TS-school Brussels | training course on Tourette Syndrome

Tuesday 6 June 2023

Royal Museum for Central Africa

Behavioural therapy and deep brain stimulation for Tourette syndrome

Andreas HARTMANN, MD

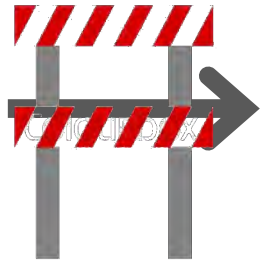
Department of Neurology

Hôpital de la Pitié-Salpêtrière, Paris / France

andreas.hartmann@aphp.fr

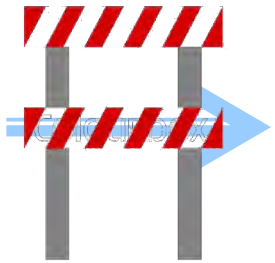
2023 Brussels

Behaviour therapy: theoretic principles

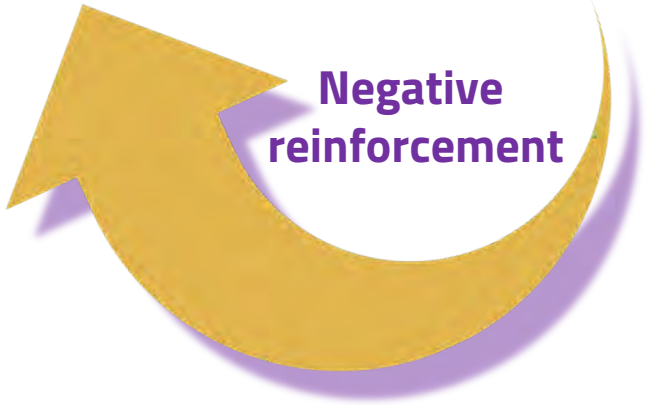
Stimulus  Response 

Consequence

Tic blockage

Premonitory sensation  TIC 

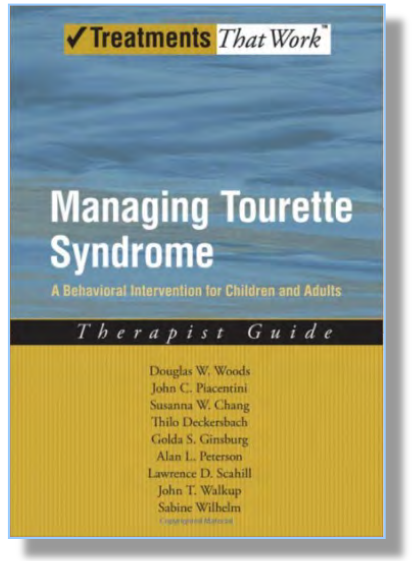
Relief



BT for tics: two methods

Habit reversal training (HRT):

- Treat tics one by one
- Awareness training and competing response training
- Change environmental factors



Exposure and response prevention (ERP):

- Targets all tics at once
- Resisting tics for a long period of time
- Exposure to premonitory urges

Results post treatment

Authors	N	Age M (SD)	Interven	pre	post	% improv	Effect size
Wilhelm et al, 2003 HRT > ST	32	36.2 (12.7)	HRT ST	30.5 26.6	19.8 26.9	**35.1%** -1.1%	**1.50** -0.03
Verdellen et al, 2004 HRT = ERP	43	20.6 (12.1)	HRT ERP	24.1 26.2	19.7 17.6	**18.3%** **32.8%**	**1.06** **1.42**
Deckersbach et al, 2006 HRT > ST	30	35.1 (12.2)	HRT ST	29.3 27.7	18.3 26.8	**37.5%** 3.2%	
Piacentini et al, 2010 HRT > ST	126	11.7 (2.3)	HRT ST	24.7 24.6	17.1 21.1	**30.8%** 14.2%	**0.68**
Wilhelm et al, 2012 HRT > ST	122	31.5 (13.7)	HRT ST	24.0 21.8	17.8 19.3	**25.8%** 11.5%	**0.57**
Yates et al, 2016 Group HRT > PE	33	12.0 (1.38)	G HRT G PE	29.0 30.5	25.6 27.2	**18%** 11%	**0.39**
Rizzo et al, 2018 BT > PE BT = med	110	11.2 (2.43)	BT PE Med	19.7 21.9 24.1	12.3 21.9 14.7	**37.5%** 0% **39.0%**	
Nissen et al, 2018 Grp= Ind HRT/ERP	59	12.2 (2.32)	G comb Ind comb	23.4 23.8	15.9 14.3	**32,1%** **39.9%**	**1.38** **1.21**
Andren et al 2019 BIP-TIC ERP > HRT	23	11.80 (2.51)	BIP ERP BIP HRT	23.75 23.45	19.00 21.18	**20%** **9,7%**	**0.73**
Rachamim et al 2020 iCBIT > WL	41	11.26 (1.94)	iCBIT WL	22.72 21.88	16.12 20.94	**29.0%** 4.2%	**0.83**
Hollis et al., 2021 Online ERP>online PE	224	12.2 (2.0) 12.4 (2.1)	OnlineERP Online PE	28.4 28.4	23.9 26.8	**15.8%** 5.6%	**0.31**

Results at follow-up

Authors	Int	Pre	Post	FU 3mths	FU 6mths	FU 10/12mths	% impro
Wilhelm et al, 2003	HRT (17) ST (15)	30.5 26.6	19.8 26.9			21 23.8	**31.1%** 10.5%
Verdellen et al, 2004	HRT (22) ERP (21)	24.1 26.2	19.7 17.6	13.5 14 .0			**44.0%** **46.6%**
Deckers-bach et al, 2006	HRT (15) ST (15)	29.3 27.7	18.3 26.8		18.4 26.6		**37.2%** 4%
Piacentini et al, 2010	HRT (61) ST (65)	24.7 24.6	17.1 21.1	13.9 9.9	13.3 10.4		**46.2%** 57.7%
Wilhelm et al, 2012	HRT (63) ST (59)	24.0 21.8	17.8 19.3				
Dabrowski et al, 2018	HRT (16) PE (17)	29.0 30.5	25.6 27.2			22.2 23.0	**17.8%** 11.2%
Rizzo et al, 2018	BT (25) MED(47) PE (24)	19.76 24.13 21.96	11.44 15.70 21.66	12.36 14.72 20.67			**37,4%** **39%** 5.8%
Andrén et al 2019	BIP ERP BIP HRT	23.75 23.45	19.00 21.18	18.25 20.18	15.00 19.45	16.92 19.36	**36,8 %** **17.1 %**
Hollis et al., 2021	OnlineERP online PE	28.4 23.9 28.4 26.8			21.5 25.0		**24.3 %** 10.7 %

AMERICAN ACADEMY OF NEUROLOGY

SPECIAL ARTICLE

Practice guideline recommendations summary: Treatment of tics in people with Tourette syndrome and chronic tic disorders

Tamara Pringsheim, MD, MSc, Michael S. Okun, MD, Kirsten Müller-Vahl, MD, Davide Martino, MD, PhD, Joseph Jankovic, MD, Andrea E. Cavanna, MD, PhD, Douglas W. Woods, PhD, Michael Robinson, Elizabeth Jarvie, MSW, LCSW, Veit Roessner, MD, Maryam Oskoui, MD, Yolanda Holler-Managan, MD, and John Piacentini, PhD

Correspondence
American Academy of Neurology
guidelines@aan.com

Neurology® 2019;92:896-906. doi:10.1212/WNL.0000000000007466

Level	Recommendation
Level B	For people with tics who have access to CBIT, clinicians should prescribe CBIT as an initial treatment option relative to other psychosocial/behavioral interventions.
Level B	For people with tics who have access to CBIT, clinicians should offer CBIT as an initial treatment option relative to medication.
Level C	Clinicians may prescribe CBIT delivered over teleconference or secure voice-over-internet protocol delivery systems if face-to-face options are unavailable in a patient care center. If CBIT is unavailable, other behavioral interventions for tics may be acceptable, such as exposure and response prevention.

High confidence in the evidence

People with tics receiving the Comprehensive Behavioral Intervention for Tics are more likely than those receiving supportive psychotherapy to have reduced tic severity (SMD 0.56; 95% confidence interval [CI] 0.31–0.82, high confidence, 2 Class I studies[22,23]).

European Child & Adolescent Psychiatry
https://doi.org/10.1007/s00787-021-01845-z

REVIEW

European clinical guidelines for Tourette syndrome and other tic disorders—version 2.0. Part II: psychological interventions

Per Andrén[1] · Ewgeni Jakubovski[2] · Tara L. Murphy[3] · Katrin Woitecki[4] · Zsanett Tarnok[5] · Sharon Zimmerman-Brenner[6] · Jolande van de Griendt[7] · Nanette Mol Debes[8] · Paula Viefhaus[4] · Sally Robinson[9] · Veit Roessner[10] · Christos Ganos[11] · Natalia Szejko[12,13,14] · Kirsten R. Müller-Vahl[2] · Danielle Cath[15] · Andreas Hartmann[16] · Cara Verdellen[17]

Received: 9 March 2021 / Accepted: 7 July 2021

European Child & Adolescent Psychiatry
https://doi.org/10.1007/s00787-021-01832-4

REVIEW

European clinical guidelines for Tourette syndrome and other tic disorders: summary statement

Kirsten R. Müller-Vahl[1] · Natalia Szejko[2,3,4] · Cara Verdellen[5,11] · Veit Roessner[6] · Pieter J. Hoekstra[7] · Andreas Hartmann[8] · Danielle C. Cath[9,10]

Received: 8 March 2021 / Accepted: 19 June 2021

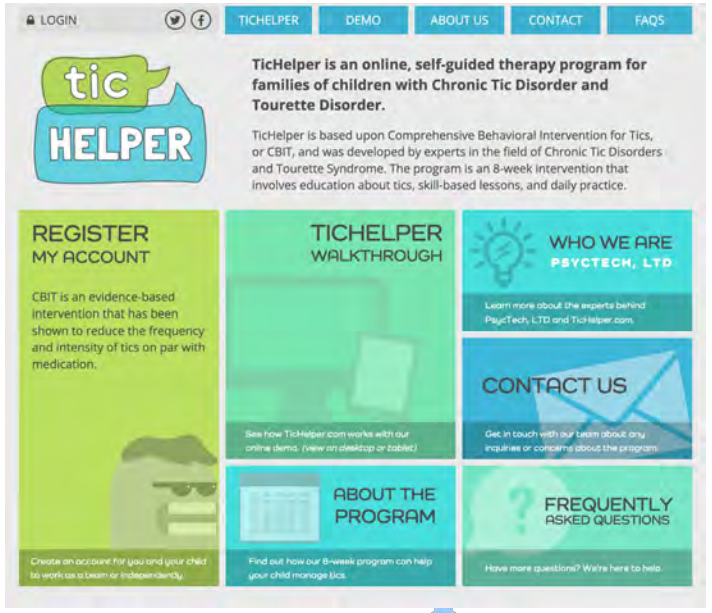
Modalities of delivery

It also works online

- Himle et al., 2010
- Ricketts et al., 2012
- Andren et al., 2019
- Hollis et al, 2021
- Rachmamim et al., 2020, 2022

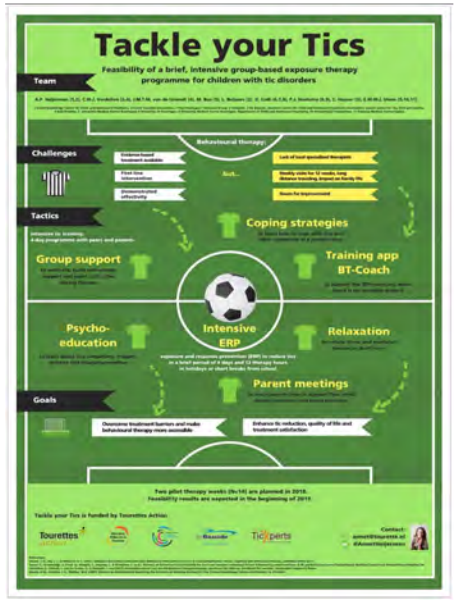
Modalities of delivery

- Even without therapists!
  - Haas et al., 2021 (self-help ONLINE-TICS CBIT)
  - Tichelper.com (self-help CBIT website)
  - BT-Coach (app for ERP homework)



Modalities of delivery

- BT also works in groups
  - Yates et al., 2016
  - Zimmerman-Brenner et al., 2021
  - Nissen et al., 2019
  - Heijerman-Holtgrefe et al., 2020



European Child & Adolescent Psychiatry (2019) 28:57–68
https://doi.org/10.1007/s00787-018-1187-z

ORIGINAL CONTRIBUTION

Combined habit reversal training and exposure response prevention in a group setting compared to individual training: a randomized controlled clinical trial

Judith B. Nissen[1,3] · Martin Kaergaard[1] · Lisbeth Laursen[1] · Erik Parner[2] · Per Hove Thomsen[1,3]

European Child & Adolescent Psychiatry
https://doi.org/10.1007/s00787-020-01702-5

ORIGINAL CONTRIBUTION

Group behavioral interventions for tics and comorbid symptoms in children with chronic tic disorders

Sharon Zimmerman-Brenner[1,2] · Tammy Pilowsky-Peleg[3,4] · Lilach Rachamim[1,5] · Amit Ben-Zvi[1] · Noa Gur[3,4] · Tara Murphy[6] · Aviva Fattal-Valevski[7] · Michael Rotstein[7,8,9]

Contents lists available at ScienceDirect

Behaviour Research and Therapy

journal homepage: www.elsevier.com/locate/brat

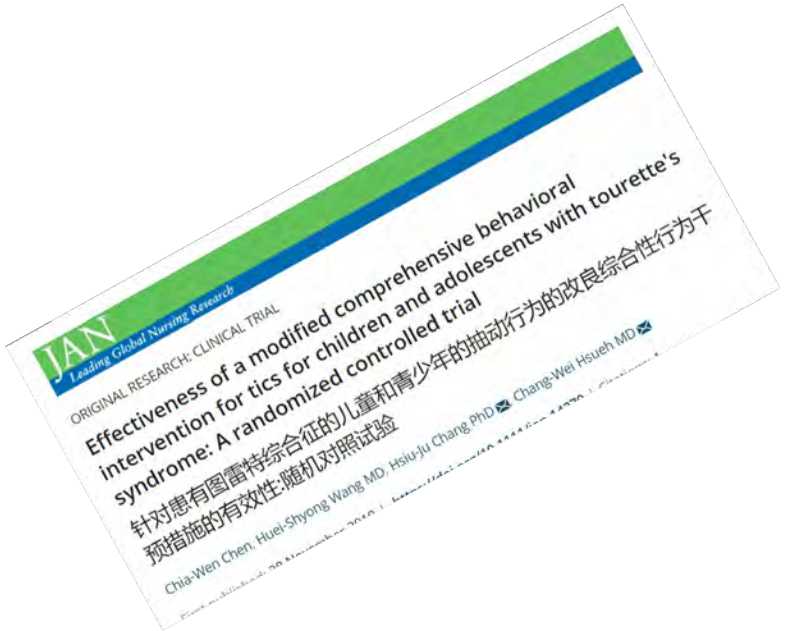
Shorter communication

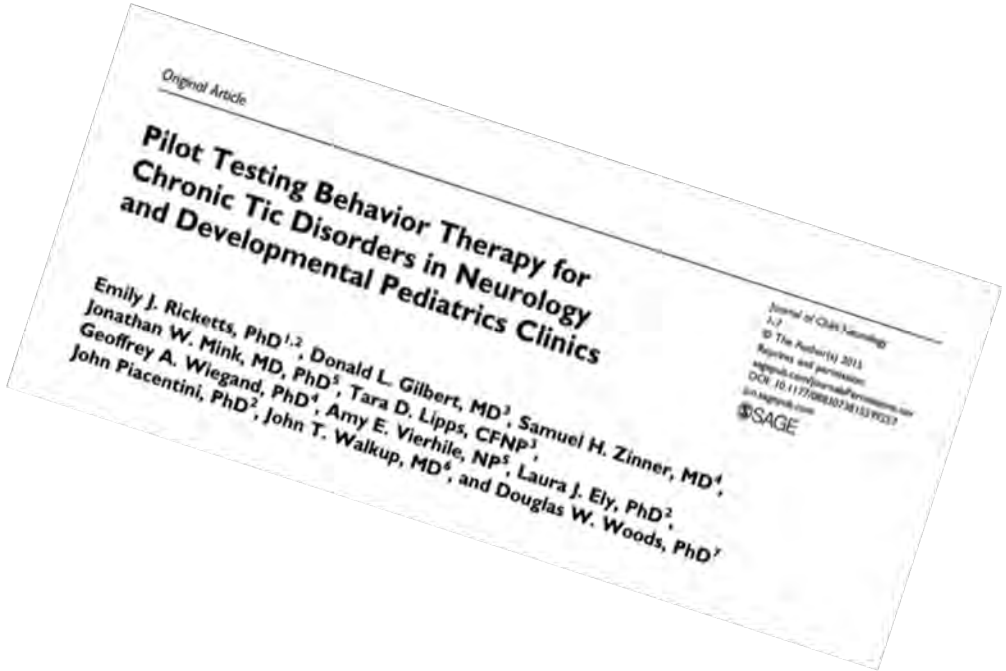
Habit reversal training and educational group treatments for children with tourette syndrome: A preliminary randomised controlled trial

Rachel Yates [a], Katie Edwards [b], John King [b], Olga Luzon [a], Michael Evangeli [a], Daniel Stark [c], Fiona McFarlane [c, d], Isobel Heyman [c, d], Başak İnce [e], Jana Kodric [f], Tara Murphy [c, d, *]

Modalities of delivery

- Also works in *fewer* sessions (Chen et al., 2020)
- Also works in *shorter* sessions (van de Griendt et al., 2018)
- Also works if *intensified* (Blount et al., 2014; Heijerman-Holtgrefe et al., 2020)
- Also works in *younger children* (5-8 years old; Bennett et al., 2020)





Guidelines

- Start with psycho-education
- Watch and wait?

Psychoeducation

For whom?

- Patient
- Parents
- Brothers/sisters?
- Other family members/ relatives?
- Teachers

Why?

- Resolve misunderstanding, uncertainty and stigma in TS
- Improve knowledge, attitudes and behaviours
- Help the patient/environment to identify personal strengths
- Provide the child with the tools to explain to others (especially teachers and schoolmates)
- Help to understand the aim and the method of therapy
- Provide educators with general information about TS

Advice to patients

Ancient (intuitive)

- Ignore tics
- Tics cannot be controlled
- Evacuate tics
- Behavioural approaches/therapies don't work
- Tic suppression increases tics
- Tic suppression increases premonitory sensation
- Tic suppression creates new/different tics

New (counter-intuitive)

- Becoming aware of tics
- Learn to conrol tics
- Reward tic control
- Use behavioura approaches/therapies
- Tic suppression does not increase tics
- Tic suppression does not increase premonitory sensation
- Tic suppression does not create new/different tics

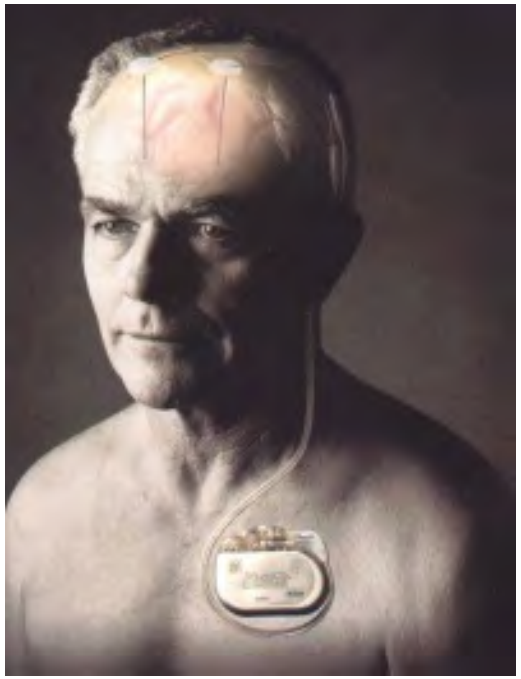
Thanks to the Dream Team !

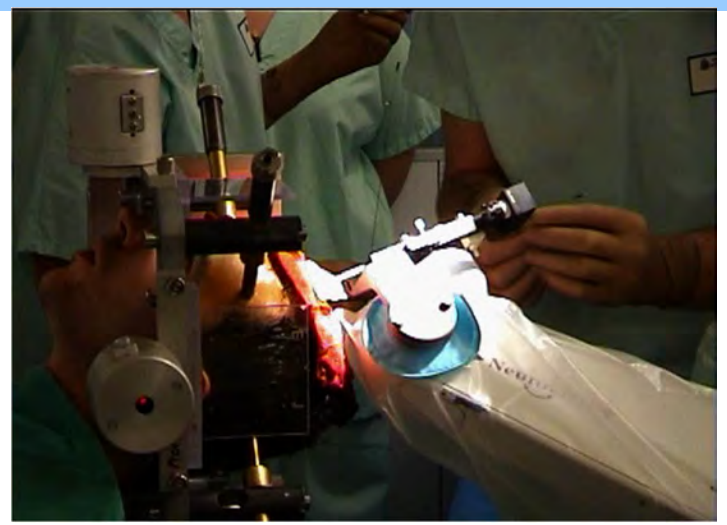
Tara Murphy

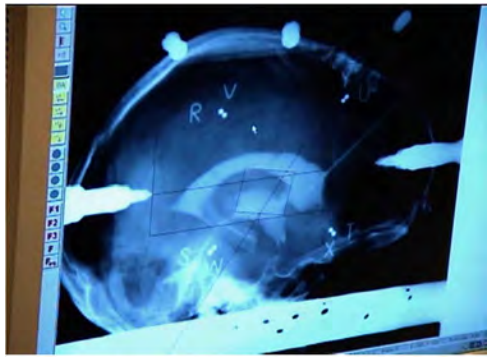
Cara Verdellen

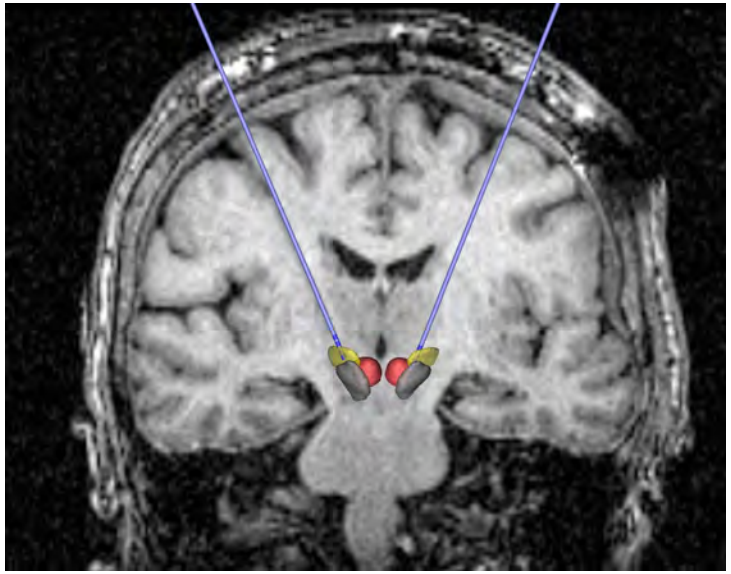
Jolande van de Griendt

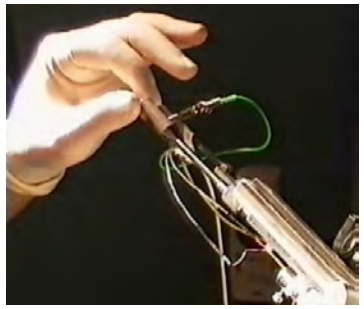
Zsanett Tarnok

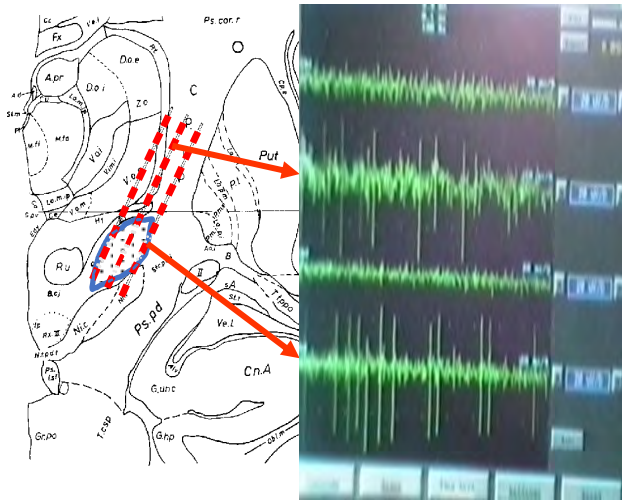












2023 Brussels

European Child & Adolescent Psychiatry
https://doi.org/10.1007/s00787-021-01881-9

REVIEW

European clinical guidelines for Tourette syndrome and other tic disorders—version 2.0. Part IV: deep brain stimulation

Natalia Szejko[1,2,3] · Yulia Worbe[4,5] · Andreas Hartmann[14] · Veerle Visser-Vandewalle[6] · Linda Ackermans[7] · Christos Ganos[8] · Mauro Porta[9] · Albert F. G. Leentjens[10] · Jan-Hinnerk Mehrkens[11] · Daniel Huys[12] · Juan Carlos Baldermann[12] · Jens Kuhn[12,13] · Carine Karachi[5,14,15] · Cécile Delorme[14] · Thomas Foltynie[16] · Andrea E. Cavanna[17] · Danielle Cath[18,19] · Kirsten Müller-Vahl[20]

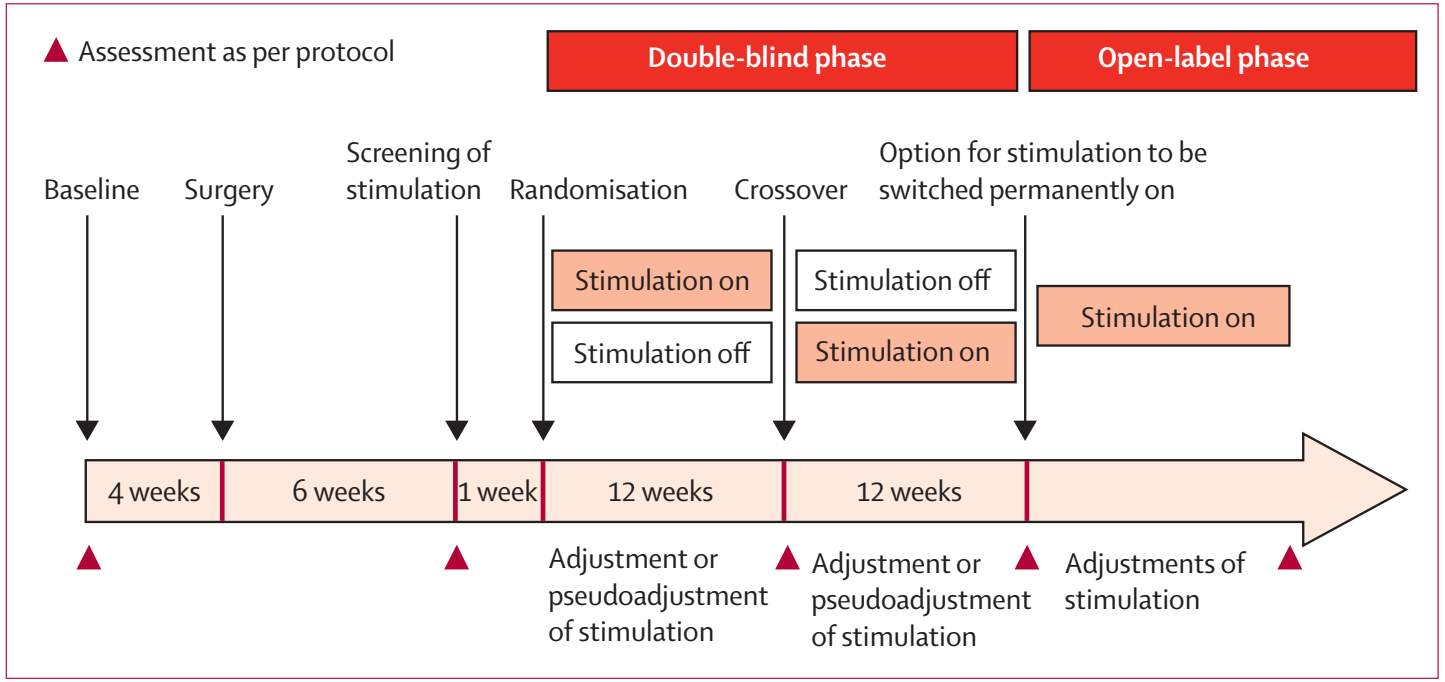
Received: 7 March 2021 / Accepted: 15 September 2021

- 8 RCTs
- International Tourette DBS Registry
- 2 meta-analyses
- 88 open uncontrolled case studies
- Multiple targets: globus pallidus internus (antero-medial and postero-ventrolateral), thalamus (centromedial–parafascicular complex and centro-nucleus ventro-oralis internus), globus pallidus externus, subthalamic nucleus, anterior limb of the internal capsule, H field of Forel, nucleus accumbens...
- No predictors for prognosis

Bilateral globus pallidus stimulation for severe Tourette's syndrome: a double-blind, randomised crossover trial

Zinovia Kefalopoulou, Ludvic Zrinzo, Marjan Jahanshahi, Joseph Candelario, Catherine Milabo, Mazda Beigi, Harith Akram, Jonathan Hyam, Jennifer Clayton, Lewis Kass-Iliyya, Monty Silverdale, Julian Evans, Patricia Limousin, Marwan Hariz, Eileen Joyce, Thomas Foltynie

www.thelancet.com/neurology **Published online April 14, 2015** **http://dx.doi.org/10.1016/S1474-4422(15)00008-3**



	YGTSS score						Difference in YGTSS scores	
	Baseline	6 weeks postoperative	Treatment group	Blinded off-stimulation	Blinded on-stimulation	Open-label on-stimulation	Blinded phase (off-stimulation period vs on-stimulation period)	Baseline vs open-label stimulation phase
Patient A	80	48	Off, on	68	39	33	29 (43%)	47 (59%)
Patient B	99	98	Off, on	99	78	42	21 (21%)	47 (58%)
Patient C	93	92	NA	NA	NA	4	..	89 (96%)
Patient D	87	74	Off, on	85	66	63	19 (22%)	24 (28%)
Patient E	81	81	Off, on	81	81	66	0	15 (19%)
Patient F	93	70	On, off	67	59	48	8 (12%)	45 (48%)
Patient G	74	75	On, off	75	77	74	−2 (−3%)	0
Patient H	93	79	Off, on	82	63	49	19 (23%)	44 (47%)
Patient I	82	83	On, off	NA	NA	47	..	35 (43%)
Patient J	80	55	On, off	67	62	62	5 (7%)	18 (23%)
Patient K	96	96	On, off	70	55	46	15 (21%)	50 (52%)
Patient L	71	59	Off, on	71	71	59	0	12 (17%)
Patient M	98	97	On, off	94	97	83	−3 (−3%)	15 (15%)
Patient N	99	100	Off, on	98	100	51	−2 (−2%)	48 (48%)
Patient O	92	40	On, off	92	40	46	52 (57%)	46 (50%)
Mean (SD)	87·9 (9·2)	76·5 (19·1)	..	80·7 (12·0)	68·3 (18·6)	51·5 (18·5)	12·4 (15·9)	36·3 (22·6)
95% CI for mean difference (p value)	..	..	..	..	..	..	0·1–24·7 (p=0·048)*	23·8–48·9 (p<0·0001)†
Proportional mean difference (95% CI)	..	..	..	..	..	..	15·3% (5·3–25·3)	40·1% (28·1–52·1)

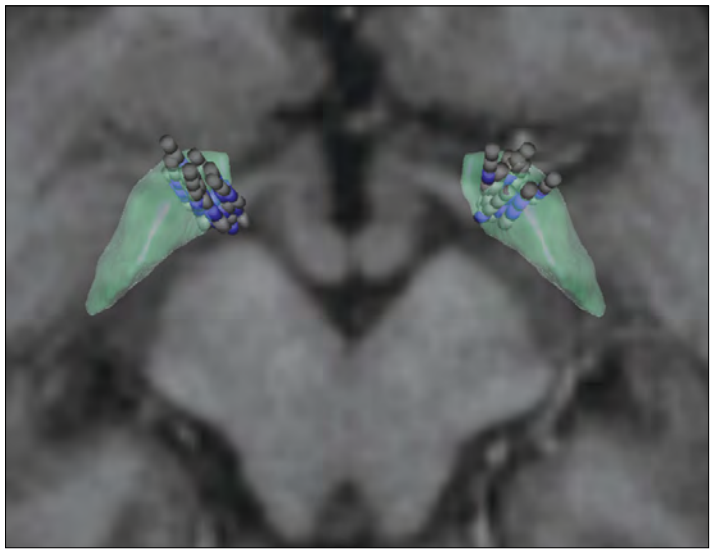
For purposes of maintaining confidentiality, the patient sequence presented in here (and in the appendix) does not correspond with the sequence presented in table 1. YGTSS total score on a scale of 0 to 100. This scale comprises a total tic severity subscore (providing an evaluation of the number, frequency, intensity, complexity, and interference of motor and vocal tics, ranging from 0 to 50) and an impairment subscore (taking into account difficulties in self-esteem, family life, social acceptance, or school or job functioning due to tics, ranges from 0 to 50), with higher scores suggesting greater severity. During trial recruitment, impairment subscore was transformed to a 0–5 analogue and added to the total tics severity subscore (ranging from 0 to 55). Positive difference means improvement. YGTSS=Yale Global Tic Severity Scale. NA=not available. *Primary endpoint analysis; pairwise comparisons of YGTSS total scores after Bonferroni correction. †Post-hoc analysis.

Table 2: **Individual results for YGTSS total score in all patients**

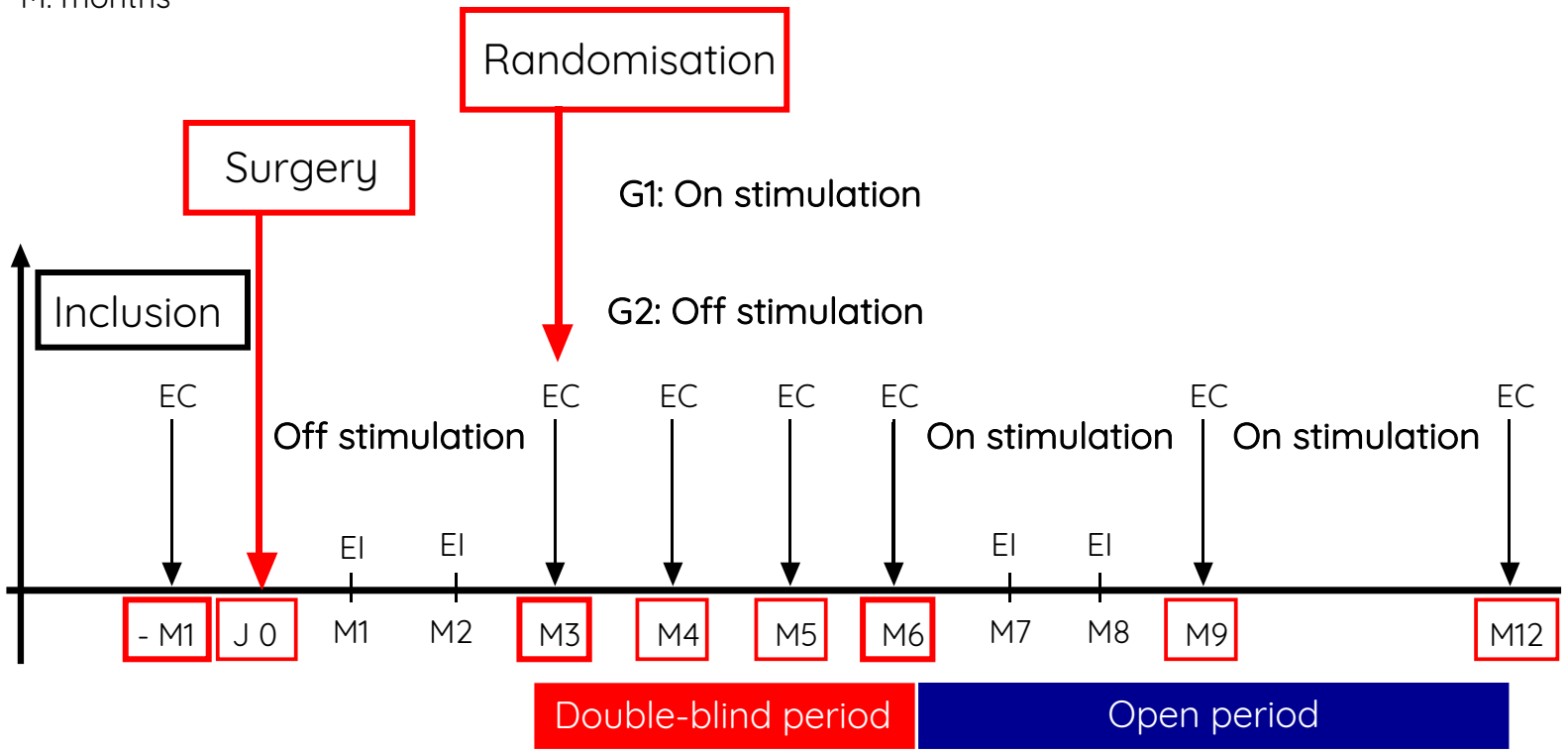
Anterior pallidal deep brain stimulation for Tourette's syndrome: a randomised, double-blind, controlled trial

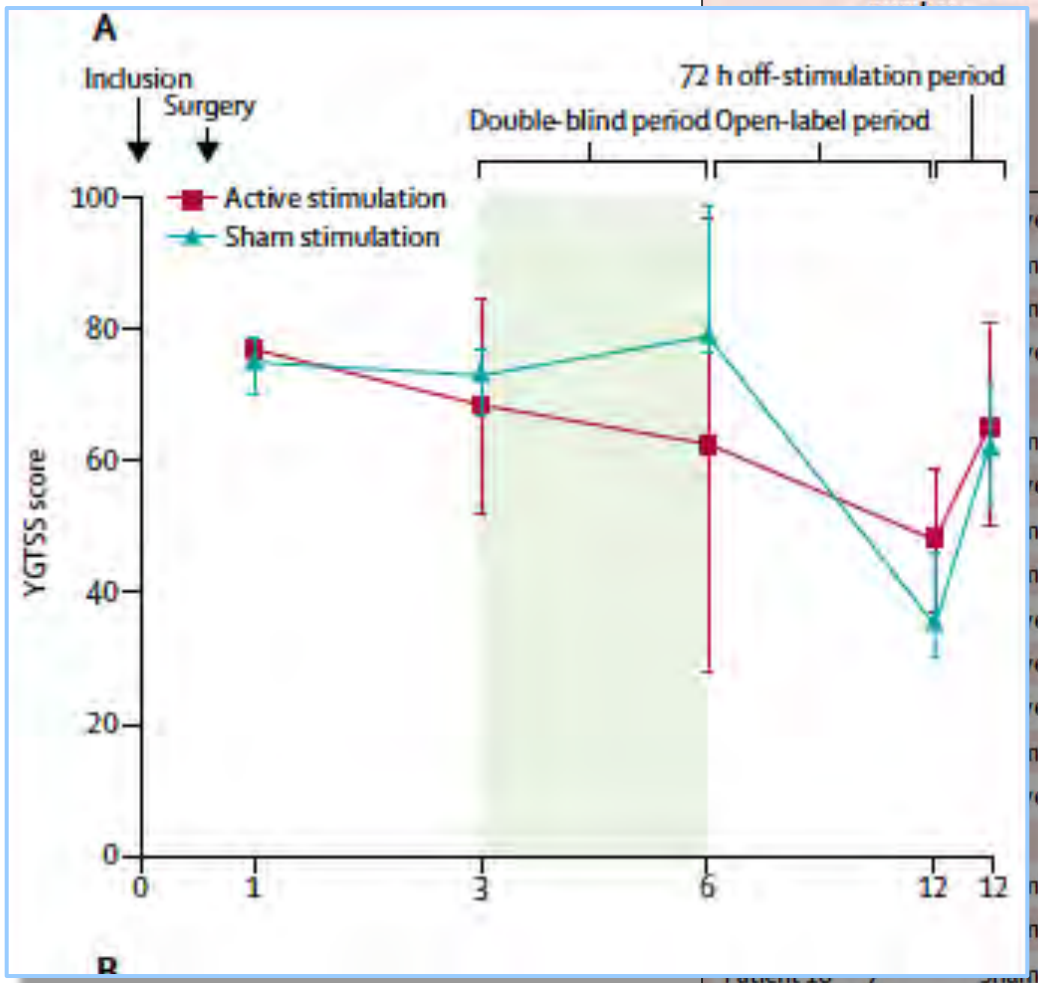
*Marie-Laure Welter, Jean-Luc Houeto, Stéphane Thobois, Benoit Bataille, Marc Guenot, Yulia Worbe, Andreas Hartmann, Virginie Czernecki, Eric Bardinet, Jerome Yelnik, Sophie Tezenas du Montcel, Yves Agid, Marie Vidailhet, Philippe Cornu, Audrey Tanguy, Solène Ansquer, Nematollah Jaafari, Emmanuel Poulet, Giulia Serra, Pierre Burbaud, Emmanuel Cuny, Bruno Aouizerate, Pierre Pollak, Stephan Chabardes, Mircea Polosan, Michel Borg, Denys Fontaine, Bruno Giordana, Sylvie Raoul, Tiphaine Rouaud, Anne Sauvaget, Isabelle Jalenques, Carine Karachi, Luc Mallet, for the STIC study group**

www.thelancet.com/neurology **Vol 16 August 2017**



7 EC: Complete assessment
5 EI: Partial assessment
M: months





	Centre	Stimulation	Sex	Age (years)	YGTSS score	Difference in YGTSS score	
					Inclusion	Double-blind phase (month 6 *vs* month 3)	Inclusion *vs* end of open-label active stimulation period (month 12)
			Male	57	77	14 (63%)	−48 (−62%)
			Male	22	76	0	−54 (−71%)
			Female	23	75	41 (108%)	−40 (−53%)
			Male	47	71	..	..
			Female	21	75	..	..
			Male	33	75	−32 (−43%)	−32(−43%)
			Male	31	82	−1 (−1%)	−11 (−13%)
			Female	19	67	1 (1%)	−40 (−60%)
			Female	22	79	−21 (−30%)	−55 (−70%)
			Male	22	63	−45 (−46%)	31 (49%)
			Male	37	83	1 (1%)	5 (6%)
			Male	40	58	25 (104%)	−22 (−37%)
			Male	28	97	−10 (−11%)	−17 (−18%)
			Male	28	81	8 (12%)	−33 (−41%)
			Male	27	78	..	..
			Male	21	95	3 (5%)	−71 (−75%)
			Female	57	68	−1 (−1%)	−28 (−41%)
			Male	21	71	6 (8%)	−34 (−48%)
Patient 19	9	Active	Male	30	59	−35 (−63%)	−36 (−61%)
Mean (SD)	..	..	..	30·8 (11·8)	75·3 (10·3)	−1·2 (22·6); (6·8% [48·2])	−30·3 (24·5); (−39·9% [32·6])

Data are the absolute mean change in YGTSS score, with percentage change in parentheses, unless otherwise indicated. A negative value indicates improvement. YGTSS=Yale Global Tic Severity Scale. *Withdrew before receiving stimulation in the double-blind period. †Withdrew before randomisation.

***Table 1*: Changes in YGTSS score at baseline and after anterior internal globus pallidus deep brain stimulation**

Long-Term Effects of Anterior Pallidal Deep Brain Stimulation for Tourette's Syndrome

Received: 4 October 2018; **Revised:** 11 January 2019; **Accepted:** 28 January 2019

Published online 00 Month 2019 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/mds.27645

TABLE 1. Changes in tic severity (YGTSS) after anteromedial GPi stimulation in 16 patients with Tourette's syndrome

					YGTSS score				Difference in YGTSS scores	
Patient No.	Center No.	Randomized study	Sex	Age	Baseline	M12	M30	M48	Last follow-up vs baseline (%)	Last follow-up vs M12 (%)
1	1	On	M	57	77	29	18	24	−53 (−69%)	−5 (−17%)
2	1	Off	M	22	76	22	8	_	−68 (−89%)	−14 (−64%)
3	1	Off	F	23	75	35	39	35	−40 (−53%)	0
6	1	Off	M	33	75	43	33	28	−47 (−63%)	−15 (−34%)
7	1	On	M	31	82	71	51	33	−49 (−59%)	−38 (−53%)
8	1	Off	F	19	67	27	62	80	13 (19%)	53 (196%)
9	1	Off	F	22	79	24	30	33	−46 (−58%)	9 (37.5%)
10	2	On	M	22	63	94	71	71	8 (13%)	−23 (−24%)
11	4	On	M	37	83	88	—	—	—	—
12	5	On	M	40	58	36	—	—	—	—
13	5	Off	M	28	97	80	—	—	—	—
14	6	On	M	28	81	48	32	19	−62 (−76.5%)	−29 (−60%)
16	7	Off	M	21	95	24	44	28	−67 (−70.5%)	4 (17%)
17	7	Off	F	57	68	40	87	69	1 (1.5%)	29 (72.5%)
18	7	Off	M	21	71	37	18	10	−61 (−86%)	−27 (−73%)
19	9	On	M	30	59	23	—	—	—	—
Mean				30.7	75.4	45.1	41.8	39.1	−39.3 (−49.3%)	−4.7 (−0.3%)
SD				11.9	11.1	24.4	23.3	23.2	29.5 (38.2%)	26.1 (76.0%)

YGTSS, Yale Global Tic Severity Scale (range, 0 to 100), higher scores indicate greater severity; NA, not available.
Difference and percentage of changes (%) between month 48 and baseline (inclusion) and between month 48 and month 12 (open-label period). Negative values indicate improvement.

ESSTS

Brain Stimulation 14 (2021) 662–675

Contents lists available at ScienceDirect

Brain Stimulation

journal homepage: http://www.journals.elsevier.com/brain-stimulation

Randomized double-blind sham-controlled trial of thalamic versus GPi stimulation in patients with severe medically refractory Gilles de la Tourette syndrome

K.R. Müller-Vahl [a, *], N. Szejko [a, d, h, i], A. Saryyeva [b], C. Schrader [c], D. Krueger [a], A. Horn [e], A.A. Kühn [e, f, g], J.K. Krauss [b]

[a] Clinic of Psychiatry, Socialpsychiatry and Psychotherapy, Hannover Medical School, Germany
[b] Department of Neurosurgery, Hannover Medical School, Germany
[c] Department of Neurology, Hannover Medical School, Germany
[d] Department of Neurology, Medical University of Warsaw, Poland
[e] Department of Neurology, Movement Disorders and Neuromodulation Unit, Campus Charite Mitte, Charité – Universitätsmedizin Berlin, Berlin, Germany
[f] Berlin School of Mind and Brain, Charité – Universitätsmedizin Berlin, Berlin, Germany
[g] NeuroCure, Charité – Universitätsmedizin Berlin, Berlin, Germany
[h] Department of Neurology, Yale School of Medicine, New Haven, USA
[i] Department of Bioethics, Medical University of Warsaw, Warsaw, Poland

- 10 patients
- Targets: pvl GPi + CM-Voi
- 36 weeks (3x12) blinded
- F/U to 9 years

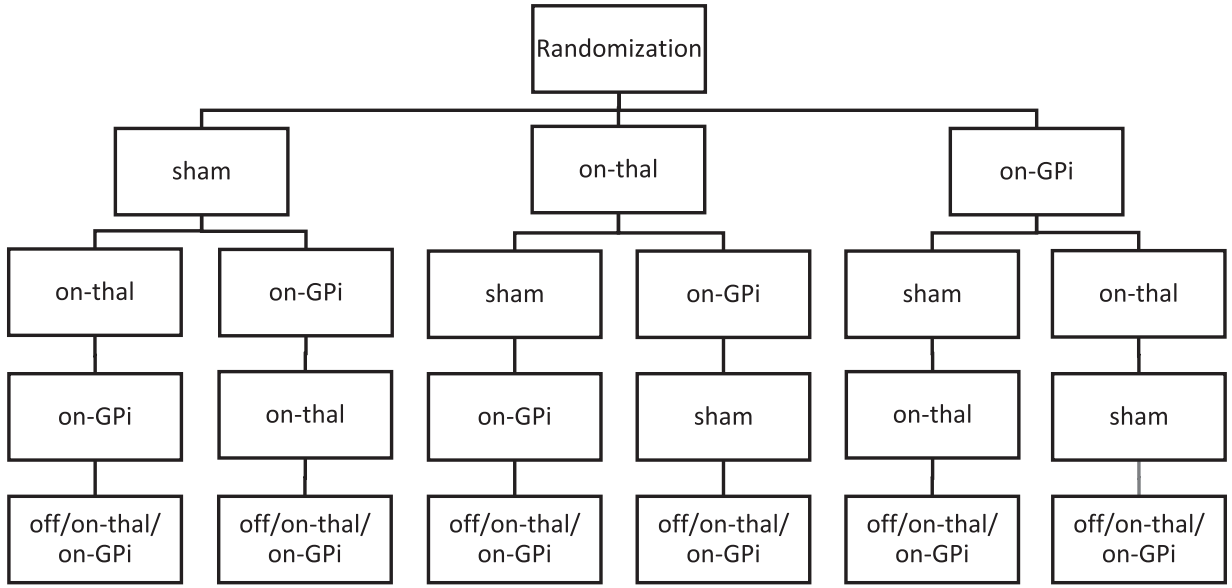
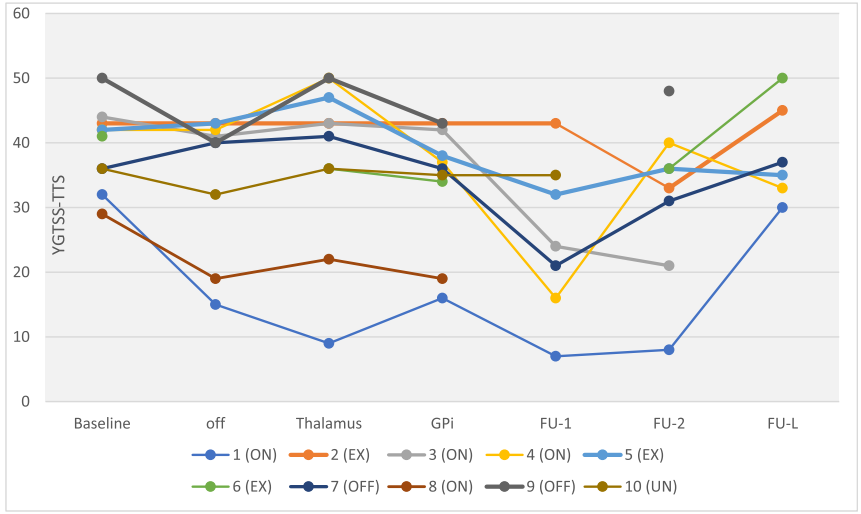


Fig. 1. Randomization schemePatients
were randomized in 3 periods of 3 months each including sham stimulation (sham), pv
i GPi stimulation (on-GPi), and thalamic stimulation (on-thal). Thereafter all patients entered an open uncontrolled follow-up phase, where they could freely decide between on-thal or on-GPi stimulation or switching the stimulation off (off).

Table 4
Change in tics (according to YGTSS-TTS, MRVS, and TSSL) after 3-month periods of GPi, thalamic, and sham stimulation compared to baseline and direct comparisons of treatment effects after GPi, thalamic, and sham stimulation during double-blind study phase.

	YGTSS-TTS			MRVS			TSSL		
	mean ± SD	range	p-value	mean ± SD	range	p-value	mean ± SD	range	p-value
on-GPi vs. BL	−5.78 ± 4.99	−16 to +0	**0.01415**	−4.25 ± 4.20	−9 to +2	**0.0243**	−3.80 ± 6.15	−3 to 16	0.5702
on-thal vs. BL	−2.0 ± 9.23	−23 to +8	0.7984	−5.22 ± 4.92	−14 to +1	**0.0300**	−6.83 ± 2.14	−14 to 1	**0.0240**
sham vs. BL	−4.33 ± 6.73	−17 to +4	0.1226	−3.63 ± 7.33	−12 to +10	0.20	−1.50 ± 2.88	−5.29 to −2.29	0.30
on-thal vs. sham	+2.33 ± 5.26	−6 to +10	0.22	+0.5 ± 5.81	−8 to +10	0.9532	+6.83 ± 5.23	−1 to+14	**0.024**
on-GPi vs. sham	−1.44 ± 3.81	−3 to +7	0.29	+0.63 ± 4.72	+10 to −5	**0.0243**	+9.0 ± 17.26	+33 to −19	0.22
on-GPi vs. on-thal	−3.77 ± 5.69	−7 to +13	0.08	0.11 ± 4.7287	−10 to +4	0.7874	+2.67 ± 15.67	−24 to 10	0.6940

YGTSS-TTS (Yale Global Tic Severity Scale Total tic score, range 0–50), MRVS (Modified Rush Video-based Tic Rating Scale, range 0–20), TSSL (Tourette Syndrome Symptom List, range 0–100), on-thal = thalamic stimulation, on-GPi = globus pallidus internus stimulation, sham = sham stimulation, BL = baseline. p values < 0.05 are marked in bold.



- GPi DBS (p = 0.05)—but not thalamic DBS (p = 0.18)—resulted in a significant tic reduction compared to baseline
- No effect on premonitory urges and psychiatric comorbidities.
- Direct comparisons of both targets to sham stimulation: inconsistent or negative findings
- Follow-up, at group level, no improvement of tics, comorbidities, and quality of at group level
- Single patients benefitted continuously from thalamic DBS.

VIEWS & REVIEWS

The 5 Pillars in Tourette Syndrome Deep Brain Stimulation Patient Selection

Present and Future

Davide Martino, MD, PhD, Wissam Deeb, MD, Joohi Jimenez-Shahed, MD, Irene Malaty, MD, FAAN, Tamara M. Pringsheim, MD, Alfonso Fasano, MD, PhD, Christos Ganos, MD, Winifred Wu, FRAPS, MBA, and Michael S. Okun, MD

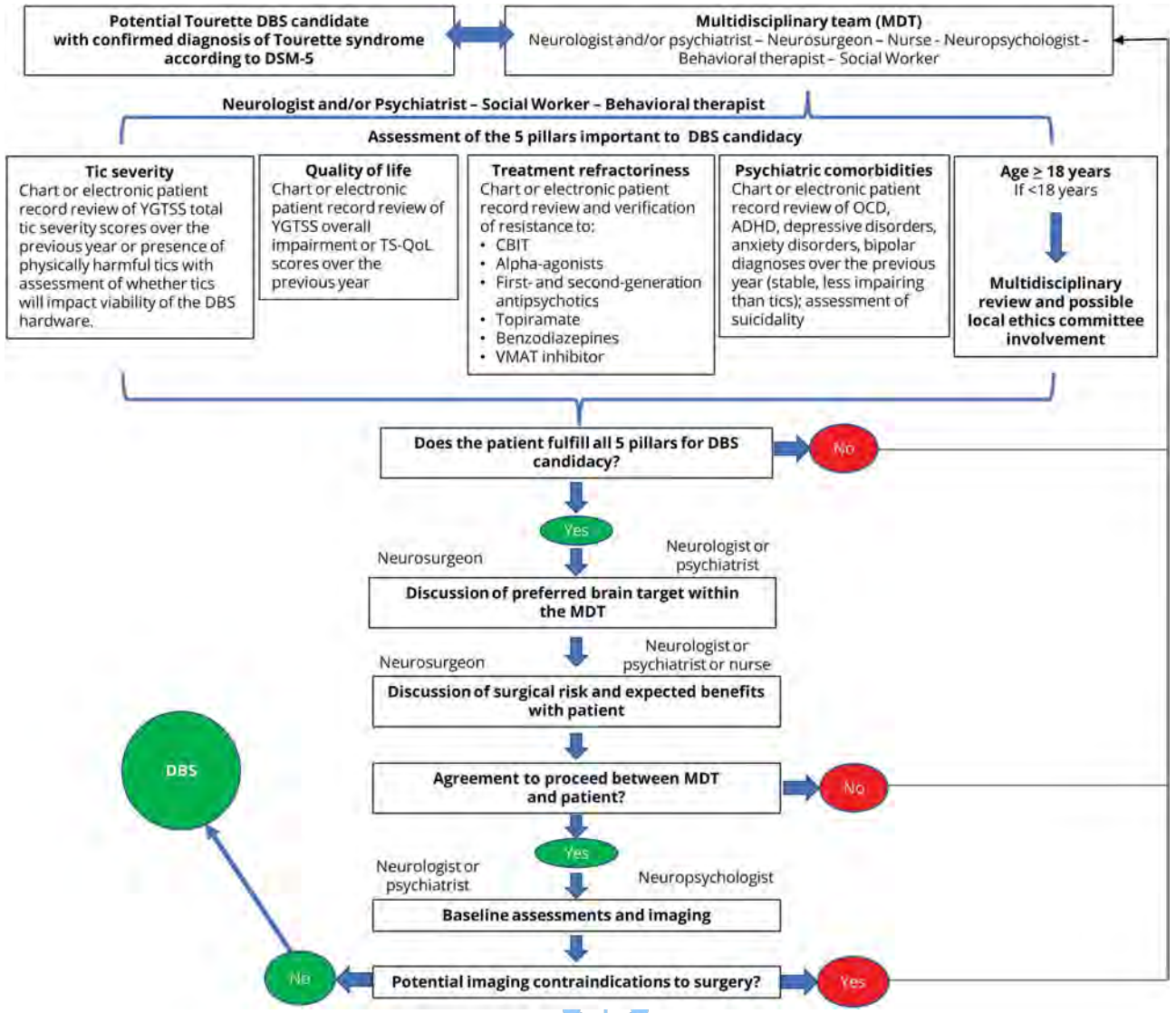
Correspondence
Dr. Martino
davide.martino@ucalgary.ca

Neurology® 2021;96:664-676. doi:10.1212/WNL.0000000000011704

Table Summary of Established Concepts and Questions for Future Research Related to Each of the Five Pillars of Tourette Syndrome Patient Selection for Deep Brain Stimulation.

Clinical aspect included in the patient selection process	Established concepts	Knowledge gaps/Questions for future studies
First pillar: tic severity	Validated tic severity rating scales should be used to measure tic severity. A threshold severity score was proposed by expert consensus. Physically harmful tics may be sufficient for eligibility to DBS, regardless of severity scores.	For how long should high tic severity persist before DBS can be considered? What rating instrument is the most appropriate to assess tic-related functional impairment in defining eligibility to DBS?
Second pillar: quality of life	The use of validated, disease-specific quality of life rating instruments is encouraged	Does the use of different instruments to capture the specific impact on quality of life of different symptoms within the TS spectrum help in defining eligibility for DBS?
Third pillar: treatment refractoriness	Suitability or efficacy of behavioral treatment should be assessed by therapist before considering DBS. The number of failed medication trials (with the related drug classes) needed before considering DBS was proposed by expert consensus	What steps should be undertaken to establish lack of tolerability, efficacy, and adherence to a single treatment for tics? Which definition of refractoriness to a single treatment for tics is likely to reach consensus among experts? How many drug classes should be tried before considering DBS? Should the combination of behavioral and pharmacologic therapies be tried before considering DBS?
Fourth pillar: behavioral comorbidities	Common comorbidities can confound the impact of treatment on quality of life and functioning and create a false perception of treatment refractoriness	For how long should the severity of behavioral comorbidities remain stable (or not increase) before DBS can be considered? What treatment algorithms should be considered to stabilize behavioral comorbidities before DBS can be considered? Can DBS be considered to target tics and comorbid behavioral symptoms at the same time?
Fifth pillar: age	Very severe tics can be considered for DBS in individuals younger than 18 years with local ethics committee approval	How does DBS modify the long-term outcome of very severe or malignant TS? What are the predictors of response to DBS in young patients (in the first 2 decades)?

Figure 5 Summary of the Multiple Steps That Should Be Undertaken by a Multidisciplinary Team (MDT) Responsible for the Screening, Treatment, and Postoperative Monitoring of Patients With Tourette Syndrome (TS) Undergoing Deep Brain Stimulation (DBS) Surgery



European Society for the Study of Tourette Syndrome

2023 Brussels