Feasibility and acceptability of aquatic exercise therapy in burn patients – A pilot study

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ABSTRACT

Background: As the assistive and resistive properties of water can facilitate the performance of exercise, aquatic exercise therapy might be a promising rehabilitation modality for burn patients. This study aimed to investigate the feasibility and acceptability of aquatic exercise therapy in adult burn patients with an indication for supervised exercise therapy.

Methods: Eligible for this observational pilot study were all competent adult burn patients with an indication for supervised exercise therapy who had been admitted to the burn centre of the Maasstad Hospital between June 2016 and February 2017. Patients were asked to participate in an in-hospital aquatic exercise therapy program for a minimum of 2 weeks, 2 times per week, or otherwise serve as control by having land-based exercise therapy (regular care). Feasibility of aquatic exercise therapy was assessed by comparing the number of eligible patients to the number of patients that could actually participate, monitoring attendance rates, monitoring complications, and evaluating early experiences. Acceptability was assessed using the Water Exercise Acceptability Questionnaire.

Results: Eleven patients were invited and ten of them agreed to participate. All chose aquatic instead of land-based exercise therapy. Participants were aged between 19 and 64 years and their burns affected 18–53% of total body surface area (TBSA). Aquatic exercise therapy appeared feasible in nine of 13 eligible patients (69%). Attendance rates were high (42–100%) and the majority of participants (n = 9) continued with aquatic exercise therapy beyond the initial two weeks. No serious complications (e.g. infections) occurred. Adverse symptoms (wound healing issues) were reported in five participants, but in four of them these were not likely to be due to the aquatic exercise therapy. Enjoyment was high and adherence to the aquatic exercise therapy was further facilitated by support from staff, a sense of achievement, noticeable improvements, personal motivation, and support from other participants. Peer support was reported as a positive side effect.

Conclusions: These preliminary results indicate that aquatic exercise therapy is both feasible and acceptable for the majority of adult burn patients with an indication for supervised exercise therapy. No indications were found for an increased risk of infection or other serious complications.

1. Introduction

To optimize functioning, and therewith (long-term) outcomes of health and quality of life after burns, there is strong evidence to support strength training and aerobic exercise both during hospital stay and after discharge from the burn center [1–5]. In Dutch burn centres, patients are therefore encouraged to start exercising and pick up daily (self-care) activities as soon as possible, preferably from the day of hospital admission. However, exercising with healing wounds is generally uncomfortable, if not painful. As a result, some burn patients develop a strong belief that exercise would harm their scars, or even fear of movement, leading to avoidance of affected limb use or avoidance of all forms of physical activity [6–9].

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In several rehabilitation groups, the assistive and resistive properties of water are used to facilitate the performance of exercise therapy [10–16]. The buoyancy of the water supports body weight and reduces the load on painful joints [10]. The density of the water forces the body upwards, the relatively high water temperature promotes muscle relaxation, and the hydrostatic pressure reduces the development of oedema [10]. All these features make moving in water easier compared to moving on land. On the other hand, the viscosity of the water allows challenging strengthening exercises. Limbs moving relative to water experience resistance that increases as more force is exerted [10,17]. In addition, the hydrostatic pressure of the water in itself causes a training effect by the induced cardiovascular response and the increased work of breathing (especially inspiration) when the body is passively immersed [10]. Considering this, aquatic exercise therapy would also be a promising rehabilitation modality for burn patients. Offering an environment that facilitates the performance of exercise is expected to reduce fear of movement, inhibit avoidance behaviour, and facilitate the return to normal daily life and former (sports) activities.

Despite the potential benefits of aquatic exercise therapy after burns [18–20], it may in itself be a barrier for burn patients. Being exposed to water might affect wound healing and burn patients may have problems exposing themselves in a swimsuit. Since 2015, the burn centre of the Maasstad Hospital in Rotterdam has offered aquatic exercise therapy as an optional rehabilitation modality for burn patients requiring supervised exercise therapy. The first reports from participants and physical therapists were promising: both were very enthusiastic. Questions arose if aquatic exercise therapy should have a more prominent place in the rehabilitation of burn patients, and if other burn centres (in the Netherlands) also should offer aquatic exercise therapy. This study therefore aimed to investigate the feasibility and acceptability of aquatic exercise therapy in adult burn patients with an indication for supervised exercise therapy beyond discharge.

2. Material and methods

2.1. Design and study population

Eligible for this observational pilot study were adults with nearly healed burns, who were admitted to the burn centre of the Maasstad Hospital in Rotterdam between June 2016 and February 2017, and had an indication for supervised exercise therapy (as determined by the physical therapist). An indication for supervised exercise therapy was needing continuation of exercise therapy beyond discharge but not likely to achieve this without supervision due to fear of movement, avoidance of using affected body parts, or serious deconditioning. Exclusion criteria were one-day admissions, insufficient competence (as determined by the treating burn physician), no permission to swim (as determined by the treating burn physician or hospital hygienist), and insufficient understanding of the Dutch language to be able to follow instructions and/or give informed consent.

If a patient needed supervised exercise therapy, the patient was asked to participate in an in-hospital aquatic exercise therapy program after discharge, or otherwise serve as control by having land-based exercise therapy. Non-participants were asked why they did not want or were not able to participate.

2.2. Intervention

Aquatic exercise comprised an in-hospital therapy program for a minimum of two weeks, twice a week, in combination with regular follow-up visits at the burn centre. In patients with open wounds and/or residual defects, wound dressings were covered carefully by a burn nurse, using cling film and Tegaderm®, before entering the water. All participants started with an *individual* aquatic exercise therapy session guided by a physical therapist. As soon as the patient was considered able to perform aquatic exercise safely without individual guidance, the patient joined *group-based* sessions given by a movement teacher and/or physical therapist. Each session lasted for 60 min. All sessions started with gentle movements in the water, followed by active range of motion exercises and, if possible, various strengthening and aerobic exercises. More information regarding therapy content is added as supplementary content [see Appendix A]. However, exact therapy content, including intensity, was individualized - based on personal indication - and adjusted as the patient proceeded. The end of supervised exercise therapy was determined by the physical therapist in consultation with the patient. Exercise therapy was considered no longer necessary at the time the patient had experienced that he/she could safely exercise affected limbs, had overcome his/her fear of movement, and did not show avoidance behaviour anymore. From this point, patients were considered able to perform exercise therapy on their own and return to normal life by picking up activities of daily living and former (sports) activities.

2.3. Aquatic environment

All aquatic exercise therapy sessions were conducted in the hydrotherapy pool of the Maasstad Hospital, which is 16 m × 7 m, with adjustable water depth ranging from 0 m to 1.80 m. The average water temperature was 31.3 °C, ambient air temperature 30.2 °C, and relative air humidity 77%. The pool water was sanitized by means of natrium chloride electrolysis. Although multiple modes of entry were available to enter the pool (adjustable floor, stairs, and hoist access), all participants were encouraged to use the adjustable floor to enter and exit the pool safely. Separate private changing rooms with bench seats were on site for men and women. Futhermore, a toilet with hand rails and multiple showers were available, with shower chairs if nessecary.

2.4. Data collection

2.4.1. Participant characteristics

For all participants, age, sex, extent of burn, location of burns, aetiology, presence of inhalation injury, number of surgeries, and dates of the burn incident, admission and discharge were obtained from the national Dutch Burn Repository. Patients were asked about previous swimming experience and swimming certificates, and information regarding former sports participation was obtained from the Baecke's Habitual Activity Questionnaire (BAQ) [21]. As self-efficacy was considered an important moderator of adherence to exercise therapy [22,23], self-efficacy with regard to rehabilitation outcome was assessed once, at discharge, using the general part of the Self-Efficacy for Rehabilitation Outcome Scale by Waldrop et al. [24]. Higher scores reflect better self-efficacy, with a maximum score of 70.

2.4.2. Feasibility

To gain insight in the feasibility of in-hospital aquatic exercise therapy following burn injury, first the number of eligible patients was compared to the number of patients who were actually able to participate. Second, attendance rates were monitored, including reasons for non-attendance. Third, adverse symptoms and potential complications during the aquatic exercise therapy program were carefully monitored and registered by the physical therapist and research nurse. Finally, in order to identify early experiences and specific precautions regarding aquatic exercise therapy in burn patients, all correspondence regarding the preparation and implementation was checked carefully and de-briefing discussions were held with the physical

therapist in charge of the project (SS), the research coordinator and the research nurse of the burn centre of the Maasstad Hospital (MvB, NT), and two additional members of the project group (MA, MN).

2.4.3. Acceptability

Acceptability of the in-hospital aquatic exercise therapy was assessed using a questionnaire based on the Water Exercise Acceptability Questionnaire as developed by McNamara et al. [25], two weeks after the start of the program. The questionnaire included items with regard to enjoyment, attendance including barriers and facilitators, satisfaction with the aquatic environment, and preferences with regard to the exercise therapy environment.

2.4.4. Aquatic exercise therapy versus land-based therapy

To compare the profiles and outcomes of participants who chose aquatic exercise therapy to those who served as control by having land-based exercise, information regarding enjoyment of physical activity, physical activity habits, and health-related quality of life were collected. The Physical Activity Enjoyment scale (PACES) [26], the BAQ [21], and the Burn-Specific Health Scale-brief (BSHS-B) [27] were used respectively for this purpose.

3. Results

In the period from June 2016 till February 2017, 16 patients out of 118 burn related admissions who needed continuation of exercise therapy beyond discharge had an indication for supervised exercise therapy and were thus eligible for this pilot study. Five patients were excluded, so eleven patients were asked to participate. One of them refused to participate because of the traveling distance and being overburdened (participation rate: 91%, Fig. 1). All ten participants chose aquatic exercise therapy instead of land-based exercise therapy, the latter being currently standard care in the Dutch burn centres.

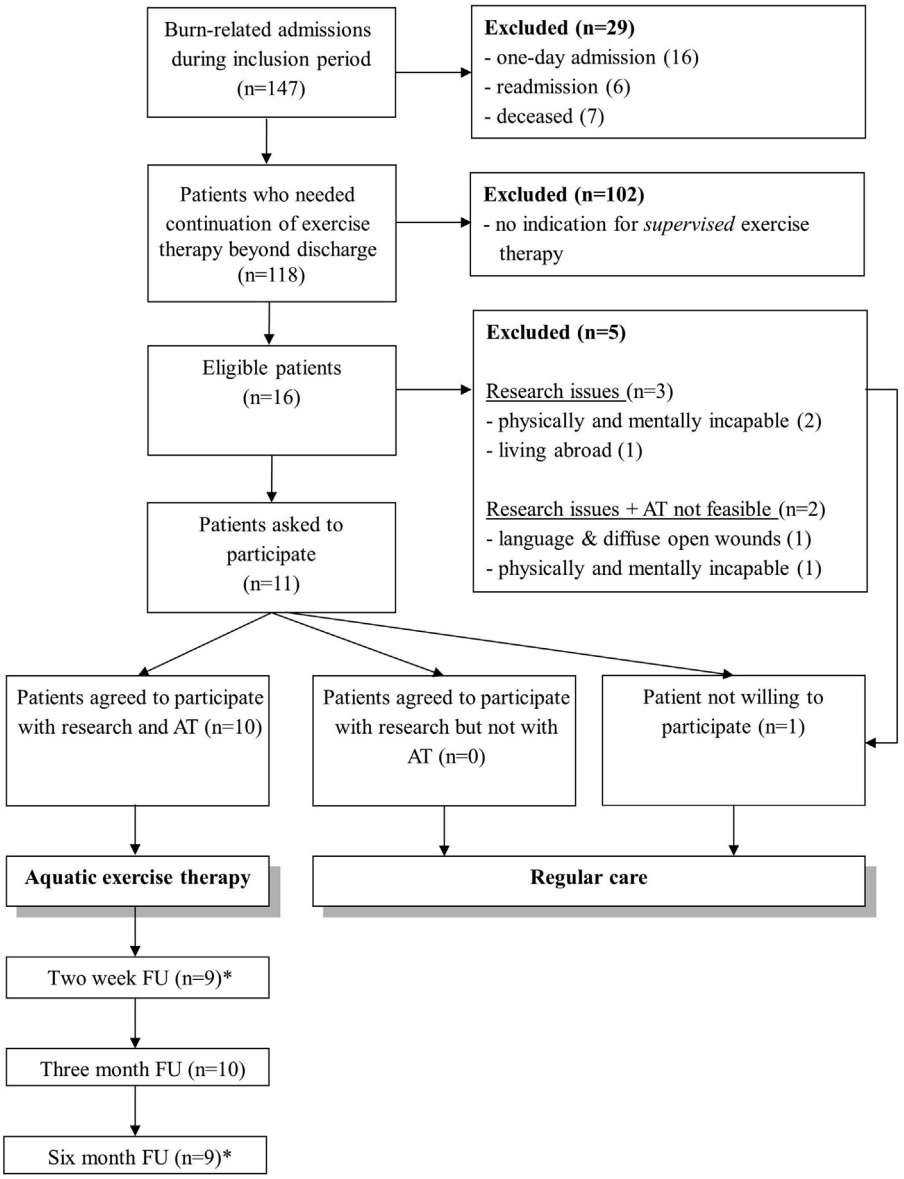

Fig. 1. Flow of patients. * No response to the questionnaires, despite repeated requests from the burn centre staff. *Abbreviations:* AT = aquatic exercise therapy, FU = follow-up. The 2-week FU took place two weeks after the start of the aquatic exercise program and the 3- and 6-month FU respectively three and six months after discharge from the burn centre.

Table 1
Participant characteristics.

Parameter	Participants (n = 10)	
Male, *n (%)*	8	(80.0)
Age at burn injury (yr)	44	(26–48)
%TBSA involved	30	(22–48)
% full thickness burns	19	(2–34)
Inhalation injury, *n (%)*	5	(50)
Length of hospital stay (days)*	55	(34–70)
≥ 6 weeks, *n (%)*	7	(70)
Number of surgeries	3	(0–5)
Time post burn at the start of aquatic exercise therapy (days)*	63	(41–70)
Time after discharge at the start of aquatic exercise therapy (days)*	14	(10–16)
Self-efficacy‡	46	(45–64)

Results are shown as median (interquartile range), unless specified otherwise. *Based on nine participants, as one participant had an extreme length of hospital stay (408 days) due to both physical and mental complications. This participant started with aquatic exercise during hospital stay (time after discharge: −32 days, time post burn: 376 days). ‡ Assessed using the general part of the Self-Efficacy for Rehabilitation Outcome Scale (15). Higher scores represent higher levels of self-efficacy, with a maximum score of 70.
Abbreviations: n = number; %=percentage; yr = years; %TBSA = percentage of total body surface area affected by burns.

3.1. Participant characteristics

Participants were aged between 19 and 64 years and were dominantly male (Table 1). All burns were caused by fire/flames. In all participants at least one extremity was affected. In two participants only upper body parts were affected and in one participant only lower body parts. Seven participants had undergone surgery.

At the start of the aquatic exercise program, median time post burn was 63 days (IQR 41–70) and the median time after discharge was 14 days (IQR 10–16). All ten participants had previous swimming experience and nine of them had at least one swimming certificate. Six participants were involved in regular (organized) sports activities before the burn incident. Based on clinical evaluation, nine out of the ten participants showed fear to use affected body parts. Despite this, self-efficacy with regard to rehabilitation outcome was moderately high (Table 1). Most concerns were related to fatigue and performing exercise with pain.

3.2. Feasibility

Of the 16 eligible patients, ten did actually participate (Fig. 1). Aquatic exercise therapy was feasible in nine of them, as one patient showed hypersensitivity to water in combination with wearing pressure garments afterwards (i.e. this participant also got skin rash after taking a shower).

Of the 16 eligible patients, however, three were excluded due to the fact that this pilot concerned a research project (Fig. 1). Considering this, aquatic exercise therapy was feasible in 69% of the adult burn patients with an indication for supervised exercise therapy (9 out of 13 eligible patients).

3.2.1. Attendance rates

All participants chose aquatic exercise therapy instead of land-based exercise therapy. The intended number of two aquatic exercise sessions per week for a minimum of two weeks was achieved by 5 of the 10 participants. The other participants managed one aquatic exercise therapy session per week, primarily due to conflicting pool and outpatient wound care schedules. The mean attendance rate was 69% (range 42–100%), with on average eight (SD: 4.5, range: 2–14) aquatic exercise therapy sessions per participant (Fig. 2). Six patients needed wound dressing coverage during (part of the) therapy sessions. The participants who did require wound dressing coverage attended on average less aquatic exercise therapy sessions compared to those who did not (Fig. 2). Individual attendance rates and reasons for cancellation are shown respectively in Fig. 2 and Table 2.

After the initial two weeks, the majority of participants (n = 9) continued with the aquatic exercise therapy. The end of the therapy sessions was determined in consultation with the participants, i.e. when regular follow-up visits ended (n = 1), when supervised exercise therapy was no longer necessary (n = 5), due to the participant's lack of time (n = 1), or due to logistic problems for the participant (n = 1). One participant decided to stop after three aquatic exercise therapy sessions because of skin rash caused by water contact, which also occurred after taking a shower, in combination with wearing pressure garments afterwards. One participant was still having aquatic exercise therapy at the time this pilot study ended (August 2017).

3.2.2. Adverse symptoms

No serious complications (e.g. infections) occurred during the study period. Wound healing issues were reported in five out of the ten participants. In four participants, however, this was likely to be due to overtraining on land (i.e. boxing without pressure bandages), complicated wound healing in general (i.e. this participant was more than one year post burn at the start of aquatic exercise therapy), hypersensitivity to water in general in combination with wearing pressure garments afterwards (i.e. also skin rash after taking a shower), or colonization with *Staphylococcus Aureus* and/or

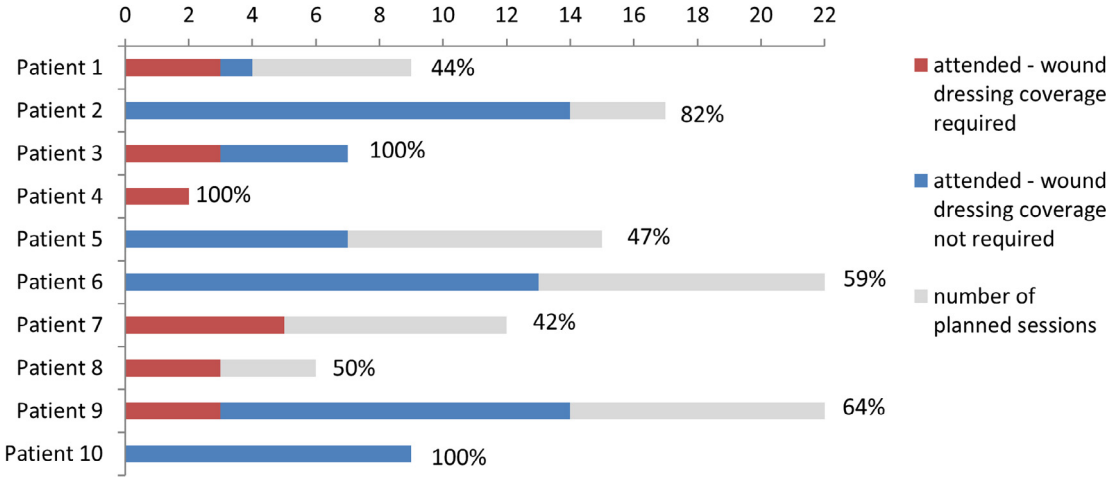

Fig. 2. Individual number of aquatic exercise therapy sessions, including attendance rates.

Table 2
Reasons for cancellation of aquatic exercise therapy per session.

Not attended	43 / 121	
• Hospital issues		
- logistics	11	e.g. absence of staff, planning wound care
- pool availability	7	e.g. pool maintenance
• Patient issues		
- wound healing-bacteria	41	e.g. delayed wound healing, enlargement of the wounds
- transport	2	
- bacteria	0	
- not fit	6	e.g. flu, period
- other	3	e.g. birthday, funeral, holiday
• Unknown	10	

Pseudomonas before the start of the aquatic exercise therapy. In one participant it was not possible to preclude that the colonization with *Staphylococcus Aureus* and *Pseudomonas* was caused by the aquatic environment.

Another issue was that some participants got cold during the aquatic exercise therapy sessions, but this symptom was temporary and easily solved by taking a warm shower afterwards.

3.2.3. Early experiences

From the analysis of the correspondence regarding the preparation and implementation of aquatic exercise therapy, and the debriefing discussions concerning the feasibility of this rehabilitation modality, the following topics were distinguished:

Availability of staff – Aquatic exercise therapy requires additional staff (i.e. a person who can help cover the wound dressings and assist participants with showering, getting (un)dressed, etc.).

Efficiency – Wound dressing coverage with cling film and Tegaderm® proved to be really time consuming. During implementation it was discovered that, in case of wound dressings on extremities, swim covers (Seal Protect Sport®) can be used. These swim covers are specifically designed for protection of casts and dressings through a watertight seal during light water recreation. Swim covers proved to be less time consuming as they can be easily applied and eliminate the need for cling film and adhesive tapes.

Planning – For participants with open wounds it was considered necessary to visit the wound care nurse directly following each aquatic exercise therapy session, as dressings did not stay entirely dry in the pool, despite careful covering. This implies that all involved health care professionals (the movement teacher, physical therapist, wound care nurse), the participant, and the hydrotherapy pool have to be available within the same time frame, making scheduling complex.

Clinical patients – Throughout the study period, three participants already started with aquatic exercise therapy during hospital admission, without complications.

Peer support – The majority of participants described peer support as a positive side effect of the aquatic exercise therapy program.

Implementation – At the start of this study, the majority of the burn centre staff was sceptic about aquatic exercise therapy in burn patients, let alone with wounds that are not fully closed. As in all implementation trajectories, proper communication turned out to be key.

3.2.4. Specific precautions

According to the hydrotherapy protocol of the Maasstad Hospital, burn patients can safely make use of the hydrotherapy pool. For those with open wounds it is advised to carefully cover wound dressings before entering the pool. Patients who are colonized with multi-resistant *Staphylococcus Aureus* or other resistant micro-organisms should not participate in group sessions. Although those bacteria do not survive long in pool water with adequate pH levels and proper disinfectant, they can be spread via contact with other facilities in the aquatic environment. Therefore, patients colonized with these resistant micro-organisms should exercise alone and at the end of the day, and all facilities in the aquatic environment must be properly cleaned afterwards.

To safely participate in *group-based* aquatic exercise, patients need to be able to swim, or at least be able to keep their head out of the water independently. It is important to realize that swimming ability can be compromised by the burns, for example by pain, fatigue, restrictions in joint range of motion, or amputations of (a part of) an extremity. For this reason, it is recommended to start with an *individual* aquatic exercise therapy session guided by a physical therapist and to expand this to *group-based* aquatic exercise therapy supervised by a movement teacher and/or a physical therapist as soon as the patient is ready for it.

3.3. Acceptability

Enjoyment was high: five participants scored a 4 'high enjoyment' and five participants scored a 5 'complete enjoyment' on a 5-point rating scale for the level of enjoyment of aquatic exercise therapy. Adherence to the exercise therapy was reported to be facilitated by support from staff (n = 4), enjoyment (n = 3), a sense of achievement (n = 3), noticeable improvements (n = 3), personal motivation (n = 4) and support from other participants (n = 2). Reported barriers involved pool maintenance (n = 1), fatigue (n = 1), additional reconstructive surgery (n = 2), suspected skin infection (n = 1), and residual skin defects that could not be covered properly (n = 1). Pain was never mentioned as a barrier to aquatic exercise therapy. Satisfaction with the changing room facilities, shower facilities, staff assistance, and pool entry options was high, all participants indicated they were either satisfied or completely satisfied with these features. Less satisfaction (three participants who were either fairly satisfied or neutral) was reported with regard to the temperature of the pool water and the ambient air. Participants reported that aquatic exercise therapy helped them regaining the confidence in their body and their self-efficacy with regard to exercise and physical activity. The following quotes were documented as additional comments to the Water Exercise Acceptability Questionnaire [25]: "*The aquatic exercise therapy sessions were very pleasurable and nice to do. I think the therapy enhanced my muscle strength*." and "*Aquatic exercise therapy was enjoyable. It was easier and less painful to move in the water.*" and "*Movements felt smoother and more pleasant in the water, as you are weightless. I can only be positive about aquatic exercise therapy*." Seven out of ten participants (70%) indicated they preferred to continue with aquatic exercise therapy if there was no longer an indication for supervised exercise therapy, either or not in combination with land-based exercise. However, continuing aquatic exercise therapy somewhere else than at the hospital hydrotherapy pool was not readily embraced by the participants.

3.3.1. Aquatic exercise therapy versus land-based therapy

As none of the participants chose land-based exercise therapy, no comparison can be made with patients prepared to join the aquatic exercise therapy regarding differences in enjoyment of physical activity (PACES), physical activity habits (BAQ), and health-related quality of life (BSHS-B). These results are therefore added as supplementary content [see Appendix B-D]. Comparing pre- and post, three participants reported higher physical activity enjoyment scores after aquatic exercise therapy compared to the pre-burn situation, two participants reported equal scores, and four reported lower scores. Five participants reported higher habitual physical activity levels six months after discharge compared to the situation before the burn injury, one participant reported sim-

ilar levels and three reported lower levels. Burn-specific health-related quality of life improved from discharge to six months after discharge in seven participants, whereas three reported a slight decrease.

4. Discussion

The current pilot study indicated that aquatic exercise therapy is both feasible and acceptable in adult burn patients with an indication for supervised exercise therapy beyond discharge. It appeared even feasible and acceptable to include clinical patients prior to discharge. No serious complications (e.g. infections) occurred. Both patients and health care professionals were very positive about the aquatic exercise therapy. Participants reported it was easier, more comfortable, and less painful to exercise in water compared to exercising on land, based on their earlier experiences with land-based exercise therapy during hospital stay. Furthermore, they really enjoyed exercising in water and most of them experienced a sense of achievement and/or noticeable improvements. The majority of participants wanted to continue exercising in water after their indication for supervised exercise therapy was ended.

The results of this pilot study are promising. The fact that all participants chose aquatic exercise therapy instead of land-based therapy indicates that they initially liked the idea of exercising in water. Fear of movement and avoidance behaviour disappeared in all participants while exercising in water, based on clinical evaluation. This might be because patients reported that they experienced less stretch on their scars during exercise in water compared to exercise on land. This is promising, as patients may then be able to reach greater ranges of joint motion while exercising in 31 degree water, compared to exercising on land, without additional pain. It would be interesting to confirm this suggestion in future studies. Aquatic exercise therapy was considered to lower the threshold of becoming physically active and returning to daily life beyond discharge from the burn centre. Of the six participants who were engaged in organized sports before the burn injury, at least four of them had returned to their former sport activities within three months. One of them added swimming (1–2 h per week) to his former sport activities. One participant did not fill out the 3-month questionnaires, but six months after discharge he had returned to one of his two former sport activities.

Peer support was identified as positive side effect of the aquatic exercise therapy program. Participants described that they experienced the possibility of both receiving and giving support, which was recently identified as the most important attribute of peer support in adult burn patients [28]. Papamikrouli et al. [28] also reported that 74% of adult burn patients were willing to help other burn patients, even if they did not feel the need for peer-support themselves. The 'ideal peer support program' described by their respondents comprised talking to peers in a relaxed atmosphere combined with recreational activities. Group-based aquatic exercise therapy definitely meets these requirements. Additionally, a number of respondents of Papamikrouli et al. [28] reported that they would not attend to peer support activities because they did not want to see themselves as 'burn patients'. Participants in our study, however, reported that they did not feel like a patient when exercising in the water together. Of course, peer support can also be achieved by means of group-based exercise therapy on land. However, land-based exercise therapy generally comprises individual physical therapy sessions in the home environment of the patient.

Despite these promising results, some issues were faced during this pilot study. Some of these were patient-related, but the majority comprised hospital logistics and pool availability. Starting with aquatic exercise therapy in an early phase, before full wound closure, was considered to facilitate functional recovery by reducing fear of movement and avoidance behaviour as soon as possible. However, wound dressing covering appeared time consuming and wound care was considered necessary directly after each aquatic exercise therapy session, which complicated scheduling and negatively affected attendance rates. If it appears not feasible to ensure adequate wound dressing coverage before and wound care directly after the aquatic exercise sessions, one can opt to start aquatic exercise at the time wounds are fully closed. In that case, patients do neither require wound dressing covering nor subsequent wound care. This also opens up the opportunity for them to participate in aquatic exercise therapy in their home environment, for instance during rehabilitation lessons offered in local hydrotherapy pools. The latter eliminates the need for an in-hospital hydrotherapy pool. However, this will also remove the positive side effect of peer support and, at least within the Dutch health care system, the reimbursement from basic health insurance. Additional costs for outpatient (aquatic) exercise therapy can for some patients be a reason not to attend.

With any implementation of a new rehabilitation modality, issues and scepticism were to be expected. Indeed, the staff of the burn centre and rehabilitation department were sceptic at first about aquatic exercise therapy in burn patients with wounds that are not fully closed. Conflicting information from various health care professionals regarding aquatic exercise therapy also negatively affected attendance rates. To avoid these communication issues due to scepticism, all involved health care professionals should be informed properly about former experiences, options to cover open wounds in an adequate manner, existing hospital hydrotherapy protocols that minimize the risk of infection, and the potential added value of aquatic exercise therapy for burn patients. The designation of a qualified person who is responsible to head the new rehabilitation modality is essential in this case. Only when involved health care professionals feel they are well-informed and convinced about the benefits of aquatic exercise therapy, they will encourage their patients to participate. Convincement will also increase their collaboration and flexibility with regard to the planning of wound care following the aquatic exercise therapy sessions, which will further increase feasibility. But of course, convincement takes time and needs to grow based on positive experiences. The health care professionals involved in this study have become very positive in the course of this study, and aquatic exercise therapy is being continued after the research project stopped.

4.1. Limitations

Some limitations need to be discussed. First, the number of eligible patients was relatively small. This was particularly due to the rather specific indication for supervised exercise therapy after discharge in Dutch burn centers. In the Netherlands, patients are preferably encouraged to perform specific exercises on their own and return to normal life, including picking up their activities of daily living and (former) sports activities, as soon as possible. Only patients who are not likely to achieve this on their own are referred for supervised exercise therapy after discharge. This does - of course - not mean that aquatic exercise would not be useful for the rest. Second, since all participants chose aquatic exercise therapy instead of land-based exercise therapy, it was not possible to compare the feasibility and acceptability of aquatic exercise therapy with land-based exercise therapy. Part of the outcome measures became therefore less relevant and were consequently added as supplementary content. Third, as nine out of the ten participants showed fear of movement before the start of the aquatic exercise therapy program, it would have been interesting to assess

fear of movement before and after the aquatic exercise therapy program, for example with the Dutch version of the Tampa Scale for Kinesiophobia [29]. Unfortunately, we did not measure fear of movement. Based on clinical experience, however, aquatic exercise therapy definitely helped to reduce fear of movement. Only after a few sessions of aquatic exercise therapy, the participants were less anxious to move, also on land, and showed improvement in physical functioning. Finally, although many participants wanted to continue exercising in water after their indication for exercise therapy was stopped, doing so somewhere else than at the hospital hydrotherapy pool was not readily embraced. Swimming with visible scars amongst other, unaffected, people, was commonly described as a barrier. Going to a regular swimming pool with another burn survivor, a buddy, might be helpful to overcome this barrier. Given the fact that the majority of adult burn patients would like to help other burn patients [28], this option is definitely worth further exploration.

4.2. Implications for clinical practice

Aquatic exercise therapy proved to be feasible and acceptable in burn patients, even if wounds are not fully closed. No indications were found for an increased risk of infection. Enjoyment amongst participants was high and aquatic exercise therapy was reported to be more comfortable and less painful compared to exercise therapy on land. Although this study focused exclusively on burn patients with an indication for supervised exercise therapy beyond discharge, aquatic exercise therapy might be beneficial for all burn patients. It is therefore recommended to inform all burn patients about the positive experiences with exercising in water.

4.3. Implications for further research

The results of this study will be used to further develop aquatic exercise therapy as rehabilitation modality for burn patients in the Netherlands. Although aquatic exercise therapy appeared both feasible and acceptable, and seemed to have additional value over land-based exercise, its' effectiveness on rehabilitation outcome in both the short- and the long-term requires further examination.

5. Conclusions

These preliminary results indicate that aquatic exercise therapy is both feasible and acceptable for the majority of burn patients with an indication for supervised exercise therapy. Based on clinical experience, aquatic exercise therapy clearly showed promise over land-based exercise therapy. No indications were found for an increased risk of infection or other serious complications.

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Ethics approval and consent to participate

All participants provided written informed consent. The regional Medical Ethics Committee (TWOR – Toetsingscommissie Wetenschappelijk Onderzoek Rotterdam e.o.) approved this study (NL54712.101.16).

Competing interests

The authors declare that they have no competing interests.

Authors'contributions

All authors were member of the project group and thus responsible for the project proposal. SS, NT, JE, IO, MvdV, CvdV, and MvB were responsible for the implementation of aquatic exercise therapy in the Maasstad Hospital. SS and JE actually conducted the aquatic exercise therapy sessions. MA, MN, MvB, SS and NT analysed and interpreted the data. MA wrote the manuscript in close collaboration with SS, NT, MvB, and MN. All authors read and approved the final manuscript.

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Trial registration

This study was registered in the National Academic Research and Collaborations Information System (OND1359297).

Appendix A – Therapy content

Table A1
Description of aims and examples of specific exercises performed during the aquatic exercise therapy sessions.

	Specific aim	Average duration	Exercises	Intensity
Individual sessions	Reducing fear of movement	15 min	- Slowly lowering the bottom of the pool - Slowly walking through the water - Performing gentle limb movements in the water	Low intensity
	Improving active joint ROM	15 min	- Eliciting controlled active movements in the water, approaching current maximal range of motion of affected joints	Low intensity
	Improving strength	10 min	- Various strengthening exercises using the resistance of the water	Intensity was adjusted by varying the speed of movement and/or the use of specific attributes (e.g. aquatic weights, aqua dumbbells, aqua barbells, aqua boxing gloves)
	Improving aerobic capacity	10 min	- Various aerobic exercises, like swimming and stepping exercises in the water	Intensity was adjusted by varying the speed of movement
	Relaxation	10 min	- Letting the patient float on his back, supported by diverse foam attributes, like buoyancy belts and water noodles - Passively moving the patient through the water according to the Halliwick method	Low intensity
Group sessions	Warming-up	5 min	- Slowly walking through the water - Performing gentle limb movements in the water	Low intensity
	Improving active joint ROM	20 min	- Eliciting controlled active movements in the water, approaching current maximal range of motion of affected joints - Eliciting active movements during various forms of play (e.g. throwing a ball)	Low-moderate intensity
	Improving strength	15–20 min	- Various strengthening exercises using the resistance of the water	Intensity was adjusted by varying the speed of movement and/or the use of specific attributes (e.g. aquatic weights, aqua dumbbells, aqua barbells, aqua boxing gloves)
	Improving aerobic capacity	15–20 min	- - Various aerobic exercises, like swimming and stepping exercises in the water	Intensity was adjusted by varying the speed of movement. Some mutual competition was encouraged.
	Cooling-down	5 min	- Slow movements in the water, or low-intensity swimming	Low intensity

Appendix B – 1 Enjoyment of physical activity

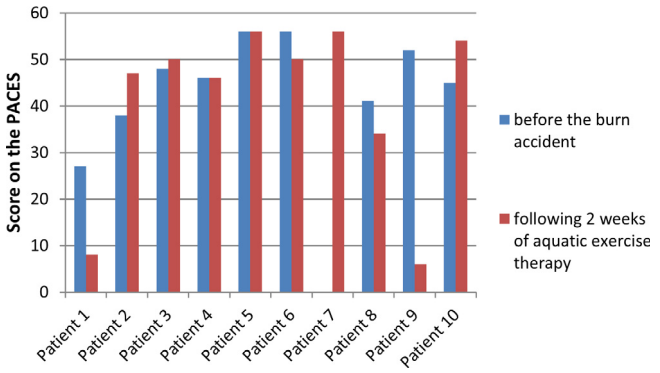

Fig. B1. Enjoyment of physical activity. [a] Figure showing scores on the Physical Activity Enjoyment scale (PACES) (17) in the aquatic exercise group (n = 10) both before the burn accident and following two weeks of aquatic exercise therapy. [a] Enjoyment of physical activity was assessed using the short, 8-item, version of the Physical Activity Enjoyment scale (PACES) (17). The PACES was filled in twice, once at inclusion, concerning enjoyment of physical activity prior to the burn accident, and once two weeks following the start of the program. Higher PACES scores reflect greater levels of enjoyment, with a minimum of 8 and a maximum of 56.

Appendix C – Physical activity habits

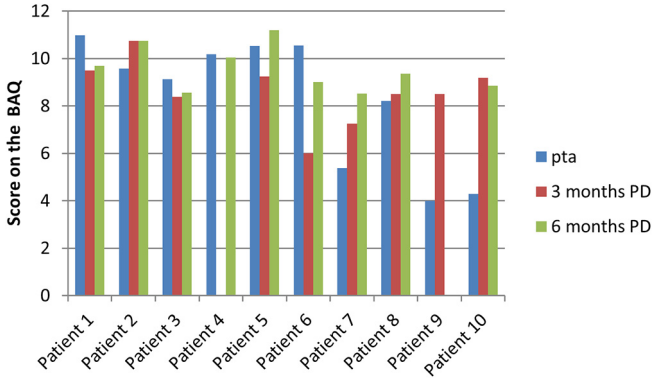

Fig. C1. Physical activity habits. [a] Figure showing total scores on the Baecke's Habitual Activity Questionnaire (BAQ) (18) prior to accident (pta), three months, and six months post-discharge (PD) in the aquatic exercise therapy group (n = 10). [a] Previous activity habits were assessed using the 16-item Baecke's Habitual Activity Questionnaire (BAQ) (18). As an indication of recovery, this questionnaire was repeated 3 and 6 months after discharge. The BAQ addressed three domains of PA: occupational, sport, and leisure time. The total PA score was calculated by the summation of the mean scores of all three subdomains (min 3 – max 15). Higher scores reflect higher levels of physical activity. *Abbreviations*: PA = physical activity; PD = post-discharge.

Table C1
Physical activity habits [a] Table showing outcomes on the Baecke's Habitual Activity Questionnaire in the aquatic exercise therapy group (n = 10). [a] Previous activity habits were assessed using the 16-item Baecke's Habitual Activity Questionnaire (BAQ) (18). As an indication of recovery, this questionnaire was repeated 3 and 6 months after discharge. The BAQ addressed three domains of PA: occupational, sport, and leisure time. The total PA score was calculated by the summation of the mean scores of all three subdomains (min 3 – max 15). Higher scores reflect higher levels of physical activity.

	Prior to accident		**3 months PD**		**6 months PD**		*p*-value[†]
	Median	IQR	Median	IQR	Median	IQR	
Work index	3.2	(3.0–3.8)	3.0	(2.9–3.6)	3.2	(2.9–3.6)	0.54
Sports index	3.0	(1.0–3.6)	2.8	(1.6–3.3)	2.8	(2.5–3.4)	0.45
Leisure time index	3.2	(3.0–3.3)	3.0	(2.8–3.5)	3.3	(3.0–3.8)	0.25
Total PA	9.4	(5.1–10.5)	8.5	(7.8–9.4)	9.4	(8.7–10.4)	0.28

[†] *p*-value based on Friedman's two-way ANOVA. *Abbreviations*: PA = physical activity; PD = post-discharge.

Appendix D – Health-related quality of life

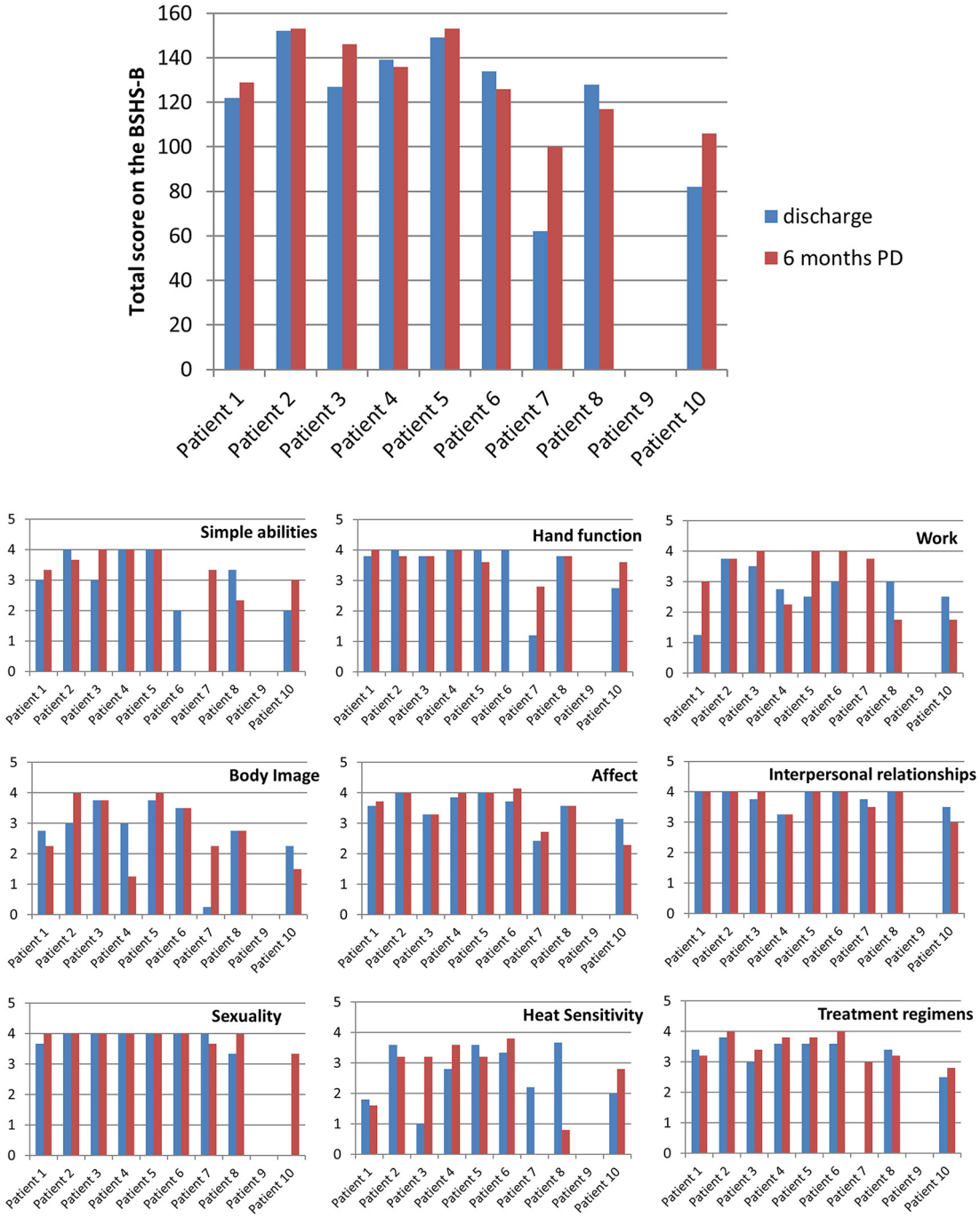

Fig. D1. Health-related quality of life [a] Figure showing individual total and domain scores on the Burn-Specific Health Scale-Brief at discharge from the burn centre and six months later. [a] Health-related quality of life was assessed using the Burn-Specific Health Scale-brief (BSHS-B) (19) at discharge and six months after discharge. Higher scores reflect better perceived health-related quality of life, with a maximum sum score of 160. *Abbreviations:* HRQOL = health-related quality of life; PD = post-discharge.

Table D1
Health-related quality of life [a] Table showing outcomes of the Burn-Specific Health Scale-Brief in the aquatic exercise therapy group (n = 10) [a] Health-related quality of life was assessed using the Burn-Specific Health Scale-brief (BSHS-B) (19) at discharge and six months after discharge. Higher scores reflect better perceived health-related quality of life, with a maximum sum score of 160.

	Discharge		**6 months PD**		***p*-value**[†]
	Median	IQR	Median	IQR	
Simple functional abilities	3.0	(2.0–4.0)	3.3	(2.7–4.0)	0.67
Hand function	3.8	(3.3–4.0)	3.8	(3.2–3.9)	0.99
Work	2.8	(1.9–3.3)	3.8	(2.1–4.0)	0.23
Body image	3.0	(2.6–3.7)	2.8	(1.9–3.9)	0.92
Affect	3.6	(3.2–4.0)	3.7	(3.0–4.0)	0.50
Interpersonal relationships	4.0	(3.7–4.0)	4.0	(3.4–4.0)	0.29
Sexuality	4.0	(3.8–4.0)	4.0	(3.9–4.0)	0.41
Heat sensitivity	2.8	(1.9–3.6)	3.2	(1.2–3.4)	0.99
Treatment regimens	3.4	(2.8–3.6)	3.4	(3.1–3.9)	0.05*
Total HRQOL	128	(102–144)	129	(112–150)	0.26

[†] *p*-value based on Wilcoxon signed rank test. *Abbreviations:* HRQOL = health-related quality of life; PD = post-discharge.

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