Rehabilitation Sciences Research Centre

Projects for Prospective Students

PhD Projects

Lifespan Gait

Contact person: Dr Noel Lythgo

Gait maturation is a major developmental milestone in early childhood. In contrast, gait changes in the elderly usually signal the need for a change of lifestyle and possibly supported living. There is an indisputable need to acquire reference data in order to examine the variability in healthy people and mechanisms of gait maturation, malfunction and decline. Current decisions about the quality or abnormality of gait are based on limited reference data that is unrepresentative of specific age groups.

Technology now available at the Rehabilitation Sciences Research Centre allows the easy collection and examination of numerous gait parameters over many trials for large groups of people within a laboratory or field setting. The current generation of instrumented gait mats, such as the GAITRite walkway system for example, allows gait to be comprehensively examined since large amounts of data can be collected in relatively short periods of time. High speed 3-dimensional motion analysis systems combined with force plates allow the collection of complex information such as lower limb joint powers and moments, foot clearance, joint angular data and segment accelerations. Importantly, these systems allow the mechanisms of gait to be examined. The specific aims of this work are to: (1) develop a reference data set of walking in healthy people (2) identify markers of gait maturation and decline; (3) better understand mechanisms of gait maturation and decline; and (4) better understand gait in even (level ground) and uneven terrain (e.g. stairs or steps) and terrain requiring a sudden stop or turn.

(N.B. Parts of this project would be suitable for AMS, Honours, or Masters students)

Muscle stiffness reduction in healthy and pathological populations

Contact person: Dr Noel Lythgo, Prof Mary Galea

Short resting lengths of the lower limb muscles restrict mobility and can lead to acute injuries such as Achilles tendon rupture or chronic injuries such as plantar fasciitis. In populations recovering from pathologies such as a stroke, high levels of muscle stiffness in the gastrocnemius and soleus muscles restrict movement by reducing the amount of dorsi and plantar flexion in the stance phase of gait. Basically, reductions in the range of lower limb motion predispose a person to injury and lessen the capacity of people recovering from pathology to live independently or move freely within the community.

The aim of this research is threefold. Firstly, to develop innovative measurement techniques (eg. muscle length) in order to better understand the mechanisms behind muscle stiffness. Secondly,

to ascertain the value of intervention programs designed to prevent, alleviate or reduce muscular stiffness. By so doing, the degree or extent of departure from normal movement can be determined and the progressive changes resulting from intervention strategies can be assessed. The specific interventions to be undertaken involve eccentric exercise programs, muscle and neural stimulation by vibration systems, PNF and traditional stretching. Thirdly, to examine the effects of different whole body vibration systems upon muscle stiffness and length-tension especially in people recovering from stroke.

(N.B. Parts of this project would be suitable for AMS, Honours, or Masters students)

Amputee Gait

Recent advances in lower limb prosthetic design (knee and foot devices) claim to improve walking smoothness, movement efficiency and physical function by reducing factors such as hip hiking (reduces energy cost), increasing foot-ground/obstacle clearance and push-off power (increases walking speed and ability to avoid obstacles such as a step or low barrier). Although work has provided valuable information about the characteristics of amputee gait in level terrain, it has not provided any insight into the characteristics of amputees when traversing uneven or winding terrain commonly encountered in "everyday" life. These terrains are challenging since they may require a sudden increase or reduction in speed (e.g. pedestrian crossings), a sudden change in direction to avoid an object such as a pothole or accommodation of an object such as a step or stair.

This project has four aims. Firstly, to examine the gait patterns of a group of unilateral above knee amputees in even (flat ground) and uneven (containing a step or small obstacle) terrain, and in terrain that requires a change of direction. Secondly, to examine the effect of knee and foot prosthetic devices (traditional versus novel) upon amputee gait in these terrains. The selected knee devices have different braking and damping qualities, whereas the selected foot devices differ in stiffness or rigidity. Specifically, gait patterns will be examined in terrain that requires level walking at preferred and fast speeds, step ascent and descent, obstacle avoidance and steering control. A second aim is to ascertain the effect of knee/foot device (traditional versus novel) upon daily physical activity, duration and function. The final aim is to develop superior gait models through software development to record amputee gait. The gait patterns of the amputees will be recorded by a high-tech "state of the art" motion analysis system housed in the Movement Laboratory at the RSRC. The system simultaneously records distance and speed measures of gait and measures of muscular force and timing. This information is then used to derive precise measures of limb movement such as 3D joint angles, limb rotary forces and muscle activation.

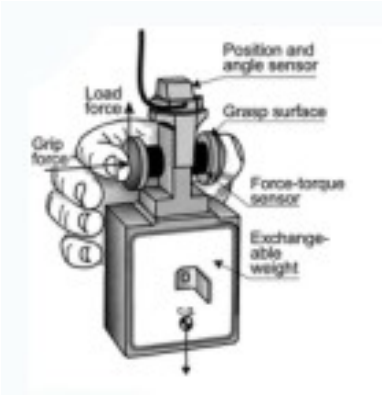
(N.B. Parts of this project would be suitable for AMS, Honours, or Masters students)

Sensorimotor integration in the hand

Contact Person: Prof Mary Galea, Dr Clarissa Martin

The purpose of this project is to investigate some of the mechanisms underlying sensorimotor integration in the hand, through observation of performance of a simple manipulative task. The hand is the primary way by which we interact with the environment. Through exploration and manipulation of everyday objects, we are able to learn about our environment and perform essential tasks. This project will explore the mechanisms of sensorimotor integration in people with central or peripheral nervous system injury using a simple grasp and lift task. Information

about force generation at the fingertips is collected from two highly sensitive strain gauge transducers located within the grasping surfaces of the test object (Figure 1)



Participants for this project will have either suffered a first time stroke, have a diagnosed peripheral neuropathy affecting the hands, or have another neurological disease (e.g. MS). Clinical assessments of neurological function (sensory, motor and functional tasks) will be performed. Participants will then be asked to grasp the test object using a precision grip, lift it approximately 5cms vertically and hold it in this position for approximately 5 seconds before gently replacing the object back on the table and releasing their grip. Characteristics of the test object, such as the weight, curvature and texture will be systematically varied between lifting trials. Grip force, loading force and minimum force required to prevent the object dropping will be recorded.

Masters Projects

Assessment of hand function in stroke patients using the NK Dexterity Board

Contact Person: Ms Kimberly Miller, Prof Mary Galea

The NK Hand Dexterity Test (NKHDT; NK Biotechnical Corp, Minneapolis, MN, Fig. 1) was designed to evaluate gross and fine manual dexterity in individuals with upper limb impairment. The NKHDT consists of a number of objects grouped as small, medium and large object sub-tests. The sub-tests require participants to pick up objects from individual slots on the customised board, insert, screw and/or assemble objects in corresponding slots on the board, and then remove the objects and replace them in their original places. The sub-tests incorporate a variety of prehensile functions including grasp and release, screwing movements, precision grip, and assembly of pins and washers, thereby providing a more comprehensive appraisal of gross and fine dexterity than any other standardised manual dexterity assessments currently in use in the clinic.

Figure 1. The NK Hand Dexterity Test

Test-retest reliability of the NKHDT has been shown to be fair to excellent in people with no known upper limb impairments, as well as in stroke survivors.

We used the NKHDT as in measure of upper limb recovery in a clinical trial investigating the efficacy of the task-oriented upper limb training in the sub-acute phase following stroke. No previous studies had utilised the NKHDT in a longitudinal investigation of a clinical population where the number of elements of each sub-test completed over time might vary as the manual dexterity capabilities of the participants improved. In the clinical trial, not only did the sub-test completion times for the stroke patients change, but also the number of objects within the sub-tests that they were capable of handling (e.g. a patient might complete more objects and therefore have a longer completion than his/her previous assessment despite being capable of doing 'more'). As result of these combined changes in performance, meaningful direct comparisons of raw sub-test completion times were not possible.

We aim to develop weighting formulae to adjust the sub-test completion times on the NKHDT for the number and types of sub-test objects executed to permit the pooled analysis of the change in dexterity performance. These formulae can be published so that researchers and clinicians will be able to use the NKHDT to accurately quantify changes in manual dexterity over time in stroke survivors and in other clinical populations.

A tool for evaluating sensation

Contact person: Ms Kimberly Miller, Prof Mary Galea

Loss of sensation is an important factor contributing to disability in three core clinical conditions: peripheral nerve injuries, peripheral neuropathies related to diagnoses such as diabetes mellitus, and disorders of the central nervous system such as stroke. Accurate and reliable methods to quantify sensation are essential to screen for sensory impairment, and to measure changes in sensation resulting from treatment of these conditions. Most sensation screening devices require time-consuming assessment protocols that are impractical in the clinic,

Our group has devised an instrument, the AsTex®, for screening sensation of the hands and feet. The assessment protocol for the instrument is quick and simple for easy application in variety of clinical settings. We have shown that the AsTex® has high test-retest and inter-rater reliability such that it can be used to track changes in sensation over time or in response to treatment. Pilot data has been acquired for establishing an age-based normative database for sensation screening (Fig 1). The project involves further testing of healthy adults and children, as well as in people with nervous system injury.

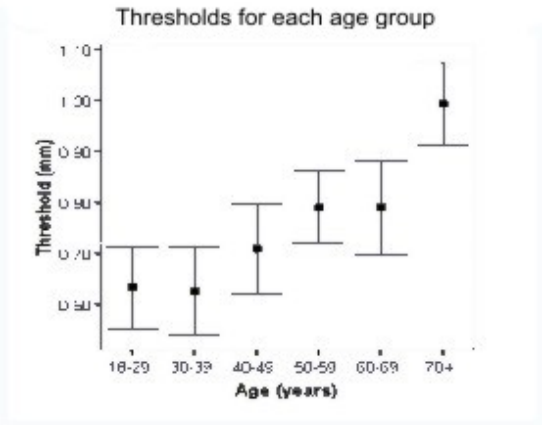


Figure 1. AsTex® thresholds for the index fingers of healthy adults aged from 18 to over 70 years of age.

The use of accelerometers to measure upper limb use after stroke

Contact Person: Prof Mary Galea, Dr Chris Manzie

The most important outcome for rehabilitation is functional activity in the real-life situation. However, direct, objective, and accurate measures of arm use in the real world are currently not available. Previous attempts to use accelerometry to measure extremity movement have failed because of unacceptable variability.

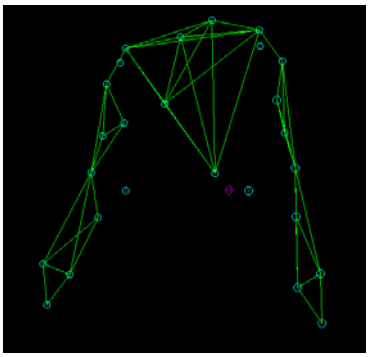
We are using an accelerometer with Bluetooth wireless technology and a threshold filter to measure arm movements. The project involves the accelerometer being worn by healthy individuals while they carry out their usual activities at home. The accelerometer data will be transformed and the raw value recorded for a given epoch will be set to a constant if it exceeds a low threshold. The aim is to develop threshold-filtered recordings that measure the duration of movement accurately and with very little variability. Programming will be undertaken to permit the identification of specific types of upper limb activity, e.g. bringing food to the mouth, reaching to objects, dressing.

We plan to use threshold-filtered accelerometer recordings for objectively measuring the amount of real-world upper-extremity movement as an index of treatment outcome for stroke patients.

A model to investigate upper limb movement using 3-D motion analysis

Contact Person: Dr Noel Lythgo, Prof Mary Galea

A 3-D model has been developed, based on recommendations by the International Shoulder Group, to measure upper limb movement. This model can be used to assess movement of any of the joints of the upper limb in a variety of conditions, including stroke.



Ultrasound biofeedback in the management of incontinence after stroke

Contact Person: Prof Mary Galea, Margaret Sherburn

Urinary incontinence is one of Australia's largest health problems. This condition can affect 40-60% of people admitted to hospital after a stroke, with 25% still having problems on hospital discharge and around 15% remaining incontinent at one year. Physiotherapy intervention, including pelvic floor exercises, has been shown to be an effective treatment for women with incontinence after stroke. However, assessment of the pelvic floor muscles typically requires an internal (vaginal or rectal) examination, which can be distressing for many people. We have already shown that transabdominal diagnostic ultrasound is a reliable, non-invasive method of visualising action of the pelvic floor muscles in males and females. We have also shown that transabdominal ultrasound is effective as a biofeedback tool for teaching activation of the pelvic floor muscles and improving incontinence in the elderly. In this project we wish to investigate whether ultrasound biofeedback is similarly effective in stroke patients with incontinence. Evidence that this feedback is effective in stroke patients will encourage its adoption in the management of incontinence after stroke in order to improve long-term outcome.

Clinical and laboratory-based measures of gait performance in people with Multiple Sclerosis.

Contact Person: Dr Clarissa Martin, Prof Mary Galea

Multiple sclerosis (MS) is a chronic progressive disease of the central nervous system. People with MS may experience a variety of symptoms including impaired motor control, co-ordination, sensation, vision and vestibular function, all of which may affect gait and mobility. Despite the fact that up to 85% of people with MS describe reduced mobility as their main problem, the outcome measures currently employed in the clinical management of this patient group demonstrate poor reliability and are insensitive to the changes in gait performance that inevitably accompany disease progression. A study recently undertaken by our research group has shown that the temporal-spatial parameters of gait, including speed and stride length, provide valid, reliable, and responsive measures of gait performance in people with MS, when evaluated in the laboratory setting using sophisticated movement analysis techniques. While gait speed and stride length may be calculated using data obtained from clinical tests such as the timed 10m walk, it is currently not known whether such clinically derived measures demonstrate the same psychometric properties as the equivalent measures recorded in a laboratory setting. Therefore, in this project we plan to investigate the reliability and responsiveness of clinical measures of gait performance in people with MS, using laboratory-based measures as a comparative "gold standard". This information may prove invaluable to physiotherapists and neurologists who seek to use psychometrically sound outcome measures in the clinical management of people with MS.