CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For a 35-year-old female with relapsing-remitting multiple sclerosis (P), does participating in cold-water aquatic activity (I) reduce the severity or frequency of pseudo-exacerbations or other flares of disease symptom (O) compared to warm-water aquatic therapy or dry land exercise (C)?

AUTHOR

Prepared by	Sam Ward	**Date**	12/2/2020
Email address	sam_ward@med.unc.edu		

CLINICAL SCENARIO

The patient is a 35-year-old female with relapsing-remitting multiple sclerosis (MS), diagnosed about 7 years ago. She continues to work and is active in the community, with friends and family, but has developed increasingly severe symptoms related to her MS since diagnosis, including back and lower extremity pain, headaches, fatigue, heat sensitivity, and weakness that makes her usual routine more difficult than it was previously. She remains independent in all activities of daily living (ADLs), but would like to focus the energy she does have on exercise and physical activity that will allow her to stay as fit as possible for as long as possible, without causing undo stress on herself. The patient has always enjoyed swimming and other pool-based activities, but has stopped going because she is not sure whether her local pool is too warm, too cold, or just right to help ameliorate her heat sensitivity. Heat sensitivity is a common symptom of MS that most people are able to manage with various cooling strategies.[1] Likewise, getting appropriate levels of exercise is difficult for many people with MS due to their variable and unique disease symptoms.[2] I would like to determine if exercising in cool to cold water is more beneficial than warm water or dry land as a way to prevent overheating in people with MS, allowing them to exercise with more intensity, with greater frequency, and/or for longer durations, without negative side-effects. If this is the case, cool or cold-water aquatic therapy would be an appropriate way for someone with MS (the patient) to reduce pain, increase his or her level of exercise and gain or regain greater fitness, function, and/or well-being through enhanced therapeutic activity and exercise.

SUMMARY OF SEARCH

- The search strategy returned 75 articles after removal of duplicates. The final 8 that were chosen as the highest quality and most applicable to the clinical scenario, having met inclusion/exclusion criteria, are made up of 5 randomized controlled trials (RCTs)[3–7], 2 systematic reviews[1,8], and 1 controlled cohort study.[9]
- Aquatic therapy at multiple temperatures (28-35.5 degrees Celsius)[1] is safe and effective at addressing numerous dimensions of MS symptoms and limitations.
- There is no one temperature or range of temperatures that results in fewer disease exacerbations or that produces greater therapeutic results.
- Water temperature should be closely monitored along with patient's report of symptoms and exertion level to prevent overheating and limit the risk of a pseudo-exacerbation.

CLINICAL BOTTOM LINE

Adults with MS may safely participate in aquatic therapy to address current limitations due to their disease. The physical therapist or other clinician working with the patient should closely monitor the individual in order to discontinue therapy in the event of a disease relapse or pseudo-exacerbation. The specific water temperature and therapeutic activity or exercise may be chosen based on the patient's own interest and comfort.

This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
18-65 multiple sclerosis	Participation in cold water aquatic therapy	Warm water aquatic therapy or dry land therapy	Flare up (Pseudo)-exarcerbation Adverse event

Final search strategy (history):

1. "Multiple sclerosis" OR MS
2. "Aquatic therapy" OR "pool therapy" OR hydrotherapy OR "aquatic exercise" OR "water therapy" OR "water exercise"
3. Flare OR "flare up" OR pseudo-exacerbation OR exacerbation OR "adverse events"
4. #1 AND #2 AND #3
5. **#1 AND #2**

Databases and Sites Searched	**Number of results**	**Limits applied, revised number of results (if applicable)**
PubMed	104	Limits: English language, age 19-64, journal article. **Revised results: 47**
CINAHL	85	Limits: English language, age 19-64, academic journals. **Revised results: 29**
Web of Science	28	Limits: English language, articles, reviews, early access. **Revised results: 25**

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Adults, 19-64 with MS • Exercise takes place in pool • Water temperature recorded • Incidence of flares, pseudo-exacerbation, or disease progression is reported • RCTs, quasi-experimental, cohort observation, case study (depending on availability)
Exclusion Criteria
• Not English • Water temperature not reported

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Bansi et al (2013)[3]	PEDro (7/10)	1b	Moderate (6 in aquatic intervention group lost to f/u, not due to adverse events)	RCT
Bayraktar et al (2013)[9]	Modified Downs and Black (20/29)	2b	Moderate (4 in intervention group lost to f/u, not due to adverse events)	Controlled Cohort study (single blind, non-randomized)
Castro-Sánchez et al (2012)[4]	PEDro (7/10)	1b	Moderate (well-reported temperatures but not comparison of different water temp. No adverse events)	RCT
Corvillo et al (2017)[1]	AMSTAR (6/11)	2a (mix of RCTs and non-RCTs. Modified D&B avg score 17.3/28 = fair)	High (does not specifically compare different water temps, but included articles report different temps so this SR offers more information than other RCTs in this list of 8 articles)	Systematic Review
Kargarfard et al (2018)[5]	PEDro (7/10)	1b	Moderate (3 in intervention group lost to f/u, not due to adverse events)	RCT
Marinho-Buzelli et al (2015)[8]	AMSTAR (8/11)	2a (mix of RCTs and non-RCTs)	Low (SR of neurological diseases in general with little in depth discussion specific to MS)	Systematic Review
Razazian et al (2016)[6]	PEDro (6/10)	1b	Low (no report of whether or not there was loss to f/u or if there were adverse events)	RCT
Sadeghi Bahmani et al (2020)[7]	PEDro (7/10)	2b	Moderate (2-arm intervention plus active control, with 1 drop out in each intervention, but no discussion of reason for loss)	RCT

BEST EVIDENCE

The following 2 studies were identified as the 'best' evidence and selected for critical appraisal. Rationale for selecting these studies were:

- **Castro-Sánchez et al. -** One of the higher quality RCTs with good adherence to intervention, pre- and post-test measures, with follow-up continued for greater amount of time than other studies. Water temperature in this study was also warmer than in other RCTs and compared to most of the included studies in the Corvillo et al., systematic review. This will at least allow me an additional, useful data point to use in my CAT.
- **Corvillo et al. -** Provides a broad overview of studies with report of multiple water temperatures and at least a minor discussion on risk of injury with aquatic interventions. The other SR (Marinho-Buzelli et al) is not specific to MS, and the remaining studies are not of substantially better quality than those included in the Corvillo et al.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of *Hydrotherapy for the treatment of pain in people with multiple sclerosis: a randomized controlled trial* by Castro-Sánchez et al., 2012.

Aim/Objective of the Study/Systematic Review:

Castro-Sánchez et al. sought to determine how effective Ai-Chi hydrotherapy is at improving pain and disability (primary measures), as well as spasm, quality of life, fatigue, depression, and function (secondary measures) in people with multiple sclerosis.

Study Design

The Castro-Sánchez et al. study was a randomized-controlled trial that took place from January 1, 2009 through June 30, 2010, with participants recruited through the MS Association of Almeria (AEMA) in Spain. The control group consisted of people with MS who underwent relaxation interventions in a therapy room and the experimental group consisted of people with MS who participated in an Ai-Chi aquatic therapy intervention. All participants underwent pretrial screening to gather demographic information, assess inclusion/exclusion criteria, and gather informed consent. A blinded researcher randomized (computer software) the control and experimental groups after stratification based on type(s) of medications used. Each group received its respective treatment 2 times per week (on different days to avoid overlap) for 20 weeks. After the first 20 participants had been treated a power analysis was performed that estimated a minimum sample of 33 subjects per group (power = 80%, SD = 3.1).

Both groups underwent outcome measure assessment at the same 4 time points: baseline (0 weeks), immediately upon conclusion of intervention (20 weeks), 4 weeks post-intervention (24 weeks), and 10 weeks post-intervention (30 weeks).

Primary outcome measures: Pain; Disability.

Secondary outcome measures: Spasm; Quality of Life; Fatigue; Depression; Function.

Groups were compared at all 4 time points with repeated-measures analysis of variance and Student's *t*-test also used for analysis of independent sample differences. Statistical significance set at ≤ 0.05 for all measures.

Setting

The Castro-Sánchez et al. paper does not describe the specific location where the study took place. The researchers are associated with the University of Almeria (Spain) and the ethics and research committee of the same university approved the protocol, so the assumption is that study took place on or near there at a university clinic and therapy pool locations.

Participants

Participants were recruited through the AEMA. A total of 198 people were screened. Of these, 98 did not meet inclusion criteria (MS diagnosis, 18-75 years old, pain > 4 on VAS for past 2 months, EDSS ≤ 7.5) and/or exclusion criteria (treatment with other complementary and alternative medicine, relapse within previous 2 months requiring hospital stay or steroid treatment); 27 people refused/declined to participate. The remaining 73 people were randomized into control group (n = 37, 24 females) and experimental group (n = 36, 26 females). Two participants in the control group dropped out by the end of the 20-week intervention due to MS disease relapse, otherwise no other drop outs or adverse events were reported.

Baseline demographics and outcome assessments did not differ significantly between the 2 groups:

- Control Group: average age 50 years (SD=12.31); average EDSS = 5.9 (SD=0.9); average years since diagnosis = 11.9 (SD=8.7); average pain VAS = 7.8 (SD=1.6); primary progressive MS (n=9), secondary progressive MS (n=12), unknown MS type (n=16).
- Experimental Group: average age 46 years (SD=9.97); average EDSS = 6.3 (SD=0.8); average years since diagnosis = 10.7 (SD=9.1); average pain VAS = 8.3 (SD=1.2); primary progressive MS (n=6), secondary progressive MS (n=9), unknown MS type (n=21).

Baseline description of pain location within and between groups was not significantly different. Subjects reported anatomic region of *most* pain (n =): lumbar spine (51); cervical spine (22); legs (32); feet (29); arms (23); shoulders (17); forearms (13).

Intervention Investigated

Control

The control group was led by a single physiotherapist in group relaxation exercises, which consisted of abdominal breathing and contraction-relaxation exercises. These were performed in supine on an exercise mat in a quiet therapy room with an ambient air temperature of around 26 degrees Celsius. Control group intervention took place on Tuesdays and Fridays for approximately 20 minutes.

Total treatment time = 20 minutes x 2/week x 20 weeks = 800 minutes = 13 hours 20 minutes

Experimental

The same physiotherapist led the experimental group intervention on Mondays and Thursdays in a therapy pool kept at 35.5 degrees Celsius (ambient air temperature 20-25 degrees Celsius). No more than 10 subjects were in the pool at a time. The physiotherapist led the group through 10 minutes of relaxation exercises at the beginning and end of each treatment (the same as control group, except in pool instead of exercise mat). The middle part of each treatment session consisted of the Ai-Chi experimental intervention performed in shoulder-deep water. Ai-Chi consists of 16 specific movements and postures that use slow and wide arm/leg movements with continued focus on breathing. Relaxing music was played throughout the session, which lasted a total of about 60 minutes (40 minutes of Ai-Chi plus 20 minutes of relaxation before and after).

Total treatment time=60 minutes x 2x/week x 20 weeks = 2400 minutes = 40 hours

Outcome Measures

A single researcher blinded to group allocation performed all outcome measure assessment at each time point (baseline, end of 20-week intervention, 4 weeks post-intervention, 10 weeks post-intervention).

Primary outcome measures:

- Pain – Visual Analogue Scale (VAS) 0-10 points; McGill Pain Questionnaire (MPQ) Pain Rating Index (PRI) 0-77 points; MPQ Present Pain Intensity (PPI) 0-5 points.
- Disability – Roland Morris Disability Questionnaire (RMDQ) 0-24 points; Expanded Disability Status Scale (EDSS) 0-10 points.

Secondary outcome measures:

- Spasm – VAS 0-10 points.
- Quality of Life – MS Impact Scale-29, 0-100 points (psychological and physical subscores).
- Fatigue – Modified Fatigue Impact Scale (physical subscore 0-36, cognitive subscore 0-40, psychosocial subscore 0-40); Fatigue Severity Scale 1-7 points.
- Depression – Becks Depression Inventory, 0-63 points.
- Function – Barthel Index 0-100 points.

Main Findings

Castro-Sánchez et al. reported on 13 individual outcome measures, some of which were subscales of larger measures. Participants were assessed using all 13 measures at each of the 4 time points, though the authors do not provide detailed data of their findings. Median values, standard deviations (SD), and percent improvement are all listed for each measure by group, with statistical significance ($p \leq 0.05$) noted where appropriate. The statistical methods, however, are not given in any detail, and the conclusions that the authors draw are less than clear. For example, from baseline to week 20, the experimental group's median RMDQ score improved from 7/24 to 2/24. The authors report this as a statistically significant, 100% improvement. This 5-point may have been interpreted as a 71% decrease [(7-2)/2] or possibly a 21% decrease (5/24=0.21) relative to a score of 24/24. Either way, this discrepancy, and others like it, cannot be accounted for, despite the obvious and detailed care that Castro-Sánchez et al. put into designing the rest of their study.

The authors reported an improvement in all 13 measures (though not all statistically significant) for both the experimental and control groups between weeks 0 and 20. While the control group's improvements tended to be of lesser magnitude, this consistent result across so many outcome measures could point to a deeper statistical flaw that cannot be accounted for with the given information.

Inconsistent reporting notwithstanding, the experimental group demonstrated significant improvements from baseline to week 20 in all 13 outcome measures, from baseline to week 24 in all but the MPQ PPI measure, and from baseline to week 30 in 4 measures (pain VAS; RMDQ; MSIS-29 physical and psychological subscales). In contrast, the control group demonstrated significant improvement from baseline to weeks 20, 24, and 30, in 2 (RMDQ; MSIS-29 psychological), 1 (RMDQ), and 0 measures, respectively.

Original Authors' Conclusions

Castro-Sánchez et al. conclude that participants were able to achieve significant reductions in pain, as well as improvements in measures of disability, fatigue, and depression, following a 20-week Ai-Chi hydrotherapy program. They report that these results were superior compared to the control, which consisted of a similar protocol performed on dry land.

Critical Appraisal

Validity

PEDro Score: 7/10. The study lost points for blinding of subjects, blinding of therapists, and lack of intention-to-treat analysis. At first reading, this randomized-controlled trial, level 1b evidence, provides a moderate to high level of evidence with low to moderate risk of bias, supporting the efficacy of Ai-Chi aquatic therapy to reduce pain and other symptoms in people with MS. However, a closer look reveals some flaws that reduce the internal validity of the paper. The authors are not entirely clear about the control group intervention nor do they explain the math underlying their statistical conclusions. The way they report each intervention results in the experimental group performing 3 times as much exercise as the control group by the end of the study. This, perhaps the study's greatest weakness, in and of itself, calls into question the ability of the researchers to draw meaningful comparisons between the two groups.

Strengths:

1. Random allocation – subjects were stratified based on medications used, then randomly allocated to either the control or experimental group.
2. Concealed allocation – a researcher blinded to the subjects and allocation used computer software to generate randomized lists.
3. Baseline comparability – authors clearly present baseline data between and within groups with discussion of change in characteristics at various time points.
4. Blind assessors – outcome assessment was performed by researcher blinded to group allocation of subjects.
5. Adequate follow-up – assessment performed at pre and post-intervention time points as well as 4 and 10 weeks after end of intervention with minimal loss to follow-up.
6. Between-group comparisons – comparison between groups in all outcome measures and baseline characteristics.
7. Point estimates and variability – standard deviations, median values, and percent change provided for all outcome measures.

Weaknesses:

1. Blind subjects – subjects could not be blinded due to nature of interventions. Authors also mention that given that participants were recruited from same AEMA group, there was a chance that some could have talked with other participants enrolled in the study.
2. Blind therapists – the same physiotherapist led both the experimental and control group in their respective interventions.
3. Intention-to-treat analysis – Not performed.
4. As noted in the previous section, the reporting of specific data and the statistical formulas used to calculate reported results is inconsistent. Many of the results cannot be accounted for even though there does seem to be a high level of rigor present throughout the other sections of the paper.

Interpretation of Results

The strength of this study lies more in its robust discussion of protocol than comparison to a control or placebo group. As mentioned in previous sections, there was a large difference in total treatment time between the two groups, rendering meaningful comparisons moot. The study and its results are better interpreted as if it were a single-arm observational study. The study had good internal and external validity, with robust use of assessments to demonstrate a variety of outcomes. The Ai-Chi intervention was shown to be safe and effective at reducing pain and other symptoms in people with MS. Taking the authors at their word in regards to statistical outcomes, it was particularly beneficial in the categories of disability (RMDQ), spasm (VAS), and quality of life (MSIS-29), where improvements of 100%, 91%, and 78%/81% (physical/psychological subscores) were found, respectively, from baseline to week 20. Most assessments of the experimental intervention group demonstrated lasting improvement at week 30 (compared to baseline), except as measured by the MPQ and MSIS physical subscore, which both returned to pre-intervention levels without getting worse.

From a clinical standpoint, these data demonstrate the safety, feasibility, and utility of a 20-week Ai-Chi program for adults with MS, primarily to address pain and function, as well as other symptoms of MS. Where the study is lacking, from an exercise and physical therapy standpoint, is in its gauge of activity intensity. To better apply the results of this study to other populations in a physical therapy setting, it would be beneficial to know the level of intensity at which each participant felt he or she was exercising. We know the baseline disability and functional status of each participant, but knowing whether the intervention was very easy, very difficult, or somewhere in between would help other researchers to reproduce the study and clinicians to better

use a similar protocol in their practices.

Applicability of Study Results

[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.]

The results of the study are moderately relevant and applicable to the clinical question and scenario presented earlier. While Castro-Sánchez et al. did not explore multiple water temperatures this article and the study results demonstrate that warmer water temperatures are safe for Ai-Chi therapeutic exercise for people with MS. The researchers reported 2 disease relapses in the control group, but none in the experimental group. The study also demonstrates useful improvements in many of the domains where the clinical scenario patient is experiencing difficulty or impairment: pain, independent function, and fatigue. As noted in the previous section, the study would be more applicable if better information had been recorded regarding exercise intensity and/or perceived exertion on an individual basis. Because the clinical scenario concerns a mid-30s, still active, woman with MS, who is experiencing pain and increased levels of fatigue, the study results would be more applicable and easier to interpret with detailed information about appropriate levels of exercise intensity.

The protocol used in the study is also feasible and moderately practical. A 20-week, group exercise intervention is certainly no small undertaking, but nor is it entirely unrealistic. It is possible to imagine that in a geographic location with many people with MS who have access to the same pool, an Ai-Chi class could be instigated as part of or totally separate from a physical therapy clinic. The specific routine and movements of Ai-Chi make it more practical to be reproduced from location to location, and group to group.

(2) Description and appraisal of *Efficacy of aquatic therapy for multiple sclerosis: a systematic review* by Corvillo et al., 2017.

Aim/Objective of the Study/Systematic Review:

This systematic review by Corvillo et al. aimed to assess how people with MS responded to aquatic therapy versus other therapies for an improvement in function.

Study Design

Systematic Review of journal articles published January 1, 2011 through April 30, 2016.

Search Strategy

Databases searched: PubMed, Scopus, Web of Science, PEDro.

Search terms: multiple sclerosis; hydrotherapy; balneotherapy; thalassotherapy; aquatic or aquatic therapy.

Selection Criteria

Inclusion criteria: full-text articles; any language; published in journal within Journal Citation Reports (JCR); human study.

Exclusion criteria: case studies; letters to the editor; meeting presentations; other contributions.

Article Selection and Data Collection

Two reviewers performed the search individually, using title/abstract to select appropriate studies. Another 2 reviewers independently read full text of selected articles, providing detailed explanations for inclusion/exclusion. Two other reviewers were consulted where any disagreement arose.

Quality Assessment

A modified version of the Downs and Black scale (final question scored 0 or 1) was used for quality assessment of the randomized and non-randomized studies included in the review. Quality of individual articles was reported with subsection scores, total score, percentage, and classification, where <50%, 50-69%, 70-79%, and 80-100% indicate weak, fair, good, and very good quality, respectively.

Setting

The authors of this systematic review work or are affiliated with the Department of Physical and Rehabilitation Medicine, Complutense University of Madrid Faculty of Medicine, in Madrid, Spain.

Participants

A total of 306 articles were retrieved with the search strategy, of which 140 were published in the requisite time period before removing duplicates. Thirty-one articles remained after removal of duplicates, 11 did not meet inclusion criteria, and the remaining 20 were read in full. Half of these were again excluded due to being published in journal not within JCR (n=7) or because the topic was not relevant (n=3). A final 10 articles were

included for synthesis in this systematic review.

These 10 articles were comprised of 400 total participants (61 men, 349 women), 19 to 69 years old. Study designs were as follows: RCT (n=5); randomized quasi-experimental (n=2); semi-experimental (n=1); blind controlled pilot (n=1); pilot (n=1).

Intervention Investigated

Control

Half of the studies did not include a control group, and of the 5 RCTs, the control consisted of maintaining usual care (n=1), land-based cycle ergometer (n=2), home exercise program (n=1), and relaxation exercises (n=1).

Corvillo et al. do not discuss details of control group methods or specific interventions. It is assumed that total treatment time was equal or similar to the experimental group (listed below), though this too is not mentioned.

Experimental

Aquatic exercise – 3 studies, consisting of general strengthening, stretching, coordination, relaxation, balance, posture, function, warm-up, and cool-down activities. These 3 studies took place in water between 28-29.5, 28-30, and 31 degrees Celsius. Duration and frequency was different for each: 3 times per week for 8 weeks, 45 minutes per session; 2 times per week for 8 weeks, 60 minutes per session; 2 times per week for 5 weeks, 60 minutes per session.

Aquatic cycling – 2 papers from 1 study protocol, consisting of cycle ergometer in 28 degree Celsius water. Warm-up period of no resistance followed by increasing pedal resistance. Protocol consisted of daily treatment for 105 minutes for 3 weeks.

Aquatic training and pilates – 1 study, consisting of 2 experimental groups that performed strength, resistance, relaxation, balance, and pilates exercises in water of unspecified temperature. Each group was treated 3 times per week for 12 weeks, 60 minutes per session.

Aquatic aerobic exercise – 2 papers from 1 study protocol, consisting of walking in water of 28 degrees Celsius. Participants were treated 3 times per week for 8 weeks, 55-75 minutes per session.

Ai-Chi – 2 studies consisting of series of 16 specific movements unique to Ai-Chi. Water temperature for one study was 28 degrees and the other 35.5 degrees Celsius. One study protocol consisted of intervention 2 times per week for 8 weeks, 60 minutes per session; the other was 2 times per week for 20 weeks for 60 minutes.

Outcome Measures

The modified Downs and Black scale (detailed previously in the Quality Assessment section) used to assess the 10 articles in the systematic review rated 2 as very good, 4 as good, 2 as fair, and 2 as weak.

Assessment tools for the 10 studies themselves were wide ranging, though specific outcome measures are not detailed by Corvillo et al. The studies used measures of quality of life, fatigue, cardiorespiratory fitness, brain-derived neurotrophic factor, balance, functional mobility, strength, walking endurance, depression, happiness, pain, disability, motor function, and walking speed.

Main Findings

The articles included in this systematic review are heterogeneous with little overlap of intervention technique or outcome measures assessed. For this reason, Corvillo et al. provide some qualitative discussion of each individual study's results and conclusions, but do not provide any effect sizes, mean scores or differences, meta-analysis, or other data with which to perform further calculations.

Corvillo et al. found that aquatic therapy in multiple forms (i.e. Ai-Chi, pilates, cycle ergometer, etc.) is effective relative to other, non-aquatic modalities in treating patients with MS. Aquatic exercise can increase strength; aquatic cycling effectively addresses general rehabilitation by reducing tendon and muscle injury risk, and improves aerobic capacity; aquatic aerobic exercise improves breathing, circulation, and overall patient function; and Ai-Chi can improve range of motion, functional mobility, muscle strength, pain, and disability.

Original Authors' Conclusions

Corvillo et al. conclude that various types of aquatic therapy can improve symptoms and/or quality of life in people with MS. The studies included in the review are of varying quality, but all demonstrated some amount of improvement in their respective primary outcome assessments. They report that the lack of high quality studies stems from the costliness and complexity of performing robust research on aquatic therapy in general. A final conclusion, they state on page 7 (page 950 of the journal), is "that aquatic therapy can be safely used as supplementary to medical treatment in patients with MS."

Critical Appraisal

Validity

AMSTAR 6/11: 1. A priori (yes); 2. Duplicate selection/extraction (yes); 3. Comprehensive literature search (no); 4. Grey literature (no); 5. List of studies (no); 6. Study characteristics (yes); 7. Quality assessment documented (yes); 8. Quality assessment appropriate (yes); 9. Appropriate methods for combination of findings (no); 10. Publication bias (no); 11. Conflict of interest (yes).

Strengths:

Three different sets of 2 researchers were used at each stage of the search strategy to ensure the proper retrieval of appropriate material. These researchers acted independently, allowing for a high quality search strategy.

Weaknesses:

Exclusion of studies not in the past 5 years (at time of search) unnecessarily limits the potential data that could have been assessed. Given the relatively sparse and low to moderate quality evidence included in this review, this exclusion criterion was not beneficial.

The authors, ultimately, do not provide a robust discussion of the findings from each of the studies. While they do report the general findings from each article, there is little synthesis that would improve upon simply reading the conclusions of the individual articles themselves.

Interpretation of Results

Aquatic therapy is safe, effective, and feasible in multiple different forms for the treatment of MS-related symptoms. While the heterogeneity of the included articles makes meaningful comparison difficult and meta-analyses impossible, it also helps to justify the use of many different modalities. Rather than a single type of aquatic therapy being demonstrated as most appropriate, a physical therapist can read this systematic review as showing that patient preference, clinic and staff availability, and knowledge base may also help determine specific intervention or protocol. Similarly, the variable water temperatures reported in the articles demonstrate that no single temperature is most appropriate, but rather type of aquatic therapy and patient preference should be used to determine water temperature.

Applicability of Study Results

This systematic review is moderately relevant and applicable to the clinical scenario and question in that it provides further information about multiple water temperatures used in various aquatic therapies in people with MS. The results demonstrate that no one intervention or protocol is necessarily better than another, but each can address different aspects of living with MS. Likewise, cool or cold water did not seem to impart greater benefit than warm water therapies, or vice versa.

The interventions described by the 10 articles of the systematic review are mostly practical and feasible. Group and individual exercise can generally be reproduced, though specialized equipment, such as an underwater cycle ergometer or treadmill, could prove cost prohibitive. However, because walking can be achieved without a treadmill and cycle ergometry was not shown to be the clear best choice, this limitation would have minimal bearing on the clinical patient scenario.

SYNTHESIS AND CLINICAL IMPLICATIONS

Synthesis of the evidence:

The RCT and systematic review presented here demonstrate that aquatic therapy is safe, feasible, and effective at improving many of the limitations and symptoms that someone with MS faces as his or her disease progresses. There is no single intervention and there are no set rules that dictate best practice. Every patient is unique and there are myriad ways that aquatic therapy can be utilized to promote an improvement in multiple domains of health and wellness.

Neither the RCT nor the systematic review directly answers the clinical question posed at the beginning of this paper. The results from both papers demonstrates that people with MS can safely exercise in cool to warm water, at least in the range of 28 to 35.5 degrees Celsius. It is unclear whether the same type of exercise (e.g. cycle ergometer, Ai-Chi, walking, etc.) could be equally beneficial in that temperature range, or if, for example, Ai-Chi exercises are best within a more narrow range that is distinct from the range in which walking is preferred.

The study by Castro-Sánchez et al. demonstrates that a 20-week group Ai-Chi intervention in warm water (35.5 degrees Celsius) is safe and feasible, effectively improving measures of pain and disability, as well as other common symptoms of MS. The systematic review by Corvillo et al. reports that Ai-Chi, as well as other aquatic therapies, can all provide benefit to people with MS to varying degrees. The articles included in the systematic review demonstrate that timeframe protocols of around 45-105 minutes per session, varying between 2 and 7 days per week for up to 20 weeks can address many MS symptoms, as well as improve overall fitness in people with MS. Due to limited, heterogeneous research, it is not possible to conclude that one intervention or protocol is superior to another.

Implications for current practice:

Because the current evidence is unable to demonstrate that one type of aquatic therapy or one narrow range of water temperature is ideal for people with MS, current physical therapy practice should, instead, take patient preference and best clinical judgement into account when prescribing aquatic therapy. The limitations that many people with MS have, such as pain, heat sensitivity, and the risk of relapse, require the physical therapist to be especially diligent in monitoring patient outcomes and general well-being before, during, and after treatment.

While the limitations of current research discussed here should be taken into account and addressed by future studies, current practitioners should feel confident in using aquatic therapy to achieve many physical therapy goals in people with MS. Aquatic therapy at multiple water temperatures, using numerous protocols is safe and effective when appropriate monitoring of patient safety is incorporated.

Implications for further research:

Based on the research presented here and the other articles included in the references, it appears unlikely that a single temperature range would prove most effective for all people with MS. Rather, there is likely a temperature (or narrow range) that is ideal for each different therapeutic exercise or activity performed at a specific exercise intensity.

Further research should explore specific differences between exercising in different temperatures in populations of people with MS. In order to adequately explore the benefits and drawbacks of these temperatures, researchers will need to clearly define the interventions used, closely monitor participant symptoms, actual and perceived exertion levels, and well-validated outcome measures. By expanding the knowledge base with more rigorous studies, future systematic reviews would be better able to synthesize data from multiple sources and perform meta-analyses of the results.

REFERENCES

1. Corvillo I, Varela E, Armijo F, Alvarez-Badillo A, Armijo O, Maraver F. Efficacy of aquatic therapy for multiple sclerosis: a systematic review. *Eur J Phys Rehabil Med*. 2017;53(6):944-952. doi:10.23736/S1973-9087.17.04570-1
2. Fifolt M, Richardson EV, Barstow E, Motl RW. Exercise behaviors of persons with multiple sclerosis through the stepwise implementation lens of social cognitive theory. *Disabil Rehabil*. 2020;42(7):948-956. doi:10.1080/09638288.2018.1514077
3. Bansi J, Bloch W, Gamper U, Kesselring J. Training in MS: influence of two different endurance training protocols (aquatic versus overland) on cytokine and neurotrophin concentrations during three week randomized controlled trial. *Mult Scler*. 2013;19(5):613-621. doi:10.1177/1352458512458605
4. Castro-Sánchez AM, Matarán-Peñarrocha GA, Lara-Palomo I, Saavedra-Hernández M, Arroyo-Morales M, Moreno-Lorenzo C. Hydrotherapy for the treatment of pain in people with multiple sclerosis: a randomized controlled trial. *Evid Based Complement Alternat Med*. 2012;2012:473963. doi:10.1155/2012/473963
5. Kargarfard M, Shariat A, Ingle L, Cleland JA, Kargarfard M. Randomized controlled trial to examine the impact of aquatic exercise training on functional capacity, balance, and perceptions of fatigue in female patients with multiple sclerosis. *Arch Phys Med Rehabil*. 2018;99(2):234-241. doi:10.1016/j.apmr.2017.06.015
6. Razazian N, Yavari Z, Farnia V, et al. Exercising Impacts on Fatigue, Depression, and Paresthesia in Female Patients with Multiple Sclerosis. *Med Sci Sports Exerc*. 2016;48(5):796-803. doi:10.1249/MSS.0000000000000834
7. Sadeghi Bahmani D, Motl RW, Razazian N, Khazaie H, Brand S. Aquatic exercising may improve sexual function in females with multiple sclerosis - an exploratory study. *Mult Scler Relat Disord*. 2020;43:102106. doi:10.1016/j.msard.2020.102106
8. Marinho-Buzelli AR, Bonnyman AM, Verrier MC. The effects of aquatic therapy on mobility of individuals with neurological diseases: a systematic review. *Clin Rehabil*. 2015;29(8):741-751. doi:10.1177/0269215514556297
9. Bayraktar D, Guclu-Gunduz A, Yazici G, et al. Effects of Ai-Chi on balance, functional mobility, strength and fatigue in patients with multiple sclerosis: a pilot study. *NeuroRehabilitation*. 2013;33(3):431-437. doi:10.3233/NRE-130974