Key Words
Hydrotherapy, systematic review, evidence-based research, critical appraisal.

by Jenny Geytenbeek

Evidence for Effective Hydrotherapy

Summary

Purpose The purpose of this study was to search for, appraise the quality of and collate the research evidence supporting the clinical effectiveness of hydrotherapy.

Method A systematic search of literature was performed using ten medical and allied health databases from which studies relevant to physiotherapeutic hydrotherapy practice were retrieved. Patient trials were critically appraised for research merit using recognised published guidelines and the results were collated into clinical, functional and affective outcomes for the investigated populations.

Results Seventeen randomised control trials, two case-control studies, 12 cohort studies and two case reports were included in the appraisal. Two trials achieved appraisal scores indicating high quality evidence in a subjectively evaluated merit categorisation. Fifteen studies were deemed to provide moderate quality evidence for the effectiveness of hydrotherapy.

Discussion Flaws in study design and reporting attenuated the strength of the research evidence. Recommendations were made for the future direction of clinical hydrotherapy research. Randomised controlled trials with larger sample sizes, assessor blinding and the use of validated and reliable outcome measures in subjects with neurological conditions and acute orthopaedic injuries are particularly required.

Conclusion The balance of high to moderate quality evidence supported benefit from hydrotherapy in pain, function, self-efficacy and affect, joint mobility, strength, and balance, particularly among older adults, subjects with rheumatic conditions and chronic low back pain.

Geytenbeek, J (2002). 'Evidence for effective hydrotherapy', *Physiotherapy*, **88**, 9, 514-529.

Background and Purpose

Hydrotherapy practice in physiotherapy has developed from a scientific basis of hydrodynamic theory. An understanding of the physical properties of water and the physiology of human immersion, coupled with skills to analyse human movement, have helped physiotherapists in using hydrotherapy as a tool for facilitating movement and restoring function. Although there is a large body of anecdotal evidence, many hypothesised benefits remain to be proven with rigorous research designed with minimal sources of bias (McIlveen and Robertson, 1998). Expert opinion and clinical experience alone do not confirm the effectiveness of treatment (Bithell, 2000), but combined with clinical reasoning and evidence-based research, clinicians, patients and healthcare funders will be better assured of effective hydrotherapy (Goldby and Scott, 1993; Wakefield, 2000). In compiling their extensive 1997 text entitled *Aquatic Rehabilitation*, Ruoti *et al* commented that their 'review of literature revealed a scarcity of studies dealing with specific pathologies and functional outcomes'. The evidence for effective 'swimming pool exercise' was specifically excluded by the Philadelphia Panel (2001) in developing its evidence-based clinical practice guidelines for the management of low back, cervical, shoulder and knee pain; suggesting the intervention to be of infrequent use despite its anecdotal popularity with patients.

The purpose of this study was to identify and critically appraise clinical trials of physiotherapeutic hydrotherapy for research merit. The clinical effectiveness and outcomes attributable to hydrotherapy are also examined.

Table 1: Levels of evidence

Level of evidence	*Study design*
I	Systematic review of randomised controlled trials
II	Randomised controlled trials
III-1	Pseudo-randomised controlled trials (alternate allocation or some other method)
III-2	Comparative studies with concurrent controls and allocation is not randomised, cohort studies, case-control studies, or interrupted time series with a control group
III-3	Comparative study with historical control group, two or more single arm studies, or interrupted time series without a parallel control group
IV	Case-series, either post-test or pre-test/post-test

Adapted from NHMRC (2000)

Method

A search strategy was developed to identify published clinical trials in hydrotherapy. Anecdotal, expert and clinical opinions were excluded in preference to more sophisticated evidence of controlled trials and cohort studies with greater potential to provide minimal sources of bias in accordance with the 'hierarchy of evidence' (Lloyd-Smith, 1997).

Allied health, medical, nursing and sports science databases were accessed including Medline, CINAHL, Current Contents, AMED, EMBASE, the Expanded Academic ASAP, SportsDiscuss, PEDro, the Cochrane Library and Ageline. The terms 'hydrotherapy', 'aquatic therapy', 'aquatic physiotherapy' and 'water exercise' were applied to journal article titles, abstracts and key words in the electronic databases. Searches covered literature from 1980 to October 2001, but were limited to publications in English. Terms commonly captured under the keyword 'hydrotherapy' within the databases but excluded from this literature search were colonic irrigation, water birth, Kneipp therapy, spa therapy, whirlpool therapy, immersion in water, contrast baths and balneology. Trials investigating only physiological responses of subjects immersed in or exercising in water were also excluded (for example, heart rate, blood pressure, aerobic capacity and renal function). Thus, hydrotherapy trials with professional exercise instruction towards achieving therapeutic, rehabilitative or habilitative goals in neurological, musculoskeletal and/or cardiovascular function were targeted.

The level of evidence provided by the trial design was identified in accordance with those described by the National Health and Medical Research Council of Australia (NHMRC, 2000) which recognises the potential for trial design flaws to introduce biases that may confound results and compromise the strength of evidence. Randomised controlled trials were appraised for research merit using the ten-point scale of the Physiotherapy Evidence Database (PEDro) (http://ptwww.cchs.usyd.edu.au/pedro) (Sherrington *et al*, 2000). One point is awarded for each of the following: random allocation to groups, concealed allocation to groups, similarity of measures between groups at baseline, subject blinding, therapist blinding, assessor blinding, complete data collection from more than 85% of subjects, intention-to-treat analysis, provision of statistics showing between-group differences, and reporting of both point measures and the variability, or range, of those measures. The PEDro scale includes the three items that have been shown to predict bias in clinical trials – concealed allocation to groups, blinding, and adequacy of follow-up (Moher *et al*, 1999, cited by Moseley *et al*, 2002). The validity of the scale has been described by Moseley *et al* (2002). Where trials were previously reviewed, scored and listed on PEDro, trials were appraised blindly, and the scores later compared. Scores concurred in all but one case.

Case-control and cohort studies were appraised against the observational study criteria recommended by Crombie (1996). Parameters included reporting of subject eligibility, appropriateness of not using a control group, clearly stated aims, the selection of a study design appropriate for the aims, justification of sample size, likelihood of reliable and valid measures, omission of relevant outcome measures, adequate description of statistical methods, reporting of the occurrence of untoward events, adequate description of the data, assessment of statistical significance, potential for confounding influences, interpretation of null findings, comparison of results

Author

Jenny Geytenbeek BAppSc (Physio) MPhysio (Manipulative) CertHydro MAPA is a private practitioner in Adelaide, Australia.

This research project was undertaken in partial fulfilment of the award of Master of Physiotherapy at the University of South Australia in 2000.

This article was received by *Physiotherapy* on May 4, 2001, and accepted on March 1, 2002.

Address for Correspondence

Ms J Geytenbeek,
PO Box 6,
Cudlee Creek,
South Australia 5232.

E-mail:
geyts@senet.com.au

Table 2: Merit categories

	*PEDro scores for randomised control trials (maximum 8/10)**	*Scores for case-control studies (maximum 18/18)*	*Scores for pre-test/ post-test cohort studies (maximum 19/19)*	*Scores for case reports*
Level of evidence	II to III-1	III-2	III-3 to IV	-
High quality	7 to 10	Not awarded	Not awarded	Not awarded
Moderate quality	5 to 6	14 to 18	14 to 19	Not awarded
Poor quality	0 to 4	10 to 13	10 to 13	Not awarded
Very poor quality	Not awarded	0 to 9	0 to 9	Awarded to all

* Subject and therapist blinding not possible in hydrotherapy trials

against previous reports, and implications for clinical practice. Trials were scored twice, at least two months apart, and the average taken of the two scores. Repeat scores did not vary by more than two points.

Case reports were not scored as they were considered to provide a very poor level of evidence with a broad scope for bias. They were included in this review as a reflection of clinical practice.

Not all appraisal scoring items were considered of equal importance. Equal scores on the different scales would not necessarily reflect equivalent merit. Based upon subjective evaluation of the perceived importance of scale items and the strength of trial-types, merit categories were devised to describe the strength of evidence that could be yielded from the trial (table 2). PEDro scores of five or more were noted to reflect moderate to high quality evidence according to Moseley *et al* (2002). Only randomised controlled trials were considered to provide potential for high quality evidence, while very high scores for case-controlled and cohort studies could receive no higher merit than moderate quality.

Following critical appraisal for research merit, the outcome measures of all trials were collated. The effectiveness of hydrotherapy on each measure was noted and cross-referenced with the merit of the trial.

Results

More than 500 journal articles were identified from the databases using the specified keywords and terms of exclusion. Journal articles were manually screened for their trial type and relevance to this review. Seventeen randomised controlled trials (type II) were included along with two case-controlled trials (type III-2), 12 pretest/post-test cohort studies (type IV) and two case reports.

Table 3: Investigated populations

Investigated population	*Number of trials*	*Number of subjects*
Rheumatoid arthritis	3	280
Rheumatic diseases	3	83
Rheumatoid and osteo-arthritis	2	57
Hip osteo-arthritis	2	61
Fibromyalgia	2	124
Ankylosing spondylitis	3	218
Older adults	7	419
Low back pain	7	366
Multiple sclerosis	2	14
Late poliomyelitis	1	30
ACL reconstruction	1	20
Complex regional pain syndrome	1	103
Totals	34	1775
Average sample size		52.2
Range of sample sizes		1 to 140

The most investigated subjects, represented in 15 trials, were those with rheumatic conditions including osteo-, psoriatic and rheumatoid arthritis, ankylosing spondylitis, fibromyalgia, scleroderma and systemic lupus erythematosis. Other populations included older adults, subjects with low back pain, multiple sclerosis, complex regional pain syndrome, late poliomyelitis and one study specifying patients being rehabilitated after anterior cruciate ligament reconstruction (table 3).

Table 4 summarises attributes of the trial design, populations, sample sizes, control groups, appraisal scores and merit categorisation.

Two trials achieved the merit of high quality. Fifteen trials were deemed to

Table 4: Appraisal summary

Primary author of trial	Group diagnosis	Randomised trial	Control group	Intervention group size	Control group size	Drop-outs	Assessor blinding	Cointer-ventions	Reported on reliability	Appraisal score	Level of evidence	Merit category
Ahern	Rheumatoid and osteo-arthritis	Yes	Untreated symptomatic	22	8	0*	Yes		Yes	4/10	II	Moderate
Bulstrode	Ankylosing spondylitis	Yes	Untreate symptomatic	27	12	7	Yes		No	6/10	II	Moderate
Danneskiold-Samsoe	Rheumatoid arthritis	No	Untreated, age and sex matched	8	8	0*	–		No	11/18	III-2	Poor
Gehlsen	Multiple sclerosis	No	–	13	–	10	–		No	11/19	IV	Poor
Gowans (a)	Fibromyalgia	Yes	Untreated symptomatic	23	22	4	–		No	5/10	II	Moderate
Gowans (b)	Rheumatic diseases	No	–	39	–	0*	–		No	15/19	IV	Moderate
Green	Hip osteo-arthritis	Yes	Symptomatic, alternative intervention	24+	23+	16	Yes	Yes	Yes	5/10	II	Moderate
Hall	Rheumatoid arthritis	Yes	Symptomatic, alternative intervention, and sham	35	35,35,35	1	Yes		Yes	7/10	II	High
Helliwell	Ankylosing spondylitis	Yes	Symptomatic, alternative intervention	15	14,15	15	–		No	4/10	II	Poor
Hidding	Ankylosing spondylitis	Yes	Symptomatic, alternative intervention	67	68	8	Yes	Yes	Yes	7/10	II	High
Langridge	Low back pain	No	–	45	–	18	–		No	4/19	IV	Very poor
LeFort	Low back pain	No	–	50	–	10	–	Yes	Yes	14/19	IV	Moderate
Lineker	Rheumatic diseases	No	–	31	–	9	–		Yes	14/19	IV	Moderate
Lord	Older adults	No	Untreated, age and sex matched	15	13	0*	–		Yes	15/18	III-2	Moderate
Lorenzetti	Low back pain	No	–	1	–	0	–	Yes	No	–	–	Very poor
Mannerkorpi	Fibromyalgia	Yes	Untreated symptomatic	37	32	11	Yes	Yes	Yes	6/10	II	Moderate
McIlveen	Low back pain	Yes	Untreated symptomatic	56	53	14	Yes		Yes	5/10	II	Moderate
Rissel	Older adults	No	–	51	–	18	–		No	5/19	IV	Very poor
Roberts	Low back pain	No	–	81	–	13	–		No	3/19	IV	Very poor
Ruoti	Older adults	Yes	Untreated	22	22	24	–		No	3/10	II	Poor
Peterson	Multiple sclerosis	No	–	1	–	0	–	Yes	Yes	–	–	Very poor
Sandford Smith	Rheumatoid arthritis	Yes	Symptomatic, alternative intervention	12	12	4	Yes		Yes	6/10	II	Moderate
Sherry	Complex regional pain syndrome	No	–	103	–	54	–	Yes	No	7/19	IV	Very poor
Simmons	Older adults	Yes	Age matched, alternative interventions and sham	13	13,13,13	13	–		Yes	4/10	II	Poor
Sjogren	Low back pain	Yes	Symptomatic, alternative intervention	30	30	2	Yes		Yes	5/10	II	Moderate
Smit	Low back pain	No	–	20	–	2	–		No	9/19	IV	Poor
Suomi	Rheumatoid and osteo-arthritis	Yes	Untreated symptomatic	17	10	4	–		Yes	5/10	II	Moderate
Sylvester	Hip osteo-arthritis	Yes	Symptomatic, alternative intervention	7	7	0	–		No	5/10	II	Moderate
Templeton	Rheumatic diseases	No	–	13	–	0	–		Yes	10/19	IV	Poor
Tovin	ACL reconstruction	Yes	Symptomatic, alternative intervention	10	10	0*	Yes		Yes	4/10	II	Poor
Watanabe	Older adults	Yes	Age matched, alternative intervention	36	37	0*	–		Yes	5/10	II	Moderate
Weiss	Older adults	No	–	97	–	9	–		No	4/19	IV	Very poor
Whitlatch	Older adults	No	–	74	–	8	–		No	6/19	IV	Very poor
Willen	Late poliomyelitis	No	Untreated symptomatic	15	15	2	–		Yes	4/10	II	Poor

* inferred to be nil

provide moderate quality evidence, nine were of poor quality and eight were very poor.

The investigated outcomes fell broadly into measures of pain, strength, flexibility, functional ability and self-efficacy and affect. Figure 1 portrays the number of trials of each merit category that investigated each type of outcome. The appendices summarise the effect of hydrotherapy on each outcome measure selected by researchers. Where researchers concluded a positive effect was yielded by the hydrotherapy treatment a + was ascribed in contrast to no effect, or no significant effect, which was noted with 0. Not all authors stated the size or the achievement of statistical significance for the effects, although generally, those of poor and very poor merit were the most contestable. It was not possible to summate the actual effect size, even of the more popular outcome measures, as it was considered the investigated samples lacked homogeneity and the intervention was not applied consistently in all trials.

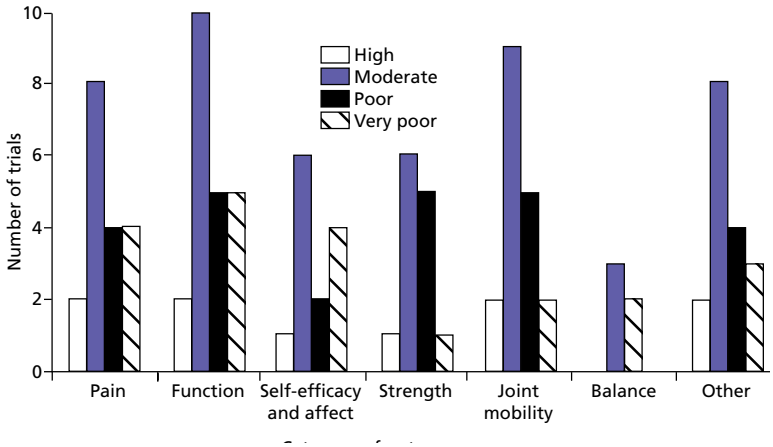

Fig 1: Number of trials investigating categorical outcomes

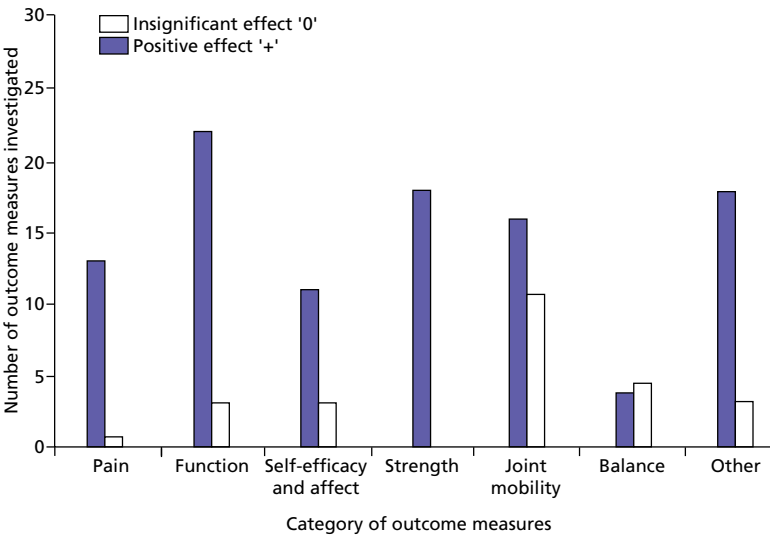

Fig 2: Hydrotherapy effect on outcome measures in high and moderate quality trials

Figure 2, which represents only the outcome measures from high and moderate quality trials, and the appendices may provide readers and clinicians with insight to the number and types of outcome measures researchers have claimed to be effected by hydrotherapy.

Eighteen of the 34 trials in this review measured the effect of hydrotherapy on pain. Ten of these were considered to provide high to moderate quality evidence with all but one outcome measure failing to record a positive effect. Eighteen trials investigated the effect on joint mobility with 11 of these providing high to moderate quality evidence.

More than half of the joint mobility outcome measures in the high to moderate quality trials showed a positive effect from hydrotherapy.

Six of the 13 trials that assessed the effect of hydrotherapy on strength were of moderate quality, while one trial was of high quality, with all the outcome measures of these quality trials yielding a beneficial effect.

Ten out of the 14 trials that examined the effect of hydrotherapy on function were of moderate quality, two were of high quality, and 22 out of 25 functional outcome measures yielded a positive result.

Thirteen trials selected measures of self-efficacy or affect with six of these being of moderate and one of high quality.

Eleven of the 14 outcome measures used by these high to moderate quality trials demonstrated a beneficial effect of hydrotherapy on self-efficacy and affect.

Other positive outcomes from high to moderate quality trials included indicators of balance, measures of fitness, medication use and neurological signs.

Discussion

The balance of evidence from high to moderate quality trials indicates that hydrotherapy offers benefit toward improving pain, strength, flexibility, function, self-efficacy and affect, and with a lesser representation, balance and fitness, in patients with generally chronic conditions such as rheumatic

diseases and hip osteo-arthritis, chronic low back pain, and among elderly people. Hydrotherapeutic rehabilitation in neurological conditions, such as multiple sclerosis, traumatic brain injury, stroke, paediatric neurology, and rehabilitation from acute orthopaedic injury have received little attention from researchers to date.

In asking the question 'Is hydrotherapy effective?' one must consider what is hydrotherapy, for whom it might be effective, and how effectiveness is determined. Synonymous key words of 'aquatic physiotherapy', 'aquatic therapy' and 'water exercise' were applied to the databases in an attempt to extract evidence of efficacious physiotherapeutic hydrotherapy practice.

Although eligibility criteria were specified in the selected trials, eligibility was usually determined by diagnosis, not clinical signs and symptoms. It was impossible to glean the impact of physiotherapists' assessment skills and their appropriateness for matching patients with the hydrotherapy exercise medium and exercise selection.

Not all hydrotherapy trials in this review were conducted by physiotherapists. Other professionals apparently involved in the trials included physical educators, exercise scientists, personal trainers, nurses and chiropractors. It was deemed that the exercises used by other practitioners were also those that physiotherapists might include in their rehabilitation programmes.

In terms of professional accountability and market-place niche, it was not possible to assess better outcomes from physiotherapists' over other practitioners' water-based exercise programmes.

Research protocol usually imposed standardisation of the hydrotherapy intervention under investigation. In the majority of trials it appeared that all subjects within each trial received the same programme of exercises. Exercise programme content was not audited in this review; in fact it was sometimes omitted from the reports or poorly described. Replicating the various treatment regimes would be challenging from most reported exercise descriptions. The imposition of standardised intervention may well have detracted from the potential to demonstrate effective hydrotherapy in suppressing interactive physiotherapy practice of constantly reassessing the patients' responsive movement in water, facilitation of optimal exercise performance and consequent adjustment in technique.

Hands-on techniques like Bad Ragaz, Halliwick or passive joint mobilisation (Shepherd and Mickel, 1998), or placement and adjustment of assistive and resistive devices, were thus generally not included in the repertoire of hydrotherapy exercises in the trials of this review.

It was not possible to determine the benefit of individually conducted hydrotherapy over hydrotherapy conducted in a group or class format where all participants performed the same exercises, nor where patients performed prescribed exercises unsupervised. These are important distinctions worthy of future analysis to determine both cost-effectiveness of the treatment and professional expertise. Hidding *et al* (1993) investigated supervised exercise regimes against an unsupervised regime of home-based exercises, but not unsupervised pool-based exercise. Nevertheless, they concluded the effect was superior with supervision.

Also pertinent to cost and benefit, the frequency and duration of hydrotherapy were not explicitly investigated. Researchers failed to argue their choices of treatment frequency or duration. The length of treatment ranged from four days (Ahern *et al*, 1995, phase 1) to 36 weeks (Hidding *et al*, 1993), with an average of 9.9 weeks. The frequency of treatment ranged from daily to weekly with an average of 2.6 times per week.

Half of the trials (17 out of 34) were awarded moderate to high quality (table 4) which compares with the appraisal scoring and merit categorisation claimed for other physiotherapy trials. Moseley *et al* (2001) reported that 52% of the 2,376 randomised controlled trials conducted across all areas of physiotherapy listed on the Physiotherapy Evidence Database were of moderate to high quality, rating five or more on the PEDro scale.

Uncontrolled trials (type IV) cannot truly attribute any observed changes to the intervention. However, pre-test/post-test measurements in cohort trial designs may accommodate the ethical dilemma of withholding treatment from some patients – the would-be control subjects. Failing to control these trials should not

altogether devalue the research claims, rather, they can be acknowledged as providing supportive, albeit contestable, evidence as subjects may have improved over time regardless of treatment. Appraisal and scoring of the type IV trials with Crombie's list (1996) was more variable, and more prone to value-judgements than scoring with PEDro. However, nine of the 12 type IV trials in this review were deemed to provide 'poor' to 'very poor' quality evidence (table 4).

Seven trials included hydrotherapy treatment with other modalities, perhaps replicating clinical practice, but confusing the interpretation of results from either modality. Co-interventions included concurrent home exercise programmes (Le Fort and Hannah, 1994; Hidding *et al*, 1993; Green *et al*, 1993), a supervised gym programme (Hidding *et al*, 1993), weight training (Le Fort and Hannah, 1994), aerobic and functional exercise programmes (Sherry *et al*, 1999), supervised therapeutic exercises (Peterson, 2001), an education programme including understanding long-term pain and strategies to cope with pain (Mannerkorpi *et al*, 2000) and chiropractic manipulation with electrical muscle stimulation to relieve pain (Lorenzetti, 1999).

Alternative interventions were applied to the control groups of ten type II trials including home exercises (Green *et al*, 1993), supervised land-based exercises (Watanabe *et al*, 2000; Sandford Smith *et al*, 1998; Sjogren *et al*, 1997; Hall *et al*, 1996; Helliwell *et al*, 1996; Simmons and Hansen, 1996; Hidding *et al*, 1994; Tovin *et al*, 1994), supervised sporting activities (Hidding *et al*, 1994), progressive relaxation (Hall *et al*, 1996), supervised socialisation (playing cards) (Simmons and Hansen, 1996), and short-wave diathermy (Sylvester, 1989).

Hydrotherapy effect was then compared to the alternative intervention, either of which may be beneficial, but the actual effect-size of one of the interventions possibly blurred in the statistics. That is, improvements were often measured in both the hydrotherapy group and the supervised land-based exercise group, and occasionally the hydrotherapy group improved significantly more. Sham 'treatments' of 'seated immersion' were included in two trials in an attempt to distract the effect of warm water exercise from immersion (Simmons and Hansen, 1996; Hidding *et al*, 1993). Outcome measures of the control groups undergoing the sham treatments did not improve in either trial.

Potential confounding influences were present in all trials. No randomised controlled trial scored more than seven out of 11 on the PEDro Scale. No trial specified whether the allocation to treatment and control groups was concealed from the investigators ('concealed allocation'). This criterion ensures against selection bias where those allocated to the intervention group might be chosen, consciously or unconsciously, because they are expected to do well. Only 16% of all PEDro listed trials have satisfied this criterion (Moseley *et al*, 2002). Only 12% of all PEDro listed trials have reported on 'intention-to-treat analysis'. That is, researchers needed to state that all subjects received the intended treatment protocol, or, where violations occurred, these were reported and demonstrated not to prejudice the results. Only one trial in this review satisfied this criterion (Hidding *et al*, 1993).

It was not possible to award points for the blinding of subjects or therapists. By the nature of exercise-based intervention, all subjects knew they were undergoing hydrotherapy and all therapists knew what intervention was being applied and to whom. Subjects may show improvements in their conditions simply because they know they are receiving 'special treatment', a phenomenon known as the Hawthorne effect (Polgar and Thomas, 2000). Therapists may have instructed subjects in the intervention group differently. While subject and therapist blinding are practicable in drug trials and some physiotherapy electrotherapy trials, such is not the case in hydrotherapy trials (Moseley *et al*, 2001). Assessor blinding then becomes paramount in hydrotherapy trials to minimise bias where it is expected by all that the treated group will perform better.

Appropriate sample size is not scored on the PEDro scale. Among the studies reviewed, sample size varied from one in the two case reports (Lorenzetti, 1999; Peterson, 2001) to 140 (Hall *et al*, 1996). with an average of 52.2 (table 3). Obviously, larger samples will have greater power to strengthen research findings.

Yet with a relative sparsity of hydrotherapy researchers, the convenience and expedience afforded in smaller trials should not obviate their contribution to the pool of evidence for effective hydrotherapy. Rather, consumers of research knowledge must bear this potential confounder in mind in accepting claims of hydrotherapy effectiveness or rejecting an outcome measurement that fails to yield significant effect.

Appropriate demonstration of validity of measures, reliability of measurement, and interpretation of results are fundamental issues in producing meaningful evidence. Only half of the trials in this review reported on the reliability of their selected measures, either adequately or inadequately. Several cited previously established reliability, some reported their own test-retest, inter-rater and intra-rater reliability (see appendix). Generally, more recent researchers in hydrotherapy have adopted recognised and validated measurement tools. Hydrotherapeutic effect has been investigated with both self-assessment scales of pain, function and affect, and more technical objective measuring instruments including dynamometry, electromyography (Kelly *et al* (2000), pedabarography and computerised force platforms.

Critical appraisal is fundamentally subjective from defining search terms to screening journal articles for inclusion or exclusion, to scoring indefinite appraisal criteria, comparing trial types for merit, combining trial types with appraisal scores to rank trials into a descriptive category of merit, and summarising pooled results. Critical appraisal by panels of experts such as the Philadelphia Panel (2001) and independent scoring as is the protocol of the Physiotherapy Evidence Database, tempers subjectivity. Systematic review and critical appraisal can occur only after clinical trials have been conducted; a lengthy process. However, in daily clinical practice, physiotherapists need to draw on their experiential knowledge and the available research evidence in a critical manner, not always devoid of value judgements, to select treatments likely to be effective. Hydrotherapy is a treatment worthy of consideration.

Conclusion

The body of evidence supporting the effectiveness of physiotherapeutic hydrotherapy is incomplete. This report presents the evidence available at a specific time. More randomised controlled trials of improved research merit, with reporting that defends design choices and protocol, are required. Neurological populations are under-investigated. The benefit of hydrotherapy in acute orthopaedic rehabilitation and peripheral joint conditions also lack presence among the research evidence. Questions pertaining to the cost-benefit of hydrotherapy remain to be answered, including the level of physiotherapy supervision, exercise selection, frequency and duration of treatment, and sustained benefit following cessation of intervention.

Key Messages

- Clinical evidence of a moderate quality exists to support the effectiveness of hydrotherapy treatment on pain, joint mobility, strength, function, self-efficacy, affect, fitness and balance.
- Clinical trials of hydrotherapy have been conducted more often in populations with rheumatic conditions and chronic low back pain and with older adults than in populations with neurological conditions or acute musculoskeletal injuries.
- More randomised controlled trials with larger samples and conscientious reporting of conduct minimising bias, defending validity and reliability of measures will support assurance of the effectiveness of hydrotherapy.

Appendix

Merit of evidence determining hydrotherapy effect on outcomes

Outcome measure	*Reliability of measure*	*Hydro-therapy effect*	*Merit category*	*Level of evidence*	*Group diagnosis*	*Primary author of trial*
Pain						
Visual analogue scale of pain	Not reported	0	Very poor	–	Low back pain	Lorenzetti
McGill pain questionnaire	Not reported	+	High	II	Rheumatoid arthritis	Hall
Beliefs in pain control questionnaire	Citation	+	High	II	Rheumatoid arthritis	Hall
Visual analogue scale of pain	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Visual analogue scale of pain	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Descriptive pain scale	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Analgesic requirement	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Multidimensional pain inventory	Citation	+1	Moderate	II	Fibromyalgia	Mannerkorpi
McGill pain questionnaire	Citation	0	Moderate	II	Low back pain	McIlveen
Visual analogue scale of pain	Not reported	+	Moderate	II	Low back pain	Sjogren
Visual analogue scale of pain	Citation	+	Moderate	II	Hip osteo-arthritis	Sylvester
Visual analogue scale of pain	Citation	+	Moderate	III-2	Older adults	Lord
Pain rating index of McGill pain questionnaire	Citation	+	Moderate	IV	Low back pain	LeFort
Visual analogue scale of pain	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Numerical pain rating scale	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Visual analogue scale of pain	Inter-rater	+	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Visual analogue scale of pain	Test-retest	+	Poor	II	Ankylosing spondylitis	Helliwell
Pain drawing	Not reported	0	Poor	II	Late poliomyelitis	Willen
Visual analogue scale of pain	Citation	0	Poor	II	Late poliomyelitis	Willen
Nottingham health profile (pain)	Not reported	+	Poor	II	Late poliomyelitis	Willen
Visual analogue scale of pain	Citation	+	Poor	IV	Low back pain	Smit
Present pain level	Not reported	+	Very poor	IV	Low back pain	Langridge
Pain area score	Not reported	+	Very poor	IV	Low back pain	Roberts
Pain intensity score	Not reported	+	Very poor	IV	Low back pain	Roberts
Verbal and visual analogue pain scales	Not reported	+	Very poor	IV	Complex regional pain syndrome	Sherry
1-6 pain scale	Not reported	+	Very poor	IV	Older adults	Whitlatch
Function						
Arthritis impact measurement scales –2	Citation	+	High	II	Rheumatoid arthritis	Hall
Functional index for ankylosing spondylitis	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Health assessment questionnaire for spondyloarthropathies	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Sickness impact profile	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Fibromyalgia impact questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Gowans (a)
Modified six-minute walk test	Citation	+	Moderate	II	Fibromyalgia	Gowans (a)
Ability to rise from a chair	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Time and number of steps to walk a fixed distance	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Time taken to walk up and down a fixed staircase rig	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Fibromyalgia impact questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Mannerkorpi
Six-minute walk test	Not reported	+	Moderate	II	Fibromyalgia	Mannerkorpi
Oswestry low back pain disability questionnaire	Citation	+	Moderate	II	Low back pain	McIlveen
Standford health assessment questionnaire	Citation	0	Moderate	II	Rheumatoid arthritis	Sandford Smith

Merit of evidence determining hydrotherapy effect on outcomes (continued)

Outcome measure	*Reliability of measure*	*Hydro-therapy effect*	*Merit category*	*Level of evidence*	*Group diagnosis*	*Primary author of trial*
Oswestry low back pain disability questionnaire	Not reported	+	Moderate	II	Low back pain	Sjogren
Timed 100-metre walk test	Test-retest	+	Moderate	II	Low back pain	Sjogren
Oswestry low back pain disability questionnaire	Not reported	+	Moderate	II	Low back pain	Sylvester
Pedabarographic maximal vertical force during gait	Not reported	0	Moderate	II	Hip osteo-arthritis	Sylvester
Pedabarographic stance time during gait	Not reported	0	Moderate	II	Hip osteo-arthritis	Sylvester
Six-minute walk test	Not reported	+	Moderate	IV	Rheumatic diseases	Gowans (b)
Oswestry low back pain disability questionnaire	Test-retest	+	Moderate	IV	Low back pain	LeFort
Arthritis impact measurement scales 2	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Medical outcomes short form 36	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Need for help from others	Not reported	+	Moderate	IV	Rheumatic diseases	Lineker
Use of walking devices	Not reported	+	Moderate	IV	Rheumatic diseases	Lineker
Western Ontario and McMaster Universities osteo-arthritis index	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Time to climb four steps	Inter-rater	+	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Time to walk 25 m	Inter-rater	+	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Lyshom scale (functional questionnaire)	Not reported	+	Poor	II	ACL reconstruction	Tovin
Physical activity scale for the elderly	Not reported	0	Poor	II	Late poliomyelitis	Willen
Walking speed over 30 metres	Not reported	0	Poor	II	Late poliomyelitis	Willen
Functional status index	Citation	+	Poor	IV	Rheumatic diseases	Templeton
Patient evaluation conference system	Citation	+	Very poor	–	Multiple sclerosis	Peterson
Change in ease of work	Not reported	+	Very poor	IV	Low back pain	Langridge
Activities of daily living	Not reported	+	Very poor	IV	Low back pain	Roberts
Verbal scale of dysfunction and observation of physical function	Not reported	+	Very poor	IV	Complex regional pain syndrome	Sherry
Medical outcomes short form 36	Not reported	0	Very poor	IV	Older adults	Whitlatch
Walking speed over 3 minutes	Not reported	+	Very poor	IV	Older adults	Whitlatch
Self-efficacy and effort						
Arthritis impact measurement scales - 2	Citation	+	High	II	Rheumatoid arthritis	Hall
Arthritis self-efficacy questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Gowans (a)
Fibromyalgia impact questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Gowans (a)
Philadelphia (life satisfaction) questionnaire	Not reported	0	Moderate	II	Hip osteo-arthritis	Sylvester
State/trait anxiety inventory	Citation	+	Moderate	II	Older adults	Watanabe
Fibromyalgia impact questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Mannerkorpi
Short-form 36 (social functioning and general health)	Not reported	+	Moderate	II	Fibromyalgia	Mannerkorpi
Arthritis self-efficacy scales	Not reported	0	Moderate	II	Fibromyalgia	Mannerkorpi
Arthritis impact measurement scales (anxiety and depression)	Not reported	+	Moderate	II	Fibromyalgia	Mannerkorpi
Quality of life questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Mannerkorpi
Rosenburg self-esteem scale	Test-retest	+	Moderate	IV	Low back pain	LeFort
State/trait anxiety inventory	Not reported	+	Moderate	IV	Low back pain	LeFort
Memorial University mood scale	Not reported	+	Moderate	IV	Low back pain	LeFort
Centre for Epidemiological Studies Depression scale	Citation	Not reported	Moderate	IV	Rheumatic diseases	Lineker

Merit of evidence determining hydrotherapy effect on outcomes (continued)

Outcome measure	*Reliability of measure*	*Hydro-therapy effect*	*Merit category*	*Level of evidence*	*Group diagnosis*	*Primary author of trial*
Zung self-rating depression scale	Not reported	+	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Middlesex Hospital questionnaire	Not reported	Not reported	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Illness behaviour questionnaire	Not reported	0	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Arthritis self-efficacy questionnaire	Not reported	+	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Frenchay activities index	Not reported	0	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Nottingham health profile (part 1)	Not reported	0	Poor	II	Late poliomyelitis	Willen
Visual analogue scale of quality of life	Not reported	+	Very poor	IV	Low back pain	Langridge
Health and well being	Not reported	+	Very poor	IV	Older adults	Rissel
Scale of affect	Not reported	+	Very poor	IV	Older adults	Rissel
Affective questionnaire	Not reported	+	Very poor	IV	Older adults	Weiss
Revised Oswestry questionnaire	Not reported	+	Very poor	–	Low back pain	Lorenzetti
Joint mobility						
Ritchie articular index (joint mobility)	Citation	+	High	II	Rheumatoid arthritis	Hall
Duration of morning stiffness	Not reported	0	High	II	Rheumatoid arthritis	Hall
Active range of wrist and knee flexion and extension	Not reported	0	High	II	Rheumatoid arthritis	Hall
Thoracolumbar flexion-extension	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Chest expansion	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Cervical rotation	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Visual analogue scale of stiffness	Test-retest	0	High	II	Ankylosing spondylitis	Hidding
Hip flexion	Test-retest	0	Moderate	II	Ankylosing spondylitis	Bulstrode
Hip extension with knee in extension	Test-retest	+	Moderate	II	Ankylosing spondylitis	Bulstrode
Hip extension with knee in flexion	Test-retest	+	Moderate	II	Ankylosing spondylitis	Bulstrode
Single hip abduction	Test-retest	+	Moderate	II	Ankylosing spondylitis	Bulstrode
Bilateral hip abduction	Test-retest	+	Moderate	II	Ankylosing spondylitis	Bulstrode
Medial rotation of the hip, lateral rotation of the hip	Test-retest	+	Moderate	II	Ankylosing spondylitis	Bulstrode
Immobility, stiffness	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Hip internal rotation	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Flexion deformity	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Goniometric active hip joint range	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Shoulder range of motion: 0-4 scale	Citation	0	Moderate	II	Fibromyalgia	Mannerkorpi
Range of active lumbar flexion – Schober method	Citation	0	Moderate	II	Low back pain	McIlveen
Range of active lumbar extension	Citation	0	Moderate	II	Low back pain	McIlveen
Duration of morning stiffness	Not reported	0	Moderate	II	Rheumatoid arthritis	Sandford Smith
Schober's test for thoracolumbar mobility	Intra-rater	0	Moderate	II	Low back pain	Sjogren
Active range of hip abduction	Not reported	0	Moderate	II	Hip osteo-arthritis	Sylvester
Passive ankle dorsiflexion	Citation	0	Moderate	III-2	Older adults	Lord
Visual analogue scale for stiffness	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Visual analogue scale for flexibility	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Morning stiffness	Citation	+	Moderate	IV	Rheumatic diseases	Lineker
Pendulum goniometry of shoulder flexion	Inter-rater	0	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Spondylometry of lumbar flexion	Inter-rater	0	Poor	II	Rheumatoid and osteo-arthritis	Ahern

Merit of evidence determining hydrotherapy effect on outcomes (continued)

Outcome measure	*Reliability of measure*	*Hydro-therapy effect*	*Merit category*	*Level of evidence*	*Group diagnosis*	*Primary author of trial*
Goniometric active and passive knee flexion-extension	Inter-rater	0	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Visual analogue scale of stiffness	Inter-rater	+	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Goniometric range of movement of 'target joints'	Inter-rater	0	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Supine cervical rotation	Test-retest	+	Poor	II	Ankylosing spondylitis	Helliwell
Xiphisternal chest girth (expansion)	Test-retest	+	Poor	II	Ankylosing spondylitis	Helliwell
Modified Schober's test for lumbar movement	Test-retest	+	Poor	II	Ankylosing spondylitis	Helliwell
Visual analogue scale of stiffness	Test-retest	+	Poor	II	Ankylosing spondylitis	Helliwell
Joint laxity	Inter-rater	0	Poor	II	ACL reconstruction	Tovin
Goniometric passive range of joint motion – knee flexion	Inter-rater	0	Poor	II	ACL reconstruction	Tovin
Goniometric passive range of joint motion – knee extension	Inter-rater	0	Poor	II	ACL reconstruction	Tovin
Thoracolumbar mobility	Citation	+	Poor	IV	Low back pain	Smit
Goniometric joint range of motion	Inter-rater	+	Poor	IV	Rheumatic diseases	Templeton
Range of movement	Not reported	+	Very poor	IV	Low back pain	Roberts
Ranges of shoulder abduction and hyper extension	Not reported	+	Very poor	IV	Older adults	Whitlatch
Range of hip flexion	Not reported	+	Very poor	IV	Older adults	Whitlatch
Strength						
Grip strength	Not reported	0	High	II	Rheumatoid arthritis	Hall
Power extension maximum	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Power abduction maximum	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Power extension 90%	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Power abduction fatigue	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Power abduction fatigue rate	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Endurance abduction work done	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Endurance extension on target	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Endurance flexion scored time	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Muscle dynamometry – hip	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Muscle dynamometry – hip	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Chair test (lower limb endurance)	Citation	+	Moderate	II	Fibromyalgia	Mannerkorpi
Grip strength endurance	Citation	+	Moderate	II	Fibromyalgia	Mannerkorpi
Shoulder abductor	Citation	+	Moderate	II	Fibromyalgia	Mannerkorpi
Grip strength	Not reported	+	Moderate	II	Rheumatoid arthritis	Sandford Smith
Quadriceps strength	Citation	+	Moderate	III-2	Older adults	Lord
Ankle dorsiflexion strength	Citation	+	Moderate	III-2	Older adults	Lord
Total weights lifted	Not reported	+	Moderate	IV	Low back pain	LeFort
Sphygmomanometric grip strength	Inter-rater	Not reported	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Endurance of shoulder musculature	Not reported	+	Poor	II	Older adults	Ruoti
Isometric knee flexion at 85°	Not reported	0	Poor	II	ACL reconstruction	Tovin
Isometric extension at 60°	Not reported	0	Poor	II	ACL reconstruction	Tovin
Isokinetic knee extension through 80°-40° at 90°/s	Not reported	0	Poor	II	ACL reconstruction	Tovin
Isokinetic knee flexion through 0°-70° at 90°/s	Not reported	+	Poor	II	ACL reconstruction	Tovin
Thigh girth	Inter-rater	0	Poor	II	ACL reconstruction	Tovin

Merit of evidence determining hydrotherapy effect on outcomes (continued)

Outcome measure	*Reliability of measure*	*Hydro-therapy effect*	*Merit category*	*Level of evidence*	*Group diagnosis*	*Primary author of trial*
Knee extensor isometric strength at 60°	Not reported	0	Poor	II	Late poliomyelitis	Willen
Knee flexor isometric strength at 60°	Not reported	0	Poor	II	Late poliomyelitis	Willen
Knee extensor isokinetic strength at 60° and 180°/s	Not reported	0	Poor	II	Late poliomyelitis	Willen
Knee flexor isokinetic strength at 60° and 180°/s	Not reported	0	Poor	II	Late poliomyelitis	Willen
Knee extensor isometric endurance	Not reported	0	Poor	II	Late poliomyelitis	Willen
Isometric knee extensor strength at 60° flexion	Test-retest	+	Poor	III-2	Rheumatoid arthritis	Danneskiold-Samsoe
Isokinetic knee extensor strength at 30° and 60°/s	Test-retest	+	Poor	III-2	Rheumatoid arthritis	Danneskiold-Samsoe
Isokinetic knee extensor strength at 12°, 18°, 24° and 300°/s	Test-retest	0	Poor	III-2	Rheumatoid arthritis	Danneskiold-Samsoe
Isometric peak torque of knee extensors	Not reported	+	Poor	IV	Multiple sclerosis	Gehlsen
Isometric peak torque of knee flexors	Not reported	0	Poor	IV	Multiple sclerosis	Gehlsen
Peak torque of knee flexors from 60°/s to 300°/s	Not reported	0	Poor	IV	Multiple sclerosis	Gehlsen
Peak torque of knee extensors from 60°/s to 300°/s	Not reported	0	Poor	IV	Multiple sclerosis	Gehlsen
Total work of knee extensors	Not reported	+	Poor	IV	Multiple sclerosis	Gehlsen
Lower extremity fatigue	Not reported	+	Poor	IV	Multiple sclerosis	Gehlsen
Biokinetic swim bench for upper extremity peak force	Not reported	+	Poor	IV	Multiple sclerosis	Gehlsen
Biokinetic swim bench for upper extremity speed	Not reported	+	Poor	IV	Multiple sclerosis	Gehlsen
Total work of upper extremities	Not reported	+	Poor	IV	Multiple sclerosis	Gehlsen
Upper extremity fatigue	Not reported	0	Poor	IV	Multiple sclerosis	Gehlsen
Computerised physical capacity tests isometric lifts	Not reported	+	Very poor	–	Low back pain	Lorenzetti
Manual muscle testing	Citation	+	Very poor	–	Multiple sclerosis	Peterson
Timed isometric hold in deltoid front raise with weight	Not reported	+	Very poor	IV	Older adults	Whitlatch
Number of resisted leg extensions	Not reported	+	Very poor	IV	Older adults	Whitlatch
Balance						
Total sway area	Test-retest	+	Moderate	II	Rheumatoid and osteo-arthritis	Suomi
Sagittal sway standard deviation	Test-retest	+	Moderate	II	Rheumatoid and osteo-arthritis	Suomi
Lateral sway standard deviation	Test-retest	+	Moderate	II	Rheumatoid and osteo-arthritis	Suomi
Sagittal/lateral sway ratio measure	Test-retest	0	Moderate	II	Rheumatoid and osteo-arthritis	Suomi
Reaction time to visual stimulus via foot switch	Citation	0	Moderate	III-2	Older adults	Lord
Neuromuscular control via repetitive depression of foot switch	Citation	0	Moderate	III-2	Older adults	Lord
Body sway via sway meter	Citation	+	Moderate	III-2	Older adults	Lord
Balance questions	Citation	0	Moderate	IV	Rheumatic diseases	Lineker
Functional reach	Citation	+	Poor	II	Older adults	Simmons
Berg balance scale	Citation	0	Poor	II	Late poliomyelitis	Willen

Merit of evidence determining hydrotherapy effect on outcomes (continued)

Outcome measure	*Reliability of measure*	*Hydro-therapy effect*	*Merit category*	*Level of evidence*	*Group diagnosis*	*Primary author of trial*
Other outcomes						
C-reactive protein (disease activity)	Not reported	0	High	II	Rheumatoid arthritis	Hall
Physical fitness/aerobic power	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Patient's global assessment of change – visual analogue scale	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Articular and enthesopathy indices	Test-retest	+	High	II	Ankylosing spondylitis	Hidding
Knowledge of fibromyalgia questionnaire	Not reported	+	Moderate	II	Fibromyalgia	Gowans (a)
Time of relief of articular gelling	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Overall change score	Not reported	+	Moderate	II	Hip osteo-arthritis	Green
Neurological – passive unilateral straight leg raise	Citation	0	Moderate	II	Low back pain	McIlveen
Neurological – manual muscle strength	Intra- and inter-rater	+	Moderate	II	Low back pain	McIlveen
Neurological – grade of reflex	Intra- and inter-rater	+	Moderate	II	Low back pain	McIlveen
Neurological – light touch sensation	Intra- and inter-rater	+	Moderate	II	Low back pain	McIlveen
Fitness – maximal heart rate – self-limited exercise test	Not reported	+	Moderate	II	Rheumatoid arthritis	Sandford Smith
Fitness – maximal rate-pressure product	Not reported	0	Moderate	II	Rheumatoid arthritis	Sandford Smith
Fitness – duration on treadmill and peak work load	Not reported	+	Moderate	II	Rheumatoid arthritis	Sandford Smith
Erythrocyte sedimentation rate	Not reported	+	Moderate	II	Rheumatoid arthritis	Sandford Smith
Active joint count	Not reported	+	Moderate	II	Rheumatoid arthritis	Sandford Smith
Medication use	Not reported	+	Moderate	II	Low back pain	Sjogren
Fitness – recovery pulse rate after exercise	Not reported	+	Moderate	IV	Low back pain	LeFort
Change in health status	Not reported	+	Moderate	IV	Rheumatic diseases	Lineker
Visits to health professionals	Not reported	+	Moderate	IV	Rheumatic diseases	Lineker
Use of medications	Not reported	+	Moderate	IV	Rheumatic diseases	Lineker
Standford health assessment questionnaire	Not reported	Not reported	Poor	II	Rheumatoid and osteo-arthritis	Ahern
Bone density	Not reported	+	Poor	II	Older adults	Ruoti
Percentage body fat	Not reported	0	Poor	II	Older adults	Ruoti
Heart rate response to walking in water	Not reported	+	Poor	II	Older adults	Ruoti
Maximum oxygen consumption on treadmill	Not reported	+	Poor	II	Older adults	Ruoti
Residual lung volume	Not reported	+	Poor	II	Older adults	Ruoti
Resting heart rate	Not reported	+	Poor	II	Older adults	Ruoti
Heart rate at watt load of peak work level	Not reported	+	Poor	II	Late poliomyelitis	Willen
Oxygen uptake and anaerobic threshold	Not reported	0	Poor	II	Late poliomyelitis	Willen
Astrand submaximal aerobic capacity – bicycle test	Not reported	+	Poor	III-2	Rheumatoid arthritis	Danneskiold-Samsoe
Medication use	Not reported	0	Poor	IV	Low back pain	Smit
Overall status	Not reported	+	Poor	IV	Low back pain	Smit
Number of doctor visits	Not reported	+	Very poor	IV	Low back pain	Langridge
Cost of medicines	Not reported	+	Very poor	IV	Low back pain	Langridge
Self-reported fitness level	Not reported	+	Very poor	IV	Older adults	Rissel
Blood pressure	Not reported	+	Very poor	IV	Older adults	Whitlatch

References

Ahern, M, Nicholls, E, Simionato, E, Clark, M and Bond, M (1995). 'Clinical and psychological effects of hydrotherapy in rheumatic diseases', *Clinical Rehabilitation*, **9**, 204-212.

Bithell, C (2000). 'Evidence-based physiotherapy: Some thoughts on best evidence', *Physiotherapy*, **86**, 2, 58-60.

Bulstrode, S J, Barefoot, J, Harrison, R A and Clarke, A K (1987). 'The role of passive stretching in the treatment of ankylosing spondylitis', *British Journal of Rheumatology*, **26**, 40-42.

Crombie, I K (1996). *The Pocket Guide to Critical Appraisa*l, BMJ Publishing Group, London.

Danneskiold-Samsoe, B, Lynberg, K, Risum, T and Telling, M (1987). 'The effect of water exercise given to patients with rheumatoid arthritis', *Scandinavian Journal of Rehabilitation Medicine*, **19**, 31-35.

Gehlsen, G M, Grisby, S A and Winant, D M (1984). 'Effects of an aquafitness programme on the muscular strength and endurance of patients with multiple sclerosis', *Physical Therapy*, **64**, 5, 653-657.

Goldby, L J and Scott, D L (1993). 'The way forward for hydrotherapy', *British Journal of Rheumatology*, **32**, 9, 771-773.

Gowans, S E, deHuech, A, Voss, S and Richardson, M (1999a). 'A randomised controlled trial of exercise and education for individuals with fibromyalgia', *Arthritis Care and Research*, **12**, 2, 120-128.

Gowans, S E, deHueck, A and Voss, S (1999b). 'Six minute walk test: A potential outcome measure for hydrotherapy', *Arthritis Care and Research*, **12**, 3, 208-211.

Green, J, McKenna, F, Refern, E J and Chamberlain, M A (1993). 'Home exercises are as effective as outpatient hydrotherapy for osteo-arthritis of the hip', *British Journal of Rheumatology*, **32**, 812-815.

Hall J, Skevington, S M, Maddison, P and Chapman, K (1996). 'A randomised and controlled trial of hydrotherapy in rheumatoid arthritis', *Arthritis Care and Research*, **9**, 3, 206-215.

Helliwell, P S, Abbott, C A and Chamberlain, M A (1996). 'A randomised trial of three different physiotherapy regimes in ankylosing spondylitis', *Physiotherapy*, **82**, 2, 85-90.

Hidding, A, van der Linden, S, Boers, M, Gielen, X, de Witte, L, Kester, A, Dijkmans, B and Moolenburgh, D (1993). 'Is group physical therapy superior to individual therapy in ankylosing spondylitis?' *Arthritis Care and Research*, **6**, 3, 117-125.

Hidding, A, van der Linden, S, Gielen, X, de Witte, L, Kester, A, Dijkmans, B and Moolenburgh, D (1994). 'Continuation of group physical therapy is necessary in ankylosing spondylitis', *Arthritis Care and Research*, **7**, 2, 90-96.

Kelly, B T, Roskin, L A, Kirkendall, D T and Speer, K P (2000). 'Shoulder muscle activation during aquatic and dry land exercises in non-impaired subjects', *Journal of Orthopedic Sports Physical Therapy*, **30**, 4, 204-210.

Langridge, J C and Phillips, D (1988). 'Group exercises for chronic back pain sufferers', *Physiotherapy*, **74**, 6, 269-273.

LeFort, S M, and Hannah, E (1994). 'Return to work following an aquafitness and muscle strengthening programme for the low back injured', *Archives of Physical Medicine and Rehabilitation*, **75**, 1247-55.

Lineker, S C, Badley, E M, Hawker, G and Wilkins, A (2000). 'Determining sensitivity to change in outcome measures used to evaluate hydrotherapy exercise programmes for people with rheumatic diseases', *Arthritis Care and Research*, **13**, 1, 62-65.

Lloyd-Smith, W (1997). 'Evidence-based practice and occupational therapy', *British Journal of Occupational Therapy*, **60**, 474-777.

Lord, S, Mitchell, D Williams, P (1993). 'Effect of water exercise on balance and related factors in older people', *Australian Journal of Physiotherapy*, **39**, 3, 217-222.

Lorenzetti, D P (1999). 'Rehabilitation of a lumbar disc injury with concomitant spondylolisthesis and scoliosis: Case report, *Sports Chiropractic and Rehabilitation*, **13**, 3, 107-110.

Mannerkorpi, K, Nyberg, B, Ahlmen, M and Ekdahl, C (2000). 'Pool exercise combined with an education programme for patients with fibromyalgia syndrome: Prospective randomised study', *Journal of Rheumatology*, **27**, 10, 2473-81.

McIlveen, B and Robertson, V J (1998). 'A randomised controlled study of the outcome of hydrotherapy for subjects with low back or back and leg pain', *Physiotherapy*, **84**, 1, 17-26.

Moseley, A M, Herbert, R D, Sherrington, C and Maher, C G (2002). 'Evidence for physiotherapy practice: Survey of the Physiotherapy Evidence Database (PEDro)', *Australian Journal of Physiotherapy*, **48**, 1, 43-49.

National Health and Medical Research Council (2000). 'How to use the evidence: Assessment and application of scientific evidence', *Biotext*, Canberra.

Peterson, C (2001). 'Exercise in 94˚F water for a patient with multiple sclerosis', *Physical Therapy*, **81**, 4, 1049-58.

Philadelphia Panel (2001). 'Evidence-based clinical practice guidelines on selected rehabilitation interventions: Overview and methodology', *Physical Therapy*, **81**, 10, 1629-40.

Polgar, S and Thomas, S A (2000). *Introduction to Research in the Health Sciences*, Churchill Livingstone, Sydney, 4th edn.

Rissel, C (1987). 'Water exercises for the frail elderly: Pilot programme', *Australian Journal of Physiotherapy*, **33**, 4, 226-232.

Roberts, J and Freeman, J (1995). 'Hydrotherapy management of low back pain: Quality improvement project', *Australian Journal of Physiotherapy*, **41**, 3, 205-207.

Ruoti, R G, Morris, D M, and Cole, A J (1997). *Aquatic Rehabilitation*, Lippincott-Raven, Philadelphia.

Sandford Smith, S, Mackay-Lyons, M and Nunes-Clement, S (1998). 'Therapeutic benefit of aquarobics for indiviuals with rheumatoid arthritis', *Physiotherapy Canada*, **50**, 1, 40-46.

Shepherd, J and Mickel, C (1998). 'Towards the localisation of the lumbar-posterior mobilisation technique in water in the treatment of low back pain: Clinical note', *Manual Therapy*, **3**, 3, 162-163.

Sherrington, C, Herbert, R D, Maher, C G and Moseley, A M (2000). 'PEDro: A database of randomised trials and systematic reviews in physiotherapy', *Manual Therapy*, **5**, 223-226.

Sherry, D D, Wallace, C A, Kelley, C, Kidder, M and Sapp, L (1999). 'Short- and long-term outcomes of children with complex regional pain syndrome type 1 treated with exercise therapy', *Clinical Journal of Pain*, **15**, 218-223.

Simmons, V and Hansen, P D (1996). 'Effectiveness of water exercise on postural mobility in the well elderly: Experimental study on balance enhancement', *Journal of Gerontology*, **51A**, 5, M233-M238.

Sjogren, T, Long, N, Storay, I and Smith, J (1997). 'Group hydrotherapy *versus* land-based treatment for chronic low back pain', *Physiotherapy Research International*, **2**, 4, 212-222.

Smit, T and Harrison, R (1991). 'Hydrotherapy and chronic lower back pain: Pilot study', *Australian Journal of Physiotherapy*, **36**, 3, 229-246 .

Suomi, R and Koceja, D M (2000). 'Postural sway characteristics in women with lower extremity arthritis before and after an aquatic exercise intervention', *Archives of Physical Medicine and Rehabilitation*, **81**, 780-785.

Sylvester, K L (1989). 'Investigation of the effects of hydrotherapy in the treatment of osteo-arthritic hips', *Clinical Rehabilitation*, **4**, 223-228.

Templeton, M S, Booth, D L, and O'Kelly, W D (1996). 'Effects of aquatic therapy on joint flexibility and functional ability in subjects with rheumatic disease', *Journal of Sports and Physical Therapy*, **23**, 6, 376-381.

Tovin, B J, Wolf, S L, Greenfield, B H, Crouse, J and Woodfin, B A (1994). 'Comparison of the effects of exercise in water and on land on the rehabilitation of patients with intra-articular anterior cruciate ligament reconstructions', *Physical Therapy*, **74**, 8, 710-719.

Wakefield, A (2000). Evidence-based physiotherapy: The case for pragmatic randomised controlled trials', *Physiotherapy*, **86**, 8, 394-396.

Watanabe, E, Takeshima, N, Okada, A and Inomata, K (2000). 'Comparison of water- and land-based exercise in the reduction of state anxiety among older adults', *Perceptual and Motor Skills*, **91**, 97-104.

Weiss, C R, Jamieson, N B (1987). 'Affective aspects of an age-integrated water exercise programme', *The Gerontologist*, **27**, 4, 430-433.

Whitlatch, S and Adema, R (1996). 'Functional benefits of a structured hot water group exercise programme', *Activities, Adaptation and Aging*, **20**, 3, 75-85.

Willen, C, Sunnerhagen, K S and Grimby, G (2001). 'Dynamic water exercise in individuals with late poliomyelitis', *Archives of Physical Medicine and Rehabilitation*, **82**, 66-72.