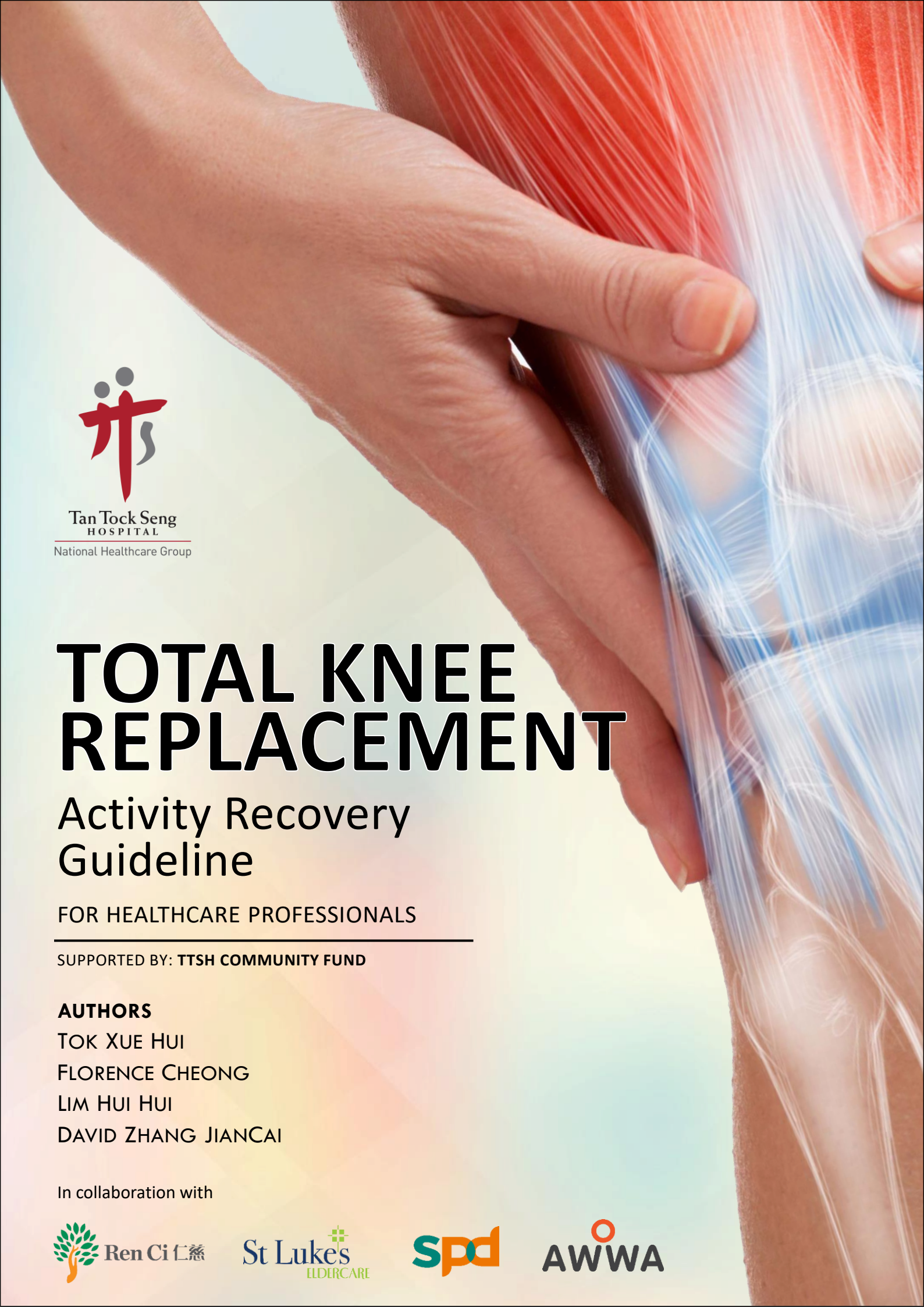

Tan Tock Seng HOSPITAL
National Healthcare Group

TOTAL KNEE REPLACEMENT

Activity Recovery Guideline

FOR HEALTHCARE PROFESSIONALS

SUPPORTED BY: **TTSH COMMUNITY FUND**

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In collaboration with

Ren Ci 仁慈 St Luke's ELDERCARE spd AWWA

PREFACE

Dear colleagues and healthcare partners,

I am honoured to introduce the Total Knee Replacement Activity Recovery Guidelines, a resource crafted to enhance the rehabilitation journey for our clients. As we are committed to adding years of healthy lives to our residents, this guideline reflects our dedication to optimising post-operative functional outcomes.

As we delve into this guideline, you will find evidence-based recommendations, tailored activities that client may resume or partake in at different recovery phases, and valuable insights to support both clients and healthcare professionals. Through the collaborative efforts of the post total knee replacement clients and healthcare partners, we aim to empower individuals on their path of recovery and improve their overall quality of life following total knee replacement.

I extend my gratitude to the healthcare professionals and clients involved in developing these guidelines. Together, we continue to pave the way for population health excellence in musculoskeletal care, ensuring that each step in the recovery process is a step toward a healthier, more active life.

Yours Sincerely,

Prof Eugene Fidelis Soh

Deputy GCEO (Population Health)

National Healthcare Group (NHG)

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Activity Recovery Guideline
FOR HEALTHCARE PROFESSIONALS

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All efforts have been made to acknowledge the sources of respective information. The publisher and authors welcome input from content originators where corrections are to be made to accurately reflect the sources.

CONTENTS

OBJECTIVES

This activity recommendation guideline is developed by a group of occupational therapists interested in helping the clients return to activities after total knee replacement (TKR). This guideline provides recommendations on gradual return to activities at various phases of the recovery and rehabilitation journey up to one year post TKR. The recommendations is based on the average activity recovery timeline of TKR clients. The information provided by this guideline can be used for realistic goal setting, treatment planning and interaction with TKR clients or candidates. This information can also serve as a guide or part of pre-surgical education content.

Most activities in this guideline are identified by TKR clients as meaningful activities that they want to spend time on after their TKR.

The activity guideline is **NOT** designed to:

a. Appraise the individual TKR client's recovery journey.

b. Encourage activities that the TKR client has no prior experience with.

c. Encourage high impact sports activities.

d. Be used by clients without a healthcare professional's evaluation and advice.

Who is it for?

Healthcare professionals who work with TKR clients. No special training is required to use this guideline.

This guideline does not override the judgement and responsibility of healthcare providers to make appropriate decisions, considering the doctor's advice and TKR clients' medical conditions, individual needs, preferences, values and response to rehabilitation.

Definitions

Activity/activities in the guideline refer to routine and non-routine activities or occupations that the TKR clients want to spend their time participating in. These activities are purposeful and meaningful to the clients. Examples of activities include activities of daily living (ADL), instrumental activities of daily living (IADL), leisure, sports, social activities and paid/unpaid occupations.

Considerations

This guideline is intended for TKR population between 50 and 75 years old (Appendix 1, page 77). The contents in the Return-To-Work section (pages 54 to 64) is targeted for clients 64 years old or younger as there is a lack of recent work-related studies or recommendations for TKR clients > 65 years old.

The ability of TKR clients to return to and achieve a certain level of activity (e.g. squatting to perform gardening or brisk walking) after surgery depends on factors such as:

- Physiological recovery and tissue healing timeline
- Complications from surgery
- Co-morbidities such as musculoskeletal disorders and osteoarthritis in other limbs
- Pre-surgical level of activity
- Presence of pre-surgical pain catastrophising
- Pre-surgical mental health
- Motivation to recover
- Physical and cognitive functions to perform activities

Activity modification is expected at the initial stage of recovery after TKR. Activity modification should be weaned off gradually during the later stages of recovery with the advice from healthcare professionals. Joint protection principles are applicable from pre- to post-surgery stages.

BACKGROUND AND METHODOLOGY

In Singapore, the number of residents over 64 years old undergoing TKR surgery has increased 2.7 times from 187 per 100,000 in 1999 to 499 per 100,000 in 2019 (Ministry of Health [MOH], 2020). TKR is expected to relieve pain, improve mobility and improve ability to participate in physical activities and paid employment (Ding and Sathappan, 2018). Maintaining participation in meaningful activities has a positive impact on the individual's health and well-being. For example, a retired individual values gardening as a medium of interaction with her neighbours and time meaningfully spent. The acute restrictions from TKR surgery should not be deterring her from participating in gardening at early stage of recovery.

Activity participation and recovery after TKR is influenced by client factors and education by healthcare professionals. Limited or inconsistent advice from healthcare professionals may create barriers to clients' return to activities. This guideline is developed to guide healthcare professionals to help clients return to activities and employment post TKR, thus standardising practices across different healthcare settings and improving the effectiveness of delivering rehabilitation services to clients after TKR.

The TKR clients' perspectives on what is important served as vital information when developing this guideline.

The workgroup interviewed 15 clients (mean age 67.3 ± 6.6) who underwent TKR and were at different phases of their recovery (2 weeks post-TKR, 4 weeks post-TKR and 12-weeks post-TKR) to understand enablers and challenges of activity recovery after their surgery, and what activities are important to them.

After hearing from clients, the workgroup next interviewed 19 experienced healthcare professionals (nurses, occupational therapists and physiotherapist) who have worked with TKR clients to understand their perspectives on what this guideline should include. Other potential meaningful activities that this group of clients would like to spend on are also identified in the interview.

Further searches on recent articles were conducted by the workgroup in May to June 2023. Online databases of CINAHL, OVID, PubMed and Medline and web search engine Google Scholar were used. Search terms and exclusion criteria are found in Appendix 1 (page 77).

After literature review, the workgroup performed a consensus exercise with the nurses, occupational therapists and physiotherapists. The result of consensus on activity recovery can be found at the end of each activity section (page 25, 28, 31, 34, 39, 42, 45, 49, 52, 61 and 62).

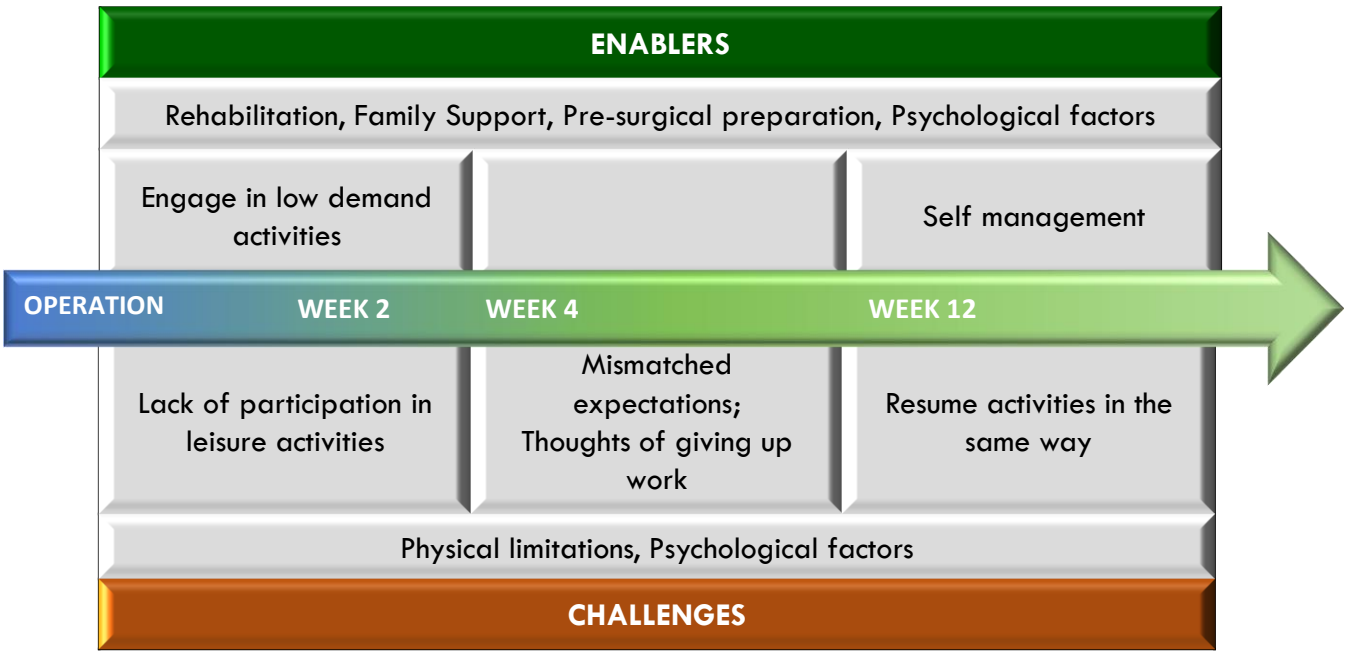
Figure 1
Methodology of TKR-ARG formation

TKR CLIENTS' EXPERIENCE WITH ACTIVITY RECOVERY AFTER SURGERY

ENABLERS BASED ON TIMELINE GROUP

The interview found that family support, psychological factors, rehabilitation and pre-surgical preparation are enablers of activity recovery of TKR participants at all time points after the surgery. Participants two weeks post-surgery engaged in low demand activities. Participants three months post-surgery opined that self-management strategies enabled activity participation.

Figure 2
Summary of enablers and challenges faced by TKR clients



CHALLENGES BASED ON TIMELINE GROUP

Participants at three different time points of recovery reported physical limitations and psychological factors as challenges to their activity recovery. Participants at two weeks post-surgery felt that they are unable to participate in leisure activities at this time. TKR participants at four weeks wanted to give up their work and felt a mismatch of expectations for activity recovery. Participants at three months post-surgery thought that it was challenging to resume activities in the same way as pre-surgery.

SEVEN IMPORTANT ACTIVITIES IDENTIFIED BY TKR PARTICIPANTS (n=15)

Each participant selected 5 most important activities using the Activity Card Sort Singapore Version (ACS-SG) during the interviews. The workgroup ranked and focused on the 7 most chosen activities by the 15 participants. These activities will be discussed in the next chapter: Activity Recommendation after Total Knee Replacement.

Figure 3
7 most important activities identified by TKR clients

Photos and illustration by TTSH Photo Library,
Tok Xue Hui, Diana Tay Gek Sian and Danielle Cheong

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ACTIVITY RECOMMENDATIONS AFTER TOTAL KNEE REPLACEMENT

GENERAL ADVICE

TKR clients are encouraged to apply **activity modification** and **energy conservation** strategies at the early acute stage of recovery when pain and edema management are the main goals. They should gradually return to usual way of performing activities at subacute and later stages of recovery with the advice from healthcare professionals. Joint protection is useful at different stages of TKR journey, including pre-surgical stage, especially if the TKR client experienced contralateral knee pain.

Implant wear rate can be contributed by material properties, surgical techniques or client factors such as activity levels and weight. TKR implants typically last for 10-15 years. There is a need to prolong the implant's life span and minimise surgical revisions, while advocating activity participation for healthier lifestyle or employment.

TKR surgical wounds typically heal within two weeks post-surgery. The surgeon will decide to use cemented or cement-less fixation for a TKR after considering the client's comorbidities. As the cementless implants rely on the ingrowth of porous bone for stability, progressive strengthening usually starts at weeks 4 to 6, depending on the clients' comorbidities, physical functions and recovery.

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RETURN TO DAILY ACTIVITIES

Daily activities refer to the basic activities of daily living (BADL) and instrumental activities of daily living (IADL). There is lack of recent studies on the TKR clients' return to performing BADL and IADL at different timelines.

One recent study by Dubljanin Raspopović et al. (2021) reported that TKR clients can achieve **Barthel Index score** of 67.7 ± 19.5 (on demand pain control group) to 82.2 ± 12.7 (scheduled pain control group) on post-surgery day 5. This result may imply that TKR clients with better pain control are more likely to be able to live in the community independently in the early post-surgery period, while clients with poorer pain control will need some support from the community services such as medical escort service if they live alone.

At one month post TKR, being able to **ascend stairs** is associated with ability to balance and strong thigh muscle strength of both surgical and non-surgical lower limbs. The ability to **descend stairs** is influenced by pre-surgical stair descending ability and age (Lee et al., 2020).

The next section discusses the resumption of sexual activity, walking, shopping for groceries, cooking and household maintenance.

Resuming Sexual Activity

The most common impact on sexual activity during pre-surgery phase were pain, decreased knee motion or flexibility, inability to kneel or assume positions that placed weight on the knee, so clients avoid kneeling or placing weight on the knee during sex (Kazarian et al., 2017).

Although TKR does not fully resolve knee-related positional limitations during sexual activity (Kazarian et al., 2017; Harmsen et al., 2020), TKR significantly decreases kneeling dysfunction and enables clients more freedom in choosing different sexual positions (Kazarian et al.,2017). After TKR, activities such as touching, holding hands and caressing can be resumed immediately (James, 2014).

On average, TKR clients took 2.4 months (range of 0-18 months) to resume sexual activity after surgery (Kazarian et al., 2017). Frequency of sexual activity in the early post-surgical recovery phase is likely to decrease as some clients may experience knee instability (Kazarian & Chen, 2017). It is also crucial to avoid kneeling on wounds which have not healed.

Most clients reported gradual improvement in their ability to participate in sexual activities in the first year after the surgery due to lesser knee pain and greater mobility/ range of motion (ROM). However, there is still a need, although lesser compared to pre-surgery, to adjust sexual positions to accommodate their knee or avoid bearing weight on the operated knee during sex (Kazarian et al., 2017) such as kneeling. TKR clients can choose sexual positions that reduce knee discomfort such as laying on their back below their sexual partner, laying on their non-operated side or standing. Generally, clients will be able to resume sexual activities if they are comfortable after surgery.

The client and partner may need to plan ahead for sexual activity. It is important to maintain joint precautions for the first 3 months. As the client may have less energy right after surgery, plan ahead to pace activities and make time for sexual activity when the client is less tired. To minimise pain, try positions where the partner takes the more active role initially.

RECOMMENDATIONS FOR **SEXUAL ACTIVITY**

2.4 MONTHS	On average, TKR clients took 2.4 months (range of 0-18 months) to resume sexual activity after surgery (Kazarian et al., 2017).
1 YEAR	Most clients reported gradual improvement in their ability to participate in sexual activities.
SAFE POSITIONS	When ready, try positions where knee is supported, kept fairly straight or bends only a little. 
UNSAFE POSITIONS	Avoid positions during sex where knee is bending a lot or where there is a lot of pressure on the knee. 

Note. These recommendations are made based on the literature review.
Illustrations by Florence Cheong

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WALKING

Walking is a light intensity physical activity and a means of getting around. Walking can be objectively measured using accelerometers (activity watches) or pedometers (step-counters).

Most TKR clients can achieve their pre-surgery walking distance and step count by 4 weeks post-surgery (Christensen et al., 2023).

Taniguchi et al. (2016) suggested that approximately 3000 steps per day is a realistic and appropriate goal for TKR clients during the first 6 months after surgery.

While the benefits of greater number of daily steps was significantly associated with lower all-cause mortality (Saint-Maurice et al., 2020) and lower fall risk in TKR clients (Taniguchi et al., 2021), the workgroup recommends to start slow with walking then gradually progress within capability. For instance, clients living in HDB flats may first begin walking at the corridor, then progress to walking more at the void deck, then walking on even surfaces, then uneven walking surfaces in the community before finally progressing to walking to neighbourhood amenities.

Post-TKR walking distance is associated with strength of the surgical knee, provided that a minimum of 67 degrees of knee flexion is achieved. The presence of knee fixed flexion deformity and symptomatic non-surgical knee osteoarthritis (OA) may affect walking distance. There is a limit to compensation provided by non-surgical knee over longer walking distance (Choi et al., 2021).

It is important to consider the following when healthcare professionals work with TKR clients on walking goals:

1. Minimum walking speed of 0.71m/s to 0.80 m/s to negotiate traffic lights safely (Wee et al., 2023).

2. The average walking distance from a Singapore public housing block to amenities ranged from 237.3 metres to 350.1 metres (Wee et al., 2023).

3. The ability of clients to negotiate obstacles such as steps and slopes as there is an average of 10 obstacles e.g. curbs, stairs, slopes, covered/open drains, and traffic lights, along each route (Wee et al., 2023).

4. Use of step count, distance or time when giving advice on walking.

5. Discussion on self-management strategies with TKR clients. It is normal to experience swelling or mild aching pain after walking. Some management strategies are elevating the operated leg, applying ice packs on the operated leg after walking or performing ankle pumps to alleviate swelling. Common warning signs to downgrade walking distance are increasing swelling and pain.

RECOMMENDATIONS FOR **WALKING**

2 TO 4 WEEKS	Most clients will be able to walk with or without aid approximately total of 2km* or 2500 steps* per day. They may require short seated breaks or use pain management strategies, when necessary.
6 TO 8 WEEKS	Most clients will be able to walk with or without aid approximately total of 3km* or about 3500 steps* per day. They may apply pacing strategies when necessary.
3 MONTHS	Most clients will be able to walk without aid approximately 4 km* or about 5000 steps* per day.
6 MONTHS ONWARDS	Most clients will be able to walk independently as tolerated.

Note. No known studies evaluated the number of steps needed by an older adult to walk one kilometre at a regular pace. For conversion between number of steps and distance of walking, the workgroup refers to The American College of Sports Medicine (ACSM) Health & Fitness Journal, which suggested a person at the average age of 27 years old with average height of 1.7 metres and average weight of 71 kilograms takes around 1408 steps to complete one kilometre when walking at a regular pace (12 minutes per kilometre) (Hoeger et al., 2008).

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GROCERY SHOPPING

American Occupational Therapy Association (AOTA)(2020) describes the subtasks of shopping as preparing shopping lists; selecting, purchasing, and transporting items; selecting method of payment and completing payment transactions; managing internet shopping and related use of electronic devices such as computers, cell phones, and tablets. Transporting of items and selecting items in-store are more likely to be affected by TKR. Some hospital guidelines suggest to avoid heavy lifting or avoid knee twisting or jarring for the first 6 to 12 weeks after surgery. The allowable weight that TKR clients can lift cannot be found in literature, however this can be adjusted according to the comfort of the clients.

Factors such as premorbid abilities, physiological recovery (i.e., bone and soft tissue healing), subjective and objective recovery (e.g., quadriceps strength, perceived stress on knee), and types of walking aids used by clients should be considered when advising on grocery shopping.

Some examples of practical modifications for grocery shopping are:

- Using shopping trolley to transport heavy, and bulky groceries instead of carrying in hands.
- Using backpack for light items.
- Taking frequent seated rest breaks when necessary.
- Applying pain management and pacing strategies when necessary.
- Matching quantities to own ability.

RECOMMENDATIONS FOR **GROCERY SHOPPING**

2 TO 4 WEEKS	Most clients will be able to walk independently for approximately 1km while carrying up to 2kg of groceries/load.
6 TO 8 WEEKS	Most clients will be able to walk independently for 2 km while carrying approximately 2kg of groceries/load.
3 MONTHS	Most clients will be able to walk approximately 3km independently while carrying approximately 2kg of groceries/load.
6 MONTHS ONWARDS	Most clients will be able to walk independently while carrying groceries as tolerated.

Figure 4

Example weight carried by client when buying daily items

Packed meal 398g | 500ml water 521g | Loaf of bread (Jumbo) 653g | Walking aid 951g

Photos by Tok Xue Hui

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HOUSEHOLD COOKING

Cooking or meal preparation requires planning, preparing, serving, cleaning up and washing crockery after meals (AOTA, 2020). Maintaining participation in cooking is an important activity valued by homemakers. Some TKR clients may want to prepare meals for themselves when they are capable of homebound ambulation.

Healthcare professionals shoulder consider the following when working on cooking related goals:

1. The TKR client's standing tolerance and standing balance for cooking task.
2. The TKR client's ability to transport cooking equipment/materials, with or without use of walking aid.
3. Activity gradation such as cooking for individual versus cooking for a family of four.
4. Environmental modifications such as placing necessary cooking equipment/materials within reach in the kitchen.
5. Use of pain management strategies, when necessary.
6. Education on activity modification techniques such as short seated breaks, preparing cooking ingredients in sitting, use of high chair, walker tray or caddy, use of microwave oven whenever possible.

Illustration by Danielle Cheong

RECOMMENDATIONS FOR **HOUSEHOLD COOKING**

2 TO 4 WEEKS	Most clients will be able to prepare ingredients and cook independently in standing for approximately 10 minutes, with or without aid.
6 TO 8 WEEKS	Most clients will be able to prepare ingredients and use the stove / oven / microwave to cook independently in standing for approximately 30 minutes, with or without aid.
3 MONTHS	Most clients will be able to prepare ingredients and use the stove / oven / microwave to cook independently in standing for approximately 60 minutes without aid.
6 MONTHS ONWARDS	Most clients will be able to complete the meal preparation independently in standing as tolerated.

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HOUSEHOLD MAINTENANCE

Household maintenance tasks include upkeeping personal and household possessions and environments (e.g., home, yard, garden, houseplants, appliances, vehicles), including maintaining and repair of items (e.g., clothing, household items) and knowing how to seek help or whom to contact (AOTA, 2020). A study by Barker et al. (2018) found that TKR clients took an average of 22 days (range 2.5 – 90) to return to household maintenance activities, which is earlier than their pre-surgical expectations of 43 days.

Generally, TKR clients are encouraged to ask for help when first resuming the household maintenance activities.

Climbing ladders is not recommended in the first 4 weeks post-TKR surgery. Examples of knee-straining heavy housework are mopping floors, cleaning bathrooms or toilets, vacuuming and cleaning windows, should be avoided in the first 4 weeks post-surgery.

RECOMMENDATIONS FOR **HOUSEHOLD MAINTENANCE**

2 TO 4 WEEKS	Most clients will be able to perform light household chores such as folding clothes, using washing machine, washing dishes.
6 TO 8 WEEKS	Most clients will be able to perform household chores such as laundry, vacuuming, cleaning, dusting and making the bed with assistance if required.
3 MONTHS ONWARDS	Most clients will be able to increase participation in heavier household tasks such as cleaning toilets, hand laundry, and washing cars.

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RETURN TO LEISURE & SOCIAL ACTIVITIES

This chapter will discuss religious activities, travelling and gardening.

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Illustration by Danielle Cheong

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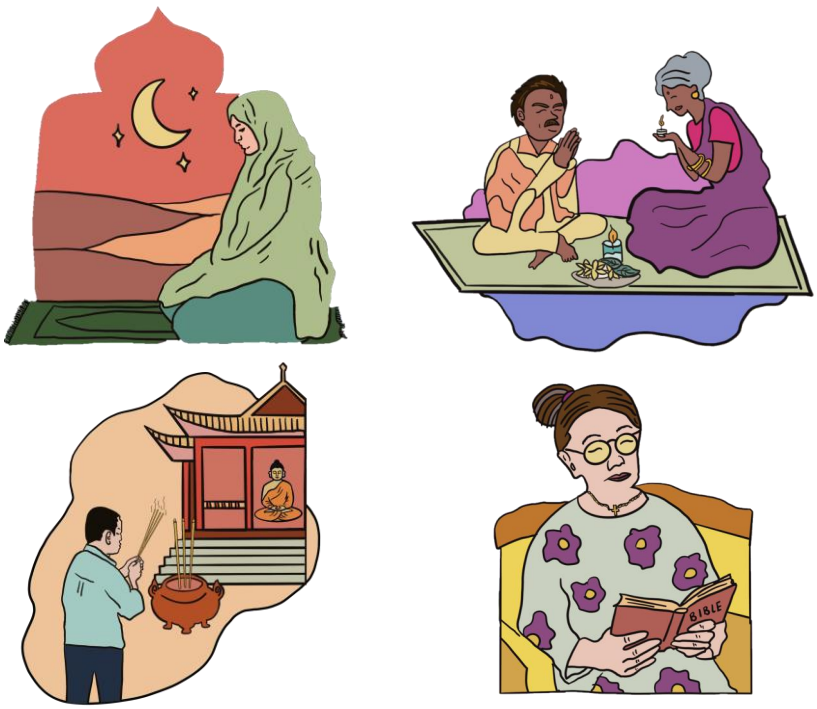
RELIGIOUS ACTIVITIES

AOTA (2020) describes religious activities as engaging in religious or spiritual activities, organisations, and practices for self-fulfillment; finding meaning or religious or spiritual value; establishing connection with a divine power, such as is involved in attending a church, temple, mosque, or synagogue; praying or chanting for a religious purpose; engaging in spiritual contemplation (World Health Organization,2008, as cited in AOTA, 2020); may also include giving back to others, contributing to society for a cause, and contributing to a greater purpose.

Common knee-demanding religious activities positions involves kneeling, sitting on calf, cross-legged sitting and prostrating can be difficult to perform despite very good knee flexion. Studies reported that most of the clients are able to kneel with minor or no difficulty between 3 months to 3.3 years (Wallace & Berger, 2019; Wilding et al., 2019; Barker et al., 2018). Wilding et al. (2019) also found that the reasons of clients unable to kneel after surgery are pain/discomfort, anxiety, unable to get up, stiff, told not to, other joint pain and other reasons. Wallace and Burger (2019) also designed a novel weekly kneeling protocol for their TKR client samples who are at least 18 months after surgery.



Illustrations by Danielle Cheong

Figure 5

Kneeling protocol

KNEELING PROTOCOL	
Week 1	Kneel 10 min a day on the couch.
Week 2	Kneel 10 min a day on a couch cushion on the floor.
Week 3	Kneel 10 min a day on a thin pillow on the floor or on thick carpet.
Week 4	Kneel 10 min a day on a thin carpet or rug.
Week 5	Kneel on the floor or on the ground outside.
Week 6	Healthcare professionals to check-in with client.

Note. Adapted from "Kneeling protocol," by S. J. S. Wallace, and R. A. Berger, 2019, *Journal of Arthroplasty, 34*(5).

Healthcare professionals should consider:

1. Knee flexion of 100 degrees or more increases the chance of being able to kneel comfortably. (Wilding et al., 2019).
2. TKR with patella resurfacing increases the likelihood of a client being able to kneel (Wilding et al., 2019).
3. Client factors such as contralateral lower limb ability, psychological factors, scar sensitivity, premorbid kneeling ability.
4. Client may gradually progress from kneeling on the sofa, cushion on floor, rug on the floor then usual ground.
5. Teaching TKR clients how to get up from kneeling position, sitting on the calf or in a cross-legged position.
6. Suggest using a cushion or kneeling pad as long-term solution if discomfort remains.
7. Sitting and standing as alternative positions to pray in.

RECOMMENDATIONS FOR **RELIGIOUS ACTIVITIES**

2 TO 4 WEEKS	Most clients will be able to participate in religious activities in seated position.
6 TO 8 WEEKS	Most clients will be able to participate in religious activities that may involve standing position.
3 MONTHS ONWARDS	Most clients will be able to participate in religious activities that may involve kneeling, crouching or cross-legged sitting position, according to their premorbid ability and kneeling clearance by surgeons.

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TRAVELLING (TAKING PUBLIC TRANSPORT, DRIVING AND AIR TRAVEL)

According to Oxford Languages, travelling is "the action or activity of going from one place to another, typically over a distance of some length".

This guideline addresses 3 types of travelling, namely taking public transportation, driving and air travel.

TAKING PUBLIC TRANSPORTATION

Singapore's public transportations are Mass Rapid Transit (MRT), public bus and Light Rapid Transit (LRT). According to Singapore's Land Transport Authority (LTA) (2013), 64% of households are within 10-minute walk of a train station, and 79% of public transport journeys under 20km can be completed within 60 minutes.

Healthcare professionals should:

- Assess and rehabilitate TKR clients' performance skills such as stabilising self in a moving transport, using escalator or travelator, boarding and alighting public transport safely and negotiating obstacles and distance in the community to use public transport such as bus stops, train stations and taxi stands (refer to the 'Walking' section at page 23).

- Educate activity modifications such as travelling during off-peak hours or being accompanied on the travel journey in case of situations requiring assistance.

- Suggest 'test-ride' with a caregiver before going out alone.

- Advise use of taxi or private hire car service, or use of wheelchair if necessary.

RECOMMENDATIONS FOR **TAKING PUBLIC TRANSPORT**

2 TO 4 WEEKS	Most clients will be able to board onto and alight from public transport with assistance.
6 TO 8 WEEKS	Most clients will be able to board onto and alight from public transport with supervision, with or without aid.
3 MONTHS	Most clients will be able to board onto and alight from public transport independently, with or without aid.
6 MONTHS ONWARDS	Most clients will be able to use public transport independently without aid as tolerated.

DRIVING

According to Singapore Medical Association [SMA] (2011),

- ✓ Right-sided lower limb total joint replacement (e.g. knee, hip) clients holding class 4, 5 and vocational licenses in Singapore need a minimum of 4 weeks before resuming driving in automatic transmission vehicles.
- ✓ Individuals on lower limb casts will require an additional 2 weeks after removal of splint/cast to allow adequate return of lower limb function.

Most studies use brake response time in a driving simulator to evaluate fitness to drive. However, this may not be practical in clinical practice as actual driving safety was not assessed. Advancement and modernisation of TKR surgery and postoperative management may reduce the timing of return to driving earlier than 4 weeks (Na et al., 2020), but more studies are required.

Additional time to return to driving after TKR is influenced by (Rondon et al., 2020; Na et al., 2020):

- Right-sided procedures
- Limitation due to pain
- Limitation due to ROM (healthy subject requires right knee ROM of 40°-80° and/or left knee ROM of 20°-85° while driving (Latz et al., 2019)
- Limited ability to brake
- Not feeling safe to drive
- Discharge to a rehabilitation facility
- Pre-surgical anaemia and pre-surgical use of a cane
- Other limitations (on pain medication, waiting for physician permission to return to driving, additional physical limitations, discouragement by family members, family members providing transportation, not mentally ready for driving, manual transmission vehicles, and vertigo symptoms)

Recommendations to return to driving must be individualised, carefully considering the client's pre-surgical driving ability, the extent of injury, the laterality of injury, the use of medications, and the type of vehicle transmission (manual or automatic) (Frane et al., 2020) to balance safety and quality of life.

Healthcare professionals can suggest the TKR clients to:

1. Hold off driving if client experiences significant pain and weakness on the operated knee, if the operated knee is required to depress any foot pedal (clutch, brake or accelerator).

2. Avoid driving when on medication that causes drowsiness.

3. Begin with and have a 'test drive' with an experienced driver before driving alone.

4. Consider driving duration and apply pacing techniques as required as some clients may experience joint stiffness with prolonged sitting.

5. For vocational drivers (e.g. taxi, minibus, omnibus drivers), check with employer if driving assessment report is needed for return-to-vocational driving. If needed, ask doctor for referral to Occupational Therapy driving assessment prior to resuming vocational driving.

6. Practice safe ways to enter and exit vehicles.

RECOMMENDATIONS FOR **DRIVING**

2 TO 4 WEEKS	At 4 weeks, most TKR clients will be able to depress the foot pedals with adequate strength and drive for personal convenience, depending on the type of vehicle transmission and laterality of limb involved. E.g., right-sided TKR clients will be able to return to drive automatic transmission vehicle by 4 weeks after TKR surgery, while left-sided TKR clients will be able to return to drive automatic transmission vehicle by 2 weeks, but manual transmission vehicle by 4 weeks.
6 TO 8 WEEKS ONWARDS	At 6 to 8 weeks, most TKR clients will be able to drive independently (derived from Straat et al., 2022; Baker et al., 2018).

AIR TRAVEL

Healthcare professionals should consider the following factors when advising clients who plan to travel by air after their TKR:

1. Air travel is not advisable in the first 4 weeks due to high risk of venous thromboembolism.

2. The client should inform and discuss with the surgeon about their plans to travel by air within 6 weeks of post-TKR.

3. From 6 weeks onwards, TKR client will be able to travel by air when he/she is able to walk and sit comfortably with the affected knee flexed.

4. Risk of venous thromboembolism should be mitigated with a combination of chemical and mechanical prophylactic strategies after joint replacement if client needs to travel by air (Donnally et al., 2018).

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GARDENING

Gardening or growing flower involves subtasks like watering, applying fertilizer, harvesting, deadheading, composting, pruning, transplanting, weeding, planting, and cleaning.

A United Kingdom (UK) study reported that TKR clients took an average of 82.5 days (range 28 – 274) to return to gardening (Barker et al., 2018). In Singapore, different types of housing, such as public housing blocks and landed property may implicate the size of 'garden' to take care of, such as potted plants along the corridor versus a landscaped garden.

Healthcare professionals to consider the following strategies to maintain TKR client's participation in gardening:

1. Raising garden beds
2. Planting low-maintenance perennial plants that minimise weeding
3. Use of a stool to sit on while working on longer-duration activities such as weeding and pruning
4. Use of smaller watering containers such as water bottle instead of watering can
5. Keeping gardening tools within easy reach
6. Consider own ability such as walking on uneven surface and carrying pot with or without walking aid

RECOMMENDATIONS FOR **GARDENING**

2 TO 4 WEEKS	Most clients will be able to return to light gardening activities that can be performed in seated or standing positions such as watering with approximately 2L watering can.
6 TO 8 WEEKS	Most clients will be able to return to light gardening activities that can be performed in standing positions.
3 MONTHS	Most clients will be able to start physically-demanding gardening tasks gradually such as shoveling, weeding, seeding, potting, with supervision if require.
6 MONTHS ONWARDS	Most clients will be able to perform gardening as tolerated.

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RETURN TO SPORTS

Generally, TKR clients can return to low-impact sports, e.g., stationary cycling, golf and bowling.

Returning to moderate-impact sport depends on the client's prior experience in the sport, e.g., rock climbing and tennis.

Returning to high-impact sports after TKR is not advisable, e.g. football and basketball.

Excessive wear of TKR implant, dislocation of cam-post mechanism and fractures could potentially happen with participation in sports activities. The amount of load over the knee joint created during sports activities is affected by the:

- Weight of the client
- Number of joint cycles e.g., jogging creates more knee joint cycles than completing a golf game
- Load force e.g., treadmill walking loads more force than stationary bicycle
- Speed of activities e.g. walking at speed of 7km/h loads more force on knee joints than walking at 5km/h
- Surface of ground e.g. ascending/descending ramp/steps, hiking on uneven terrain
- Carrying load e.g. bowling on alleys generates more knee loading than walking without load at the same speed

This section will provide recommendations for swimming and bowling.

RECOMMENDATIONS FOR **SWIMMING & BOWLING**

	SWIMMING	BOWLING
2 TO 4 WEEKS 6 TO 8 WEEKS	Swimming is not advisable to allow for wound healing and minimise risk of infection.	Leisure bowling is not advisable to avoid excessive stress applied on the implant.
3 MONTHS	Most clients will be able to return to supervised swimming without risk of complications.	Most clients will be able to bowl with supervision.
6 MONTHS ONWARDS	Most clients will be able to return to swimming without risk of complications.	Most clients will be able to bowl independently as tolerated.

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RETURN TO WORK
AFTER
TOTAL KNEE REPLACEMENT

RETURN TO WORK

Return to work (RTW) is an area of growing interest in Singapore in view of increasing retirement age, an aging population and economic changes. Additionally, many older adults find that work is a meaningful medium of 'killing boredom' and 'mind exercise' even after retirement age.

The recommendation for RTW in this section is intended for TKR clients aged ≤ 65 years old, as there is a lack of recent work-related studies or recommendations for TKR clients > 65 years old.

Healthcare professionals should consider the following favourable factors for TKR clients to RTW:

1. Type of work
    - Clients with non-manual jobs (e.g., managers, teachers) are 2.8 times more likely to return to work compared to clients with manual jobs (e.g. nurses, cleaners)
    - Lesser job-related knee and physical demands such as lifting loads < 10 kg less than 10 times per week for less than one year)

2. Advise client to discuss flexible work arrangements with employer before TKR e.g., fewer working hours, lighter duties, task adaptation, environment modification

3. Factors such as good health status pre-surgery, few absences from work, belief that knee symptoms is unrelated to work as well as expectation of early RTW are enablers to RTW post TKR

4. Psychological factors can affect RTW e.g. self-motivation and boredom

5. Necessity to RTW for pragmatic reasons e.g., financial needs

6. Medical advice or clearance to RTW such as for vocational drivers

7. Post-surgical rehabilitation should address general and knee-specific physical impairment, and knee-specific activity limitations

PRE-SURGERY RTW CONSULTATION

Ideally, healthcare professionals should screen and provide individualized advice about RTW before TKR.

As part of pre-surgical advice:

1. RTW after TKR generally occurs between 8 to 12 weeks post TKR.

2. Discuss factors affecting rate of RTW after TKR

3. Adaption to working patterns to facilitate RTW including the use of phased returns, modified hours and altered work schedules

4. Education on main goal of knee replacement is to relieve pain and marginally reduce difficulties in performing knee-demanding tasks.

5. Discuss with client on the nature of work e.g. do they work in jobs that require driving, crane operation, prolonged standing.

6. Additional pre-surgical rehabilitation may benefit client with musculoskeletal diseases to improve RTW outcomes after TKR.

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POST-SURGERY RTW CONSULTATION

Healthcare professionals should discuss with TKR clients on their RTW goal or plan within the first therapy session, if possible.

The topic of RTW can be presented to the following but not limited to:

- Employed clients
- Clients who have to RTW for pragmatic reasons e.g., financial needs
- Clients who give up their jobs prior to surgery due to knee pain AND would like to RTW after surgery
- Retired clients who plan to return to workforce, either part-time or full-time

Examples of RTW quick questions:

Mary, 58 years old lady who works as a cashier at Mini Supermarket for the past eight years. She had her right TKR one week ago. She met Carly, the physiotherapist in her first therapy session. She is keen to return to work after her paid hospitalisation leave. She hardly takes medical leave prior to her TKR as she is afraid of losing her job. She hopes that she doesn't need to follow up with physiotherapist after she returns to work. She told Carly that she will undergo TKR for her left knee next year as per her surgeon's suggestion. Carly raised some questions to follow up with Mary in their next therapy session, as today's therapy session was focused on new exercises and symptoms management.

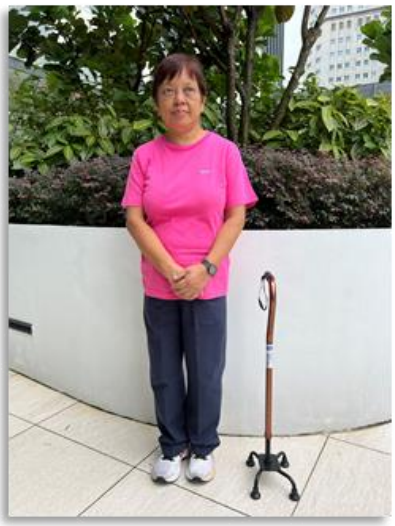


Photo by Tok Xue Hui and Diana Tay Gek Sian

	QUESTIONS	EXAMPLES
GOAL SETTING	What do you want to be able to do? Involve the client to set realistic SMART goal.	I want to be able to return to work as a cashier in Mini Supermarket by 31st December 2023, which is 8 weeks from now.
PROBLEM IDENTIFICATION	What difficulties do you anticipate you will face when returning to work? Have client list down 3 main challenges.	I'm worried about standing for long hours, as there is no highchair in the cashier area. At times. I also have to put stress on my knee to transfer heavy items such as 10kg rice bag from scanning station to packing station. I am scared my leg will give way. I am also worried about swelling if I stand and working for too long, then I will have difficult to walk home (5-10 minutes walk from my workplace to my home).
POSSIBLE SOLUTIONS	How can you overcome these difficulties? Have client list out all possible practical solutions.	I could talk to my supervisors to allow a high chair at my station so I can rest when there is no customer. Maybe I could suggest a buddy to assist with the packing of heavy items if needed? Or I could have a badge or notification at my cashier station to inform the client that "I'm not able to carry heavy item now, I'm happy if you could assist". Another option is to use the compression stockings for swelling management when at work.
IDENTIFY STAKEHOLDERS	Who can help you to overcome the solutions?	My supervisor's approval is needed. My doctor can issue light duty certificate if needed. My therapist can tell me what I can do and not do. Maybe she can teach me some pain and fatigue management strategies to help me overcome the discomfort.
ACTION	When should I discuss with them?	It is useful to discuss with my employer and my colleague way in advance of your RTW and give them time to make the arrangements, if any needed.

Carly may recommend **phased return to work** if Mary intends to RTW earlier, such as for Mary to resume working half days first and to avoid the peak period from 15 December 2023.

For TKR clients who needs to carry out strenuous knee-demanding activities, healthcare professionals should consider factors such as:

1. Pre-surgical ability in carrying out such task
2. Knee range required to perform the task
3. Efficiency of quadriceps
4. Knee stability and knee kinematics

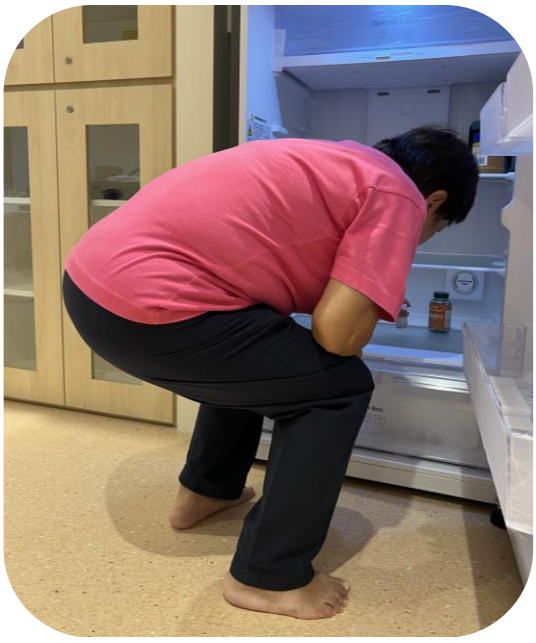
TKR clients who experience difficulty in strenuous knee-demanding activities like Mary, will more likely continue to engage in the same activities post TKR, although pain is relieved.

The ability of clients to return to heavy labor work is not conclusive as the rate of implant wear resulted from weight and repetitive movement is unknown. Excessive prosthesis wear, dislocation of cam-post mechanism and fractures could potentially be associated with these activities. Education in techniques such as joint protection, energy conservation, pacing, and body mechanics can increase the client's ability to deal with symptoms like fatigue and limitations.

STRENUOUS
KNEE DEMANDING ACTIVITIES

KNEELING

CLIMBING



CROUCHING

CLAMBERING

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RECOMMENDATIONS FOR **RETURN TO WORK**

		Work Load
FIRST 4 WEEKS	Client can consider sedentary work such as work from home with flexible working times.	-
6 TO 8 WEEKS	Client will be able to perform sedentary to light work demands, i.e. Sedentary work which involves sitting most of the time but may involve walking or standing for brief periods of time (1-33% of work time).	Occasionally (1-33% of work time) exerting up to 9 kg and/or,
		Frequently (34-66% of work time) exerting up to 5kg of force and/or,
		Constantly (67-100% of work time) exerting negligible amount of force to move objects up to 4kg

continue...

RECOMMENDATIONS FOR **RETURN TO WORK**

…continued

3 MONTHS	Most clients will be able to start performing medium work demands i.e. 1) moderate knee-demanding work such as walking on rough terrain, taking the stairs, standing, lifting or carrying, pushing or pulling, working with hands below knee height 2) Constant pace of production rate, especially in industrial/ factory setting, which requires constant stress and strain on knee although the amount of force exerted is negligible. 3) It is recommended to increase the weight gradually.	Occasionally (1-33% of work time) exerting up to 23kg of force and/or, Frequently (34-66% of work time) exerting up to 12kg of force and/or, Constantly (67-100% of work time) to move objects up to 5 kg.
6 MONTHS ONWARDS	Some clients may be able to start performing moderate to heavy knee demanding work with precautions (e.g. kneeling, crouching or clambering).	Occasionally (1-33% of work time) exerting up to 45kg of force and/or, Frequently (34-66% of work time) exerting up to 23kg of force and/or, Constantly (67-100% of work time) to move objects up to 10kg.

Note. Adapted from "Operation versus work load versus return to work time," by L. McGonagle, L. Con very-Chan, P. DeCruz, S. Haebich, D. P. Fick, and R. J. Khan, 2019, *Journal of Orthopaedics and Traumatology, 20*

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REHABILITATION OUTCOME MEASURES OF TOTAL KNEE REPLACEMENT

Some of the outcome measure listed in this section are identified from the interview with 19 healthcare professionals – the nurses, physiotherapists and occupational therapists who work with TKR clients.

The workgroup summarized the outcome measure recovery trajectory of TKR clients at 2 to 4 weeks, 5 to 8 weeks, 13 to 24 weeks and 25 weeks to ≤ 12 months, based on the result of the literature review (refer to Appendix 1 (page 77) for search terms).

Table 1: Summary of Common TKR Outcome Measures Trajectory

Outcome Measure	2 to 4 weeks	5 to 8 weeks	9 to 12 weeks	13 to 24 weeks	25 weeks to ≤ 12 months
Knee flexion ROM (degrees)	90 to 114.9 ± 11.0	95 ± 10 to 110.0	109 ± 13 to 118.2 ± 9.8	106 to 123.2 ± 10.8	115.0 ± 13.1 to 127 ± 10
Knee extension ROM (degrees)	– 6.4 ± 6.2 to 0	–4.9 ± 5.2 to 0	–3.6 ±4.6 to –1.2 ± 12.7	0 to 4.8 ± 5.4	–5.9 ± 6.8 to – 2.8 ± 5.2
Timed up and go (s)	10.6 ± 2.2 to 16.9 ±0.6		8.09 ± 1.91 to 11.1 ± 0.3	8.1 ± 1.9 to 10.4 ± 0.3	10.2 ± 0.3^
Walking speed (m/s)	0.9 ± 0.3 to 1.0 ± 0.2	1.0 ± 0.3^	1.1 ± 0.2 to 1.61 ± 0.54	1.2 ±0.3 to 1.42	1.17 ± 0.2^
6 minutes walk test (metres)	320.0 ± 75.7 to 363.7 ± 69.4		438.8 ± 96.6 to 521 ± 96	460.0 ± 113.9^	
30 seconds chair rise (n)			12.3 ± 3.2^	12.4 ± 3.2^	

^ only one study available

Table 2: Summary of TKR Return to Daily Activities Trajectory

Activities	2 to 4 weeks	5 to 8 weeks	9 to 12 weeks	13 to 24 weeks	25 weeks to ≤ 12 months
Basic daily activities	Bathing when wound has healed ǂ	Stairs climbing* ǂ	Sexual activity*		
Instrumental daily activities	Housework*	Heavy household tasks ǂ	Knee-demanding activities e.g., climbing and/or clambering ǂ	Knee-demanding activities e.g., kneeling and crouching *ǂ	
Walking					
• **Average number of steps per day**	3000 to 4200 steps*	2100 to 2800 steps*	3000 to 5200 steps*	2700 to 5300 steps*	5500 to 6200 steps*
• **Distance**			>1 km*		
• **Duration (minutes)**			316 minutes per day*	68% clients walk >30 mins; 18% can walk 16-30mins; 12% 5-15minutes*	

* Actual return reported by TKR clients in published articles

ǂ Advice by healthcare professionals or systematic review in published articles

Table 3: Summary of TKR Return to Leisure & Social Activities Trajectory

Activities	2 to 4 weeks	5 to 8 weeks	9 to 12 weeks	13 to 24 weeks	25 weeks to ≤ 12 months
Leisure and Social Activities	Driving automatic or manual transmission (if able to depress the clutch) car for L TKR ǂ	Driving* Taking airplane ǂ	Gardening*	Religious activities that may involves kneeling*	

* Actual return reported by TKR clients in published articles

ǂ Advice by healthcare professionals or systematic review in published articles

Table 4: Summary of TKR Return To Sports Activities Trajectory

Activities	2 to 4 weeks	5 to 8 weeks	9 to 12 weeks	13 to 24 weeks	25 weeks to ≤ 12 months
Cycling	Stationary bicycling (high seat, low resistance) ǂ	Cycling 2-3km ǂ Stationery cycling* ǂ	Cycling 3-10km ǂ Cycling* ǂ	Cycling 30-40km or resume without limitations ǂ	Incline cycling ǂ
Aquatic activities		Swimming ǂ Aquatic program (fitness, water walking, depth at thigh or waist) ǂ Water aerobics ǂ	Swimming includes kicking ǂ	Swimming*	Rowing ǂ Canoeing ǂ Kayaking ǂ
Gym		Free weight lifting* Elliptical machine ǂ Stair machine (low resistance, low stroke) ǂ	Weight lifting ǂ	Fitness centre training: 25 min strengthening, 25 min cardiovascular training, 10 min flexibility; 2–3×/week. ǂ	

Continue…

… continued

Golf		Putting ǂ	Putting* Chipping*	Practice* Complete 18-hole golf course*	Driving distance of 183.3 ± 50.0m* Handicap of 18.7 ± 10.2*
Others		Motocross* Going for sauna ǂ Yogaǂ	Bowling* Hiking*ǂ Tennis doublesǂ Aerobics ǂ		Mountain biking ǂ Table tennis ǂ Skiing ǂ Tai-Chi ǂ

* Actual return reported by TKR clients in published articles

ǂ Advice by healthcare professionals or systematic review in published articles

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APPENDIX 1

Population	Total knee replacement, total knee replacement "knee", "replacement", "replacement" Mean age 50 to 75 years old
Intervention/ Issue	Rehabilitation, physiotherapy, occupational therapy, vocational rehab
Comparison/ Context	Functional outcome at up to one year
Outcome	**Activities/functional recovery/occupation recovery:** • ADL "daily activities", "self care", "MBI", "modified Barthel Index", "BI", "Barthel index", "activities of daily living", "FIM" • IADL "instrumental", "community ambulant" • Leisure/Sports (low demand and high demand) "sports", "leisure", "physical activity" • Return to work "work", "employment", "occupation", "job" • Squatting (WB and NWB), stairs, kneeling, walking, running, swimming **Outcome measure** • ROM, TUG, Gait parameters, Stairs climbing test, 6 minutes walk test, FIM, MBI, 30 seconds chair rise
Time	1st May 2018 year till 30th Apr 2023 (5 years)
Exclusion Criteria	revision, uni-compartmental, uni-condylar, traumatic, cadaveric, infected, complication, MUA, fracture, bilateral TKR (≥30% of population), wound, reconstruction/repair, osteoarthritis treatment, fractures, injury, meniscus tear, prehab, allograft/graft Study protocol, comparing peri-surgical analgesia technique, intervention cohort, RCT

Note. ADL = Activities of daily living; BI = Barthel Index; FIM = Functional Independence Measure; IADL = Instrumental activities of daily living; MBI = Modified Barthel Index; MUA = Manipulation under anesthesia; NWB = Non weight bearing; RCT = Randomised controlled trial; ROM = range of motion; TUG = Timed up and go; WB = Weight Bearing

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