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Primary care

Self management of oral anticoagulation: randomised trial

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Abstract

Objective To determine the clinical effectiveness of self management compared with routine care in patients on long term oral anticoagulants.
Design Multicentre open randomised controlled trial.
Setting Midlands region of the UK.
Participants 617 patients aged over 18 and receiving warfarin randomised to intervention (n = 337) and routine care (n = 280) from 2470 invited; 193/337 (57%) completed the 12 month intervention.
Intervention Intervention patients used a point of care device to measure international normalised ratio twice a week and a simple dosing chart to interpret their dose of warfarin.
Main outcome measure Percentage of time spent within the therapeutic range of international normalised ratio.
Results No significant differences were found in percentage of time in the therapeutic range between self managment and routine care (70% *v* 68%). Self managed patients with poor control before the study showed an improvement in control that was not seen in the routine care group. Nine patients (2.8/100 patient years) had serious adverse events in the self managed group, compared with seven (2.7/100 patient years) in the routine care arm (χ^2(df = 1) = 0.02, P = 0.89).
Conclusion With appropriate training, self management is safe and reliable for a sizeable proportion of patients receiving oral anticoagulation treatment. It may improve the time spent within the therapeutic range for patients with initially poor control.
Trial registration ISRCTN 19313375.

Introduction

Increasing numbers of patients need oral anticoagulation treatment, so alternative management models are needed.[1 2] Around 950 000 people in the United Kingdom are taking warfarin,[3–5] and the service load for monitoring anticoagulation is predicted to increase by a factor of five over the next decade.[6]

The international normalised ratio (INR) measures the level of the anticoagulation induced clotting defect; the incidence of adverse events is related to the intensity of treatment.[7] Point of care devices have been shown to be reliable for estimating INR.[8] Small observational and randomised studies, generally within private healthcare systems, suggest that point of care testing is an appropriate way to enable self management of oral anticoagulation by patients.[9–11] However, these studies were small and in select populations, and the lack of robust trial data for systematic reviews has led to the conclusion that more data from large scale randomised controlled trials are needed.[12–14] The UK is a challenging environment for trials of anticoagulation self management—clinical effectiveness and cost effectiveness are more difficult to demonstrate, as routine care within the NHS is better than routine care reported in previous self management studies in countries without socialised health care. Any new model of care will therefore have to show levels of control of greater than 60% of time within the therapeutic range of INR to be deemed safe and a greater than 10% superiority over routine care to be deemed superior.[13] The advantages for healthcare policy of doing such trials in the UK are considerable, as the comparator population will represent realistic "best practice" anywhere, and the results of any trial would therefore be valid and generalisable.[15–17]

This paper reports clinical outcomes of the first UK, and the largest worldwide, study of non-selected patients to investigate self management of oral anticoagulation. Cost effectiveness, quality of life, and training aspects[18] are reported separately elsewhere.

Methods

We identified patients from primary care centres within the UK Midlands Research Consortium (MidReC). We purposively sampled centres to cover rural and suburban centres with a socioeconomic range of patients. We identified eligible patients from practice generated computer lists. These were patients aged 18 or over, with a long term (greater than 12 months) indication for oral anticoagulation,[19] who had taken warfarin for at least six months with a target INR of 2.5 or 3.5. Patient recruitment took place in three phases: 15 practices in phase 1 (April 2001), 15 practices in phase 2 (September 2001), and 19 practices in phase 3 (April 2002).

Administrators verified computer lists to remove patients who had discontinued warfarin, moved away, or died. We asked general practitioners to remove only those patients they believed should be excluded from the trial on clinical or social grounds. Remaining patients were sent written invitations to participate in the study. Patients or carers (defined as someone who takes care of the patient but not employed to do so) who gave a positive response were invited to an information session in the patients' general practice.

We allocated consenting patients to intervention or routine care by central telephone randomisation using a variable block sized random allocation. Phases 1 and 2 were randomised 1:1, whereas phase 3 was randomised 3:2 in favour of the intervention (agreed by the Trial Steering Committee) because of the initial dropout rate. We asked intervention patients to attend two training sessions.[18] Trained anticoagulation nurses gave patients training at the practice. This covered the theory of anticoagulation, the INR, INR targets, how to measure and interpret INR, how to adjust dose, and quality control. Patients who did not attend training sessions were withdrawn and returned to routine care. After the training, patients considered capable of doing self management were given home testing equipment

(Coaguchek S, Roche Diagnostics). Intervention patients managed their own anticoagulation for 12 months, testing INR every two weeks (one week after a dose change). They adjusted dosage by using a laminated dosing schedule based on a traffic light system, where green represented INR within target range (no dose adjustment), amber represented INR slightly high or low (minor dose adjustment dependent on stable dose), and red represented INR too high or too low (contact a healthcare professional). Patients were instructed to do internal quality control tests if they got an unusual INR result or started a new box of test strips. Intervention patients were reviewed at a practice based clinic every three months to assess progress and to do external quality assessment procedures.

Patients not considered capable of self management were asked to return to routine care. Similarly, at the three month assessment patients not safely self managing (for example, using multiple finger pricks to obtain INR results) were returned to routine care. Other reasons for withdrawal were self withdrawal and serious adverse events. Routine care patients continued attending either hospital or practice based anticoagulant clinics.

The primary outcome measure was therapeutic INR control determined by the percentage of time spent within the therapeutic range.[20] We collected adverse event data from general practice records. We defined serious adverse events as those needing treatment or medical evaluation. An independent adverse event committee (comprising a neurologist, a haematologist, and a general practitioner) were responsible for classifying serious adverse events at the end of the trial.

Patients withdrawn from the intervention completed the study off the assigned treatment, and we collected INR data and included them in the intention to treat analysis. Patients who reached a study end point (discontinued warfarin, withdrew consent, or died) or were lost to follow-up (moved away) had no further INR data collected.

Study power and analysis plan

We did analyses by intention to treat (all patients randomised to intervention group), on treatment (patients actually receiving intervention), and off treatment (intervention data from patients who discontinued the intervention early).

For the primary outcome, if INR control in terms of percentage of time spent within the therapeutic range in both groups was equivalent at a level of 10%, with 5% significance and 80% power, we needed 261 patients in each group (total 522). For comparisons of percentage time in range we established a common dataset for all analyses, which included information on time in range in both the pre-study (six months before inclusion in study) and study periods.

We used the paired *t* test and the Wilcoxon signed rank test for comparisons of patients' quantitative results between the pre-study and study periods. We used the two sample *t* test and the Mann-Whitney test for quantitative comparisons between different groups of patients. For comparisons of proportions of patients the equivalent tests were McNemar's test and the χ^2 test. The purpose of the non-parametric Wilcoxon and Mann-Whitney tests was to confirm the results of the *t* test, which, in broad terms, was the outcome in each case. Because of occasional missing data for individual comparisons, the degrees of freedom of some *t* tests varied slightly from those to be expected if all patients had supplied all items of data.

Results

In all, 2530 patients from 49 practices were eligible (mean 51/practice, range 8-119). Total practice populations ranged from 2150 to 14500 patients (mean 7831/practice). Only 60 (2%) patients were excluded by their general practitioner (mainly because of terminal illness), leaving 2470 patients who were invited to participate in the study, of whom 1888 (76%) responded; 1156 declined to participate, and 732 agreed to attend an information session to discuss participation in the trial. Of those who initially agreed to attend, 48 (7%) did not attend the information sessions and 45 (6%) were unwilling to provide informed consent. A further 22 (3%) were excluded by researchers (figure).

Of patients initially agreeing to attend the information session, 617 (84%) gave written informed consent and were randomised to the intervention or routine care arm of the study (337 intervention, 280 routine care). The number of patients per practice randomised ranged from 2 to 35 (mean 13). Of all patients invited to take part in the study, 617/2470 (25%) were recruited (10-63% per practice). Significantly more men than women were invited to enter the study (1366 (55%) male *v* 1104 (45%) female, $P<0.001$) and randomised into the study (400 (65%) male *v* 217 (35%) female, $P<0.001$). The mean age of those invited to participate was 69 (range 18-95) compared with a mean of 65 for those recruited (range 18-87). Routine care patients were older than intervention patients (66 *v* 64, $P=0.015$). In the intervention group, the mean age of those completing training was significantly lower than that of those initially randomised (61 *v* 64, $P=0.012$).

Clinical indications for warfarin in rank order were atrial fibrillation, mechanical prosthetic heart valves, recurrent pulmonary embolism or deep vein thrombosis, cardiomyopathy, and transient ischaemic attack or stroke. We found no significant differences between intervention and routine care in terms of coronary risk factors. Hypertension was the most widespread risk factor (143, 42% intervention *v* 136, 49% routine care), followed by hyperlipidaemia (84, 25% *v* 61, 22%).

Of 337 patients randomised to intervention, 242 (72%) attended and successfully completed training. Ten (3%) did not attend training, 80 (24%) did not complete training, and five (1%) reached a study end point (three patients discontinued warfarin, one patient withdrew consent, and one patient died). Main reasons for not completing training were difficulties with obtaining a large enough blood sample or placing it correctly on to the test strip. Of the 242 patients who completed training, 193 (80%) completed the intervention. Thirty four (14%) patients did not complete the intervention, and 15 patients reached a study end point (seven discontinued warfarin, four died, and four moved away).

In the routine care group, five patients had no data collected (one withdrew permission for data to be collected from the medical records, one discontinued warfarin, two died, and one began to self monitor immediately after randomisation). Twenty five patients reached a study end point (nine died, 14 discontinued warfarin, and two moved away). Of the 280 patients randomised to routine care, 250 (89%) completed 12 months.

The mean frequency of testing before the study was 38.1 (95% confidence interval 36 to 40.2) days in the intervention group and 37.9 (35.6 to 40.2) days in the routine care group. During the study period, the mean frequency of testing was 12.4 (11.9 to 12.9) days in the intervention group and 37.9 (37.1 to 40.1) days in the routine care group.

Adverse events

Intention to treat analysis

We had 582.1 patient years of follow-up for the intention to treat analysis. The overall incidence of serious adverse events was 2.8/

Table 1 Serious adverse events in intervention and routine care groups

Description of event	Intervention: intention to treat (n=337)	Intervention: on treatment (n=242)	Intervention: off treatment (n=124)	Routine care (n=280)	Total (n=617)
Cerebral haemorrhage	1*	0	1*	1*	2
Thrombotic stroke	2	2	0	1	3
Gastrointestinal bleed	1+1*	1*	1	2	4
Transient ischaemic attack	1	1	0	0	1
Pulmonary embolism	0	0	0	2	2
Graft thrombosis	1	0	1	0	1
Clot retention from haematuria	0	0	0	1	1
Epistaxis	1	0	1	0	1
Rectal bleed	1	0	1	0	1
Total events	9	4	5	7	16
Patient years	318	214	103	264	582
Bleeding (per 100 patient years)	1.6	0.5	3.9	1.5	1.5
Thrombotic events (per 100 patient years)	1.3	1.4	1.0	1.1	1.2

*Fatal event.

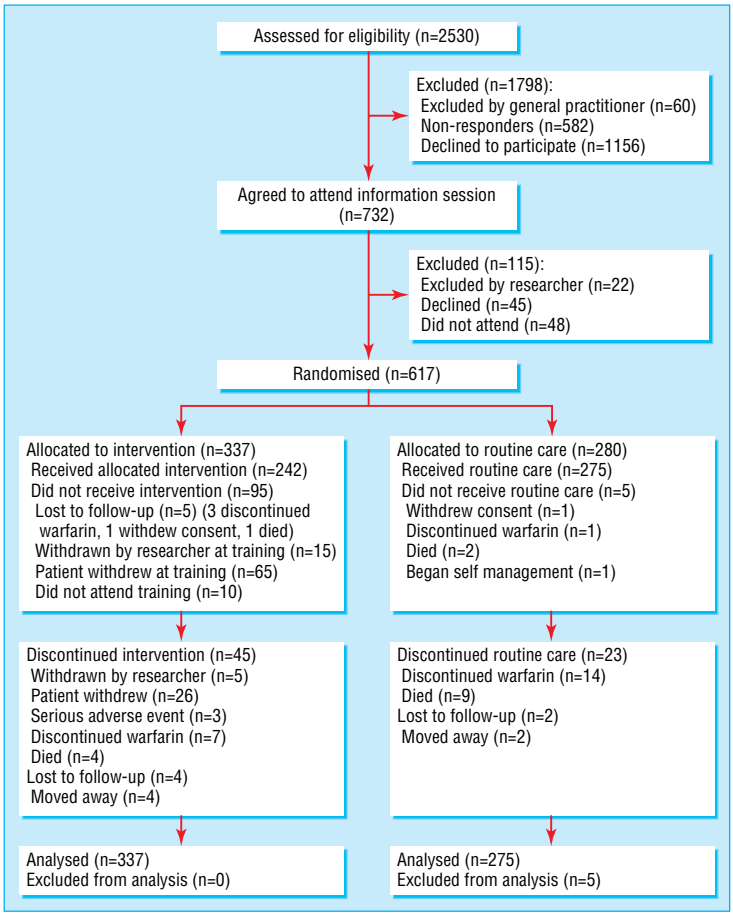
100 patient years (16 events), comprising 2.8/100 patient years (nine events) in the intervention arm and 2.7/100 patient years (seven events) in routine care (χ^2(df=1)=0.02, P=0.89). The overall rate of serious bleeding was 1.5/100 patient years (1.6 intervention *v* 1.5 routine care). The overall rate of serious thrombosis was 1.2/100 patient years (1.3 *v* 1.1) (table 1).

Intervention: on-treatment analysis

We had 214 patient years of follow-up for the on-treatment analysis. The incidence of serious adverse events was 1.8/100 patient years (four events). The incidence of bleeding episodes was 0.45/100 patient years (one fatal gastrointestinal bleed), and the incidence of thrombotic events was 1.4/100 patient years (two thrombotic strokes and one transient ischaemic attack).

Intervention: off-treatment analysis

We had 103 patient years of follow-up for the off-treatment analysis. The incidence of serious adverse events was 4.83/100 patient years (five events). The incidence of bleeding episodes was 3.86/100 patient years (four events, comprising one rectal bleed, one epistaxis, one cerebral haemorrhage, and one



Flowchart of study

Table 2 Percentage of time (95% confidence interval) within therapeutic range for international normalised ratio and number of patient years

Patient group	Pre-study	Study	Change	Patient years
Intervention total (n=337)	68 (64.3 to 70.7)	70 (68.1 to 72.4)	2.50 (–0.64 to 5.65)	318
Routine care (n=280)	69 (65.2 to 72.1)	68 (65.2 to 70.6)	–0.69 (–4.35 to 2.96)	264
On treatment (n=242)	69 (65.2 to 72.6)	72 (69.5 to 73.7)	2.29 (–1.26 to 5.85)	214
On-treatment dropouts (n=34)	61 (51.3 to 70.9)	61 (53.2 to 68.7)	–0.13 (–10.4 to 10.2)	17

gastrointestinal bleed). The incidence of thrombotic events was 0.97/100 patient years (one graft thrombosis).

Therapeutic INR control

In the intention to treat analysis, we found no significant differences mean percentage of time within the therapeutic range for INR between pre-study and study periods in either the intervention arm ($t_{320}=1.57$, $P=0.12$) or the routine care arm ($t_{255}=-0.37$, $P=0.71$) (table 2). INR control based on mean percentage of time within the therapeutic range during the study did not differ significantly between the intervention and routine care groups (70% *v* 68%; $t_{575}=1.35$, $P=0.18$).

In the intention to treat patients, we found a significant difference in the percentage of time within the therapeutic range for INR in pre-study and study periods between patients with therapeutic targets of 2.5 and 3.5 in both groups. Intervention group: pre-study 74% versus 45% ($t_{319}=7.46$, $P<0.001$); study 74% versus 55% ($t_{319}=7.48$, $P<0.001$). Routine care: pre-study 72% versus 52% ($t_{254}=3.70$, $P<0.001$); study 71% versus 53% ($t_{254}=4.70$, $P<0.001$).

In the intervention group patients with a target of 3.5, a significant improvement occurred between pre-study and study (45% *v* 55%; $t_{65}=2.77$, $P=0.007$). No significant difference occurred in intervention group patients with a target of 2.5 (73% *v* 74%; $t_{254}=0.29$, $P=0.77$) or the routine care patients with either a target of 2.5 (72% *v* 71%; $t_{217}=-0.44$, $P=0.66$) or a target of 3.5 (52% *v* 53%; $t_{37}=0.07$, $P=0.94$) (table 3).

If we examine the distributions of percentage of time in range by centiles, patients in the intervention group who were poorly controlled at baseline (defined as time in range below the median) showed a significant increase from pre-study to study, whereas those in the routine care group did not. The magnitude of this improvement was approximately 20% (95% confidence interval 9% to 32%) for the 3.5 target group and around 15% (6% to 24%) for the 2.5 target group. In the routine care group a change of 3-5% occurred in both 2.5 and 3.5 target groups.

We found no significant difference in the number of patients within their individual therapeutic range, based on the last INR result recorded within the study period (intervention 70% *v* routine care 72%) (table 4). We found a significant difference in point prevalence in the intervention group patients between those with a target of 2.5 and those with a target of 3.5 (73% *v* 60%; $P=0.05$).

Finally, table 5 records the differences evident in tables 2, 3, and 4 between intervention and routine care patient groups. In every case but one no significant difference exists between results from the two groups. The only marginal exception is in the case of INR percentage time in range for the 2.5 therapeutic target group in the study phase of the trial. However, once adjustment is made for the difference in pre-study levels (recorded in the right hand column) a significant difference no longer exists. The significance of the effect of the intervention for the 3.5 therapeutic target group is inevitably reduced here because of the extra uncertainty included in the comparison.

Discussion

This study is the largest to evaluate the clinical effectiveness of patient self management of oral anticoagulation compared with routine care. Study recruitment was non-selective; the comparator provided good control of international normalised ratio (INR), both enhancing generalisability and reflecting real life. Overall, only 25% of eligible patients were randomised. A recent smaller Dutch clinic based study had a similar recruitment rate,[16] although a Spanish study managed to recruit nearly 50% of eligible patients.[17] Whether the relatively low recruitment rate relates to the demands of self management or the fact that patients were being asked to participate in a trial is not clear. In Germany, where self managed anticoagulation is routine, up to 80% of patients are able to self manage.[21] This may reflect the reimbursement system as well as the motivation and ability of patients to do self management.

Training

Of those patients who were randomised to self management most (72%) were able to complete training, and 78% of those who started self management were able to complete 12 months. Self management is therefore a feasible model of care for an appreciable proportion of patients.

Table 3 Percentage of time (95% confidence interval) within therapeutic range for international normalised ratio, by therapeutic target

Patient group	Pre-study	Study	Change	P value
Intervention, target 2.5 (n=255)	74 (70.7 to 77.2)	74 (72.3 to 76.6)	0.51 (–2.94 to 3.96)	0.77
Intervention, target 3.5 (n=66)	45 (37.3 to 51.7)	55 (50.0 to 60.0)	10.21 (2.84 to 17.59)	0.007
Routine care, target 2.5 (n=218)	72 (68.0 to 75.3)	71 (67.8 to 73.7)	–0.88 (–4.78 to 3.02)	0.66
Routine care, target 3.5 (n=38)	52 (42.2 to 62.1)	53 (45.3 to 60.0)	0.38 (–10.35 to 11.11)	0.94

Table 4 Percentage (95% confidence interval) of patients within their individual therapeutic range for international normalised ratio, and number of patient years

Patient group	Pre-study	Study	Change	Patient years
Intervention, total (n=337)	73 (67.9 to 77.6)	70 (64.8 to 74.8)	–4 (–10.6 to 2.7)	318
Routine care (n=279)	75 (69.3 to 79.8)	72 (66.3 to 77.1)	–4 (–11.6 to 2.6)	264
On treatment (n=242)	76 (70.1 to 81.2)	72 (65.7 to 77.4)	–4 (–11.1 to 3.6)	214
On-treatment dropouts (n=34)	65 (46.4 to80.3)	56 (37.9 to72.8)	–9 (–27.6 to 10.3)	17

Table 5 Differences in results between intervention and routine care patients. Values are percentages (95% confidence intervals)

Result, therapeutic target	Pre-study	Study	Change
INR percentage time in range	−0.8 (−5.6 to 4.0)	2.4 (−1.2 to 6.0)	3.2 (−1.6 to 8.0)
INR percentage time in range, target 2.5	2.4 (−2.5 to 7.3)	3.8 (0.1 to 7.4)	1.4 (−3.6 to 6.6)
INR percentage time in range, target 3.5	−7.6 (−19.7 to 4.5)	2.2 (−6.4 to 10.8)	9.8 (−3.0 to 22.7)
INR point prevalence	−1.9 (−8.9 to 5.0)	−1.7 (−8.9 to 5.6)	0.2 (−9.8 to 10.2)

INR=international normalised ratio.

The study population was younger than the invited population, and men were more likely to participate. Patients who completed the intervention were younger than those randomised. Around half of the study patients had atrial fibrillation as their primary indication for warfarin.

Therapeutic control

We found no overall significant differences between the study arms for the primary outcome measure. Therapeutic INR control was good in both arms; both groups spent around 70% of time within their therapeutic range, which is comparable to the Dutch study (68.6% in the self management group) and significantly better than the Spanish group (58.6%).[16 17] In keeping with previous studies, patients with a target INR of 3.5 (principally patients with mechanical heart valves) had poorer therapeutic control than those with a target INR of 2.5. Examining the change from pre-study to study for self managed patients separately for those with targets of 2.5 and 3.5 revealed that those with poorer control, as monitored by time in range, improved from pre-study to study. The improvement was approximately 15% in the 2.5 target group and 20% in the 3.5 target group. This was not the case in the routine care group. Self management is thus an effective and safe model of care for patients who have been trained appropriately and may even represent the model of choice for patients who are poorly controlled in routine care.

Routine care

Patients in the routine care group were managed through a variety of different models, ranging from hospital outpatient clinics to primary care clinics. The therapeutic control seen compared favourably with previously published data.[5] Adverse event rates also compared favourably with previously published international data; the overall adverse event rate was 2.8% compared with 7.3% in the Spanish study and approximately 4.5% in the Dutch study.[16 17 22] The comparator to self management in this study was therefore robust.

Limitations

The study was limited, as are other studies, by the parameters set down for patients doing self management. Patients were asked to do an INR test every two weeks, with weekly testing recommended after a dose change. Although this makes comparison with routine care problematic, it reflects the reality of the current models of service provision. The three month clinical reviews generally worked well, but again there were a few patients who had difficulty attending these sessions.

Only 25% of patients agreed to participate, but this probably reflects reluctance to participate in a trial and a high level of satisfaction with current services rather than a reluctance to self manage. A quarter of patients did not complete training, however, and a further fifth withdrew prematurely, which suggests that barriers to self management exist above and beyond those to taking part in research. The findings warrant further research before self monitoring is commissioned more widely in the UK (as in Germany), as demand from patients may be limited.

What is already known on this topic

Self management for oral anticoagulation has been shown to be effective in highly selected populations within healthcare environments not comparable to the UK

What this study adds

Self management for oral anticoagulation is safe and effective for a sizeable minority of patients receiving warfarin

For patients who have been appropriately trained, self management is as clinically effective as routine care provided by UK oral anticoagulation clinics

Fewer patients than anticipated wished to self manage their oral anticoagulation

Conclusions

For an appreciable number of motivated patients on oral anticoagulation, self management is a safe and realisable alternative to existing models of care in healthcare systems with high quality routine anticoagulation management. This model of care is particularly effective for treating patients with poor INR control, who are a difficult population to manage and are at risk of adverse events. Now that self management for anticoagulation has been shown to be as safe and effective as routine care, it would be valid to test whether this reassurance alters patients' (and health professionals') equipoise in considering whether to accept self management in this context.

Contributors: DAF was the principal investigator, wrote the first draft, and is the guarantor. ETM was the project manager and contributed to drafting the report. DMC assisted with training patients and collecting data. RH was the study statistician. JPR provided health economic input and assisted with the trial design. SH assisted with data analysis. HS was the study IT officer and assisted with the production of data for analysis. FDRH contributed to study design and editing the report.

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1 Taylor F, Ramsey M, Voke J, Cohen H. GPs not prepared for monitoring anticoagulation. *BMJ* 1993;307:1493.
2 Sudlow CM, Rodgers H, Kenny RA, Thomson RG. Service provision and use of anticoagulants in atrial fibrillation. *BMJ* 1995;311:558-61.
3 Baglin T. Decentralised anticoagulant care. *Clin Lab Haematol* 1994;16:327-9.
4 Rose P. Audit of anticoagulant therapy. *J Clin Pathol* 1996;49:5-9.
5 *Mediplus analysis of oral anticoagulant therapy (OAT).* London: IMS Health, 1999. (Study number MP990207.)
6 Sudlow M, Rodgers H, Kenny RA, Thomson R. Population based study of use of anticoagulants among patients with atrial fibrillation in the community. *BMJ* 1997;314:1529-30.
7 Cannegieter SC, Rosendaal FR, Wintzen AR, van der Meer FJM, Vandenbrouke JP, Briet E. Optimal anticoagulant therapy in patients with mechanical heart valves. *N Engl J Med* 1995;333:11-7.
8 Murray ET, Fitzmaurice DA, Allan TF, Hobbs FDR. A primary care evaluation of three near patient coagulometers. *J Clin Pathol* 1999;52:842-5.
9 Hasenkam JM, Kimose HH, Knudsen L, Gronnesby H, Halborg J, Christensen TD, et al. Self management of oral anticoagulation therapy after heart valve replacement. *Eur J Cardiothorac Surg* 1997;11:935-42.
10 Sawicki PT. A structured teaching and self-management program for patients receiving oral anticoagulation: a randomized controlled trial. *JAMA* 1999;281:145-50.

11 Cromheecke ME, Levi M, Colly LP, de Mol BJM, Prins MH, Hutten B, et al. Oral anticoagulation self-management by a specialist anticoagulation clinic: a randomised cross-over comparison. *Lancet* 2000;356:97-102.
12 Siebenhofer A, Berghold A, Sawicki PT. Systematic review of self-management of oral anticoagulation. *Thromb Haemost* 2004;91:225-32.
13 Fitzmaurice DA, Machin SJ. Recommendations for patients undertaking self management of oral anticoagulation. *BMJ* 2001;323:985-9.
14 Ansell J, Jacobson A, Levy J, Voller H, Hasenkam JM. Guidelines for implementation of patient self-testing and patient self-management of oral anticoagulation international consensus guidelines prepared by the International Self-Monitoring Association for Oral Anticoagulation. *Int J Cardiol* 2005;99:37-45.
15 Fitzmaurice DA, Murray ET, Gee KM, Allan TF, Hobbs FDR. A randomised controlled trial of patient self-management of oral anticoagulation treatment compared with primary care management. *J Clin Pathol* 2002;55:845-9.
16 Gadisseur AP, Breukink-Engbers WG, van der Meer FJ, van den Besselaar AM, Sturk A, Rosendaal FR. Comparison of the quality of oral anticoagulant therapy through patient self-management and management by specialized anticoagulation clinics in the Netherlands: a randomised clinical trial. *Arch Int Med* 2003;163:2639-46.
17 Menedez-Jandula B, Souto JC, Oliver A, Montserat I, Quintana M, Gich I, et al. Comparing self-management of oral anticoagulant therapy with clinic management. *Ann Intern Med* 2005;142:1-10.
18 Murray ET, Fitzmaurice DA, McCahon D, Fuller C, Sandhur H. Training for patients in a randomised controlled trial of self management of warfarin treatment. *BMJ* 2004;328:437-8.
19 British Committee for Standardisation in Haematology. Guidelines on oral anti-coagulation, 2nd edition. *J Clin Pathol* 1990;43:177-83.
20 Rosendaal FR, Cannegieter SC, van der Meer FJM, Briet E. A method to determine the optimal intensity of oral anticoagulant therapy. *Thromb Haem* 1993;69:236-9.
21 Morsdorf S, Erdlenbruch W, Taborski U, Schenk JF, Erdlenbruch K, Novotny-Reichert G, et al. Training of patients for self-management of oral anticoagulant therapy: standards, patient suitability, and clinical aspects. *Semin Thromb Hemost* 1999;25:109-15.
22 Palareti G, Leali N, Coccheri S, Poggi M, Manotti C, D'Angelo A, et al. Bleeding complications of oral anticoagulant treatment: an inception-cohort, prospective collaborative study (ISCOAT). *Lancet* 1996;348:423-8.

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