Translating Venous Thromboembolism (VTE) prevention evidence into practice: A multidisciplinary evidence implementation project.

ABSTRACT

Background: VTE is an important patient safety issue resulting in significant mortality, morbidity, and healthcare resource expenditure. Despite the widespread availability of best practice guidelines on VTE prevention we found that only 49% of our patients were receiving appropriate prophylaxis.

Aim: To improve healthcare professionals' compliance with evidence-based guidelines for VTE prevention in hospitalised patients.

Design: A practice improvement methodology was employed to identify, diagnosis, and overcome practice problems. Pre and post intervention audits were used to evaluate performance measures.

Setting: The study was conducted from September 2008 until August 2009 and took place in a 250 bed acute care private hospital in metropolitan Sydney, Australia.

Intervention: A change plan was developed which attempted to match organisational barriers to VTE guideline uptake with evidence-based implementation strategies. The strategies used included audit and feedback; documentation aids; staff education initiatives; collaboratively development hospital VTE prevention policy; alert stickers and other reminders.

Results: The proportion of patients receiving appropriate VTE prophylaxis increased by 19% from 49% to 68% ($p=0.02$). Surgical patient prophylaxis increased by 21% from 61% to 83% ($p=0.02$) while medical patient prophylaxis increased by 26% from 19% to 45% ($p=0.05$). The proportion of patients with a documented VTE risk assessment increased from 0% to 35% ($p<0.001$).

Conclusion: The intervention resulted in a 19% overall improvement in prophylaxis rates, which is a significant achievement for any behavioural change intervention. There is, however, still a significant discrepancy between surgical and medical patient prophylaxis rates which clearly warrants further attention.

BACKGROUND

Venous thromboembolism (VTE) prevention in hospitalised patients has been widely acknowledged in Australia and internationally as a major opportunity to improve patient safety (Agency for Healthcare Research and Quality 2001, National Health and Medical Research Council 2009, Shojania *et al.* 2001). VTE is one of the single most common preventable causes of hospital deaths (National Institute of Clinical Studies 2003) with ten percent of all hospital fatalities attributed to pulmonary embolism (PE) (MacDougall *et al.* 2006). In Australia, VTE has been estimated to result in 5000 deaths annually (Access Economics 2008) and in the United Kingdom (UK) this figure is 25,000 deaths annually (House of Commons Health Committee 2005). These numbers are possibly underestimations considering VTE is often under-diagnosed (National Institute of Health and Clinical Excellence 2008, Access Economics 2008).

Morbidity from VTE for survivors can also be substantial: One-third of patients with deep vein thrombosis (DVT) will develop post-thrombotic syndrome which is characterised by persistent lower limb oedema, pain, inflammation, and ulceration (Kakkar & Haas 2007); 25% of patients will experience a recurrence of their DVT (Hansson *et al.* 2000); and 5% of patients following a PE will suffer chronic pulmonary hypertension (Pengo *et al.* 2004). The combination of these factors has led to calls for VTE to be reclassified as a chronic disease process with periods of acute exacerbations (Mason 2009, Hansson et al. 2000).

Unfortunately, without appropriate prophylaxis the incidence of objectively confirmed, hospital-acquired DVT is approximately 10% to 40% among medical or general surgical patients and 40% to 60% following major orthopaedic surgery (Geerts *et al.* 2008). There is, however, strong research evidence supporting the use of both pharmacological and mechanical measures for VTE prevention and this research has informed a number of evidence-based clinical guidelines (The Australian and New Zealand Working Party on the Management and Prevention of Venous Thromboembolism 2007, Hirsh *et al.* 2008, International Consensus Statement 2006).

Importantly, despite the ready availability of these guidelines the universal application of this evidence has not been forthcoming. A recent UK survey has reported that 71% of hospitalised patients judged to be at moderate or high-risk of VTE did not receive any form of prophylaxis (National Institute of Health and Clinical Excellence 2008) and an international audit of 70,000 patients found that only 50% of at-risk patients were receiving appropriate prophylaxis (Cohen *et al.* 2008). Similar results were demonstrated in our hospital with an audit identifying appropriate prophylaxis in only 62% of surgical patients and 19% of medical patients.

Implementation research is the study of interventions to promote the systematic uptake of clinical research findings into routine clinical practice (Schunemann *et al.* 2004). A systematic review by Tooher *et al* (2005) identified 30 studies that examined the impact of various implementation strategies on VTE prophylaxis in hospitalised patients. The types of strategies employed in these studies included passive dissemination, audit and feedback, decision aids, documentation aids, continuing education, quality assurance activities, advertising, appointment of specific implementation staff, and recruitment of local change agents or opinion leaders.

The effectiveness of individual strategies was found to be highly variable but in general a single active strategy, such as clinical decision support systems, audit and feedback, documentary aids, and quality assurance activities, was consistently more effective than passive dissemination of guidelines alone. It was concluded, however, that rather than any single strategy used in isolation, the most effective approach for improving VTE prophylaxis in hospitalised patients was the combination of multiple strategies (Tooher et al. 2005).

To aid in the selection of appropriate strategies for our organisation an assessment of barriers to VTE guideline uptake was undertaken. Barriers are factors that potentially impair the effectiveness of professional practice and it has been suggested that projects that identifty and address these barriers have a greater chance of successfully improving and maintaining practice change (Grol *et al.* 2005, Grimshaw *et al.* 2004). Although, it must be noted that evidence for this supposition has not yet been established (Baker *et al.* 2010).

Setting

The project was conducted over a twelve month period in a 250 bed acute care private hospital in metropolitan Sydney, Australia. The hospital has approximately 20,000 separations annually and provides a full range of surgical and medical services, excluding maternal and paediatric care. The case mix is 70% surgical/ 30% medical; 45% of the patient population is over 65 years of age.

Target population

The prevention of VTE in our organisation is a multidisciplinary concern requiring the contributions and collaboration of a number of healthcare professionals. Project interventions were specifically targeted at nurses (n=360), doctors (n=210), and hospital pharmacists (n=6).

METHOD

Study Objectives

To improve healthcare professionals compliance with evidence-based VTE prevention guidelines in surgical and medical inpatients. Specific project objectives included the development of a hospital-wide VTE prophylaxis policy; development of a sustainable system to support routine VTE risk assessment and VTE prophylaxis management; and a standardised approach to documenting these.

Ethics

Ethical approval was obtained from the Human Research Ethics Committee of the hospital.

Design

A systematic, iterative practice improvement method was used which incorporated both qualitative and quantitative approaches to identify, diagnosis, and overcome practice problems. The steps in the process are represented in figure 1.

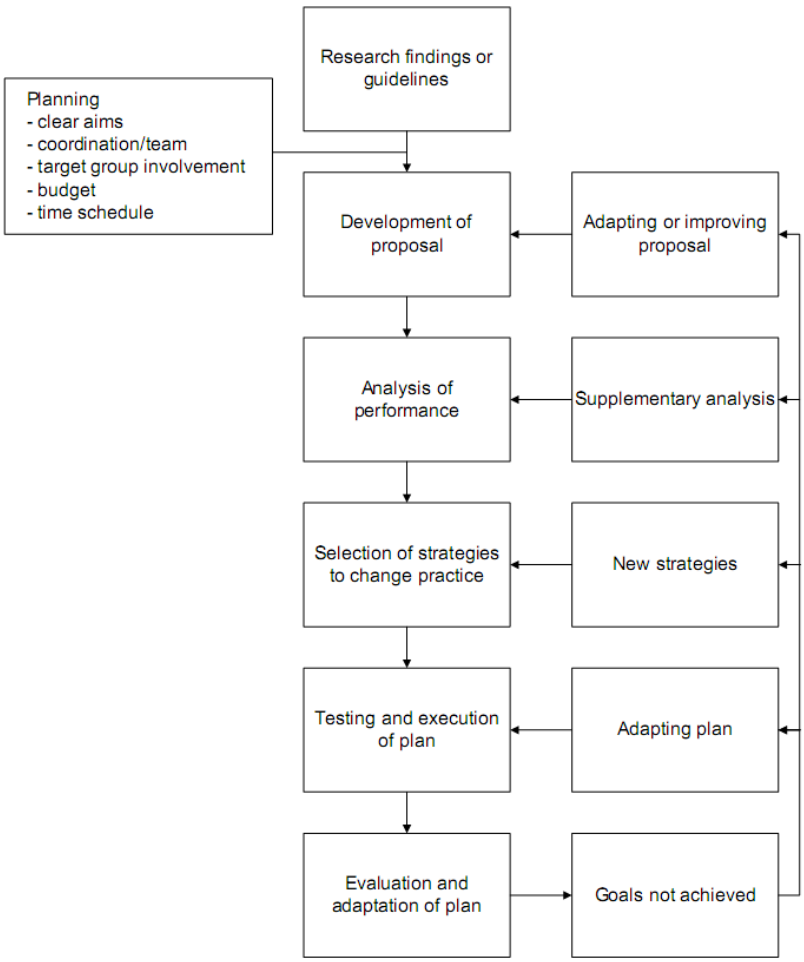


Figure 1 Implementation of change model. Adapted from Grol *et al* (2005).

Intervention

Development of proposal

The practice improvement approach employed requires the engagement of clinicians to identify barriers to evidence uptake and then design specific interventions to overcome them (Grol *et al.* 2005). Participants in this process included three nurses, a doctor, an academic, a clinical manager, and a consumer. The group reviewed the literature on strategies to improve VTE

prophylaxis in hospitals and then brain stormed possible barriers to guideline uptake in our organisation.

Strategies to change practice

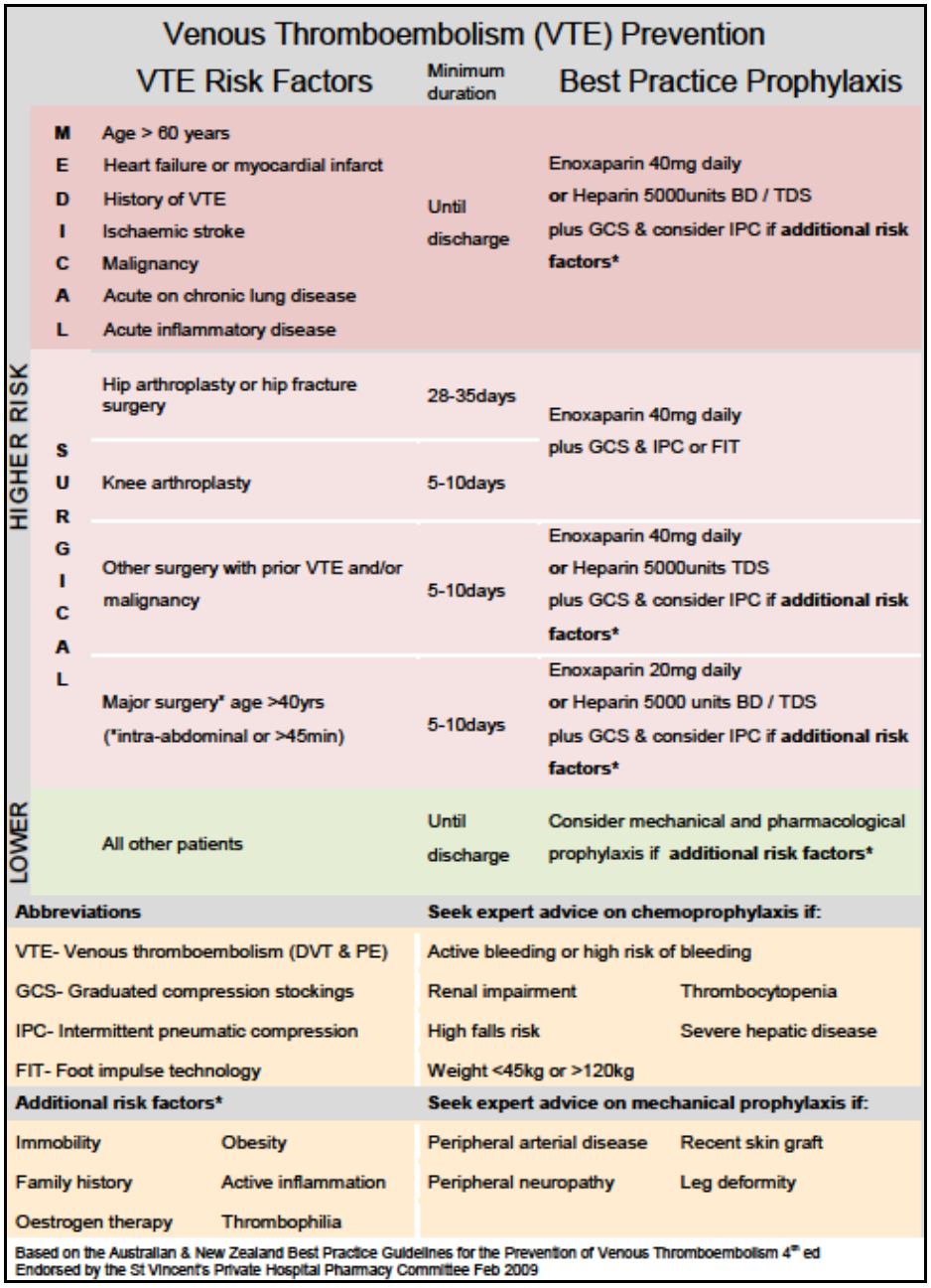
Four barriers to the uptake of VTE prevention guidelines were identified: A lack of motivation to change; a lack of systems support; a knowledge or awareness deficit; and disputed evidence. Subsequently, four strategies for change were selected on the basis of their potential effectiveness in overcoming these barriers (Grimshaw *et al.* 2004, Tooher et al. 2005):

- Audit and feedback: The results of the baseline audit and of a midpoint snapshot audit were fed back to the clinicians in short presentations.

- Documentation and decision support aids: A tool for assessing VTE risk and choosing appropriate prophylaxis measures was developed and printed in the medication chart (see Figure 2). A system where VTE risk alert stickers are placed on the medication chart was also implemented.

- Provider education: A series of education sessions was delivered to all departments to raise VTE awareness. This was complemented by an in-house multidisciplinary VTE prevention conference with expert speakers invited from across the country.

- Policy/procedure: A hospital-wide policy on VTE prevention which clearly outlined roles and responsibilities was developed and promulgated.



Venous Thromboembolism (VTE) Prevention

		VTE Risk Factors	Minimum duration	Best Practice Prophylaxis
HIGHER RISK	MEDICAL	Age > 60 years Heart failure or myocardial infarct History of VTE Ischaemic stroke Malignancy Acute on chronic lung disease Acute inflammatory disease	Until discharge	Enoxaparin 40mg daily **or** Heparin 5000units BD / TDS plus GCS & consider IPC if **additional risk factors***
	SURGICAL	Hip arthroplasty or hip fracture surgery	28-35days	Enoxaparin 40mg daily plus GCS & IPC or FIT
		Knee arthroplasty	5-10days	
		Other surgery with prior VTE and/or malignancy	5-10days	Enoxaparin 40mg daily **or** Heparin 5000units TDS plus GCS & consider IPC if **additional risk factors***
		Major surgery* age >40yrs (*intra-abdominal or >45min)	5-10days	Enoxaparin 20mg daily **or** Heparin 5000 units BD / TDS plus GCS & consider IPC if **additional risk factors***
LOWER		All other patients	Until discharge	Consider mechanical and pharmacological prophylaxis if **additional risk factors***

Abbreviations

VTE- Venous thromboembolism (DVT & PE)
GCS- Graduated compression stockings
IPC- Intermittent pneumatic compression
FIT- Foot impulse technology

Seek expert advice on chemoprophylaxis if:

Active bleeding or high risk of bleeding
Renal impairment
Thrombocytopenia
High falls risk
Severe hepatic disease
Weight <45kg or >120kg

Additional risk factors*

Immobility
Obesity
Family history
Active inflammation
Oestrogen therapy
Thrombophilia

Seek expert advice on mechanical prophylaxis if:

Peripheral arterial disease
Recent skin graft
Peripheral neuropathy
Leg deformity

Based on the Australian & New Zealand Best Practice Guidelines for the Prevention of Venous Thromboembolism 4th ed
Endorsed by the St Vincent's Private Hospital Pharmacy Committee Feb 2009

Figure 2 Tool for assessing VTE risk and choosing appropriate prophylaxis measures.

Perceived barrier	Strategy for change	Intervention	Description	Week
Lack of motivation to change	Audit and feedback	Baseline & snapshot audit	Stratified (by ward) random sample of inpatients'(n=148) audited against national VTE prevention guidelines (The Australian and New Zealand Working Party on the Management and Prevention of Venous Thromboembolism 2007).	1 & 24
		Feedback presentations	20min presentation of benchmarked (National Institute of Clinical Studies 2005, Cohen et al. 2008) baseline results to all wards and specialties.	1 to 12
		Feedback letter	To Nursing Unit Managers and Directors of medical specialties feeding back results	25
Lack of system support	Documentation aides	VTE Risk alert sticker	A 'high' or 'low risk' VTE sticker placed on the medication chart communicating risk.	32 to 52
		Decision support tool	Collaboratively developed evidence-based decision support tool (fig 1) incorporated into medication chart.	32 to 52
Knowledge/ awareness deficits	Provider education	Mock newspaper	Mock newspaper containing a collection of recent news articles from the local, national and international media on VTE.	1 to 12
		Awareness presentations	2 x 20min awareness sessions conducted on each clinical ward.	1 to 12
		Multidisciplinary conference	Full day VTE awareness conference with presentations from local and national experts.	31
	Reminders	Monthly posters	Novel posters using slogans, eye catching pictures or pop culture references.	1 to 52
Disputed evidence	Regulation and policy	Whole of hospital policy	Hospital-wide policy collaboratively developed.	1 to 52

Table 1 Change plan showing the alignment of interventions with the known barriers to VTE prevention guideline uptake

Key measures of improvement

Data on appropriate risk assessment and prophylaxis rates pre and post intervention were collected.

Measures:

- Proportion of adult inpatients receiving appropriate VTE prophylaxis
- Proportion of adult inpatients who are assessed for their risk of VTE

These measures were chosen because they have previously been used in national and international VTE studies (Cohen et al. 2008, Tooher *et al.* 2005).

Data collection

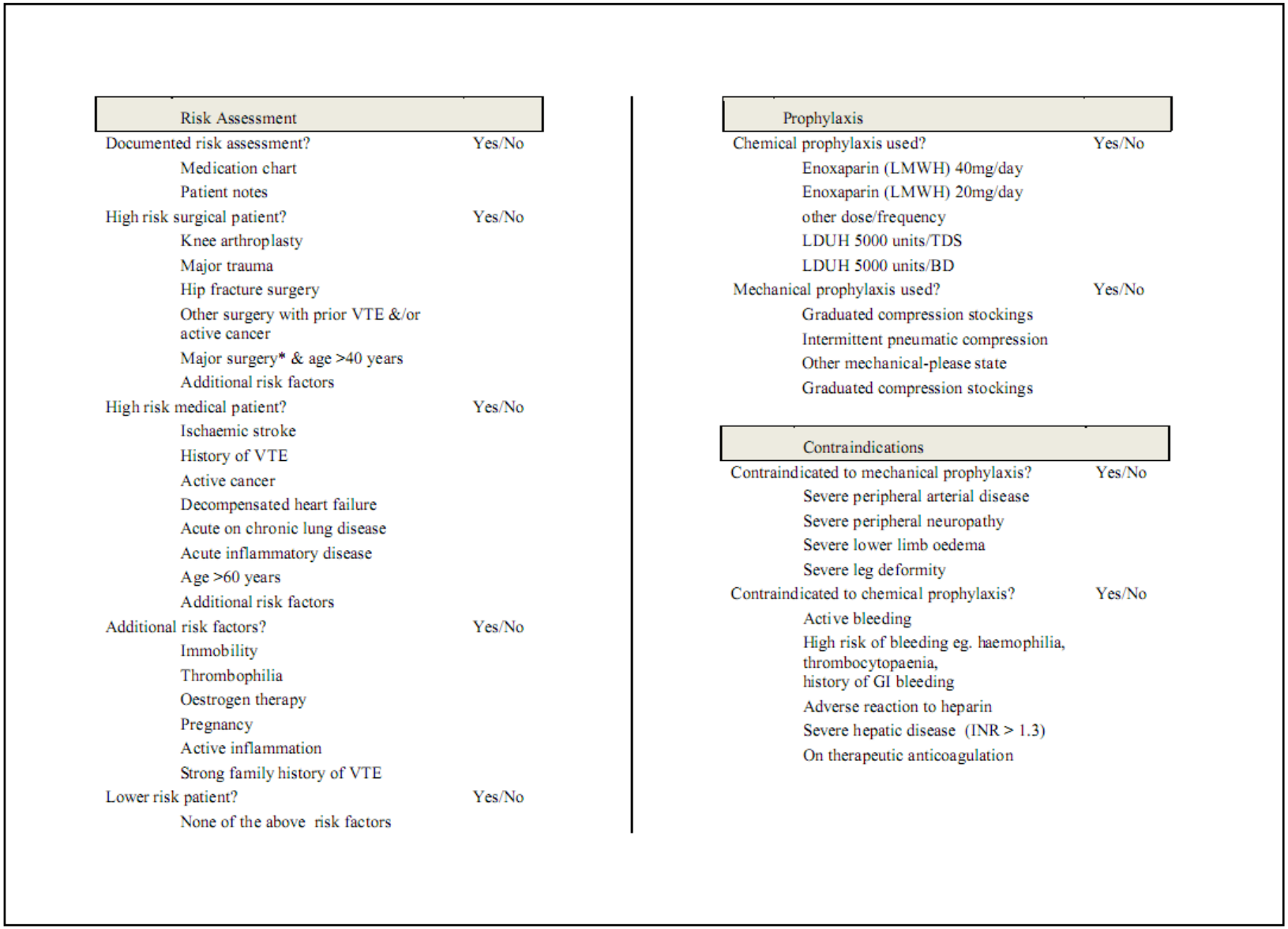
Measures were collected in prospective patient audits (n= 149). This sample size provided power (80%) to detect a 20% change at 5% alpha (two-tail). A stratified (by ward) random sample of patients were audited against the Australian and New Zealand Best Practice Guidelines (2007). An audit tool (see figure 3&4) which had been used in previous national VTE prevention projects (National Institute of Clinical Studies 2008) was used to standardise the process. The audits were conducted by two senior registered nurses (author 1 and author 2) who had received training in the use of the tool. The medical records were reviewed to determine appropriateness of the prescribed pharmacological prophylaxis and patients were observed to establish the presence or absence of mechanical prophylaxis therapies. Prophylaxis was deemed appropriate if it conformed to the locally endorsed evidence-based guidelines (The Australian and New Zealand Working Party on the Management and Prevention of Venous Thromboembolism 2007) with consideration given to individual's VTE risk status and contraindications to either pharmacological or mechanical therapies. The auditors had access to a consultant vascular physician (author 3) to provide expert clinical advice as required.

Specialties (number of specialists)	Baseline audit n (%)	Follow-up audit n (%)
Cardiology (9)	5 (6.8)	9 (12)
Cardiothoracic (5)	9 (12.3)	8 (10.7)
Colorectal (6)	6 (8.2)	7(9.3)
General Medicine (10)	11 (15.1)	8 (10.7)
General Surgery (1)	1 (1.4)	0
Gynaecology (3)	5 (6.8)	0
Haematology (1)	1 (1.4)	0
Neurosurgery (6)	8 (11)	12 (16)
Orthopaedics (12)	19 (26)	16 (21.3)
Plastics (2)	0	2 (2.7)
Urology (4)	6 (8.2)	8 (10.7)
Vascular (2)	2 (2.7)	3 (4)
Total	73	73*

*Medical/surgical specialty missing from two audits

Clinical Unit (number of beds)	Baseline audit n (%)	Follow-up audit n (%)
Intensive Care (12)	3 (4.1)	4 (5.3)
Orthopaedics (50)	21 (28.8)	21 (28)
General medical/ orthopaedic (34)	10 (13.7)	10 (13.3)
Cardiac/ cardiothoracic (38)	10 (13.7)	10 (13.3)
Vascular/ colorectal (38)	9 (12.3)	10 (13.3)
Urology/ genecology (38)	10 (13.7)	10 (13.3
Plastics/ head & neck/ neuro (38)	10 (13.7)	10 (13.3)
Total	73	75

Table 2 & 3 Characteristics of audit population at baseline and follow-up.



Risk Assessment	
Documented risk assessment?	Yes/No
Medication chart	
Patient notes	
High risk surgical patient?	Yes/No
Knee arthroplasty	
Major trauma	
Hip fracture surgery	
Other surgery with prior VTE &/or active cancer	
Major surgery* & age >40 years	
Additional risk factors	
High risk medical patient?	Yes/No
Ischaemic stroke	
History of VTE	
Active cancer	
Decompensated heart failure	
Acute on chronic lung disease	
Acute inflammatory disease	
Age >60 years	
Additional risk factors	
Additional risk factors?	Yes/No
Immobility	
Thrombophilia	
Oestrogen therapy	
Pregnancy	
Active inflammation	
Strong family history of VTE	
Lower risk patient?	Yes/No
None of the above risk factors	

Prophylaxis	
Chemical prophylaxis used?	Yes/No
Enoxaparin (LMWH) 40mg/day	
Enoxaparin (LMWH) 20mg/day	
other dose/frequency	
LDUH 5000 units/TDS	
LDUH 5000 units/BD	
Mechanical prophylaxis used?	Yes/No
Graduated compression stockings	
Intermittent pneumatic compression	
Other mechanical-please state	
Graduated compression stockings	

Contraindications	
Contraindicated to mechanical prophylaxis?	Yes/No
Severe peripheral arterial disease	
Severe peripheral neuropathy	
Severe lower limb oedema	
Severe leg deformity	
Contraindicated to chemical prophylaxis?	Yes/No
Active bleeding	
High risk of bleeding eg. haemophilia, thrombocytopaenia, history of GI bleeding	
Adverse reaction to heparin	
Severe hepatic disease (INR > 1.3)	
On therapeutic anticoagulation	

Figure 3 VTE audit tool (Risk assessment, contraindications and prescribed prophylaxis). Adapted from the National Institute of Clinical Studies (2008).

Recommended VTE prophylaxis			
Surgical risk		Duration (days)	
High	Hip arthroplasty	5-10	LMWH (Enoxaparin 40mg/day) AND IPC (with or without GCS)
	Knee arthroplasty	28-35	
	Major trauma	5-10	
	Other surgery with prior VTE &/or active cancer	5-10	LMWH (Enoxaparin 40mg/day) OR LDUH 5000 units/TDS AND GCS (with or without IPC)
	Hip fracture surgery	28-35	
	Major surgery* & age >40 years	5-10	LMWH(Enoxaparin 20mg/day) OR LDUH 5000 units BD or TDS AND GCS (with or without IPC)
Medical risk			
High	Ischaemic stroke	Until discharge	LMWH(Enoxaparin 40mg/day) OR LDUH 5000 units BD or TDS
	History of VTE		
	Active cancer		
	Decompensated heart failure		
	Acute on chronic lung disease		
	Acute inflammatory disease		
	Age >60 years		
Lower	None of the above		Consider GCS If additional risk factors consider LMWH (Enoxaparin 20mg/day) or LDUH 5000 units BD or TDS

*Surgery >45min or intra-abdominal, LMWH (low molecular weight heparin), IPC (intermittent pneumatic compression), GCS (graduated compression stockings), LDUH (low dose unfractionated heparin), BD (twice daily), TDS(three times daily). Based on the Best Practice Guidelines for Australian and New Zealand 4th ed. (2007).

Audit summary	
Appropriate prophylaxis provided?	Yes/No
Missing mechanical prophylaxis	
Missing chemical prophylaxis	
Mechanical prophylaxis inadequate	
Chemical prophylaxis inadequate	
Both inadequate	
On prophylaxis but not indicated	

Figure 4 VTE audit tool (recommended prophylaxis). Based on the Best Practice Guidelines for Australian and New Zealand 4th ed. (2007).

Data Analysis

Pre and post intervention audit results were entered into Statistical Package for the Social Sciences (SPSS) version 17 and analysed using Fisher's exact test. The P value for statistical significance was set at 5% (0.05).

RESULTS

Table 4 demonstrates significant improvements in the project measures. Both the proportion of patients being assessed for their VTE risk and the proportion of patients receiving appropriate prophylaxis increased post intervention.

Proportion of patients being assessed for their VTE risk

The proportion of all patients assessed for their VTE risk increased by 35%, from 0% at baseline to 35% at follow-up ($p<0.001$). When stratified by specialty, the majority of the improvement resulted from a 54% increase in surgical patients risk assessment, in comparison to only a 3.4% increase in risk assessment of medical patients ($p<0.001$ & $p=0.58$).

Proportion of patients receiving appropriate prophylaxis

The proportion of all patients who received appropriate VTE prophylaxis significantly increased by 19%, 49% at baseline to 68% at follow-up ($p=0.02$). A similar significant improvement was observed among both surgical and medical patients with a 21% increase for surgical patients and a 26% increase for medical patients ($p=0.02$ & $p=0.05$). However, when low-risk patients were excluded from the analysis the improvement for medical patients fell to 16% and was no longer statistically significant ($p=0.12$).

The proportion of all patients receiving appropriate pharmacological prophylaxis increased by 20%, from 61% at baseline to 81% at follow-up (p=0.01). Of this, surgical patient pharmaco-prophylaxis rates increased by 26%, while medical patients' rates increased by only 13% (p=0.01 & p=0.26). For mechanical prophylaxis, the proportion of patients receiving appropriate prophylaxis was not significant and in fact decreased by 0.6% (p=0.54). There was no significant difference in the proportion of medical (13%) and surgical (0.6%) patients receiving appropriate mechanical prophylaxis (p=0.30 & p=0.56).

Key Measures		Baseline (*total*=73)	Follow-up (*total*=75)	% Improvement	p value
		n/total (%)	*n*/total(%)	(95% CI)	
Appropriate VTE prophylaxis	All patients	36/73 (49.3)	51/75 (68)	18.6 (2.8 to 33.3)	0.02
	Medical patients	4/21 (19)	13/29 (44.8)	25.7 (0.0 to 46.7)	0.05
	Surgical patients	32/52 (61.5)	38/46 (82.6)	21.0 (3.1 to 37.9)	0.02
Appropriate VTE prophylaxis (high risk patients)	All high risk patients	30/ 67(44.8)	37/58 (63.8)	19.0 (1.5 to 34.9)	0.03
	Medical high risk patients	3/20 (15)	6/19 (31.6)	15.7 (-9.0 to 41.0)	0.12
	Surgical high risk patients	27/47 (57.4)	31/39 (79.5)	22.0 (2.1 to 39.2)	0.02
Documented VTE risk assessment	All patients	0/73 (0)	26/75 (34.7)	34.7 (23.7 to 45.9)	<0.001
	Medical patients	0/21 (0)	1/29 (3.4)	3.4 (-12.3 to 17.2)	0.58
	Surgical patients	0/52 (0)	25/46 (54.3)	54.3 (38.6 to 67.9)	<0.001
Appropriate mechanical prophylaxis	All patients	53/73 (72.6)	54/75 (72)	-0.6 (-13.7 to 14.8)	0.54
	Medical patients	11/21 (52.4)	19/29 (65.5)	13.1 (-13.3 to 37.8)	0.30
	Surgical patients	46/52 (88.5)	41/46 (89.1)	0.6 (-12.9 to 13.6)	0.59
Appropriate pharmacological prophylaxis	All patients	45/73 (61.6)	61/75 (81.3)	19.6 (5.1 to 33.2)	0.01
	Medical patients	11/21 (52.4)	19/29 (65.5)	13.1 (-13.3 to 37.8)	0.26
	Surgical patients	34/52 (65.4)	42/46 (91.3)	25.9 (9.5 to 40.4)	0.002

Table 4 Changes in VTE prophylaxis and risk assessment rates from baseline to follow-up.

DISCUSSION

The data on the associated mortality and morbidity of VTE are very compelling and the project team found all levels of hospital staff and management were prompt to accept VTE prevention as an organisational priority. This enthusiasm may help to explain the significant increase in prophylaxis rates. The change observed in this project (19%) is nearly two times greater than the median improvement (10%) identified in a systematic review of 235 guideline dissemination and implementation strategies (Grimshaw et al. 2004).

The change strategy exercised a positive effect on both medical and surgical specialties with improvements of 26% and 21% respectively. Medical prophylaxis rates remained considerably lower post intervention when compared to surgical rates (45% and 83% respectively). There was, however, a significant difference between the rates of improvement for pharmacological and mechanical prophylaxis measures. Appropriate pharmacological prophylaxis increased dramatically (20%) while appropriate mechanical prophylaxis failed to show any improvement (-0.6%). In our organisation, medical staff are responsible for pharmacological prophylaxis while the nursing staff are responsible for managing mechanical prophylaxis. The variation in the improvement between pharmacological and mechanical prophylaxis in this project may suggest that the intervention was more effective on medical staff than on the nursing staff.

The primary measure used in this project was the 'proportion of adult inpatients receiving appropriate VTE prophylaxis'. This measure was selected based on its use in previous VTE prevention projects (National Institute of Clinical Studies 2008). We found that this measure overestimated prophylaxis rates in some categories of patients. For example, appropriate prophylaxis for low-risk medical patients requires no active treatment. This means, however, that patients receiving no active treatment through omission were also

deemed to have received appropriate care. In light of this, the use of this clinical indicator should be reconsidered and redefined as 'the proportion of *high-risk* patients receiving appropriate prophylaxis'.

It was decided that risk assessments would be conducted by the nursing staff. This decision was made after considering the local context and available evidence (Collins *et al.*). Risk documentation involved the application of a high or low-risk sticker on the medication chart at admission. The intervention was much more effective in promoting risk assessment in surgical cases than in medical cases (54.3% compared to 3.4%). This result may be explained by the fact that the majority of surgical cases in our organisation are elective and therefore have a better coordinated and more systematic admission which usually includes a preadmission visit (85%). This is in contrast to medical cases which are often less well planned or are emergency cases. Further strategies are required to capture patients who enter the hospital in this way.

The introduction of sustainable solutions to the problem of VTE prevention was one of the project's main objectives. Sustainability was structured into the project by embedding interventions into existing clinical practice. For example, VTE prevention roles and responsibilities were officially clarified in a hospital-wide policy and this policy was endorsed and disseminated by the hospital executive. The development and introduction of a decision support tool was also 'hard wired' into practice by having it printed into the inpatient medication chart. Evidence of the sustained effectiveness of these strategies will need to be collected in further follow-up audits.

Limitations

Due to the concurrent roll-out of interventions it is impossible to evaluate the effectiveness of each of the individual strategies used in the improvement plan. This could have been overcome through the inclusion of a process evaluation in the project design which would

have enabled greater insight into the mechanisms responsible for the changes observed (Hulscher *et al.* 2004). A cost benefit analysis would also further evaluate this multifaceted change strategy.

The uncontrolled before-and-after design is also a limitation of the project. This quasi experimental design was chosen for pragmatic reasons as it was not possible to randomise the intervention without significant target population contamination. Unfortunately, this design is vulnerable to the influence of contemporary and fluctuating trends in treatment modalities or sudden organisational changes in policy or governance and this makes it difficult to attribute improvements solely to the intervention. There is also some evidence to suggest that the results of uncontrolled before and after studies may over-estimate the effects of interventions (Grimshaw *et al.* 2000).

Lessons learnt

A multifaceted improvement strategy including audit and feedback; documentation and decision support aids; provider education; and policy development can result in significantly improved rates of VTE prophylaxis and risk assessment in adult hospitalised patients. There remains, however, a need to address the discrepancy between medical and surgical prophylaxis rates (83% and 45% respectively). A specifically targeted intervention may be required to improve medical patient prophylaxis

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