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Cost-effectiveness of psychological interventions for children and young people with post-traumatic stress disorder

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Appendix S1: Selection of effectiveness data and transformation for use in the economic analysis

Effectiveness data were obtained from a systematic literature review and network meta-analyses (NMAs) of randomised clinical trials (RCTs) of psychological and psychosocial interventions for children and young people with clinically important PTSD symptoms (Mavranouzouli et al., 2019). The NMAs were conducted within a Bayesian framework using Markov Chain Monte Carlo simulation techniques implemented in WinBUGS 1.4.3 (Lunn, Thomas, Best, & Spiegelhalter, 2000; Spiegelhalter, Thomas, Best, & Lunn, 2003).

The NMAs included 2 analyses of changes in PTSD symptom scores (between baseline and treatment endpoint; and between baseline and 1-4 month follow-up) and one analysis of dichotomous remission data at treatment endpoint. Although dichotomous data are more suitable for use in economic modelling as they can be easily translated into probabilities of events that correspond directly to the model health states, available dichotomous remission data were sparse and did not cover all interventions of interest in the economic analysis (9 RCTs assessing 7 treatment options reported dichotomous remission at treatment endpoint; in contrast, continuous PTSD symptom change score data between baseline and treatment endpoint were available for 17 treatment options in 29 RCTs). Therefore, the economic analysis utilised the results of the NMAs of changes in PTSD symptom scores, which were reported as standardised mean differences (SMDs), and were subsequently transformed into log-odds ratios (LORs) of effect (Chinn, 2000), so that they could be utilised in the economic analysis, as described in our companion paper (Mavranouzouli et al., 2019; Appendix S3).

The log-odds ratios of remission of each intervention versus no treatment (which served as the baseline treatment) were exponentiated into odds ratios. Subsequently, the probability of remission for each intervention, which was utilised in the economic model, was estimated using the following formulae:

$$intervention\ prob = \frac{odds}{(1+odds)} \quad (1)$$

and

$$odds = \frac{baseline\ prob}{(1-baseline\ prob)} OR \quad (2)$$

where baseline prob is the probability of remission for the baseline treatment (no treatment), OR is the odds ratio of remission for each intervention versus no treatment as estimated following exponentiation of the log-odds ratios obtained from the NMA, and odds is the odds of each intervention to achieve remission.

The NMA models were run in WinBUGS with an initial burn-in period of 100,000 iterations, followed by 300,000 further iterations, thinned by 30 so as to obtain 10,000 iterations for use in the economic model. These 10,000 samples are representative of the full posterior distributions, and thus the uncertainty in the input estimates is incorporated in the economic model.

Appendix S2: Estimation of the baseline probability of remission

The probability of remission for no treatment (baseline) was obtained from a study reporting long-term data on the course of PTSD derived from 1575 people with lifetime PTSD who had participated in 22 World Health Organization (WHO) World Mental Health surveys (Rosellini et al., 2018). The study reported rates of remission of PTSD over 120 months (10 years) following PTSD onset for different age groups, including data on children aged 0-12 years and young people aged 13-24 years, in the form of a graph. Digital software (<http://www.digitizeit.de>) was used to read and extract the cumulative proportions of children aged 0-12 years and young people aged 13-24 years that remitted from PTSD at 3 months, 6 months, 12 months, 24 months, and 36 months from PTSD onset. The values at each time point were averaged between the two age groups, to cover the whole range of the economic analysis study population. The extracted values were used to estimate the probability of remission between 0-3 months, 3-12 months, 12-24 months and 24-36 months in the model, conditional on not having achieved remission prior to the beginning of each interval. The estimated probabilities of remission during these time periods were subsequently transformed into 3-month probabilities that were used to inform the economic model.

The table below shows the estimated cumulative probability of remission for children and young people at 3, 12, 24 and 36 months from PTSD onset; the probability of remission between 0-3, 3-12, 12-24 and 24-36 months (conditional on not having achieved remission prior to the beginning of the interval); and the 3-monthly probability of remission during these time periods.

Probability of remission over time in children and young people with PTSD, as estimated based on data extracted from Rosellini and colleagues (2018)

Time from PTSD onset	Cumulative probability of remission	Time interval	Probability of remission over the time interval*	3-monthly probability during the time interval*
3 months	0.174	0-3 months	0.174	0.174
12 months	0.370	3-12 months	0.238	0.087
24 months	0.445	12-24 months	0.118	0.031
36 months	0.500	24-36 months	0.100	0.026
* conditional on not having achieved remission prior to the beginning of the interval				

The economic analysis evaluated interventions for the treatment of children and young people with PTSD initiated more than three months after a traumatic event. The economic model was thus assumed to start at month 3 from PTSD onset. Therefore, remission data corresponding to 0-3 months after PTSD onset were not used in the economic analysis.

The estimated 3-month probability of remission over 3-12 months from PTSD onset informed months 0-9 of the economic model: these data were applied onto the no treatment arm. They also informed all model arms in months 3-6 of the economic model in the base-case analysis, and all model arms in months 6-9 in all analyses of the economic model, as the course of PTSD after 6 months of treatment was assumed to be independent of the treatment received.

The 3-month probability of remission over 12-24 months from PTSD onset informed all model arms in months 9-21 of the economic model. The 3-month probability of remission over 24-36 months from PTSD onset informed all model arms in months 21-36 of the economic model; this 3-month probability was also utilised over the period of 36-39 months from PTSD onset (i.e. months 33-36 of the economic model) for simplicity.

Appendix S3: Estimation of the unit cost of a clinical psychologist working for the National Health Service (NHS) in England [salary Band 7 according to the NHS Agenda for Change for qualified Allied Health Professionals]

Cost element	Unit cost (2017 price)	Source
Wages – salary (annual)	£38,951	Curtis & Burns, 2017; unit cost of community-based scientific & professional staff, including allied health professionals (Agenda for Change band 7)
Salary on-costs (annual)	£9,864	
Overheads – staff (annual)	£11,960	
Overheads - non-staff (annual)	£18,647	
Capital overheads (annual)	£5,125	
Qualifications (total)	£12,386	Based on a mean clinical psychologist training cost estimate of £159,420 (National College for Teaching and Leadership, 2016), annuitised using the formula reported in Netten, Knight, Dennett, Cooley, & Slight (1998), assuming a useful working life of 25 years, a time from obtaining the qualification until retirement of 44 years, and an equal distribution of the useful working life over the period of 44 years due to lack of specific information on this distribution.
Supervision (annual)	£316	Based on the unit cost of an Agenda for Change band 8a clinical psychologist (Curtis & Burns, 2017) providing 1.5 hour of supervision per month, delivered in groups of 4 participants (British Association for Behavioural & Cognitive Psychotherapies, 2016 and expert advice); qualification costs included, as described above.
SUM of cost elements (annual)	£97,249	
Working time	42.6 weeks /year 37.5 hours /week (1,599 hours)	Curtis & Burns, 2017
Total cost per hour	£61	
Ratio of direct to indirect time*	60:40	assumption based on expert opinion and a review of respective ratios reported in the literature for clinical psychologists and other therapists delivering psychological interventions (Curtis & Burns, 2017)
Estimated cost per hour of direct contact	£101	
* ratio of face-to-face time to time for preparation and other administrative tasks		

Appendix S4: Results of secondary probabilistic economic analyses

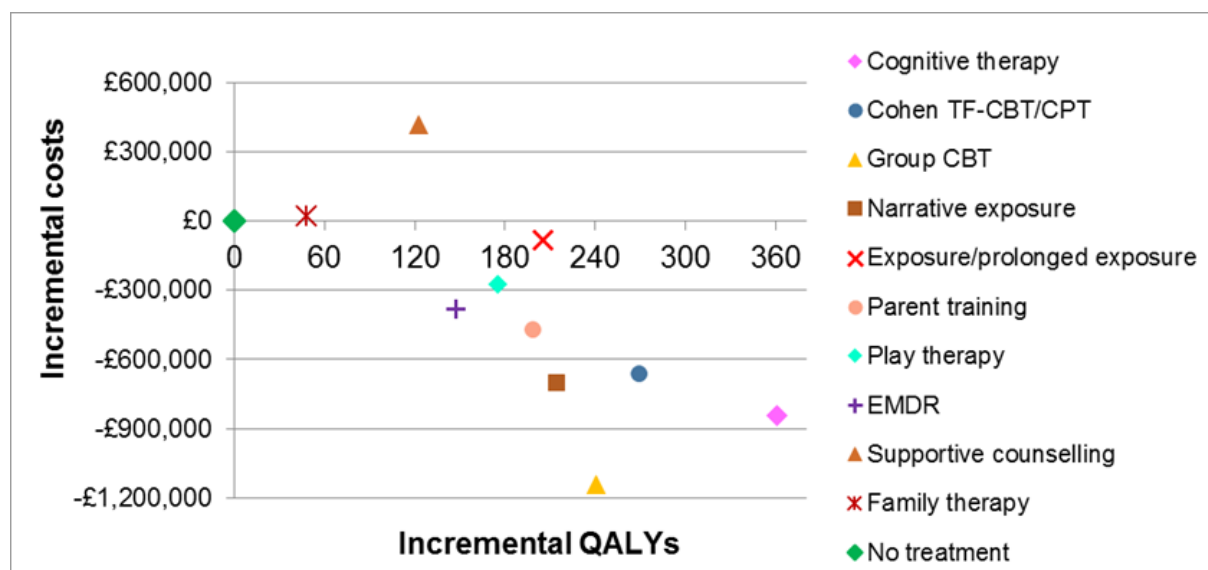
Results of Scenario B [utility data from Gospodarevskaya (2013); beneficial effect up to 3-month follow-up]

Intervention	Mean per person			NMB (£/ person)	Mean rank (at a threshold of £20,000/QALY)	Prob*
	QALY	Intervention cost (£)	Total cost (£)			
[TF-CBT] cognitive therapy	2.482	1,204	4,271	45,373	1.88	0.67
[TF-CBT] Cohen TF-CBT / CPT	2.390	911	4,453	43,348	3.90	0.30
[TF-CBT] group CBT	2.362	270	3,971	43,269	3.35	0.48
[TF-CBT] narrative exposure	2.335	517	4,414	42,296	4.71	0.31
Parent training	2.320	685	4,645	41,751	5.47	0.36
[TF-CBT] exposure / PE	2.326	1,089	5,033	41,495	6.26	0.33
Play therapy	2.297	719	4,840	41,094	6.31	0.46
EMDR	2.268	461	4,731	40,636	6.65	0.62
Supportive counselling	2.244	1,135	5,534	39,341	8.61	0.59
Family therapy	2.169	287	5,135	38,245	9.12	0.56
No treatment	2.121	0	5,114	37,312	9.76	1.00

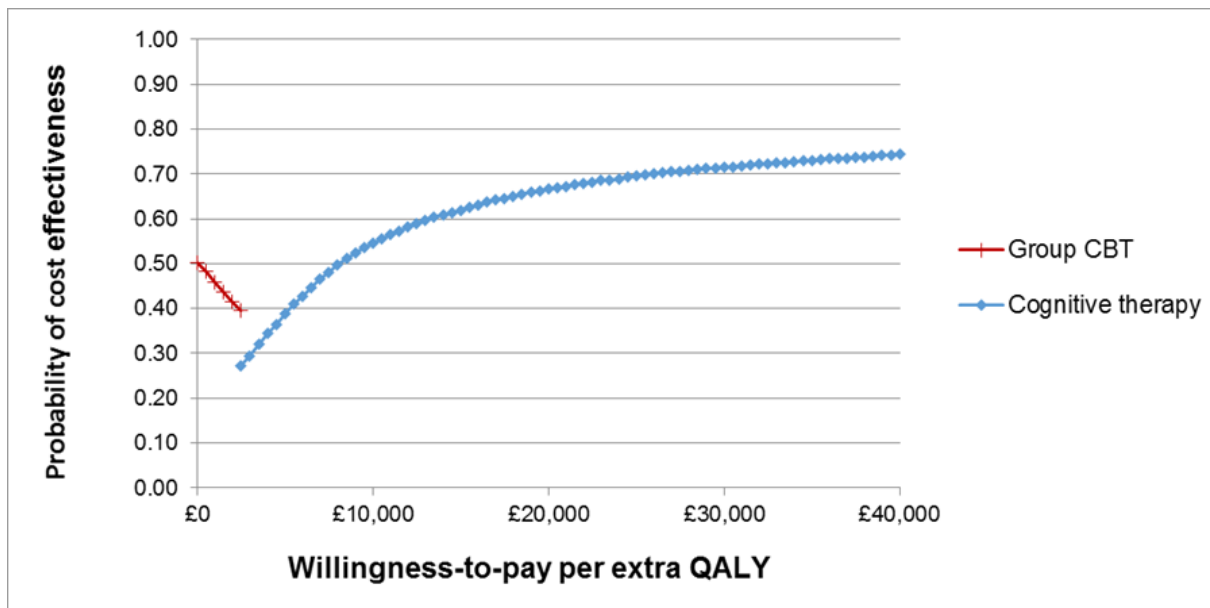
CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; Prob: probability of cost-effectiveness; TF-CBT: trauma-focused cognitive behavioural therapy

*estimated in a step-wise approach, according to which the most cost-effective intervention is omitted at each step, and the probability of cost-effectiveness of the next most cost-effective intervention amongst the remaining treatment options is re-calculated

Scenario B - Cost-effectiveness plane

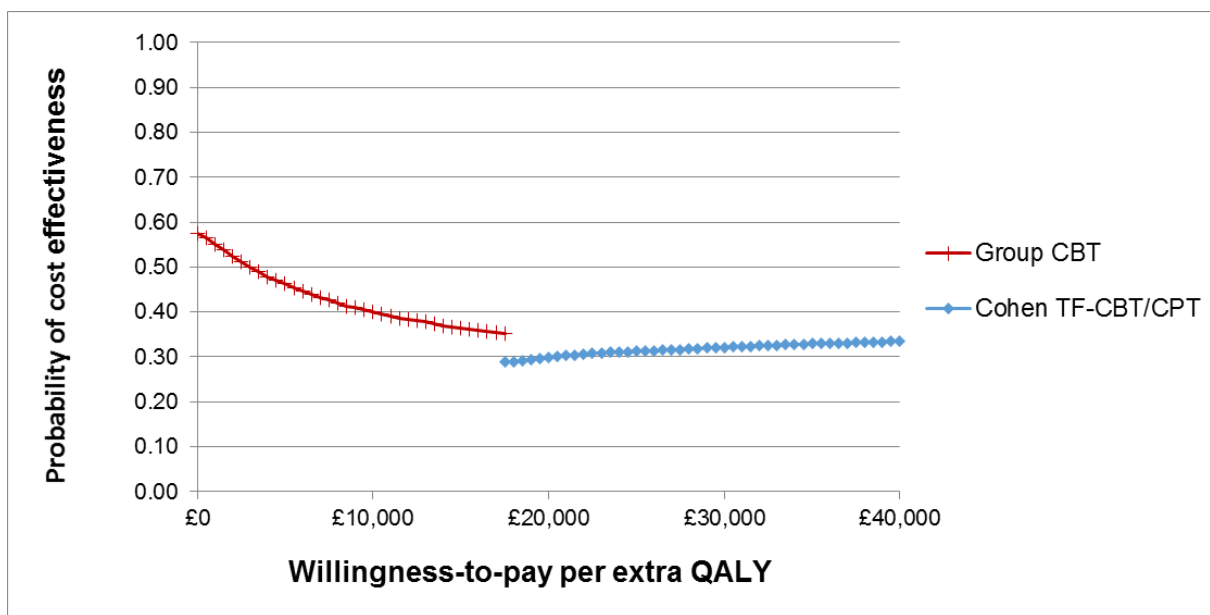


Scenario B - Cost-effectiveness acceptability frontier - cognitive therapy for PTSD included in analysis



Comparison across 11 alternative treatment options: supportive counselling, group CBT [TF-CBT], Cohen TF-CBT/ CPT [TF-CBT], cognitive therapy for PTSD [TF-CBT], narrative exposure therapy [TF-CBT], exposure/PE [TF-CBT], eye movement desensitisation and reprocessing (EMDR), family therapy, play therapy, parent training, no treatment

Scenario B - Cost-effectiveness acceptability frontier - cognitive therapy for PTSD excluded from analysis



Comparison across 10 alternative treatment options: supportive counselling, group CBT [TF-CBT], Cohen TF-CBT/ CPT [TF-CBT], narrative exposure therapy [TF-CBT], exposure/PE [TF-CBT], eye movement desensitisation and reprocessing (EMDR), family therapy, play therapy, parent training, no treatment

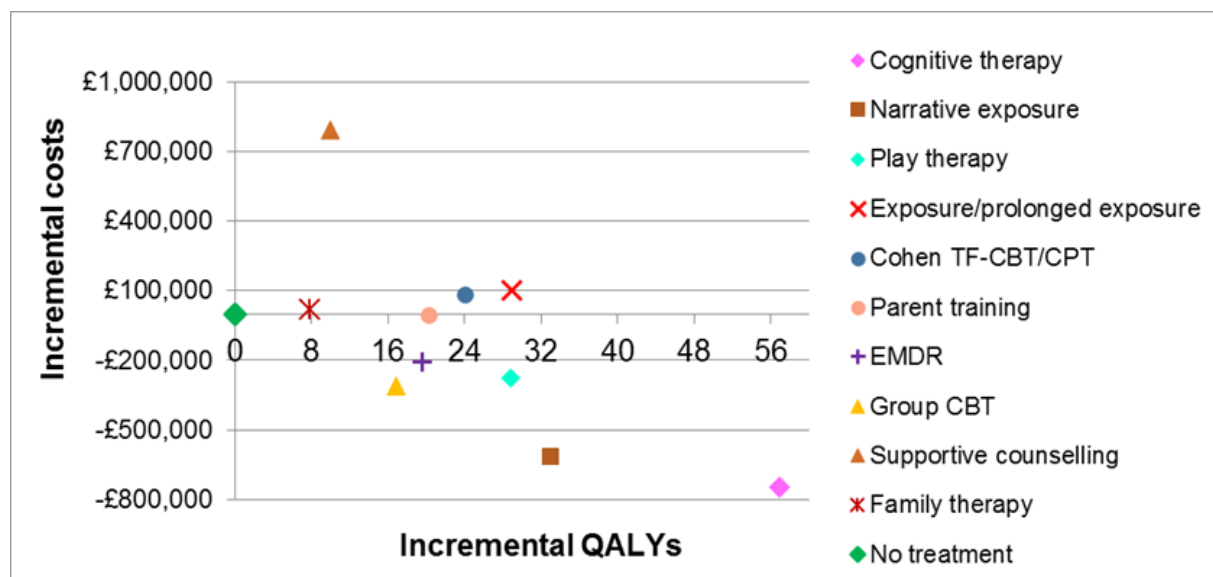
Results of Scenario C [utility data from Shearer and colleagues (2018); no beneficial effect beyond treatment endpoint]

Intervention	Mean per person			NMB (£/ person)	Mean rank (at a threshold of £20,000/QALY)	Prob*
	QALY	Intervention cost (£)	Total cost (£)			
[TF-CBT] cognitive therapy	2.224	1,203	4,373	40,108	2.05	0.59
[TF-CBT] narrative exposure	2.200	517	4,502	39,501	3.11	0.43
Play therapy	2.196	715	4,843	39,075	4.85	0.31
[TF-CBT] group CBT	2.184	270	4,807	38,872	5.05	0.21
EMDR	2.187	459	4,908	38,824	5.59	0.28
[TF-CBT] exposure / PE	2.196	1,089	5,221	38,700	6.47	0.25
Parent training	2.187	682	5,112	38,635	6.61	0.36
[TF-CBT] Cohen TF-CBT / CPT	2.191	911	5,202	38,622	6.66	0.52
Family therapy	2.175	287	5,139	38,357	7.59	0.41
No treatment	2.167	0	5,118	38,224	7.82	0.84
Supportive counselling	2.177	1,137	5,911	37,631	10.21	1.00

CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; Prob: probability of cost-effectiveness; TF-CBT: trauma-focused cognitive behavioural therapy

*estimated in a step-wise approach, according to which the most cost-effective intervention is omitted at each step, and the probability of cost-effectiveness of the next most cost-effective intervention amongst the remaining treatment options is re-calculated

Scenario C - Cost-effectiveness plane

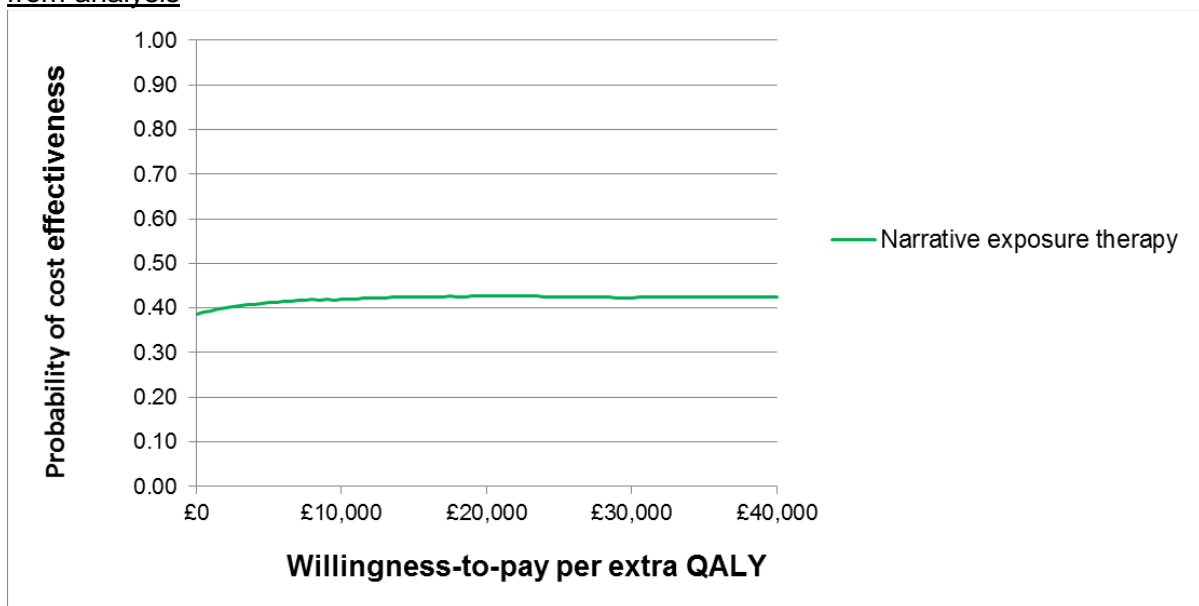


Scenario C - Cost-effectiveness acceptability frontier - cognitive therapy for PTSD included in analysis



Comparison across 11 alternative treatment options: supportive counselling, group CBT [TF-CBT], Cohen TF-CBT/ CPT [TF-CBT], cognitive therapy for PTSD [TF-CBT], narrative exposure therapy [TF-CBT], exposure/PE [TF-CBT], eye movement desensitisation and reprocessing (EMDR), family therapy, play therapy, parent training, no treatment

Scenario C - Cost-effectiveness acceptability frontier - cognitive therapy for PTSD excluded from analysis



Comparison across 10 alternative treatment options: supportive counselling, group CBT [TF-CBT], Cohen TF-CBT/ CPT [TF-CBT], narrative exposure therapy [TF-CBT], exposure/PE [TF-CBT], eye movement desensitisation and reprocessing (EMDR), family therapy, play therapy, parent training, no treatment

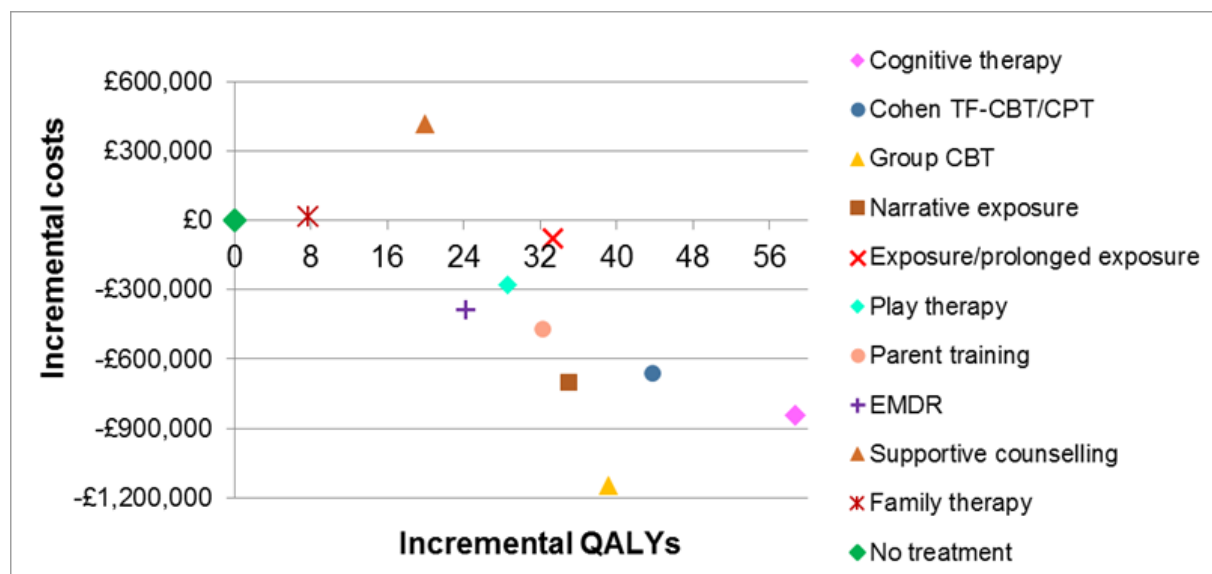
Results of Scenario D [utility data derived from Shearer and colleagues (2018); beneficial effect up to 3-month follow-up]

Intervention	Mean per person			NMB (£/ person)	Mean rank (at a threshold of £20,000/QALY)	Prob*
	QALY	Intervention cost (£)	Total cost (£)			
[TF-CBT] cognitive therapy	2.227	1,203	4,271	40,276	2.79	0.31
[TF-CBT] group CBT	2.208	270	3,966	40,190	2.54	0.50
[TF-CBT] Cohen TF-CBT / CPT	2.212	910	4,452	39,798	4.26	0.34
[TF-CBT] narrative exposure	2.204	518	4,412	39,661	4.40	0.34
Parent training	2.201	681	4,642	39,376	5.45	0.37
EMDR	2.193	462	4,727	39,130	6.25	0.31
Play therapy	2.197	718	4,833	39,113	6.40	0.44
[TF-CBT] exposure / PE	2.202	1,087	5,035	39,004	7.02	0.57
Family therapy	2.176	287	5,132	38,395	8.68	0.32
No treatment	2.169	0	5,113	38,261	8.88	0.55
Supportive counselling	2.189	1,136	5,529	38,244	9.32	1.00

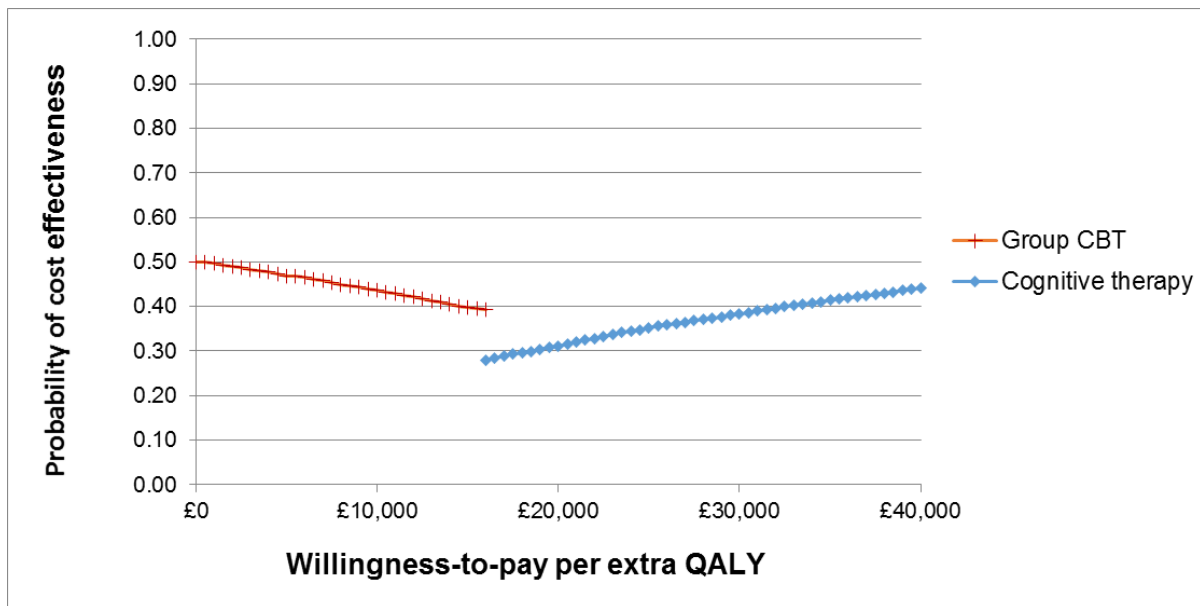
CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; Prob: probability of cost-effectiveness; TF-CBT: trauma-focused cognitive behavioural therapy

*estimated in a step-wise approach, according to which the most cost-effective intervention is omitted at each step, and the probability of cost-effectiveness of the next most cost-effective intervention amongst the remaining treatment options is re-calculated

Scenario D - Cost-effectiveness plane

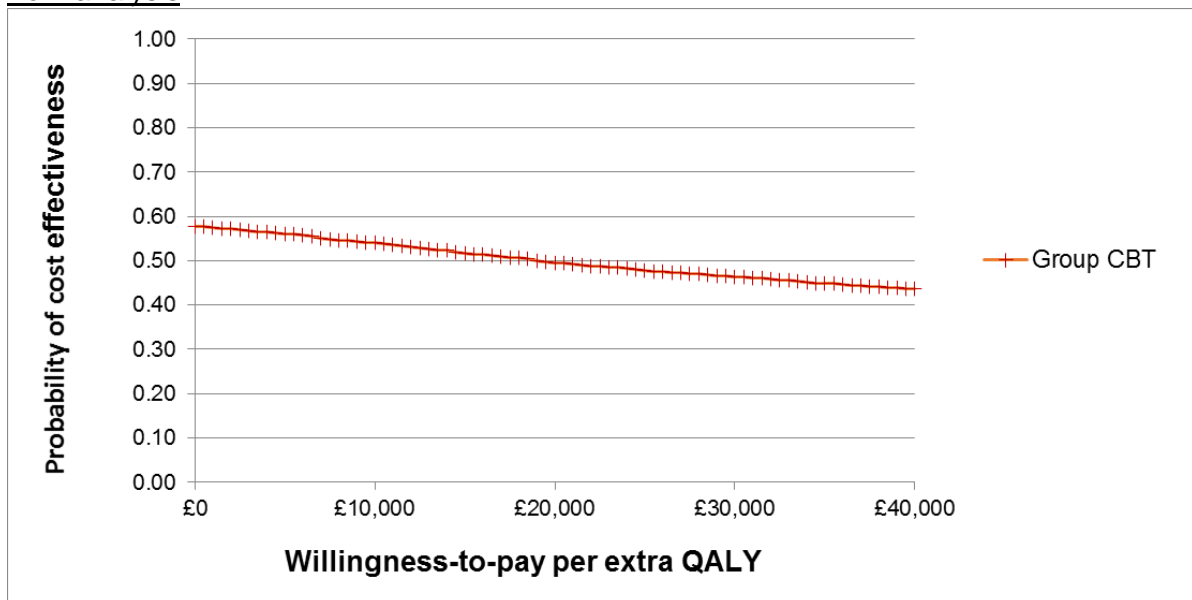


Scenario D - Cost-effectiveness acceptability frontier - cognitive therapy for PTSD included in analysis



Comparison across 11 alternative treatment options: supportive counselling, group CBT [TF-CBT], Cohen TF-CBT/ CPT [TF-CBT], cognitive therapy for PTSD [TF-CBT], narrative exposure therapy [TF-CBT], exposure/PE [TF-CBT], eye movement desensitisation and reprocessing (EMDR), family therapy, play therapy, parent training, no treatment

Scenario D - Cost-effectiveness acceptability frontier - cognitive therapy for PTSD excluded from analysis



Comparison across 10 alternative treatment options: supportive counselling, group CBT [TF-CBT], Cohen TF-CBT/ CPT [TF-CBT], narrative exposure therapy [TF-CBT], exposure/PE [TF-CBT], eye movement desensitisation and reprocessing (EMDR), family therapy, play therapy, parent training, no treatment

Appendix S5: Results of deterministic sensitivity analyses

Scenario A [utility data from Gospodarevskaya (2013); no beneficial effect beyond treatment endpoint]

Annual probability of relapse 0.10		Annual probability of relapse 0.00		Annual probability of relapse 0.20	
Intervention	NMB (£/person)	Intervention	NMB (£/person)	Intervention	NMB (£/person)
[TF-CBT] cognitive therapy	43,790	[TF-CBT] cognitive therapy	45,324	[TF-CBT] cognitive therapy	42,375
[TF-CBT] narrative exposure	41,256	[TF-CBT] narrative exposure	42,310	[TF-CBT] narrative exposure	40,279
Play therapy	40,209	Play therapy	41,175	Play therapy	39,314
[TF-CBT] exposure / PE	39,782	[TF-CBT] exposure / PE	40,744	[TF-CBT] exposure / PE	38,889
[TF-CBT] Cohen TF-CBT / CPT	39,265	[TF-CBT] Cohen TF-CBT / CPT	40,127	[TF-CBT] group CBT	38,466
[TF-CBT] group CBT	39,129	EMDR	39,885	[TF-CBT] Cohen TF-CBT / CPT	38,464
EMDR	39,127	[TF-CBT] group CBT	39,841	EMDR	38,421
Parent training	38,728	Parent training	39,473	Parent training	38,034
Family therapy	37,457	Family therapy	37,939	Family therapy	37,004
No treatment	37,075	No treatment	37,464	No treatment	36,708
Supportive counselling	36,823	Supportive counselling	37,388	Supportive counselling	36,294

CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; TF-CBT: trauma-focused cognitive behavioural therapy

Scenario B [utility data from Gospodarevskaya (2013); beneficial effect up to 3-month follow-up]

Annual probability of relapse 0.10		Annual probability of relapse 0.00		Annual probability of relapse 0.20	
Intervention	NMB (£/person)	Intervention	NMB (£/person)	Intervention	NMB (£/person)
[TF-CBT] cognitive therapy	44,079	[TF-CBT] cognitive therapy	45,637	[TF-CBT] cognitive therapy	42,639
[TF-CBT] group CBT	42,684	[TF-CBT] group CBT	43,747	[TF-CBT] group CBT	41,687
[TF-CBT] Cohen TF-CBT / CPT	42,534	[TF-CBT] Cohen TF-CBT / CPT	43,680	[TF-CBT] Cohen TF-CBT / CPT	41,459
[TF-CBT] narrative exposure	40,919	[TF-CBT] narrative exposure	41,931	[TF-CBT] narrative exposure	39,981
Parent training	40,258	Play therapy	41,175	Parent training	39,471
Play therapy	40,209	Parent training	41,095	Play therapy	39,314
[TF-CBT] exposure / PE	39,454	[TF-CBT] exposure / PE	40,301	[TF-CBT] exposure / PE	38,723
EMDR	38,722	EMDR	39,329	EMDR	38,150
Supportive counselling	38,247	Supportive counselling	38,929	Supportive counselling	37,605
Family therapy	37,457	Family therapy	37,939	Family therapy	37,004
No treatment	37,075	No treatment	37,464	No treatment	36,708

CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; TF-CBT: trauma-focused cognitive behavioural therapy

Scenario C [utility data from Shearer and colleagues (2018); no beneficial effect beyond treatment endpoint]

Annual probability of relapse 0.10		Annual probability of relapse 0.00		Annual probability of relapse 0.20	
Intervention	NMB (£/person)	Intervention	NMB (£/person)	Intervention	NMB (£/person)
[TF-CBT] cognitive therapy	39,791	[TF-CBT] cognitive therapy	40,385	[TF-CBT] cognitive therapy	39,243
[TF-CBT] narrative exposure	39,405	[TF-CBT] narrative exposure	39,813	[TF-CBT] narrative exposure	39,027
[TF-CBT] group CBT	38,814	Play therapy	39,132	[TF-CBT] group CBT	38,558
Play therapy	38,758	[TF-CBT] group CBT	39,090	Play therapy	38,411
EMDR	38,603	EMDR	38,897	EMDR	38,330
[TF-CBT] exposure / PE	38,344	[TF-CBT] exposure / PE	38,717	No treatment	38,067
[TF-CBT] Cohen TF-CBT / CPT	38,276	[TF-CBT] Cohen TF-CBT / CPT	38,610	[TF-CBT] exposure / PE	37,999
Parent training	38,263	Parent training	38,552	Family therapy	37,999
No treatment	38,209	Family therapy	38,361	Parent training	37,994
Family therapy	38,174	No treatment	38,360	[TF-CBT] Cohen TF-CBT / CPT	37,966
Supportive counselling	37,166	Supportive counselling	37,385	Supportive counselling	36,962

CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; TF-CBT: trauma-focused cognitive behavioural therapy

Scenario D [utility data from Shearer and colleagues (2018); beneficial effect up to 3-month follow-up]

Annual probability of relapse 0.10		Annual probability of relapse 0.00		Annual probability of relapse 0.20	
Intervention	NMB (£/person)	Intervention	NMB (£/person)	Intervention	NMB (£/person)
[TF-CBT] group CBT	40,191	[TF-CBT] group CBT	40,602	[TF-CBT] group CBT	39,805
[TF-CBT] cognitive therapy	39,903	[TF-CBT] cognitive therapy	40,506	[TF-CBT] cognitive therapy	39,345
[TF-CBT] Cohen TF-CBT / CPT	39,542	[TF-CBT] Cohen TF-CBT / CPT	39,985	[TF-CBT] Cohen TF-CBT / CPT	39,126
[TF-CBT] narrative exposure	39,275	[TF-CBT] narrative exposure	39,667	[TF-CBT] narrative exposure	38,911
Parent training	38,855	Parent training	39,180	Parent training	38,551
Play therapy	38,758	Play therapy	39,132	Play therapy	38,411
EMDR	38,446	EMDR	38,681	EMDR	38,225
[TF-CBT] exposure / PE	38,218	[TF-CBT] exposure / PE	38,545	No treatment	38,067
No treatment	38,209	Family therapy	38,361	Family therapy	37,999
Family therapy	38,174	No treatment	38,360	[TF-CBT] exposure / PE	37,934
Supportive counselling	37,718	Supportive counselling	37,982	Supportive counselling	37,469

CPT: cognitive processing therapy; EMDR: eye movement desensitisation reprocessing; NMB: net monetary benefit; PE: prolonged exposure; TF-CBT: trauma-focused cognitive behavioural therapy

Appendix S6: References in online supplementary material

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