent risk factor is included in the special risk category subscale. Proportional to the degree of risk relative, thrombophilia is assigned a risk score of 4.

Surgical intervention category

Appropriately, orthopaedic surgery as an independent risk factor carries a higher weighted score of 4 relative to the other types of surgery in this subscale. Incidence of DVT in orthopaedic patients ranges from 50% to 75% (Das 1994). However, this high incidence of DVT in orthopaedics relates only to patients undergoing below waist surgery such as total hip and total knee arthroplasties and surgical repair of fractured femur and tibia and fibula (Geerts et al. 1994). Incidence of DVT for other orthopaedic procedures such as upper limb surgery is not high. Therefore, the variable ''orthopaedic'' has been explicitly redefined to ''below waist'' orthopaedic surgery (Figure 3) to differentiate this from other orthopaedic surgical procedures carrying little or no risk of DVT.

Elective major surgery carries an incidence range of 0.2–2.2% rising to 2.7% for major emergency surgery (Coon 1976, Kakkar et al. 1970). In order to make the distinction between major surgery and emergency major surgery, the former is redefined as ''planned major surgery'', to highlight the difference in risk.

High risk diseases subscale

Specifically, clinical conditions such as sickle cell anaemia, haemolytic anaemia, varicose veins, and cerebrovascular accident as risk factors for DVT need re-examination, in the light of new evidence.

Sickle cell anaemia and haemolytic anaemia

Current data on sickle cell anaemia and haemolytic anaemia do not lend conviction to the view that they are associative risk factors. Sickle cell anaemia and haemolytic anaemia have been implicated in earlier literature for the reason of restricted blood flow and the release of cell breakdown products. In sickle cell anaemia thrombi occur frequently in the microcirculation, but there is no recorded evidence that it causes DVT (Bell & Simon 1982).

Haemolytic anaemia has also been previously implicated yet, there is no evidence to support any direct causal association with DVT (Belcher 1993). Early publications linking sickle cell anaemia and haemolytic anaemia to DVT, due to increased blood viscosity may have been speculative (Serjeant 1992). In the absence of new evidence, sickle cell anaemia and haemolytic anaemia have been now deleted from the subscale, as they are of no predictive value.

Varicose veins

Consistent with its high ranking by the European Consensus Group (1991) and THRiFT (1992), varicose veins as a DVT risk factor were assigned a high risk score of 6 (Autar 1994).

Recent debate on varicose vein as a DVT covariate is not disputed but challenged in relation to the nature of its association. Several investigators have utilised varicose veins as an independent covariate in their predictive indices to identify patients at risk of DVT (Clayton et al. 1976, Crandon et al. 1980, Lowe et al. 1982, Nicolaides & Irving 1975). However, many vascular surgeons (Agu 1999, Campbell & Riddler 1995, Campbell 1996) are now challenging this clinical view. They claim the assumption that DVT is an independent risk factor is derived from a lack of understanding of the differences between the deep and superficial veins of the lower limbs. This scepticism is evident in a survey of venous thromboprophylaxis for varicose vein surgery. Only 29% of vascular surgeons consider varicose veins as a high risk covariate, necessitating primary prevention (Campbell & Ridler 1995).

Current literature on varicose veins is controversial. The studies showing a relationship between DVT and varicose veins were undertaken in patients who had major abdominal surgery and invited criticism. Varicose veins may have coexisted incidentally with major abdominal surgery, advancing age and obesity as additive factors to cause DVT. In a study of 1231 patients, Anderson and Wheeler (1995) reported a DVT incidence of only 5.8% due to varicose veins.

The retention of the high risk score of 6 for varicose veins over predicts risk, is unjustified and its original risk score is re-graded to 3.

Myocardial infarction

Postal questionnaire feedback from the paired date collection nurses highlighted concerns in relation to the variable "myocardial infarction". It was deemed to be ambiguous and inclined to confuse interpretation as either an acute episode or a past medical history could be included. Incidence of DVT in acute myocardial infarction ranges between 20% and 40% but a previous myocardial infarction does not (Carter et al. 1987). Aptly, this clinical variable has been redefined to "acute myocardial infarction" to emphasise an acute event and its immediate potential for causing DVT.

CVA and previous DVT

CVA and a previous DVT are very well recognised high risk diseases in the causation of DVT, each associated with a risk score of 7 (Autar 1994). The incidence of DVT ranges between 42% and 60% for CVA (Brunner & Suddarth 1992, Kamal 1987). In patients with a previous history of DVT, the recurrence of an episode is between 48% and 68% (Dalen et al. 1986). An even higher risk was reported by Samama et al. (1993) for patients with previous DVT. There is now a strong consensus that previous DVT predisposes to the recurrence of the condition and is the highest risk factor in the causation of DVT (Anderson & Wheeler 1995, Nordstrom et al. 1992, Samama et al. 1993).

Previous DVT is a higher risk than CVA and is capped at the risk score of 7. CVA is assigned a revised of 6 and in this way, the small difference in the risk associated with these conditions is maintained.

The DVT risk assessment protocol

The DVT risk assessment strategy (Autar 1994) places patients into one of the four risk categories: no risk, low, moderate, and high risk. It is important to identify those at risk and differentiate them from those who are not so that the limited resources can be targeted most effectively (Anthony 1999, Autar 1998). Hence a no risk category was incorporated into the assessment protocol.

In reality, all patients by virtue of admission for investigation or treatment should be regarded as at risk. A DVT incidence of 11% for patients with no risk factors present was reported by Anderson and Wheeler (1995). This was evident in the data obtained on the medical unit. Two patients on the medical ward developed DVT despite having a low score of less than 6, which placed them in the no risk category. It is therefore prudent to err on the side of caution and assume all patients are at risk. Consequently, the four risk categories of the DVT scale have been reviewed to three risk categories (Figure 3). The removal of the no risk category from the assessment protocol places the low risk category into a wider risk score range of less than 10 and resolves any problem of spurious precision between the no and low risk categories. The other risk score ranges of 11–14 and $\geqslant 15$ are maintained to identify the moderate and high risk categories, respectively. This modified risk

assessment protocol is also consistent with the recommended antithrombotic assessment strategy (International Consensus Group 1997, 2001).

The Autar DVT scale relies on routine data gathered on admission, allowing for a prompt DVT risk assessment and timely intervention. As with the universally recognised Glasgow coma scale, the Autar DVT scale can be applied by nurses and doctors alike and also other health care professionals. The use of computers programmed with logistic regression formulas, as devised by Janssen et al. (1987) is technology for the future. Until artificial intelligence is readily available for carrying out bedside assessment, paper and pencil assessment tools as the DVT scale, remain the most effective method of predicting risk and guiding decision making.

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