CONTROVERSES ET ACTUALITÉS EN CHIRURGIE VASCULAIRE
CONTROVERSIES & UPDATES IN VASCULAR SURGERY
JANUARY 25-27 2018
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Neuromuscular Electrical Stimulation in Venous Disease

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Disclosure

Speaker name:

Joseph Shalhoub

☒ I have the following potential conflicts of interest to report:

☐ Consulting

☐ Employment in industry

☐ Shareholder in a healthcare company

☐ Owner of a healthcare company

☒ Other(s):

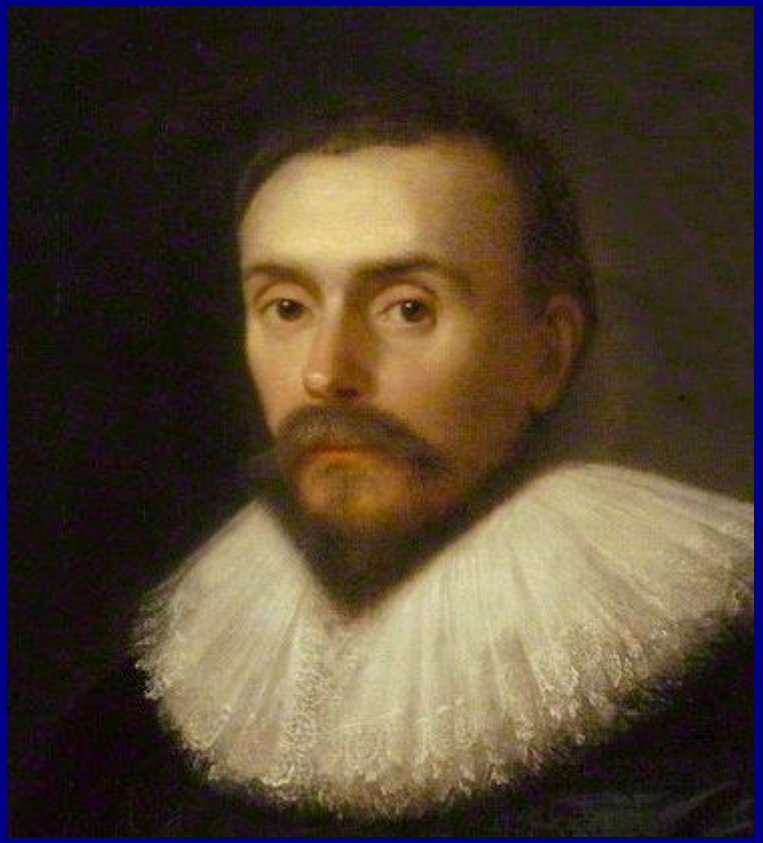
Department support for NMES research by NMES companies

☐ I do not have any potential conflict of interest

Combining Sciences

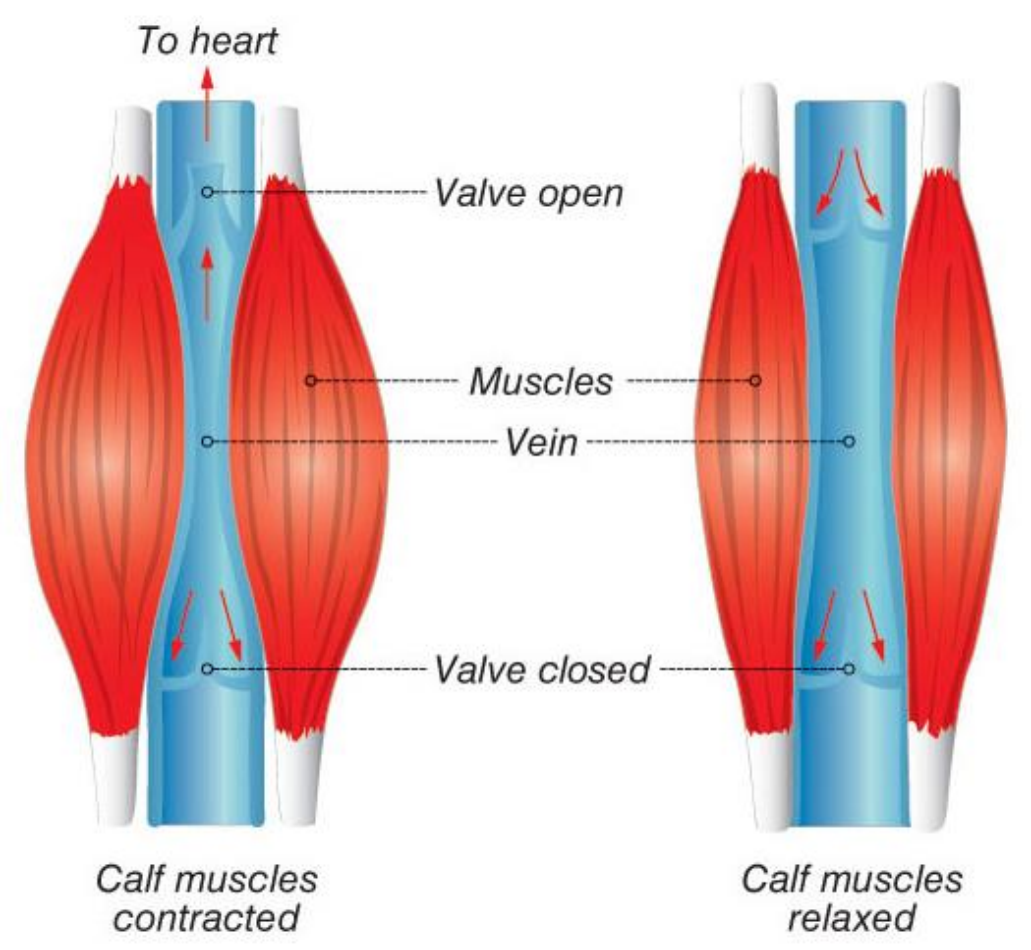
Luigi Galvani

William Harvey



Venous Disease

- Ambulatory venous hypertension
- ~50% reduction with calf muscle pump activation



Electrical Muscle Stimulators

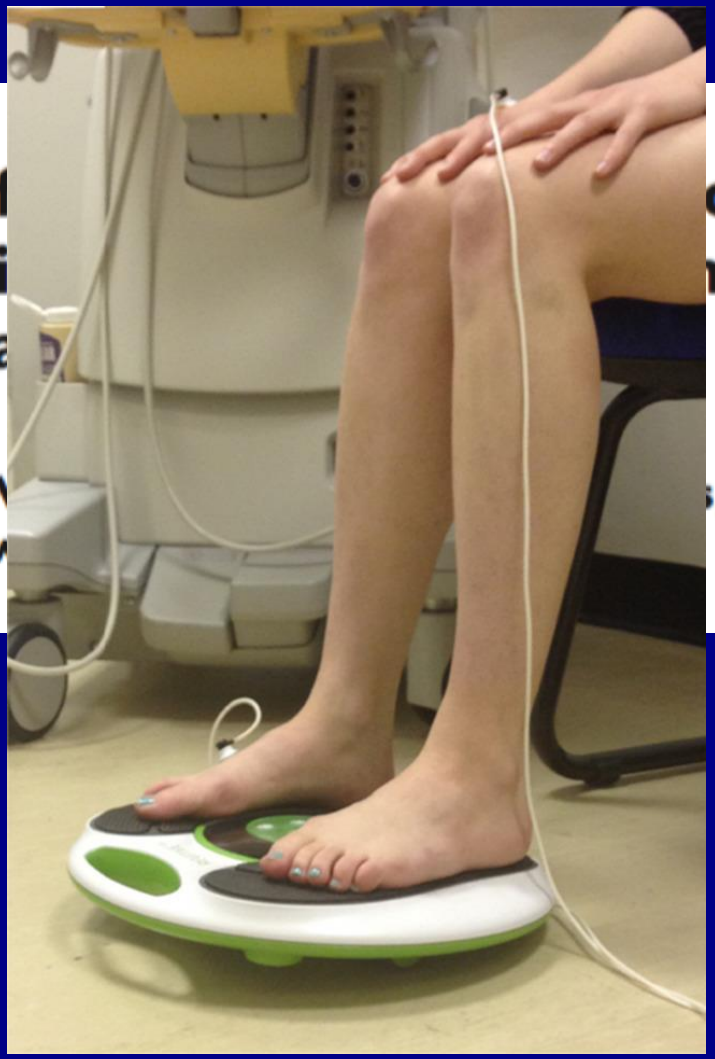
Direct stimulation of muscle

Indirect stimulation via nerve

Explore

- Venous haemodynamic impact of NMES
- Potential clinical applications of NMES in venous disease
- NMES for VTE prevention

Impact on Venous Haemodynamics



The ef … omuscular
electri … nous and
arteria …

Lavanya V … , Hayley Moore and
Alun Huv …

Phlebology
2015, Vol. 30(9) 648–650

DOI: 10.1177/0268355514542682
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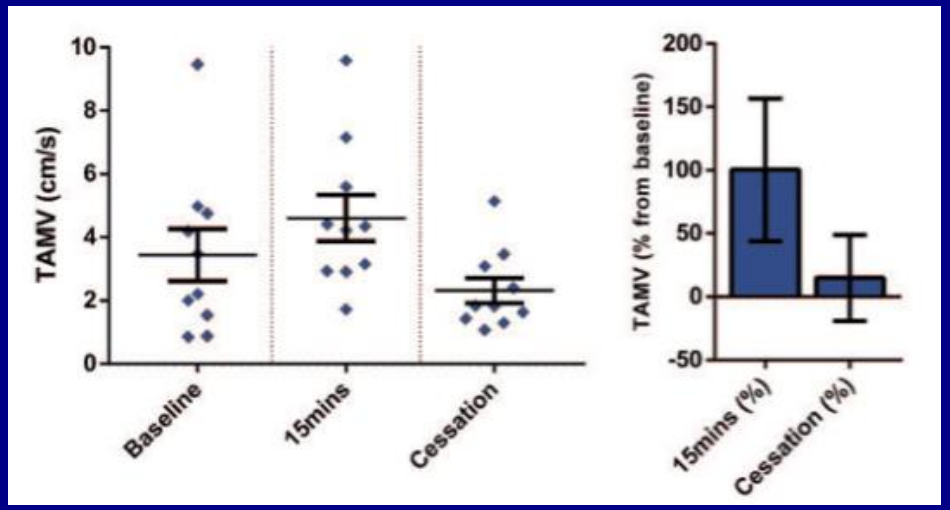
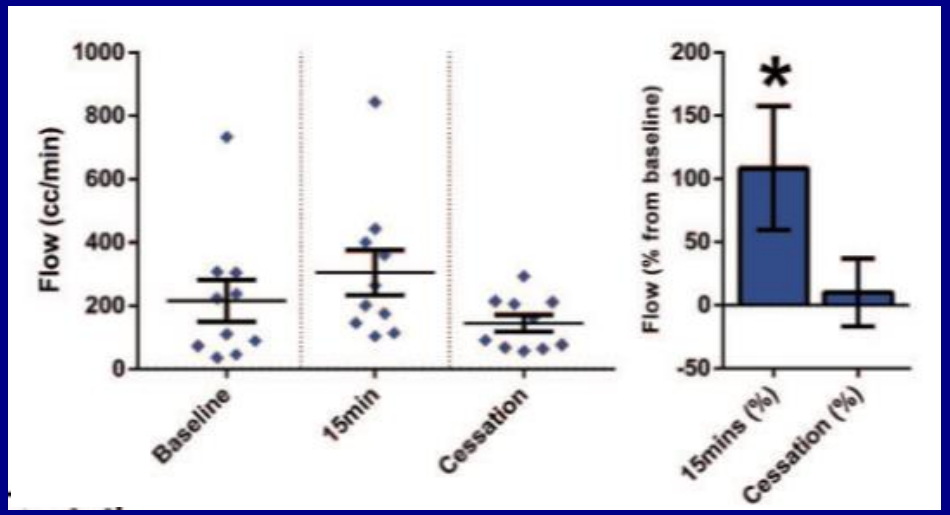
n=10 healthy subjects

Time averaged mean velocity (cm/s)



Flow (cc/min)



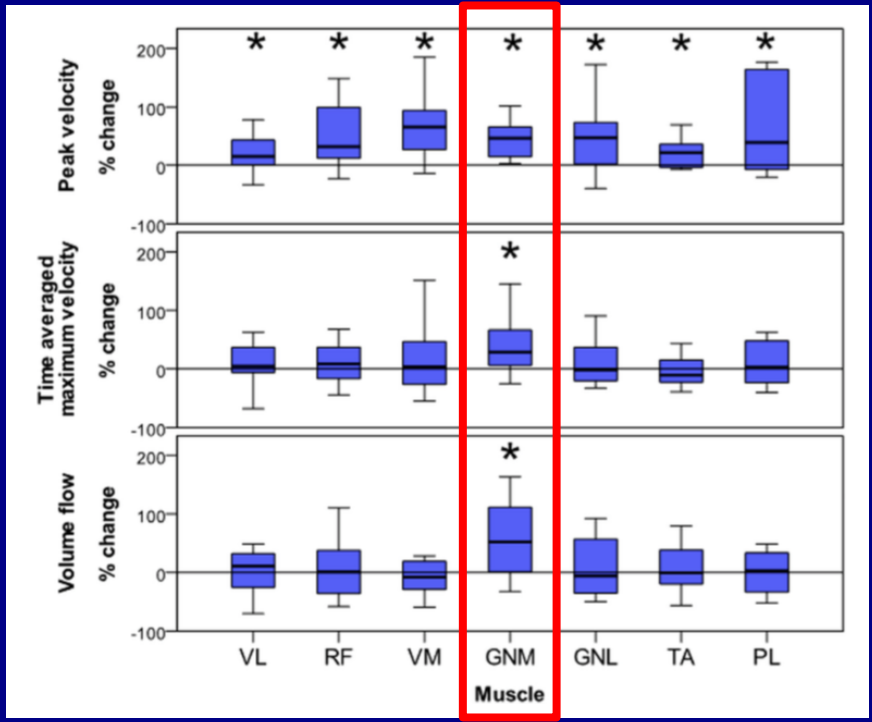
Which Muscle Group to Target?

CrossMark

Journal of
Vascular Surgery
Venous and Lymphatic Disorders™

The comparative hemodynamic efficacy of lower limb muscles using transcutaneous electrical stimulation

David Rhodri Scourfield Evans, BSc,[a] Katherine J. Williams, MBBS, MA (Cantab), MRCS,[b] Paul H. Strutton, PhD, BSc,[c] and Alun H. Davies, BM BCh, DM (Oxon), FRCS, FHEA,[b] *Cardiff and London, United Kingdom*



Local vs Systemic Impact?

CrossMark

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Venous and Lymphatic Disorders™

The comparative hemodynamic efficacy of lower limb muscles using transcutaneous electrical stimulation

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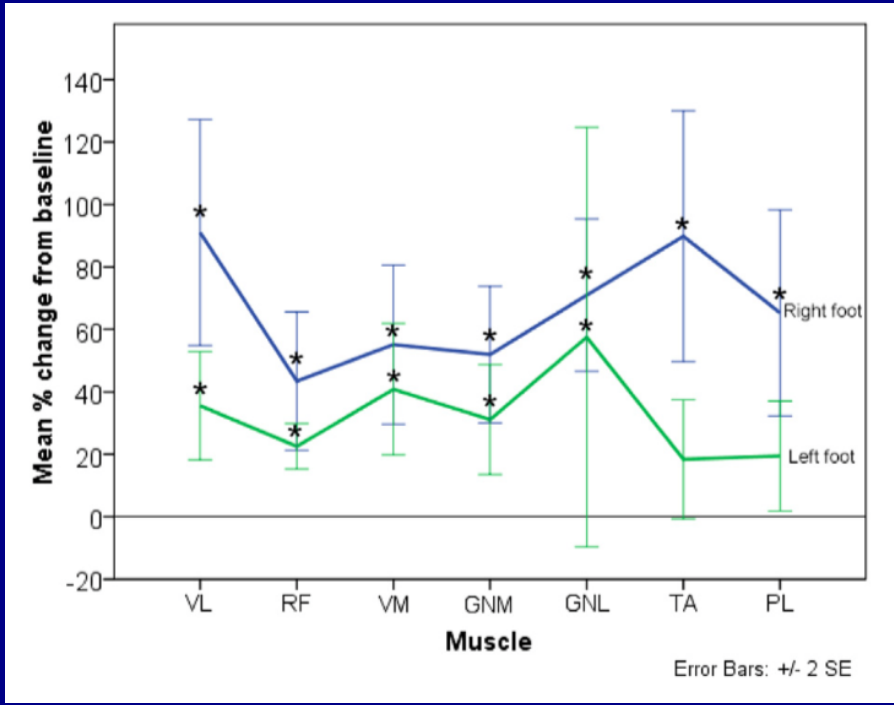
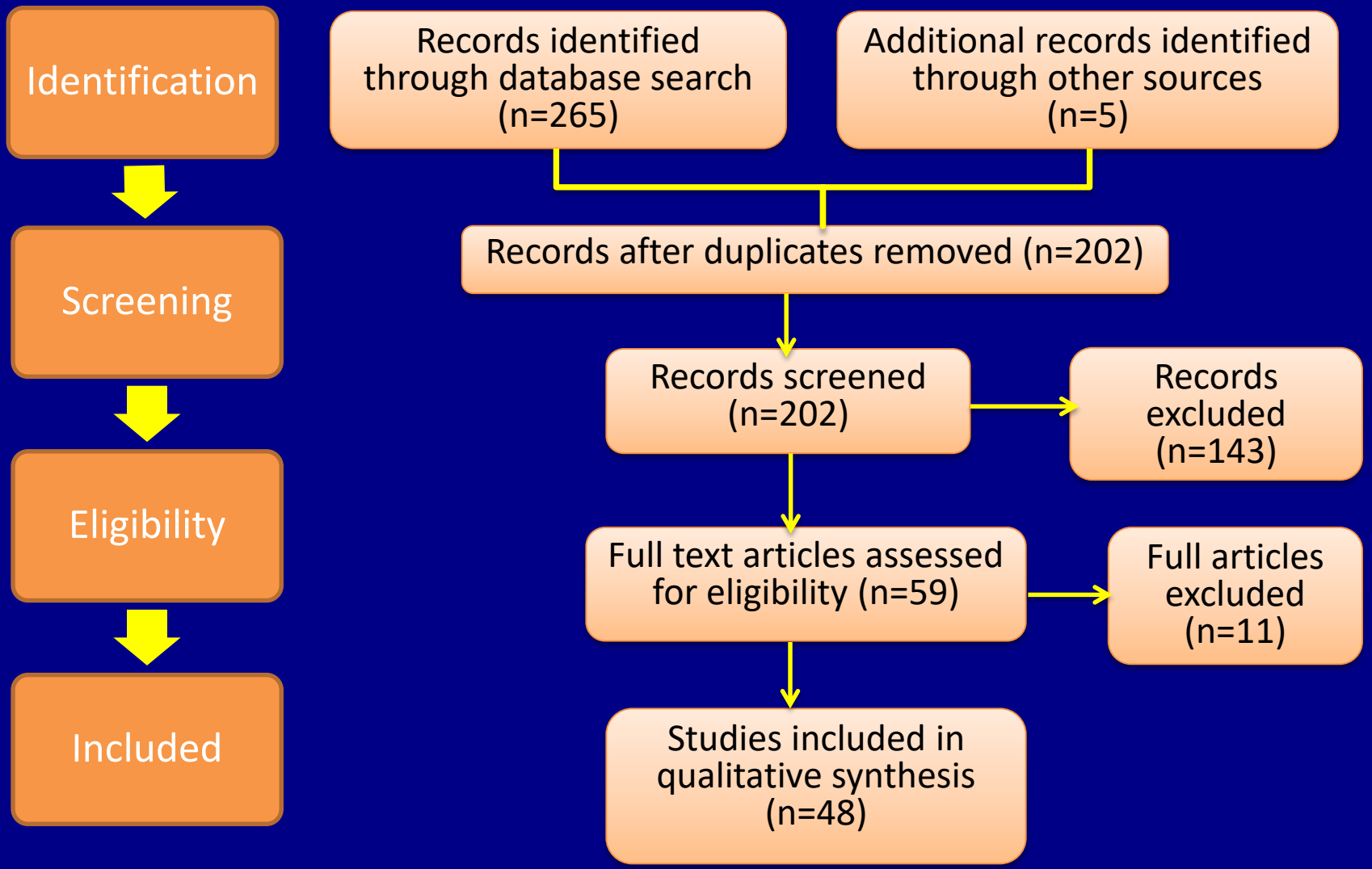
Laser Doppler Blood Flow



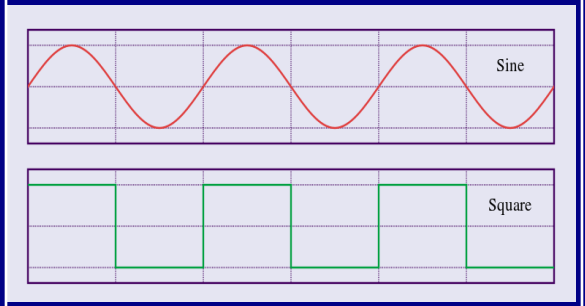
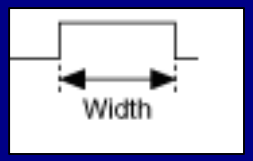
Right Stimulated

Left Unstimulated

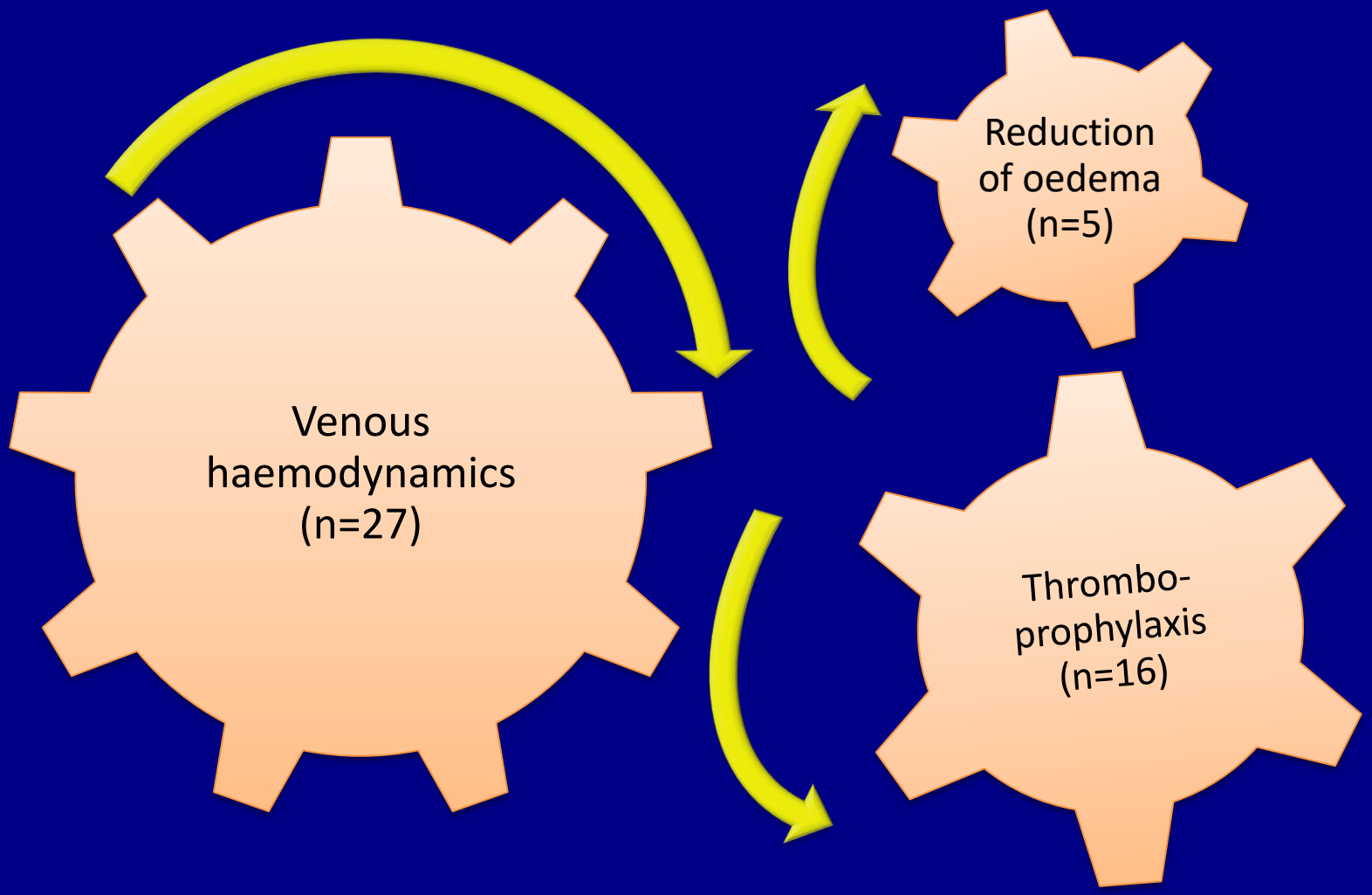
Potential Applications of NMES in Venous Disease



Variation in Electrical Parameters and Outcome Measures

Pulse Waveform	Pulse duration	Frequency
 “galvanic” “trapezoidal”	 200 - 350µs	Freq (Hz) = $\frac{1}{\text{duration}}$ 1-250Hz
Intensity	**Electrode placement**	**Outcome measure**
“miliAmperes” “microCoulombs” “Volts” “to achieve muscle contraction”	Direct - Calf muscle Indirect - Tibial nerve - Common peroneal nerve	Air plethysmography Photoplethysmography Strain gauge plethysmography Venous occlusion plethusmography Venous duplex

Results of Systematic Review



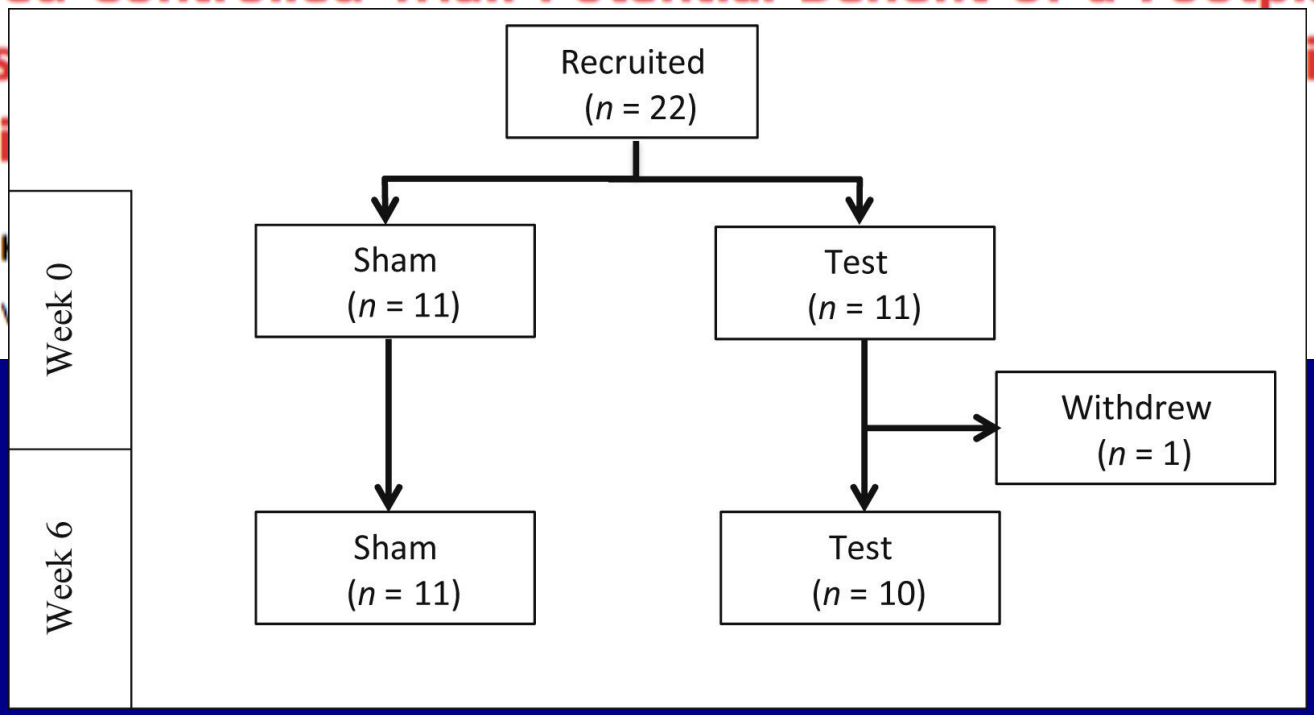
Plot Clinical Study in CVI

Eur J Vasc Endovasc Surg (2017) 53, 114–121

Randomised Controlled Trial: Potential Benefit of a Footplate Neuromus ith Chronic Venous Di

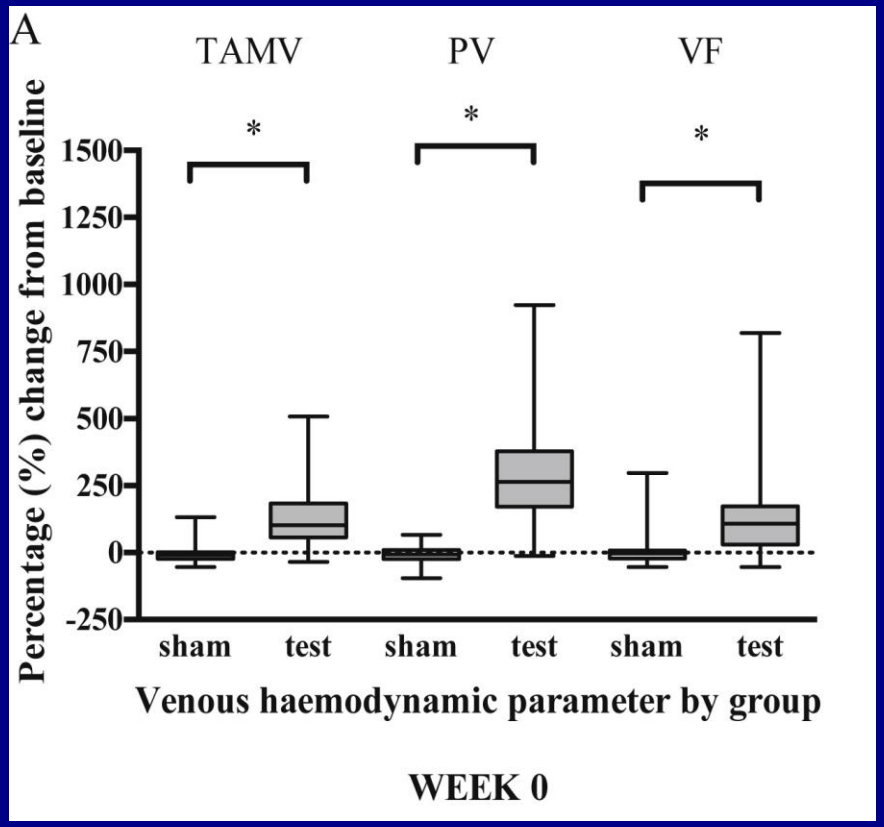
R. Ravikumar *, I

Academic Section of V

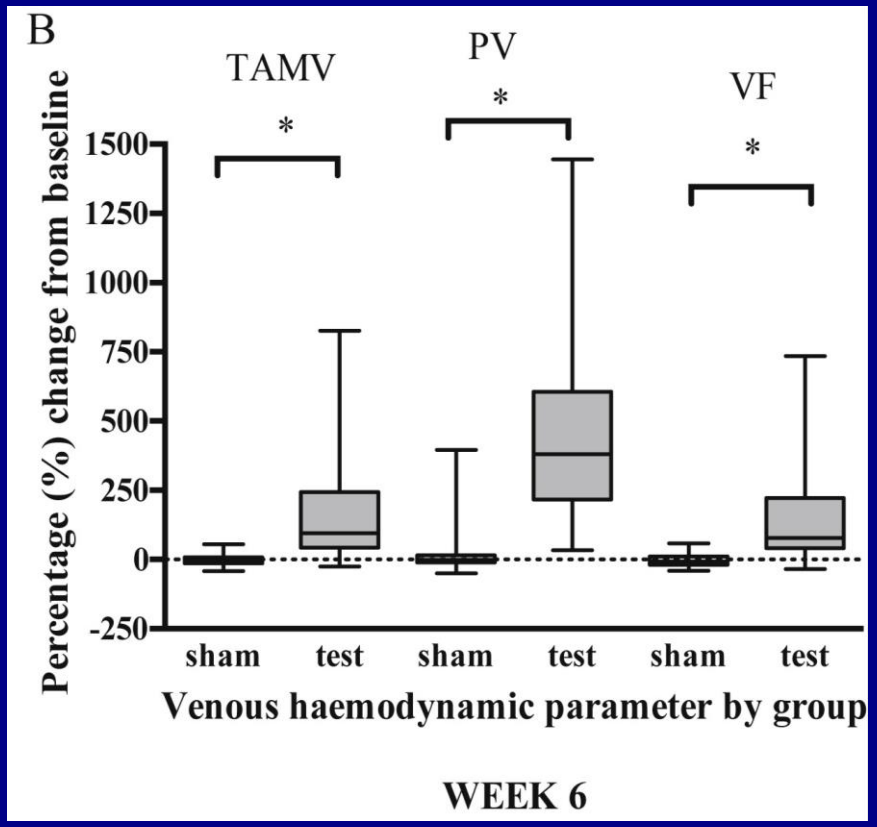


Haemodynamics in Individuals with Venous Disease

Week 0



Week 6



NMES and Limb Volume

Table 2. Limb volume in sham and test group pre- and post-stimulation at week 0 and week 6.

Week	Sham			Test		
	Pre-stimulation, mean ± SD (mL)	Post-stimulation, mean ± SD (mL)	*p*	Pre-stimulation mean ± SD (mL)	Post-stimulation mean ± SD (mL)	*p*
0	5,107 ± 1,252	5,208 ± 1,252	.0001[a]	5,377 ± 1,122	5,422 ± 1,127	.0623
6	5,143 ± 1,269	5,203 ± 1,272	.0023[a]	5,500 ± 1,173	5,553 ± 1,168	.0815

NMES and Quality of Life

Table 3. Percentage difference (%) in questionnaire scores over 6 weeks in the sham and test group.

	Sham Difference in QOL score	Test Difference in QOL score	Statistical analysis *p*
VCSS	6.4 ± 20.7[a]	−11.8 ± 31.2[a]	.127[a]
AVVQ	−3.0 (−15.3 to 68.3)[b]	−28.4 (−84.7 to −3.1)[b]	.045 *,[b]
EQ5D	0.00 (−17.53 to 18.20)[b]	0.00 (−7.55 to 1.14)[b]	.739[b]
EQ5D:VAS	−14.3 (−37.5 to 20.0)[b]	−5.0 (−11.5 to 4.2)[b]	.321[b]
SF-12: PCS	10.9 ± 24.7[a]	0.6 ± 12.7[a]	.254[a]
SF-12: MCS	−10.0 ± 22.5[a]	9.4 ± 16.3[a]	.037 **,[a]

What about DVT?

Mechanical

1960s

1970s

1900s — 1950s — 2000s

Chemical

1916 — Heparin (McLean & Howell)

1936 — Unfractionated heparin (UFH)

1954 — Warfarin

1980s — Low molecular weight heparin (LMWH) & factor Xa inhibitors

2000s — New oral anticoagulants

NMES and VTE Prevention

Review Article

Phlebology

Phlebology
0(0) 1–12

DOI: 10.1177/0268355517710130
journals.sagepub.com/home/phl
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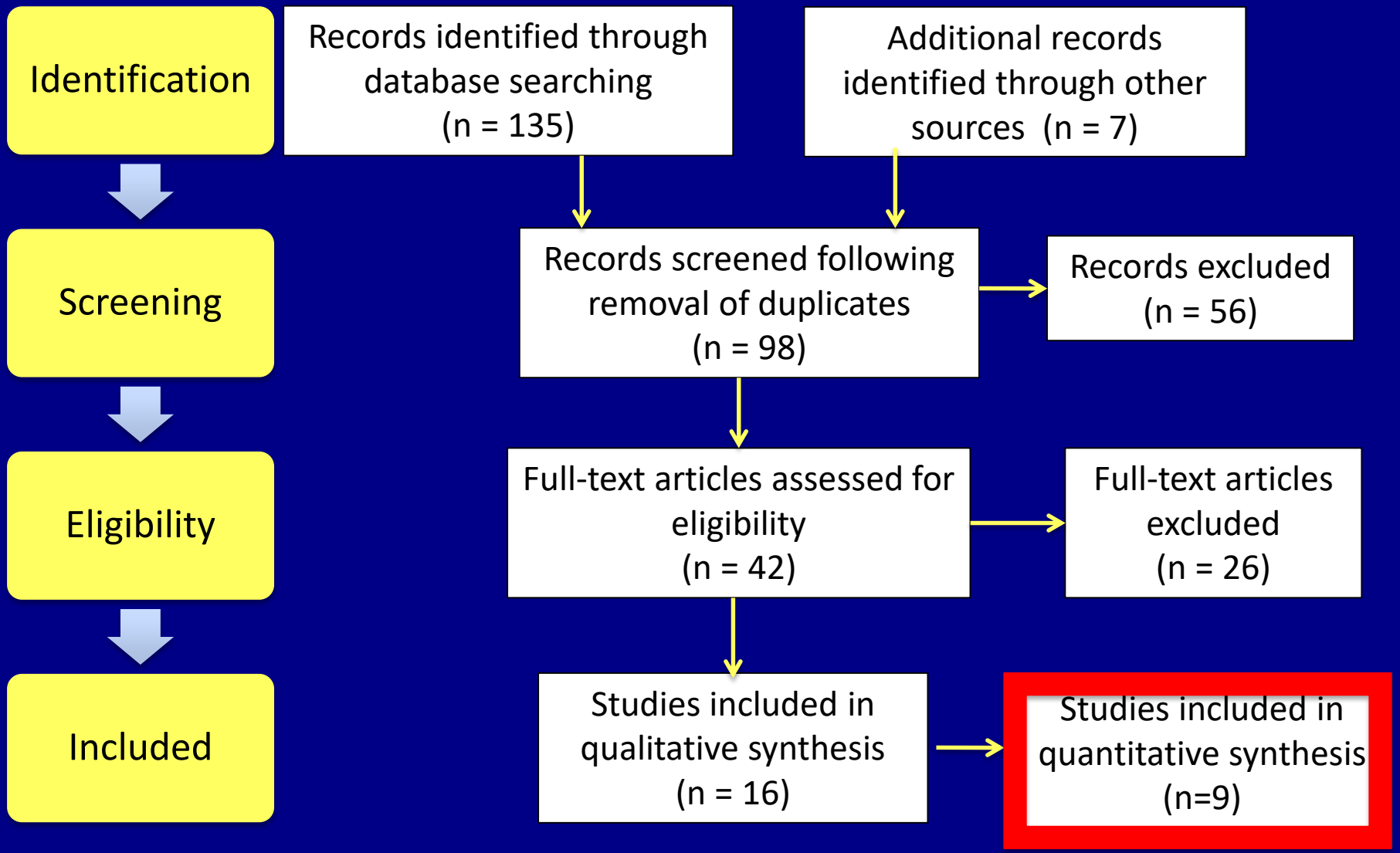
Neuromuscular electrical stimulation for the prevention of venous thromboembolism

Raveena Ravikumar, Katherine J Williams, Adarsh Babber, Hayley M Moore, Tristan RA Lane, Joseph Shalhoub and Alun H Davies

NMES and VTE Prevention

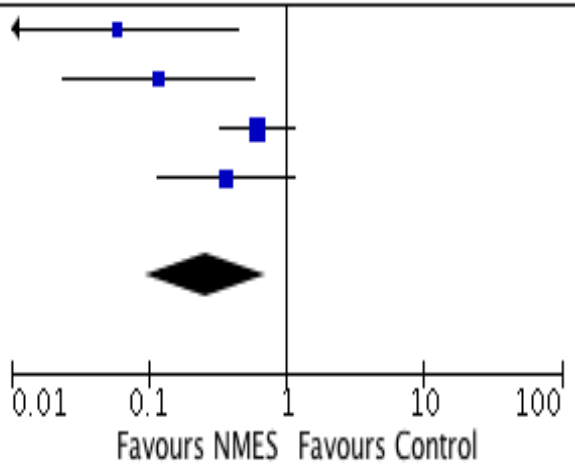


DVT
NMES vs Control

Study or Subgroup	NMES Events	NMES Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Nicolaides 1972	1	60	25	112	15.7%	0.06 [0.01, 0.45]	1972
Becker 1973	2	39	11	35	20.6%	0.12 [0.02, 0.58]	1973
Rosenberg 1975	22	73	50	121	36.6%	0.61 [0.33, 1.14]	1975
Lindstrom 1982	5	37	12	40	27.2%	0.36 [0.11, 1.16]	1982
Total (95% CI)		**209**		**308**	**100.0%**	**0.26 [0.10, 0.72]**	
Total events	30		98				

Heterogeneity: $Tau^2 = 0.63$; $Chi^2 = 8.04$, df = 3 (P = 0.05); $I^2 = 63\%$

Test for overall effect: Z = 2.60 (P = 0.009)



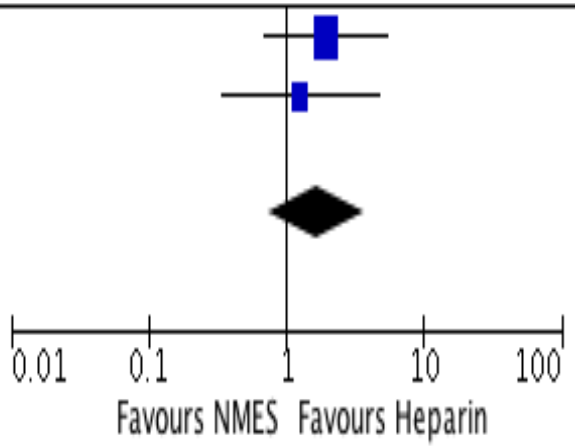
Favours NMES (p=0.009)

DVT
NMES vs Unfractionated Heparin

Study or Subgroup	NMES Events	NMES Total	Heparin Events	Heparin Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Nicolaides 1983	12	50	7	50	62.1%	1.94 [0.69, 5.43]	1983
Bostrom 1986	5	40	5	49	37.9%	1.26 [0.34, 4.69]	1986
Total (95% CI)		**90**		**99**	**100.0%**	**1.65 [0.73, 3.70]**	
Total events	17		12				

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 0.26$, df = 1 (P = 0.61); $I^2 = 0\%$

Test for overall effect: Z = 1.20 (P = 0.23)



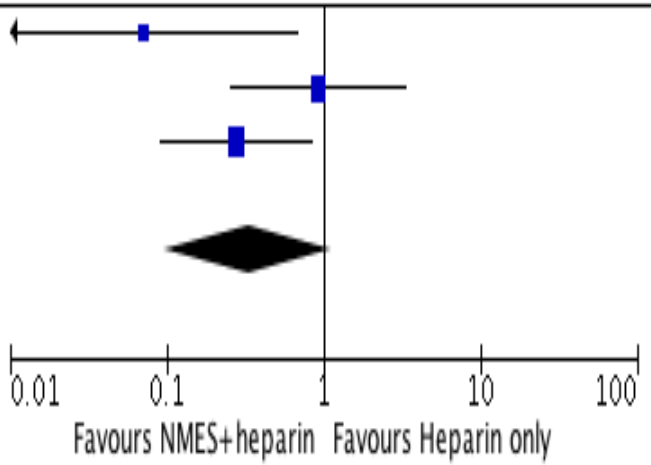
No significant difference (p=0.23)

DVT
NMES+Heparin vs Heparin

Study or Subgroup	NMES + Heparin Events	NMES + Heparin Total	Heparin Events	Heparin Total	Weight	Odds Ratio M-H, Random, 95% CI	Year
Merli 1988	1	15	8	16	20.5%	0.07 [0.01, 0.68]	1988
Velmahos 2005	7	26	6	21	37.8%	0.92 [0.26, 3.32]	2005
Izumi 2014	5	45	14	45	41.8%	0.28 [0.09, 0.85]	2014
Total (95% CI)		**86**		**82**	**100.0%**	**0.33 [0.10, 1.14]**	
Total events	13		28				

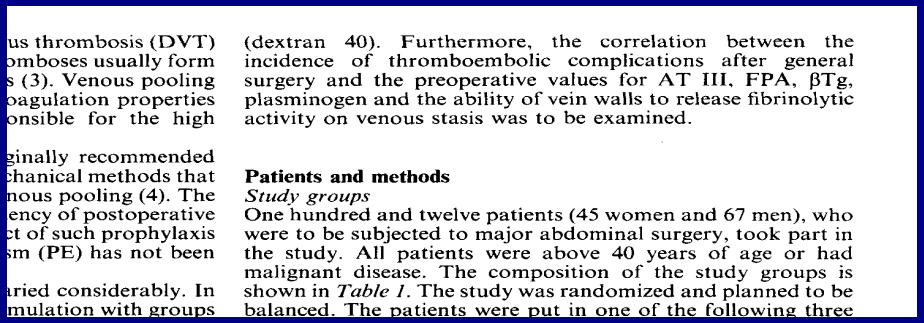
Heterogeneity: $Tau^2 = 0.63$; $Chi^2 = 4.28$, df = 2 (P = 0.12); $I^2 = 53\%$

Test for overall effect: Z = 1.75 (P = 0.08)



No significant difference (p=0.08)

NMES and Pulmonary Embolism Prevention



us thrombosis (DVT)
omboses usually form
s (3). Venous pooling
oagulation properties
onsible for the high

ginally recommended
chanical methods that
nous pooling (4). The
ency of postoperative
ct of such prophylaxis
sm (PE) has not been

aried considerably. In
mulation with groups

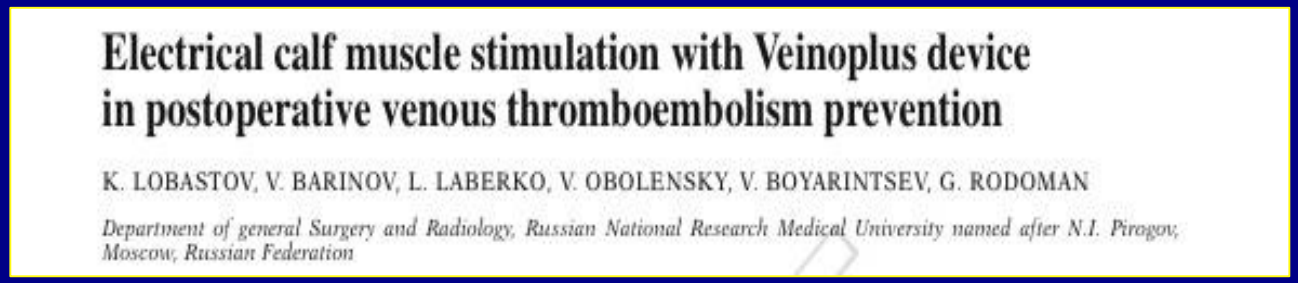
(dextran 40). Furthermore, the correlation between the incidence of thromboembolic complications after general surgery and the preoperative values for AT III, FPA, βTg, plasminogen and the ability of vein walls to release fibrinolytic activity on venous stasis was to be examined.

Patients and methods

Study groups

One hundred and twelve patients (45 women and 67 men), who were to be subjected to major abdominal surgery, took part in the study. All patients were above 40 years of age or had malignant disease. The composition of the study groups is shown in *Table I*. The study was randomized and planned to be balanced. The patients were put in one of the following three

NMES 6/37
No thromboprophylaxis
14/40
ARR 18%



Electrical calf muscle stimulation with Veinoplus device in postoperative venous thromboembolism prevention

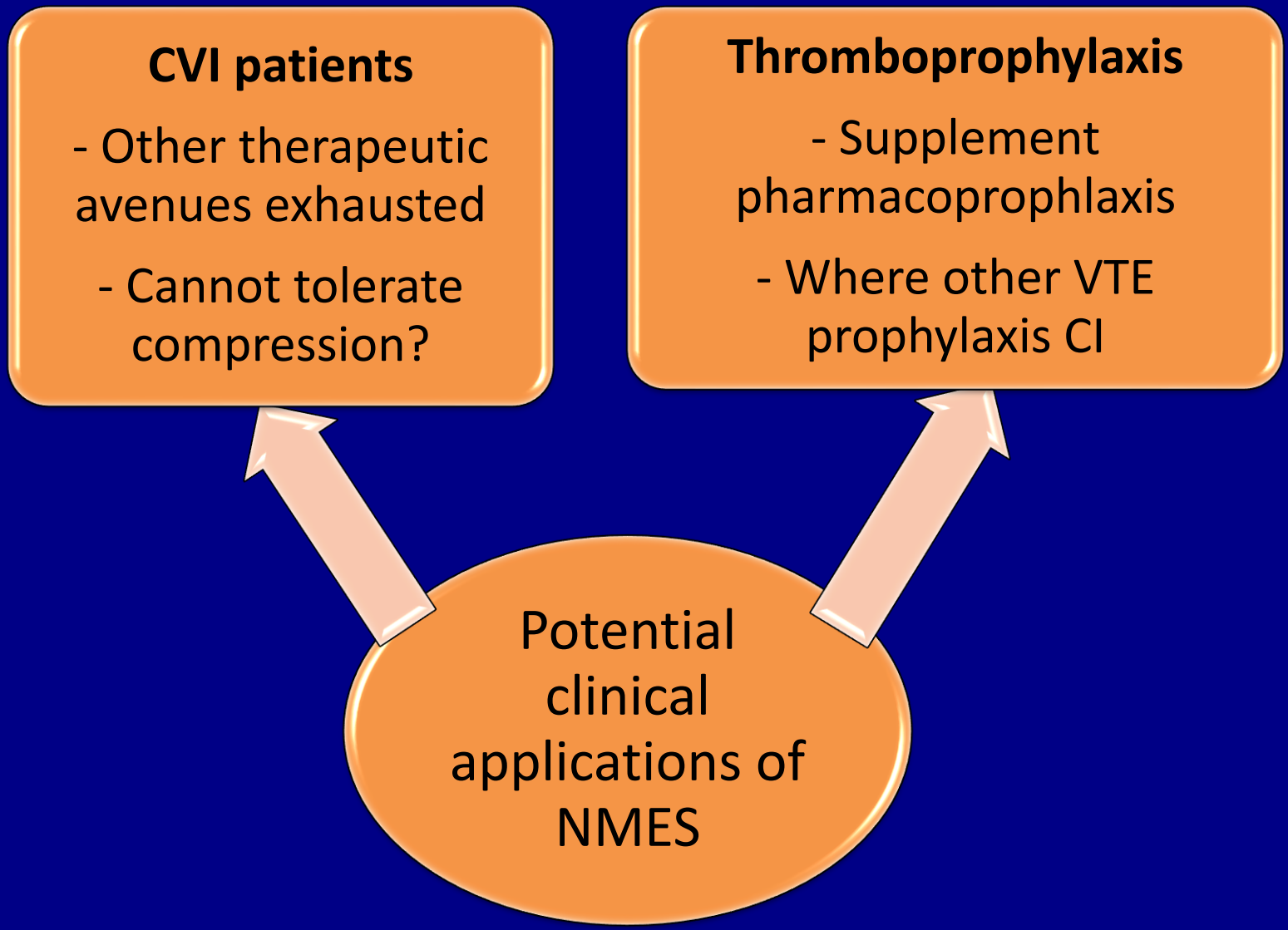
K. LOBASTOV, V. BARINOV, L. LABERKO, V. OBOLENSKY, V. BOYARINTSEV, G. RODOMAN

Department of general Surgery and Radiology, Russian National Research Medical University named after N.I. Pirogov, Moscow, Russian Federation

NMES 2/40
Control 0/40
ARR 5%

- Old studies
- Inadequate control arms

Impact on Clinical Practice



Neuromuscular Electrical Stimulation in Venous Disease

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Thank you

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Raveena Ravikumar
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