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Review Article

Efficacy of electrotherapy in Bell's palsy treatment: A systematic review

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Abstract.
BACKGROUND: Up to now there is not enough evidence that supports the use of electrotherapy in the treatment of Bell's palsy.
OBJECTIVE: Through a systematic review, we aimed to verify whether the use of electrotherapy is effective for treating Bell's palsy or peripheral paralysis.
METHODS: Publications were searched in PubMed, EBSCO and Web of Science. The present systematic review included studies that analyzed the electrotherapy as a therapeutic method for treating individuals with Bell's palsy, in order to recover the function of facial muscles.
RESULTS: Seven studies involving a total of 131 cases and 113 controls were included in this systematic review. In the studies analyzed, patients received electrotherapy combined with other treatments such as hot-wet facial napkins, massages and muscle reeducation. Although the effect of electrotherapy alone was not evaluated, the use of electrotherapy combined with other treatments produced a significant improvement in the individuals evaluated.
CONCLUSIONS: Due to the diverse methodologies used and the small number of individuals included in the studies, we could not fully prove the efficacy of electrotherapy for treating Bell's Palsy. Future studies with larger samples and homogenous populations should be performed to obtain conclusive results.

Keywords: Bell's palsy, peripheral paralysis, electrotherapy

1. Introduction

Facial peripheral paralysis, or Bell's palsy, is an acute mononeuropathy of the facial nerve. It is of unknown cause and can affect a single nerve; it starts with pain in the mastoids region and partial or total paralysis of one side of the face [1,2]. Bell's palsy affects equally males and females, with an incidence of 11.5 to 40.2/100 000 [3,4]. The incidence is higher in individuals with Diabetes Mellitus, immunocompromised patients, individuals with arterial hypertension, patients who have had a viral infection of the upper respiratory tract, and pregnant woman [5]. Although Bell's palsy can happen at any age, there are peaks of incidence

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between 15–45 years of age, mean age 40 years [6]. Bell's palsy is usually idiopathic (75% of cases), and less frequently a secondary paralysis (25%) [2]. Several etiologic mechanisms have been proposed to explain the development of Bell's palsy including herpes virus, infectious mechanisms, ischemic mechanisms and autoimmune mechanisms; nevertheless, these are not completely understood [7–9].

The treatment of Bell's palsy is divided into acute and maintenance treatments. The acute treatment consists of using corticosteroids and antivirals that must be initiated within the first 72 hours after the onset of clinical signs [8]. The use of corticosteroids represents a highly-recommended intervention with evidence of improvement [3,10]. Regarding the use of antivirals, it is recommended that antiviral drugs are not prescribed in isolation [3,11]. The maintenance treatment includes interventions such as eye care, mouth care, physical therapy, Botulinum toxin injections and even complementary medicine treatments such as acupuncture [8].

Another type of treatment is physical therapy. However, according to the general-international Guidelines and some systematic reviews, physical therapy is not a highly recommended treatment due to the scarce evidence of improvement observed in individuals with Bell's palsy who received any type of physical therapy [3,12–14]. Nonetheless, in a recent systematic review, it was reported that the combination of pharmacological treatment with some modalities of physical therapy, favored a better recovery than pharmacological treatment alone [15]. Therefore, our systematic review will determine if the use of electrotherapy is recommendable when treating individuals with Bell's palsy. The objective of this systematic review is to demonstrate the benefits and efficacy of electrotherapy for treating patients with facial paralysis (Bell's palsy), in comparison to patients who did not receive electric stimulation.

2. Methods

This systematic review followed the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) criteria. The protocol of this systematic review was registered in PROSPERO (https://www.crd.york.ac.uk/PROSPERO/index.php), registration number 42014014938.

2.1. Inclusion and exclusion criteria

2.1.1. Inclusion criteria

The studies had to be published in peer-reviewed journals; had to be written in English; had to be cross-sectional or case-control designs. The studies had to provide information regarding time of exposure and the effects of the electrotherapy when treating patients with Bell's facial paralysis. Finally, the electrical stimulation had to be performed with electrodes.

2.1.2. Exclusion criteria

Controlled clinical trials that did not include electrotherapy as part of the Bell's facial paralysis treatment. Protocol articles for future studies were also excluded [16].

2.2. Search and selection of articles

We performed a search in PUBMED and Web of Science databases. We used the terms "Bell's palsy", "electrical stimulation", "rehabilitation" and combinations such as "Bell's palsy and electrical stimulation" and "Rehabilitation and facial paralysis". The search was concluded in January 2017. Initially, the electronic search generated 1,148 potentiality relevant papers; of those, we excluded 517 because they were duplicates. Then, we excluded 580 more, as they were of no relevance for this systematic review, or were written in other language than English, or were systematic reviews. Additionally, 27 papers were excluded after reading the abstract. Finally, we considered 24 papers; however, after reading and analyzing the contents, only 7 papers were included in this systematic review (Fig. 1).

2.3. Data extraction

Data was extracted by two independent investigators (EGBP and MSM). Each reviewer extracted the following data: author, year of publication, location, number of controls, number of cases, diagnoses and evolution of the palsy, characteristics of the treatment in the clinical trials and also additional treatments.

2.4. Data analysis

The selected studies were assessed using the GRADE system (Grading of Recommendations Assessment, Development and Evaluation Scale) (http://www.gradeworkinggroup.org) for quality evaluation (Table 1).

Table 1
Quality assessment of the studies using the GRADE system

Reference	Design	Number of patients	Quality of the evidence (GRADE)	Publication bias
[23] Gittins J (1998)	Cross-sectional	10	⊕⊕⊕⊖ Moderate	Undetected
[17] Targan R (2000)	Case-control	12	⊕⊕⊕⊕ High	Undetected
[18] Manikadan N (2006)	Case-control	29	⊕⊕⊕⊕ High	Undetected
[22] Hyvärinen A (2008)	Cross-sectional	10	⊕⊕⊕⊖ Moderate	Undetected
[19] Alakram P (2010)	Case-control	8	⊕⊕⊕⊖ Moderate	Undetected
[20] Tuncay F (2015)	Case-control	32	⊕⊕⊕⊕ High	Undetected
[21] Kim J (2016)	Case-control	30	⊕⊕⊕⊕ High	Undetected

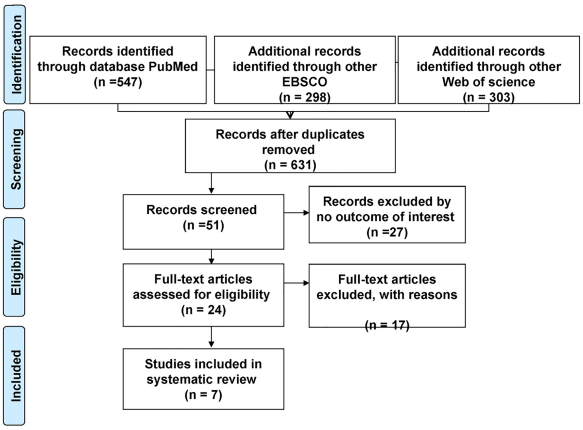

Fig. 1. Flowchart showing the search strategy used in the systematic review.

3. Results

This systematic review analyzed seven studies related to facial paralysis or Bell's palsy and rehabilitative treatment. The descriptive characteristics of each study are shown in Table 2.

3.1. Brief description of each study included

The study by Targan et al. in the USA [17] included twelve individuals with idiopathic facial paralysis and five individuals with a history of surgically affected nerves were recruited [17]. Diagnoses were based on latency and the House-Brackmann scale. They obtained the correlation coefficients between clinical residuals and nerve conduction latency ($r = 0.44$). The House-Brackmann scale and nerve conduction latency were low ($r = 0.51$), but statistically significant ($p = 0.036$ and $p = 0.02$, respectively).

Another study performed in India included 59 individuals diagnosed with Bell's palsy [18]. Patients were divided into a control group ($n = 30$) and a group of neuromuscular facial re-education ($n = 29$). The control group was treated following a standard protocol, while the facial neuromuscular re-education group received a treatment that included 3 sets of 5 to 10 repetitions of electrical stimulation. The facial scale ratings in the control group were 32 (9.7–54) in pretreatment, and 54.5 (42.2–71.7) in post-treatment, $p \leqslant 0.01$. While the group of neuromuscular reeducation scored 33 (18–43.5) in pretreatment, and 66 (54–76.7) in post-treatment, $p \leqslant 0.01$.

In a recent study performed in the region of South Africa [19], 16 individuals were recruited and divided into a re-education group ($n = 8$) and an experimental group ($n = 8$) within the early phase of Bell's palsy. Both groups had the same treatment; however, the experimental group additionally received 30 minutes of electrical stimulation of facial muscles using a TENS unit (Frequency 10 Hz, pulse width 10 μsec). According to the House-Brackmann scale, the recovery rates in the experimental group were higher than in the control group (37.6 ± 18.1 versus 29.6 ± 12.5, respectively); nevertheless, these differences were not statistically significant ($p = 0.36$).

In a different study [20], individuals with Bell's palsy were divided into a group that received electro stimulation ($n = 32$) and another group that did not ($n = 28$). Significant differences were observed between the groups when the FDI scale was evaluated. The electro stimulation-group showed a major improvement of physical function ($p = 0.02$) and social welfare function ($p = 0.03$).

Finally, in a study performed by Kim et al. in Korea [21], 60 individuals with Bell's palsy in early phase were selected and separated into two groups, control ($n = 30$) and experimental ($n = 30$). The treat ment in both groups consisted of drugs, with additional electrical stimulation for the experimental group. Prednisolone was administrated during the first 5 days (1 mg/kg/day), and then during 10 days. They also received acyclovir (1500 mg/day) during five days. The overall rate of patient recovery in the experimental group was 96%, while in the control group was 88%.

Table 2
Descriptive and clinical characteristics of the studies

Study	Location	Controls	Cases	Diagnosis	Characteristics of the treatment		Additional treatment	Result
Gittins J (1998) [23]	United Kingdom	–	10[1]	Secondary palsy of the 7th cranial nerve[2]	Evolution of the paralysis	12 to 24 months	None	Voluntary closing of the eyelid increased an average of 2.5 mm and improved the speed 0.9 seconds
					Current type and wave form	Constant voltage currents compensated monophasic current		Lagophthalmus: 2.9 mm decrease (mean) in 8 patients
					Frequency	2 Hz–200 Hz		Eyelid displacement ($P <$ 0.005)
					Intensity	Not specified		
					Pulse width	50 μsec–200 μsec		
					Duration	3 months		
					Application time	1 hour daily		
					Combination with drugs during treatment	None		
Targan R (2000) [17]	EE. UU	17	12[3]	Chronic facial nerve damage caused by Bell's palsy or acoustic neuroma excision	Evolution of the paralysis	3.7 (Bell's palsy group) and 7.2 years for acoustic neuroma group)	None	Decreased facial motor nerve latency 1.13 ms ($P = 0.001$)
					Electrical stimulation	Monophasic current		Improvement on the House-Brackmann Scale ($P = 0.003$)
					Intensity	Sub-motor level (sensory threshold)		Decrease in Clinical Impairment score 28.7 ($P =$ 0.0005)
					Pulse width	86 μsec (1 pulse every 700 ms)		
					Ramp up	1 second		
					Ramp down	0.5 second		
					Duration	6 months		
					Application time	Starting with 30 minutes for muscle, progressively increasing to 6 hours in the 6th month		
					Combination with drugs during treatment	None		
Manikadan N (2006) [18]	India	30	29	Facial paralysis idiopathic	Evolution of the paralysis	Acute[4]	Control group: Gross facial exercises, massage, orthotic devices or taping to lift drooping flaccid faces plus electrical stimulation	Significant improvement in the total score of the Facial Grading Score and in the movement subcomponent in favor of the control group was observed ($P <$ 0.01)
					Current type and wave form	Galvanic to muscle and faradic current to motor trunk		
					Frequency and pulse width	Not specified		
					Intensity	Motor level		
					Duration	2 weeks (6 days for week)		
					Application time	10 visible contractions for muscle, 3 times daily	Re-education group: Techniques tailored to each patient	There were no significant differences in synkinesis subcomponents
					Combination with drugs during treatment	None		

Table 2, continued

Study	Location	Controls	Cases	Diagnosis	Characteristics of the treatment		Additional treatment	Result
Hyvärinen A (2008) [22]	Finland	–	10	Chronic facial nerve palsy of idiopathic origin or by Herpes Zoster	Evolution of the paralysis Wave form Frequency Intensity Pulse width Duration Application time Combination with drugs during treatment	Chronic 1–24 years Monophasic current 20 Hz Sub-motor level (sensory threshold) 100 μsec 6 months Starting with 30 minutes for muscle, progressively increasing to 6 hours in the 6th month No. The use of corticosteroids and acyclovir were previous to the treatment with electrical stimulation	None	Improvement in motor latency of the facial nerve, significantly only in the upper nerve branch ($P = 0.02$) Improvement in evaluation with the House-Brackmann scale of at least 1 degree in all patients
Alakram P (2010) [19]	South Africa	8	8	Facial paralysis idiopathic	Evolution of the paralysis Wave form Frequency Intensity Pulse width Combination with drugs during treatment	Acute (less than 30 days post onset) Not specified 10 Hz Motor level 10 μsec All individuals received prednisolone (2 mg per kg daily and weaned off within 2 weeks)	Early re-education Control group: Heath, massage and exercises. prednisolone (2 mg per kg daily and weaned off within 2 weeks Experimental group: Same as control group plus electrostimulation For patients with eye problems were given eye drops and those with pain were given Panado's	The comparison of recovery rates for the House-Brackmann scale indicates that the individual rates in the experimental group were higher than that of the control group However, there was no statistically significant difference in rate of recovery between the experimental and control group ($P = 0.36$)
Tuncay F (2015) [20]	Turkey	28	32	Facial paralysis idiopathic	Evolution of the paralysis Wave form Intensity Frequency Pulse width interpulse interval Duration Application time Combination with drugs	Acute (four weeks) Monophasic current (only for group with electrical stimulation) Motor level 2.5 Hz 100 μsec 300 μsec 3 weeks (5 day for week) 3 sets of 30 contractions per treated muscle No. The use of corticosteroids was previous to the treatment with electrical stimulation	Control group: Hot pack, massage, facial expression and exercise through a mirror Experimental group: Same treatment plus facial electrostimulation All patients received corticosteroid treatment for 10 days	Significant improvement in the House-Brackmann scale in both treatment groups, in favor of the experimental group ($P = 0.0001$) Significant improvement in the amplitude and latency of the facial nerve motor in the experimental group Improvement in the Facial Disability Index in both treatment groups, in favor of the experimental group

Table 2, continued

Study	Location	Controls	Cases	Diagnosis	Characteristics of the treatment		Additional treatment	Result
Kim J (2016) [21]	Korea	30[5]	30[6]	Facial paralysis idiopathic	Evolution of the paralysis Wave form Frequency Intensity Pulse width Duration Combination with drugs	One week Monophasic current 20 Hz–5 KHz Sub-motor level (sensory threshold) 100 μsec every 50 ms 6 months Prednisolone (1 mg/kg/day for the first 5 days, weaned off within 2 weeks) for 10 days, plus acyclovir (1500 mg daily) for 5 days	Control group: Treated during the first 5 days with prednisolone (1 mg/kg/day), and decreased during 10 days. They were also treated with acyclovir (1500 mg at day) during five days Experimental group: Same drug treatment of the control group plus continuous, low frequency-impulse electrical stimulation (SCLES)	An improvement in facial performance was noted in the first 2 weeks in the experimental group, and the time for complete recovery was significantly shorter than that in the control group ($P < 0.05$) All patients except one showed complete recovery in the experimental group in three months. In the control group, 5 patients did not recover normal facial function within 6 months

[1]Voluntary closure of the eyelid was measured only in 7 individuals, but the Lagophthalmus was used in 10 individuals. [2]Eight patients secondary to Neurinoma, one with surgical lesion and one patient with trauma. [3]Twelve patients with Bell's palsy and five patients with surgical resection of the facial nerve by acoustic neuroma. [4]11.4 days for control group and 12.5 days for experimental group. [5]30 patients used medical treatment only (control group). [6]30 patients use medical treatment plus electrical stimulator.

3.2. Studies without a comparison group

In a study conducted in Finland by Hyvärinen et al., ten individuals with chronic facial paralysis were enrolled [22]. When electrical stimulation was applied in the facial nerve, patients showed improvement, and the distal latency obtained improved ($p = 0.02$). Moreover, in a study conducted in the UK, ten individuals with chronic paralysis of the seventh cranial nerve were recruited [23]. They were assessed with EMG system for measuring eyelid function. The results showed that electrical stimulation therapy improved voluntary movement, increasing the displacement of the eyebrows in a range of 1.4 mm to 4.1 mm with an average of 2.5 mm. However, due to their exclusion criteria the study group was reduced to seven individuals. Four of them showed significant improvement in range of motion ($p \leqslant 0.01$).

4. Discussion

This study was conducted in order to determine if the use of electrotherapy is helpful in the treatment of Bell's palsy. The results of this systematic review showed that there is an improvement in patients who received electrotherapy, in both phases, acute and chronic. Although there is not enough evidence regarding the effectiveness of electrotherapy for treating Bell's palsy [24], the results found in this systematic review are oriented towards a positive response to the treatment.

In the present study, we analyzed 131 cases and 113 controls. We included seven publications, while both of the previous systematic reviews only included three or four publications. For instance, the review about physical therapy for treating Bell's palsy performed by Teixeira et al. [25], analyzed 3 trials and reported no significant improvement in patients who received electrical stimulation, questioning its cost-effectiveness. In the update of the same review [14], four trials were analyzed and the results obtained were similar. It is necessary to emphasize that these previous reviews did not aim to specifically evaluate electrotherapy, but multiple physical therapies. In addition, the trials analyzed were not very recent.

On the other hand, there are several countries without an up to date guide for the long term treatment of Bell's palsy [26]. Although it has been stated that receiving electrotherapy in the acute phase of Bell's palsy is beneficial for patients [19–21,27], and it is highly used in the Mexican clinical practice (for diagnosis and management of Bell's palsy), there is not enough evidence to support the efficacy of electrotherapy in acute cases.

It is necessary to mention that although patients who received electrical stimulation improved their condition in all the studies evaluated, the methodology used in each one was different. For instance, in the study by Tuncay et al. [20], the electro stimulation with a current wave phase began four weeks after diagnosis. The results showed differences in facial re-education according to the House-Brackmann scale. Furthermore, Hyvärinen [22] used 20 Hz electro stimulation and 100 μseg pulse duration, 30 min/day, for two weeks, increasing the amount of time per day during 6 months until reaching 6 hrs of stimulation. Gittins [23] on the other hand, used a frequency of 2 Hz to 200 Hz and 50 μseg–200 μsec pulse length. Clearly, the frequency applied in the study by Hyvärinen [22] was lower than the frequency applied in the study by Gittins [23]; nevertheless, in the study by Hyvärinen [22] the results obtained were satisfactory, since all patients showed significant improvement according to the House-Brackmann scale. In the study by Gittins [23] however, the entire study population showed no improvement after treatment. Thus, we can infer that the improvement observed when using electrotherapy did not depend on the intensity or frequency used.

Unlike previous studies, Manikandan [18] used electrostimulation via galvanic and faradic current for facial muscles stimulation. Although patients showed improvement, we must emphasize that electro stimulation therapy was combined with facial rehabilitation exercises, through which much of this improvement was obtained. In more recent studies [19–21], the results of electrical stimulation treatment in the early phase of Bell's Palsy demonstrated a significant recovery. It is important to mention that this improvement was observed in studies with a considerable n, [20,21] with more than 20 patients in the control and experimental groups, unlike a recent study with a poor n, [19] in which statistical significance was not observed. Another important aspect in the methodology of all the studies was the stimulation level, while some used a motor level [18–20] others applied sub-motor level (sensory threshold) [17,21,22], this represents a controversy, because literature indicates that stimulation at motor level, could favor secondary effects such as synkinesia. It is considered that patients with chronic peripheral paralysis receiving daily treatment with electrostimulation for at least 3 months improve

significantly [23]. Nonetheless, depending on the nerve injury and latencies deficiency in nerve conduction, patients with facial paralysis will be considered for a prolonged electro stimulation combined with exercise programs or drug treatment, in order to increase the success of the intervention.

Given the importance of the treatment in Bell's palsy, our findings suggest that the use of electrotherapy may play an important role in the improvement of patients. It would be necessary to develop further studies with similar characteristics such as parameters of frequency, intensity, pulse duration, treatment time, number of sessions, number of contractions and even the same area of stimulation, with the purpose of clarifying the genuine role that electrotherapy plays in Bell's palsy treatment.

Conflict of interest

The authors have no competing interests to report.

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Appendix: PRISMA checklist

Section/topic	#	Checklist item	Reported on page #
Title			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title page
Abstract			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Abstract
Introduction			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
Methods			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4–5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4–5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4–6
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5–6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5–6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	4–6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	NA
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5–6
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Table 1
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	6, Table 2
Results			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	6–9, Table 2
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Table 1
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	6–8
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Table 1
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression (see Item 16)).	NA

Section/topic	#	Checklist item	Reported on page #
Discussion			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9–11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	9–11
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	9–11
Funding			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	12

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi: 10.1371/journal.pmed1000097.