TITLE: Functional Electrical Stimulation for Children with Spinal Cord Injuries or Cerebral Palsy: Update of Review of Clinical Effectiveness

DATE: 6 August 2015

RESEARCH QUESTIONS

1. What is the clinical effectiveness of functional electrical stimulation (FES) including FES cycling (FES Cycle) for children with spinal cord injuries?

2. What is the clinical effectiveness of functional electrical stimulation (FES) including FES cycling (FES Cycle) for children with cerebral palsy?

KEY FINDINGS

Three systematic reviews, six randomized controlled trials, and six non-randomized studies were identified regarding the use of functional electrical stimulation (FES) for children with spinal cord injuries or cerebral palsy.

METHODS

A limited literature search was conducted on key resources including CINAHL, PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2011 and July 23, 2015. Internet links were provided, where available.

The summary of findings was prepared from the abstracts of the relevant information. Please note that data contained in abstracts may not always be an accurate reflection of the data contained within the full article.
SELECTION CRITERIA

One reviewer screened citations and selected studies based on the inclusion criteria presented in Table 1.

<table>
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<tr>
<th>Table 1: Selection Criteria</th>
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<tr>
<td>Population</td>
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<td>Intervention</td>
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<td>Comparator</td>
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<td>Outcomes</td>
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<td>Study Designs</td>
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RESULTS

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials and non-randomized studies.

Three systematic reviews, six randomized controlled trials, and six non-randomized studies were identified regarding the use of functional electrical stimulation (FES) for children with spinal cord injuries or cerebral palsy. No relevant health technology assessments were identified.

Additional references of potential interest are provided in the appendix.

OVERALL SUMMARY OF FINDINGS

Two systematic reviews\(^1\)\(^-\)\(^2\) were identified regarding the use of FES for children with cerebral palsy. The 2015 systematic review\(^1\) reported weak or conflicting evidence that FES improved postural control in children with cerebral palsy, while the systematic review by Chiu\(^2\) reported that FES was more effective than no FES and had a similar effect as activity training alone for children with cerebral palsy. The third systematic review\(^3\) reported FES to be a safe and moderately effective intervention to mitigate inactivity in youth with spinal cord injury.

Table 2 summarizes the findings of the randomized controlled trials\(^4\)\(^-\)\(^9\) and non-randomized studies.\(^10\)\(^-\)\(^15\) The majority of these studies reported on electrical stimulation interventions in children with cerebral palsy,\(^4\)\(^-\)\(^8\),\(^10\),\(^11\),\(^13\)\(^-\)\(^15\) while two studies\(^9\),\(^12\) reported on electrical stimulation interventions in children with spinal cord dysfunction. The majority of studies found FES to be an effective intervention and well tolerated by patients.
<table>
<thead>
<tr>
<th>First Author, Year</th>
<th>Population</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Author Findings and Conclusions</th>
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<tr>
<td><strong>Randomized Controlled Trials</strong></td>
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<tr>
<td>Pool, 2015&lt;sup&gt;4&lt;/sup&gt;</td>
<td>N = 32 children with USCP</td>
<td>8 weeks of FES applied during every day walking</td>
<td>Usual therapy</td>
<td>FES improved self-perceived performance and satisfaction regarding functional skills</td>
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<td>Yildizgoren, 2014&lt;sup&gt;5&lt;/sup&gt;</td>
<td>N = 14 children with USCP</td>
<td>30 minute sessions (5 days a week for 6 weeks) of NMES with conventional exercise</td>
<td>Conventional exercise</td>
<td>NMES plus conventional exercise is effective at improving hand and wrist functions</td>
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<td>Arya, 2012&lt;sup&gt;6&lt;/sup&gt;</td>
<td>N = 10 children with spastic diplegic/hemiplegic CP</td>
<td>NMES plus conventional therapy (muscle strengthening exercises and physiotherapy)</td>
<td>Conventional therapy (muscle strengthening exercises and physiotherapy)</td>
<td>NMES plus conventional therapy is more effective than conventional therapy alone for improving walking ability and functional outcomes</td>
</tr>
<tr>
<td>Karabay, 2012&lt;sup&gt;7&lt;/sup&gt;</td>
<td>N = 32 children with spastic diplegic CP</td>
<td>30 minute FES application (5 days a week for 4 weeks) to abdomen-posterior back muscles plus PTR</td>
<td>PTR program</td>
<td>FES plus PTR was more effective than PTR alone in improving balance when sitting</td>
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<tr>
<td>Xu, 2012&lt;sup&gt;8&lt;/sup&gt;</td>
<td>N = 68 children with hemiplegic CP</td>
<td>ES plus constraint therapy for 2 weeks</td>
<td>Constraint therapy or occupational therapy</td>
<td>ES plus constraint therapy improved hand dysfunction more than two comparator interventions</td>
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<td>Johnston, 2011&lt;sup&gt;9&lt;/sup&gt;</td>
<td>N = 30 children with chronic SCI</td>
<td>FES cycling; or non-cycling, ES exercise</td>
<td>Passive cycling</td>
<td>FES cycling had the greatest improvement in muscle strength, ES had the greatest improvement in muscle volume</td>
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<tr>
<td><strong>Non-Randomized Studies</strong></td>
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<td>Pool, 2014&lt;sup&gt;10&lt;/sup&gt;</td>
<td>N = 12 children with USCP</td>
<td>FES device for walking (daily for 8 weeks)</td>
<td>Pre-FES measurements</td>
<td>FES effectively reduced gait impairments for children with USCP</td>
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Table 2: Summary of Findings from the Randomized Controlled Trials and Non-Randomized Studies

<table>
<thead>
<tr>
<th>First Author, Year</th>
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<tr>
<td>Meilahn, 2013&lt;sup&gt;11&lt;/sup&gt;</td>
<td>N = 10 children with hemiparetic CP</td>
<td>ES foot drop neuroprosthesis for 3 months</td>
<td>N/A</td>
<td>An ES foot drop neuroprosthesis was effective for treatment of foot drop and was well tolerated by children with hemiparetic CP</td>
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<tr>
<td>Castello, 2012&lt;sup&gt;12&lt;/sup&gt;</td>
<td>N = 6 children and adolescents with spinal cord dysfunction</td>
<td>FES cycle</td>
<td>N/A</td>
<td>FES cycle improved BMD and quality of life, and improvement was associated with number of FES cycle sessions attended</td>
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<tr>
<td>Harrington, 2012&lt;sup&gt;13&lt;/sup&gt;</td>
<td>N = 4 adolescents with spastic CP</td>
<td>FES cycle</td>
<td>Conventional cycling</td>
<td>FES cycle was well tolerated and improved cycling performance related outcomes</td>
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<tr>
<td>Prosser, 2012&lt;sup&gt;14&lt;/sup&gt;</td>
<td>N = 21 children and adolescents with CP</td>
<td>FES device while walking (4 months)</td>
<td>Non-FES conditions</td>
<td>FES was effective for treatment of foot drop and improving mild gait impairments; the FES device was well accepted by participants</td>
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<td>Alabdulwahab, 2011&lt;sup&gt;15&lt;/sup&gt;</td>
<td>N = 17 children with spastic diplegic CP in the study group; N = 15 children with spastic diplegic CP in the control group; N = 17 healthy children in the second control group</td>
<td>ES of the bilateral hip adductor and abductor muscles during walking</td>
<td>Not specified</td>
<td>Gait performance, knee position, and muscle tone were improved in children receiving ES interventions</td>
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</tbody>
</table>

BMD = bone mineral density; CP = cerebral palsy; ES = electrical stimulation; FES = functional electrical stimulation; N/A = not applicable; NMES = neuromuscular electrical stimulation; PTR = physical therapy and rehabilitation; SCI = spinal cord injury; USCP = unilateral spastic cerebral palsy.
REFERENCES SUMMARIZED

Health Technology Assessments
No literature identified.

Systematic Reviews and Meta-analyses


Randomized Controlled Trials


FES for Children with Spinal Cord Injuries or Cerebral Palsy

Non-Randomized Studies


APPENDIX – FURTHER INFORMATION:

Systematic Reviews – Uncertain Outcomes


Randomized Controlled Trials

Alternate Outcomes


Mixed Modality, Electric Stimulation with Botulinum Toxin


Non-Randomized Studies

Alternate Outcomes


PubMed: PM23042834

Mixed Modality, Electric Stimulation with Botulinum Toxin

PubMed: PM22297709

Additional References

Summary with Critical Appraisal