

## Title

Land- versus water-based exercise following TKR

## Abstract

There are no evidence-based guidelines to inform the optimal models of physiotherapy rehabilitation following total knee replacement (TKR), yet over 25,000 procedures are performed annually in Australia. Consequently, the mode, duration, performance indicators, and the associated costs of rehabilitation, vary between service providers. Institutional factors such as access to other services partly explain the variance. Water-based rehabilitation is offered at this Institution as a community pool is readily accessible, however, it is not known whether a water-based programme offers any advantage over a land-based alternative. This randomised trial compared the effectiveness of a land and a water-based programme in the first 8 weeks following TKR. Both programmes yielded equivalent improvements in all outcomes at 8 and 26 weeks post-surgery, and patient costs associated with service access and therapist costs were comparable for both models. In this context, either programme is a smart model of care. Wider a field, our results inform clinical redesign initiatives as health institutions providing onsite hydrotherapy would need to provide evidence of superior outcomes associated with this service in order to justify the high maintenance and opportunity costs.

## Aim

To determine whether land- or water-based rehabilitation is the more effective mode of delivery following primary total knee replacement (TKR) in the sub-acute period.

## Nature of the problem

Consequent to the large volume of TKR surgery performed at Fairfield Hospital (> 240/year) and limited staff resources, rehabilitation following surgery is necessarily provided on a class basis. Water- and land-based programmes are offered as a gymnasium is onsite, a community pool is within 1km, and consumers and clinicians alike express preferences for both these options. To date, no research has been undertaken to establish which option is the most effective and sustainable programme choice.

## Extent of the problem

Physiotherapy rehabilitation following TKR varies considerably between providers (Naylor et al 2006, Roos 2003). A systematic review of the literature revealed a lack of research identifying the optimal treatment strategies (Naylor et al 2007). The latter, together with differences in staff resources and access to supplementary services, contribute to the variance (Naylor et al 2006). Facilities accessing domiciliary services, hydrotherapy pools, or spacious

well-equipped gymnasiums, offer different services to those without such access. Well-staffed out-patient departments may offer 1:1 treatments, whilst those experiencing chronic staff shortages may rely on the more efficient group-based services (Fransen et al 2001).

### Strategic importance

A lack of evidence for, and variance in, the rehabilitation offered render the true value and costs of rehabilitation difficult to gauge. This is problematic for all stakeholders. For consumers, rehabilitation is potentially as much a function of location as much as what may be appropriate. For clinicians, variation in service provision (and the associated evaluation strategies) renders meaningful benchmarking between providers impractical. For policymakers, the costs of providing ongoing rehabilitation services are difficult to justify without evidence of effect. As the demand for TKR continues to increase as a consequence of both an ageing population and the treatment of choice for recalcitrant arthritis (AOA 2006), analyses concerning the sustainability of surgery must include review of the value and costs of ongoing rehabilitation post TKR, focusing preferably on class-based service delivery. A trial investigating the effectiveness and costs associated with TKR rehabilitation contributes towards “greater rigour...stronger accountability and a solid evidence base” (State Health Plan 2007) for future healthcare delivery in this area, thus, supports strategies intended to ensure “smart choices” in healthcare delivery and clinical redesign.

### Planning and implementing solutions

Outcomes following TKR are affected by many factors. Thus, a robust research design was required to evaluate the value of the two rehabilitation paradigms without contamination from confounders such as changes in surgical approach, inpatient clinical protocols, and patient demographic and health profiles across time. A single-blind randomised trial was subsequently developed to compare outcomes in TKR patients receiving either a water- or land-based programme. The programme parameters (class frequency, duration, size, content, and overall programme duration) were a compromise between what was necessary to induce meaningful physiological adaptation, and what was considered to be practicable for future widespread adoption. The definitive programmes (Table 1), therefore, were informed by both traditional exercise prescription guidelines for elderly patients (Feigenbaum & Pollock 1999) and knowledge of current practice in Australian hospitals (Naylor et al 2006).

Consenting patients attending the follow-up clinic 2 weeks post-surgery were randomised to a water or land group. Outcome measures included a six-minute walk test, the Western Ontario and McMaster Universities (WOMAC) osteoarthritis index, a visual analogue scale for operated joint pain, and knee range of motion. Measurements were taken at 2 (baseline), 8 (programme completion) and 26 weeks post-surgery.

Table 1. Programme profiles

Hydrotherapy	
Programme parameters	
Class duration	60 mins
Class frequency	x2 per week
Programme duration	6 weeks
Exercise prescription	
Exercise type	Aerobic, flexibility, mobility, resistance
Specific exercises	Walking, jogging, side-stepping, squats, cycling, upper limb aerobic exercises, kicking, balance and stretching exercises.
Exercise intensity / duration	Self-selecting intensity. Number of repetitions and / or time -dependent duration for each exercise.
Land	
Programme parameters	
Class duration	60 mins
Class frequency	x2 per week
Programme duration	6 weeks
Exercise prescription	
Exercise type	Aerobic, flexibility, mobility, resistance
Specific exercises	Stationary cycling, Stepper, Stair climbing, squats, treadmill, balance and stretching exercises.

Intention-to-treat analysis was applied. Orthogonal contrasts were employed to analyse the effects of time and group on each outcome variable. A sample size of 50/group provided an 80% chance ( $\alpha = 0.05$ ,  $\beta 0.2$ ) of detecting a 20% difference in walk distance if it existed. Crude cost and efficiency indicators were also estimated, including patients' access costs (hospital car parking or pool admission), and therapist hours.

### Outcomes and Evaluation

Patient characteristics are summarised in Table 2. Programme compliance was similarly impressive in both groups with 83% of patients attending 8 or more sessions (mean 9.3, sd 2.3). Loss to follow-up was 5%.

Patients in both programmes demonstrated significant, but equivalent mean improvements in all outcomes at all measurement periods (Figures 1-4). Obesity (body mass index > 30) and low compliance (attendance at < 8 sessions) were independent predictors of recovery of measured mobility.

Table 2. Patient characteristics

	Land, <i>n</i> = 49	Water, <i>n</i> = 53
Demographic and health profiles		
Age yrs, mean (sd)	67.8 (6.3)	68.7 (9.1)
Female, % (n)	57 (28)	57 (30)
Body mass index, mean (sd)	30.4 (4.9)	31.8 (5.8)
Index > 30, % (n)	48 (23)	55 (29)
Co-morbidities, % (n)		
Hypertension	73 (36)	62 (32)
Osteoarthritis other knee	55 (27)	66 (35)
Diabetes (type 1 or 2)	24 (12)	27 (14)
Cardiac	22 (11)	17 (9)
Respiratory	16 (8)	17 (9)
Gastro-intestinal	8 (4)	19 (10)
3 or more co-morbidities	14 (7)	13 (7)
Surgical profile, % (n)		
Cement fixation	82 (40)	75 (40)
Patella resurfacing	60 (29)	69 (36)

No significant differences between the groups were observed.

Patient access costs and therapist time were comparable for both groups. The expected time efficiencies associated with the on-site gym programme were offset by the logistics of gym circuit set-up.

In evaluating both programmes overall, as the cost of maintaining the pool is not borne by the health institution here, a water-based programme is an equally viable option for both consumers and the health service. However, health institutions providing onsite hydrotherapy would need to provide evidence of superior outcomes associated with this service in order to justify the reported high maintenance and opportunity costs.

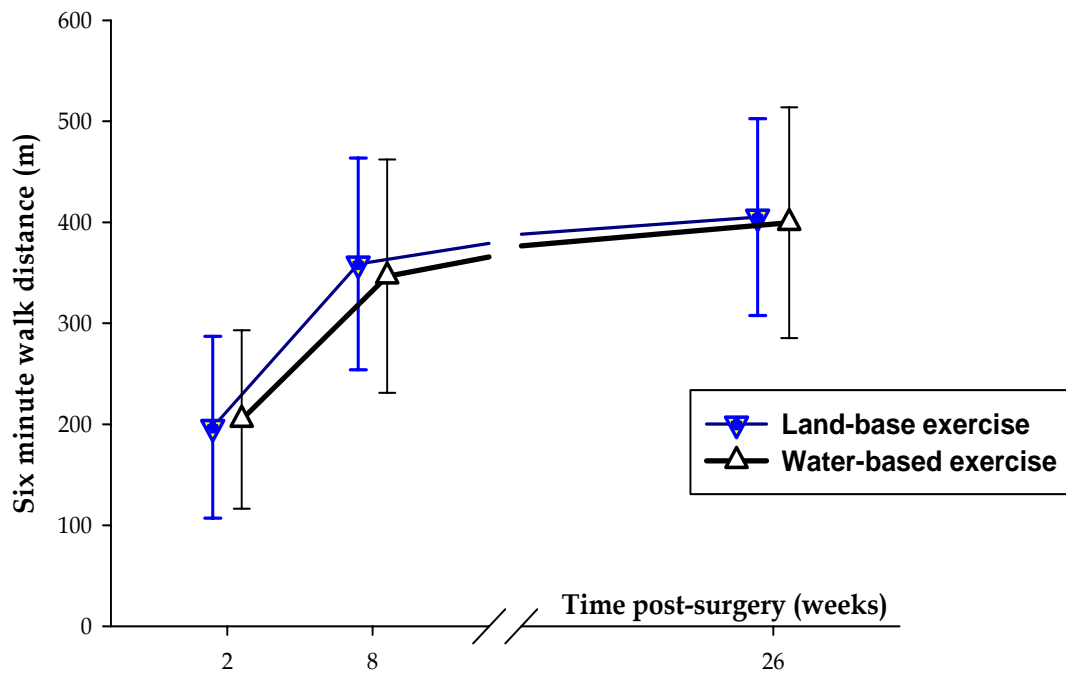


Figure 1. Six- Minute Walk Test  
 Significant differences ( $p < 0.001$ ) were observed between 2 and 8 weeks, and 8 and 26 weeks. No significant between-group differences observed. Obesity (BMI  $> 30$ ) and low compliance ( $< 8$  sessions) were independent predictors of recovery in walk distance (not shown).

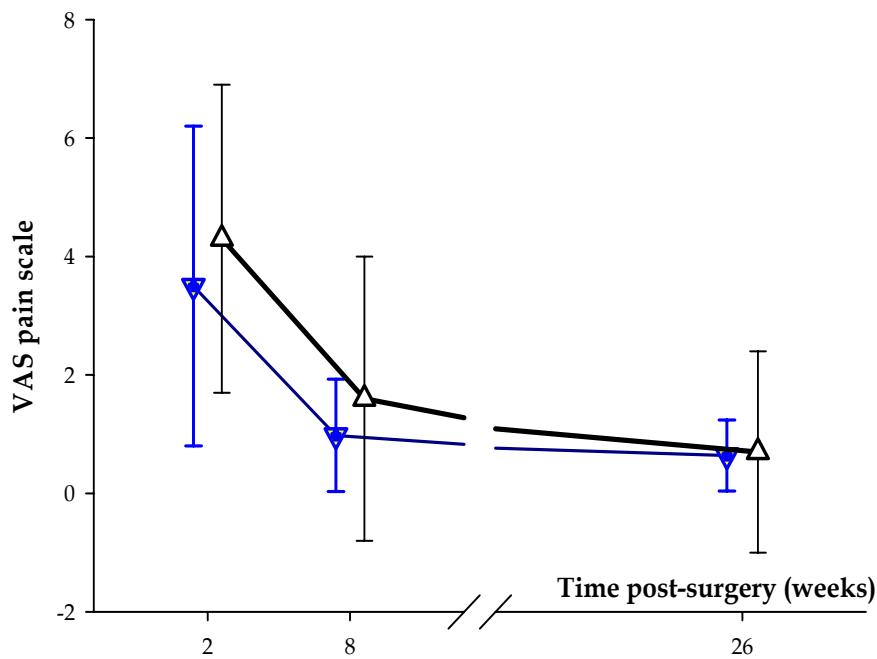


Figure 2. Visual analogue scale for Pain.  
 Significant difference ( $p < 0.001$ ) between 2 and 8 weeks; no significant between-group differences observed.

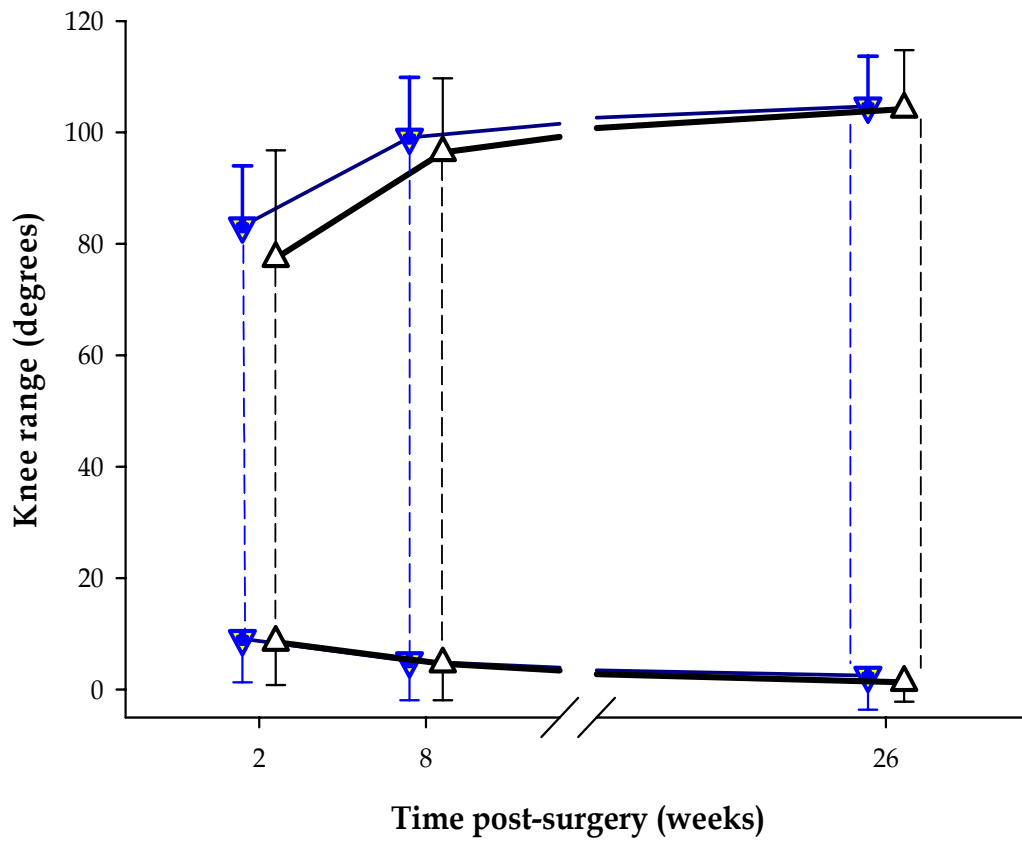
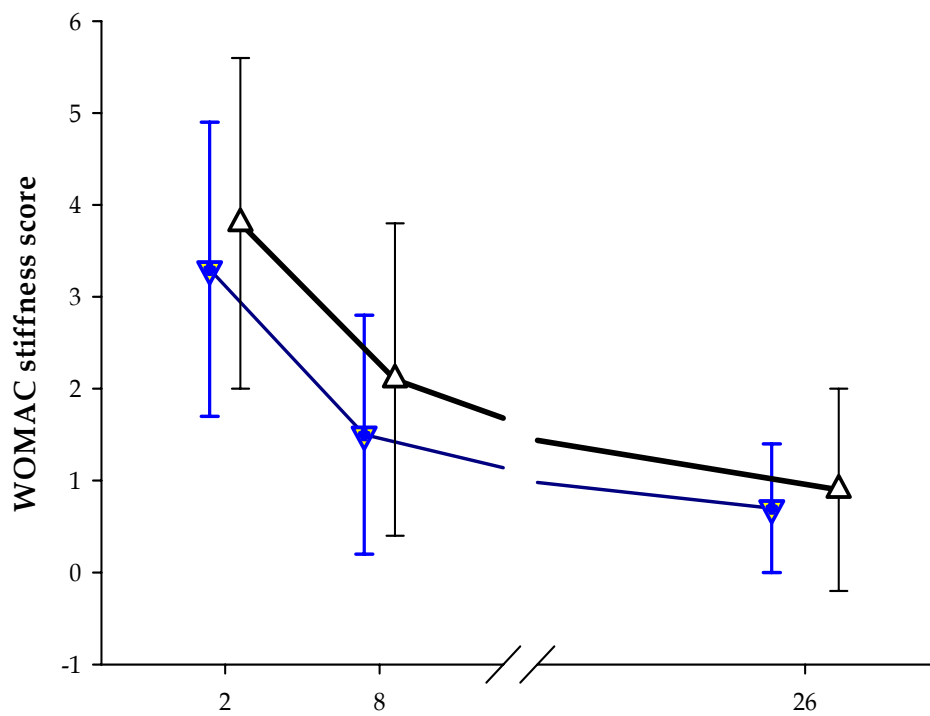
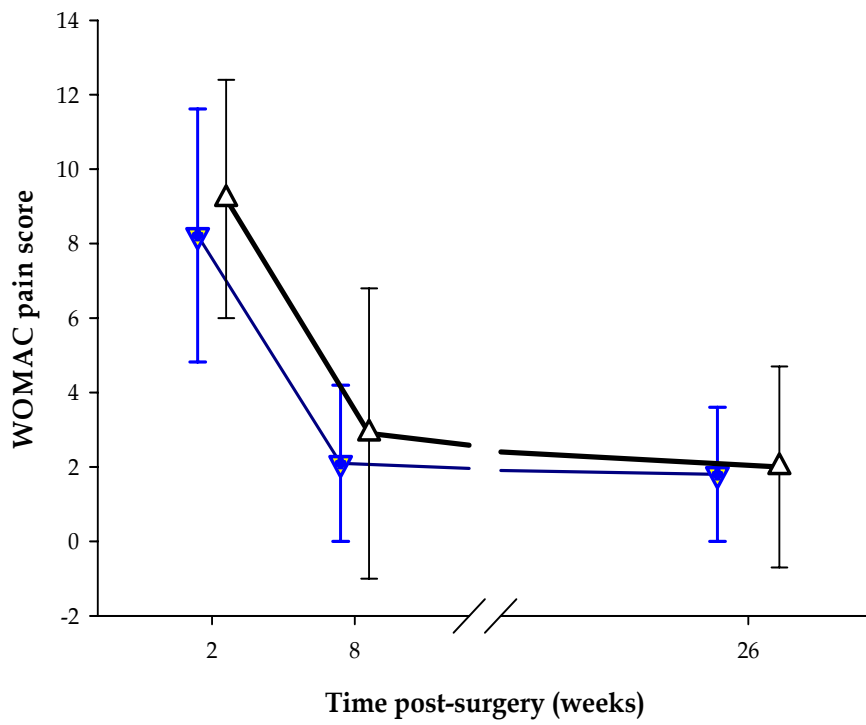
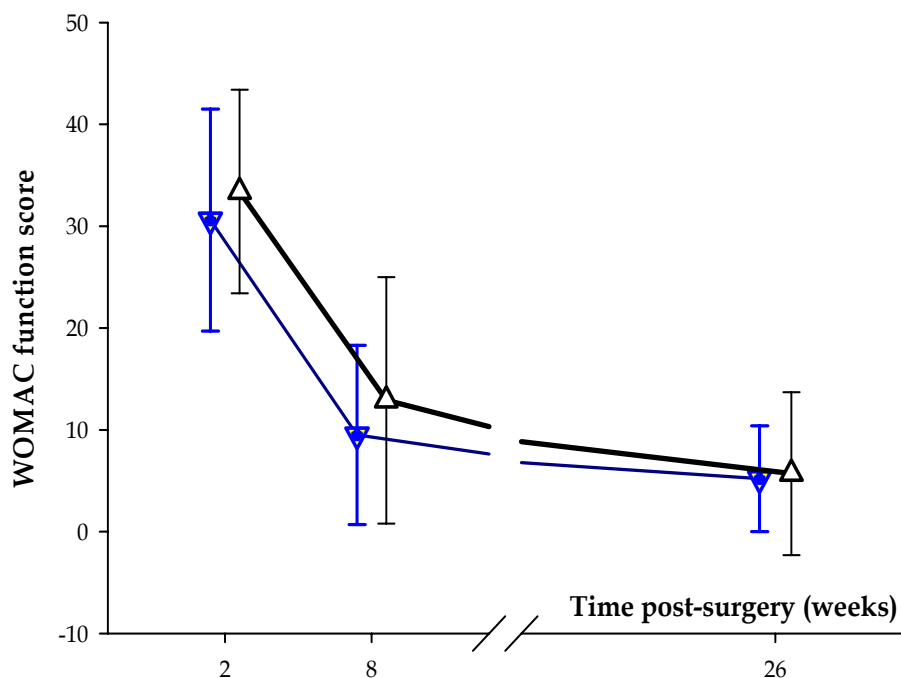


Figure 3. Knee flexion and extension range. Flexion = upper values; Extension = lower values; Significant differences ( $p < 0.001$ ) observed between 2 and 8 weeks, and 8 and 26 weeks. High compliance was associated with better recovery of flexion range ( $p = 0.02$ ) (not shown).





Figures 4a, b and c. WOMAC Pain, Stiffness and Function  
 Significant differences ( $p < 0.001$ ) observed between 2 and 8 weeks, and 8 and 26 weeks. No significant between-group differences were observed.

### Sustaining change

Given both programmes were associated with equivalent outcomes, and had similarly impressive compliance levels and low drop-out rates, high sustainability in offering both programmes was anticipated. Both continue to be offered on a weekly basis and remain supported at an executive level. Results of the study have informed pre-operative education strategies and subsequent research protocols, particularly in relation to the impact of patient compliance and obesity on outcomes.

### Future scope

Both programmes are realistic in content and frequency, thus, should be acceptable to clinicians, patients and carers. The outcome measures are well recognized, simple in their execution, and clinically relevant, thus, potentially are the bases for future key performance indicators. The study significantly and uniquely contributes to the evidence-base in this clinical field in view of its robust design. Consequently, these results can be generalised to other TKR populations as patients were not excluded based on surgeon, prosthesis type, or co-morbidity. Finally, the study has important implications for health facilities providing hydrotherapy services onsite as the costs of providing such services cannot be justified without evidence of superior outcomes associated with this mode of service delivery.

## References

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