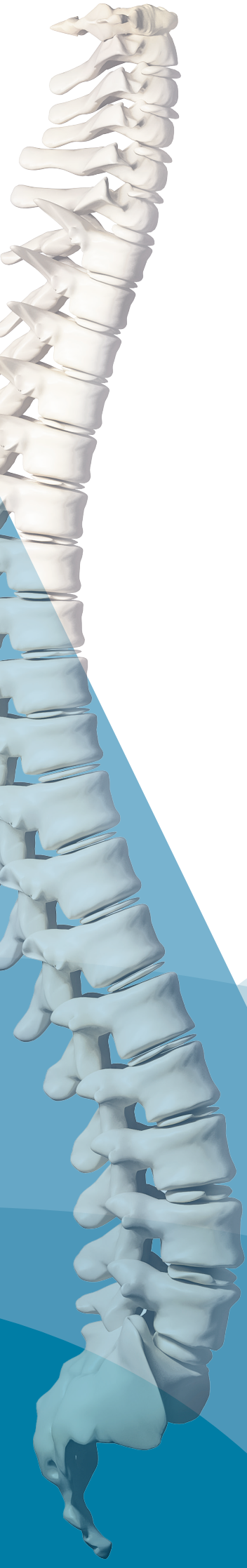

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Ageing with Spinal Cord Injury

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All recommendations are for patients with SCI as a group. Individual therapeutic decisions must be based on clinical judgment with a detailed knowledge of the individual patient's unique risks and medical history, in conjunction with this resource.

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1. INTRODUCTION

Spinal cord injury (SCI) commonly results in multiple permanent impairments, which when they interact in a person's environment, can lead to significant limitations in activity, participation and quality of life. In addition, these changes to body system functions and structures with altered physiology and reduced functional reserves, as well as increased demands of everyday living, pose increasing challenges to maintaining homeostasis across the lifespan. Based on recent trends for incident cases of persisting SCI in Australia (around 15 per million of the population, with rates highest amongst young adults and males)[1, 2] and population growth, the annual number of new cases of traumatic SCI is anticipated to increase from 253 in 1997 to 464 in 2021.[3] Based on historical data concerning survival, the prevalence of SCI is also anticipated to increase rising to nearly 12,000 by 2021.[4] Improvements in medical and rehabilitative care, coupled with technological advances, have significantly improved longevity for people with SCI. Individuals ageing with a traumatic SCI are now living an average of 30 to 40 years post injury.[5-7]

Ageing is broadly defined as the time-dependent functional decline that affects most living organisms and is characterised by a progressive loss of physiological integrity. It is said to be the primary risk factor for major human pathologies such as cancer, cardiovascular disorders and neurodegenerative diseases.[8] It has been proposed that SCI represents a model for premature or accelerated ageing, particularly in some body systems such as the cardiovascular, musculoskeletal and respiratory systems. This suggests that the declines associated with natural ageing are compounded by the injury, and are likely to occur earlier and more frequently among individuals with SCI.[9, 10] Consistent with these observations, there is now a growing body of research documenting that, with increasing age after SCI, there are declines in health status, functional independence and a corresponding increase in health system utilisation.[11-13]

The complexities of ageing and SCI are in part caused by the interaction and overlap between various age-related factors such as age at injury, current chronologic age, duration of injury and age cohort or disability inception era (that is, the generational effect of the social, economic, and medical context or health care available at the time of onset of disability).[14, 15] In addition, there may be numerous psychosocial changes associated with ageing, such as alterations in family and social support structures, ageing caregivers and potential depletion of economic resources.[16]

It is useful for individuals with SCI, and their health care team, to know what changes may be expected as the individual ages. This publication highlights the issues surrounding ageing with a major disability such as SCI, with a focus on changes occurring in various organ systems and recommendations for preventive and treatment strategies. It is important to note that individuals with SCI may not manifest typical signs and symptoms of the various health conditions for which they are at risk and this might increase the likelihood of delayed diagnosis and presentation with more advanced disease.

2. MORTALITY RATES

Even though individuals with traumatic SCI are now living longer after injury, significant disparities exist in life expectancy within and between those with SCI and the general population. Overall, mortality in people with SCI is up to three times higher than in the general population, with diseases of the circulatory and respiratory systems being among the leading causes of mortality.[7, 17] Some of the key findings and recommendations from research in this area are summarised in **Table 1.**

Table 1: Key findings and recommendations of SCI related mortality research worldwide.

Title	Study design and sample size	Key findings	Recommendations
Predictors of mortality in veterans with traumatic SCI.[18]	Retrospective record review of 147 veterans with traumatic SCI over a 12 year period (Jan 2000 to Dec 2011) in the US.	• Survival at the end of 12 years was 60%. • Three main causes of death were infection (46%), cardiovascular disease (25%), and cancer (16%). • Older age at the time of injury was the main predictor of mortality. • There was a trend toward an increase in cardiovascular deaths and a decrease in infection deaths. • The standardised mortality ratio (SMR) was 3.1 times greater than the control population.	There is a need for preventative strategies, such as cardiovascular risk factor management, in order to decrease long-term mortality.
Life expectancy after SCI: a 50 year study.[5]	Retrospective record review of 2014 patients with traumatic SCI over a 50 year period (Jan 1955 to June 2006) in Australia.	• Overall 40 year survival rates among first year survivors were 47% for persons with tetraplegia and 62% for those with paraplegia. • Three main causes of death were cancer (14.5%), ischaemic heart disease (13.2%), and pneumonia and influenza (12.7%).	• Survival related strongly to the extent of neurological impairment and there is a need to explore the contextual factors contributing to this.

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Title	Study design and sample size	Key findings	Recommendations
Mortality after traumatic SCI: 50 years of follow-up.[19]	Retrospective record review of 401 patients with traumatic SCI over a 50 year period (1952 to 2001) in Norway.	• Survival at the end of 50 years was 56.8%. • The SMR was 1.85 compared to the control population. • There was a high cause specific SMR for suicide including accidental poisoning, particularly for women (SMR of 37.59).	Special attention needed to prevent suicide and accidental poisoning.
A prospective assessment of mortality in chronic SCI.[17]	Prospective assessment of 361 males with chronic SCI in the US was done between 1994 and 2000.	• Mortality elevated compared to US rates (SMR of 1.47). • Most common underlying and contributing causes of death were diseases of the circulatory and respiratory system.	Recognition and treatment of risks such as cardiovascular disease may reduce mortality in chronic SCI.
Standardised indices of mortality among persons with spinal cord injury: accelerated ageing process.[20]	Review of 960 males with SCI rehabilitated during the period of 1965 to 1995 in Japan.	• Mortality elevated compared to population norms (SMR of 2.8). • Among the leading causes of death were malignant neoplasms, cardiovascular disease and suicide.	Ageing-related diseases seem to be the major cause of deaths in persons with SCI.

3. QUALITY OF LIFE

Quality of life or life satisfaction is influenced by a range of factors, such as level of education, mobility, perceived health, amount of social support, mental health, self-efficacy,[21] and relates to how well a person copes with SCI and the ageing process. The perception of quality of life can change over time and can be influenced by physical and functional changes in an individual's environment that may occur over time.[22] There is no clear definition of the concept of quality of life, but research shows that to get an unbiased representation of quality of life perception, the measurements should be taken by the people themselves.[23]

Whilst it is difficult to directly link depression to ageing alone, it is strongly linked to other health-related impairments, most of which become more common with the ageing process. Due to this, depression is common among individuals with SCI and those who are older and have had a SCI for a longer period of time.[24] This phenomenon is mainly due to the differing perceptions of quality of life between younger and older individuals. It is thought that chronologic age negatively correlates with life satisfaction, whereas the number of years since SCI has a positive relationship with life satisfaction. Therefore, it is the age at injury rather than ageing that has an association with quality of life.[24]

The ultimate goal of rehabilitation should be the achievement of a good quality of life, providing perspective and context to the individual's life. Identifying factors that might lead to a decreased perception of quality of life will help minimise depression and other consequences of low quality of life perception.

The research that is available shows that there is no clear correlation between satisfactory quality of life perception and the level of injury or of physical independence.[23] Perception of a good quality of life is more closely related to the quality of relationships between family members, friends and support networks. Increased secondary health complications, low income, lack of life opportunities, decreased social interaction and nursing home admissions are all factors that are thought to contribute to low perceptions of quality of life.

It is important to understand the causes of and changes in quality of life perception over time to ensure that individuals with SCI are not just living longer but living well.[22] Successful ageing can be enhanced with an awareness of any issues that may arise.

4. HEALTHCARE UTILISATION

A SCI predisposes a person to various secondary medical complications, which may interfere with their health, well-being, social activity, employment and quality of life.[25] These secondary complications often require the utilisation of health care services, including visits to general practitioners (GPs), medical specialists, allied health professionals, pathology, hospital outpatient visits and admissions. Patients with SCI also require a greater level of nursing in long-term care.[26]

It is difficult to capture access and utilisation of GPs and outpatient visits,[25] although people who sustain a SCI will experience a number of secondary health conditions in the months and years following their injury, with over 95% of patients having at least one medical complication at their routine annual check-up.[26] The most common complications are urinary tract infections, pressure injuries (PIs), cardiovascular disease (CVD), respiratory conditions and psychosocial issues. Patients with a SCI are twice as likely to require re-hospitalisation compared to the general population,[26] with re-hospitalisation impacting on many aspects of life, including time off work, education, personal relationships and quality of life.

GP visits are significantly higher for those with SCI compared to the general population and the reasons for visits differ between these two groups. People with SCI tend to require medical advice for various issues related to their spinal cord impairment, which commonly may include problems due to dysfunction of the genitourinary and gastrointestinal (GI) systems, autonomic dysreflexia (AD), pain and mental health issues.[26] In comparison, the general population tends to visit the GP for ill-defined symptoms, respiratory and musculoskeletal conditions. These reasons are not too dissimilar but the amount of times that care is accessed tends to be much higher for those with SCI. Both groups seek medical advice for mental health issues, with depression being a primary concern for those with SCI, often requiring treatment from a specialist or re-hospitalisation.[26]

The need for frequent access to health care continues long after the initial SCI and often can involve many different aspects of health care for both injury related complications and general health issues. Utilisation of health services increases initially in the first year following injury and may peak again as people with SCI age.[25] Almost 60% of an SCI study cohort required re-hospitalisation during the 10 year study period, with urinary tract infections being the most common reason for re-admission to hospital.[25] It is very important for people with a SCI, who have been discharged in to the community, to be able to access healthcare in order to prevent secondary complications and minimise the need for ongoing medical care including re-hospitalisation. It is crucial that GPs are able to maintain contact with people with SCI and that they are familiar with the long-term medical needs of this group.

Appropriate health care utilisation and management of people with SCI requires education to minimise preventable secondary health complications and this needs to be ongoing post discharge.[25] Resources should be utilised more often and more efficiently through shared care with GPs, and this may be particularly useful, for example, in identifying pressure areas. In addition, at risk individuals must be identified and targeted with follow-up. GPs should monitor check-ups and develop a follow-up system reminding patients about their required check-ups in order to prevent secondary complications.[26] Networks should be developed with local health care providers using standard checklists and this should be supported with routine follow-ups by specialised spinal outreach services. Research also shows that there is a need for information packages that are tailored to GPs with patients who have SCI.[26]

5. MODELS OF CARE

A model of comprehensive healthcare is important to improve the quality and efficiency of care and health related outcomes of people with chronic conditions and the ageing population.[27] SCI has broad medical, social and economic consequences for individuals, their carers and society. Due to this, it is important to be able to describe these issues and resources for SCI outcomes in order to enable long-term reintegration of people into society, using outcome measures that are valid and reliable.[28]

Outcomes research should look at the interaction between the environment and the impairment in conjunction with the provision of health care and participation in life activities. Disablement is a dynamic process that can increase or decrease depending on the environment either facilitating ability or creating barriers and increasing disability.[28] Information should also be obtained from registries which describe the SCI population. Information about the clinical features of care should include emergency treatment, acute inpatient, acute rehabilitation long-term outpatient rehabilitation and continuing primary care.[28]

Data measuring secondary conditions related to SCI needs to be collected. These conditions include pathologies, impairments and functional limitations caused by a disabling condition.[28] These conditions are usually costly, disruptive and stigmatising, affecting the individual's participation in society. There are conditions that are specific to SCI populations such as AD and there are other conditions such as PIs which, while more prevalent in those with an SCI, can also affect the general population. The frequency of secondary conditions is likely to increase with age. Education, therapy, adaptive devices, and screening and prevention protocols aim to reduce the prevalence and impact of secondary conditions in SCI populations. Measures that have been applied with little or no modification from the general population to SCI include the Functional Independence Measure (FIM), CES-D (Centre for Epidemiological Studies Depression Scale), SF-36 and SF-12.[28] While use of the same tools can allow comparison of SCI to general population normative values, often condition specific outcome measures are required. The Spinal Cord Independence Measure (SCIM) is one such measure reported to be more sensitive to significant functional gains, for example, among persons with tetraplegia in performing bed mobility manoeuvres, which can be important for PI prevention.

Discharge destination following rehabilitation is often used as an outcome measure, with age being the leading predictor in determining the discharge location. Living in the community increases the social interaction and independence of a person living with SCI. It also increases their sense of privacy and perception of quality of life, compared to those who are discharged to a nursing home environment.[29]

6. CHANGES WITH AGEING AND SCI IN BODY SYSTEMS

6.1 Cardiovascular System

The primary cause of morbidity and mortality in people with long-term SCI is the development of CVD. These conditions now exceed respiratory and renal complications which were previously the primary causes[30] and are the most common cause of death for men and women of all racial groups with SCI.[16] The prevalence of CVD is much higher in people with SCI than the general population and the risk of developing CVD is relative to the level and extent of the SCI.[31]

The main risk factors for CVD include a sedentary lifestyle, obesity, lipid disorders, metabolic syndromes with insulin resistance and diabetes. Physical changes related to the development of CVD include increased adiposity and decreased lean muscle mass. Up to 75% of the SCI population is overweight or obese [32] and adipose tissue, deposited particularly around the abdomen, increases the risk for developing CVD. Due to this adipose distribution, body mass index (BMI) is not an accurate measurement for those with SCI. Increased adiposity also increases the risk of developing cardio-metabolic conditions and increases inflammation within the body as detected by elevated levels of C-reactive protein and other indices. Changes in the blood lipid profile of people with SCI can also increase the risk of developing CVD with a tendency for elevation in levels of low density lipoproteins (LDL) and total cholesterol and reduction in high density lipoproteins (HDL), more so in those with tetraplegia to paraplegia, compared to the general population.[16]

The limitations and/or inability to stand, walk or lift weights significantly reduces muscle activity leading to a decrease in muscle mass.[32] Physical inactivity and a sedentary lifestyle are therefore major risk factors in developing CVD. Daily energy expenditure is significantly lower in persons with SCI, not only because of lack of motor function, but also because of a lack of accessibility and fewer opportunities to engage in physical activity. Disruption to the autonomic nervous system and normal cardiovascular control mechanisms also contributes to heightened cardiovascular risk, with changes to peripheral vasculature, blood pressure abnormalities, heart rate variability, occurrence of cardiac arrhythmias and a blunted cardiovascular response to exercise limiting the capacity to perform physical activity.[30] Furthermore, there is an inverse relationship between the neurological level of impairment and maximal oxygen uptake, and typically people with an SCI are able to achieve a maximal heart rate of only 120 to 125 bpm.[33]

Screening, timely identification and judicious management of potential risk factors for CVD, including routine analysis of blood lipids and glucose levels[16] is therefore an essential part of health promotion in a person with SCI. Weight, blood pressure, diet, physical activity, and smoking and alcohol consumption should be regularly monitored in order to identify modifiable risk factors.

6.2 Endocrine System

The endocrine system is vital for secretion of hormones into the bloodstream to mediate a prolonged response in both physiological and behavioural activities within the body. These include metabolism, growth, sleep and tissue function. Disruption of the endocrine system causes dysregulation of hormone release which, along with muscle paralysis and reduced physical activity, leads to body composition changes, obesity and metabolic disorders. In the SCI population, disorders of the endocrine system are the underlying cause of death in 8.1% of cases and contributory to the cause of death in 5.4% of cases.[17]

In the general population, levels of the anabolic hormone testosterone and human growth hormone (GH) decrease with age due to factors such as lifestyle choice and illness. People with SCI have lower testosterone and GH levels than people without injury, with levels decreasing in the third decade of life.[34] Low levels of testosterone are due to a dysfunction in the hypothalamic-pituitary-testicular axis, which in the general male population can lead to decreased libido, impotence, insomnia, fatigue, hot flushes, poor memory, anxiety, depression and irritability.[35] Bone mass, muscle mass and strength may also be reduced, increasing the risk of fractures, body fat and CVD. It is important to note that decreases in lean muscle mass and increases in adipose tissue deposition in the general population progresses as the body ages, yet this occurs prematurely within a person with SCI due to reduced/limited mobility. Testosterone replacement therapy has had some success in people

with SCI[36] by improving their lean body tissue. Dietitians should be consulted for education and development of a balanced diet to help maintain body weight, as well as for controlling serum lipids, bowel function, bone health, skin integrity, fatigue and energy levels, and reducing risk of nutrition-related co-morbidities, such as malnutrition, PIs, CVD and diabetes.

Levels of serum insulin-like growth factor 1 (IGF-1) are also found to be lower in people with SCI, correlating with low levels of GH.[37] This is typically seen in younger people with SCI, and not those who are older. This demonstrates that similar levels of IGF-1 are seen in younger people with SCI to that of the elderly able-bodied population.

People with SCI typically have elevated levels of glucose and insulin, suggesting a state of insulin resistance.[38] This in turn leads to higher rates of diabetes mellitus amongst those with SCI (22%) compared to the general population (6%)[38, 39] and age is a factor that increases the chance of developing diabetes. Education is vital for identification of symptoms which include dehydration, extreme thirst, excessive urination, and weight change, and recognition that the SCI may mask some of these symptoms.

6.3 Musculoskeletal System

The effects of physical ageing are evident in everyone. Changes to the musculoskeletal system (MSK) with ageing in the general population result from reduction in muscle mass and loss of strength, endurance and flexibility, osteoporotic weakening of bones and degenerative changes to articular cartilage, usually related to physical stresses on the joints throughout life. It is thought that MSK conditions associated with SCI are not directly related to chronological ageing but the number of years since injury. This distinction has been described by Krause *et al* (2000) in attempt to isolate the impact of ageing on secondary complications by defining the age of onset of injury.[40]

People with an SCI have unique physical stresses placed on their muscles, tendons and joints by the functional demands of everyday living, with performance of multiple transfers and wheelchair or crutch-assisted mobility for independence in the community, frequently leading to overuse syndromes and pain mainly in the upper limbs. Upper limb pain and overuse occurs in over 50% of the SCI population[16] and a correlation has been reported between ageing and increased shoulder pain. Degenerative shoulder joint changes, tendonitis and rotator cuff tears due to overuse with impingement, instability and muscle balance can result in pain and immobilisation, which can lead to disuse atrophy, contractures and increased disability.[13] While changes in the shoulder joint will occur with normal ageing, growing older with a SCI can intensify any existing bony, joint and musculo-tendinous problems.[41]

Many people are now living for 30 years or more following SCI and while MSK complications do not usually pose a threat to longevity, they occur in a large percentage of individuals and can negatively impact on function, independence and participation. Many MSK conditions can be prevented or limited with activity modification, equipment and therapy.[40]

Management and monitoring is essential as people age and implications for rehabilitation include long-term and routine equipment evaluations and regular upgrades of equipment, regular physiotherapy particularly to maintain range of movement and chair positioning. Educational programmes should be geared towards injury prevention.

Exercise prescription can help to prevent or improve muscle imbalance around the glenohumeral joint. Regular reviews of the biomechanics of transfers and wheelchair mobility and modification of daily activities can help to maintain joint mobility, particularly in the shoulder. Equipment modification as ageing occurs can also help to reduce damage and pain within the MSK.

Surgical repair of rotator cuff tears or shoulder impingement syndromes can be problematic. This method of management creates difficulties for post-operative rehabilitation and there is often an increased need for personal care assistance for some months afterwards. There is very limited research into surgical intervention and temporary post-operative functional limitation compared with the long-term benefits of the intervention, which is an area requiring further prospective research.

In addition to monitoring this system and modifying activities and equipment, frequent standing/weight bearing through lower limbs (for one hour per day, five days per week) during the first two years post injury has been reported to reduce bone mineral density (BMD) loss through mechanical loading of bone stimulating trabecular renovation. It appears that early standing can help to maintain current BMD, but it is not effective at increasing BMD and there is no evidence to suggest that later standing can be effective.[42] High intensity Functional Electrical Stimulation (FES) has been shown to stimulate bone formation at the distal femur[43] and bisphosphonate medications may help to prevent bone density loss.[44]

6.4 Bone Metabolism/ Osteoporosis

Osteoporosis (OP) is the development of skeletal fragility, which increases the risk of fractures.[45] OP is a common condition affecting a majority of people with SCI. The exact cause of OP following SCI is not known, but it is thought that disuse of the skeletal system is a contributing factor.[46] Other factors include the degree of neurological impairment, the extent of spasticity, ageing, gender and duration post injury.[47] There may also be an increase in bone resorption and repair below the level of the injury due to factors including decreased blood flow, venous stasis, tissue acidosis and hormonal changes.[46] Some medications also cause bone demineralisation. This condition is responsible for pathological fractures following SCI. OP in the lower limbs develops rapidly in the first year after a SCI, with up to one-third of bone mass lost in the first 16 months following injury,[16] but can continue to decrease at a lower rate for between three to eight years post injury,[48] often reaching steady state values below normal clinical fracture thresholds. The extremity fracture rate and lower limb fracture rate is reportedly over 30% of the SCI population.

The pattern of bone loss following SCI is significantly different from OP caused by disuse or post-menopausal OP. OP following SCI does not usually affect the lumbar spine as it does in the general population and usually does not occur above the level of the lesion.[47] The regions of greatest bone loss and most common fracture sites are the supracondylar distal femur and proximal tibia, with trabecular bone often reduced by around 50% in distal femur and up to 60-70% in proximal tibia. Complications following a fracture are also significant and include hospitalisation, increased medical costs and increased disability.

There is also a physiological decrease in BMD in the persons ageing with SCI. BMD assessments are an effective measure to predict an increased risk of fracture and are necessary to inform appropriate clinical management and prevention, with BMD in the general population decreasing in women after menopause and in men with ageing.

Due to the prevalence and severity of OP following SCI, it is important to establish long-term rehabilitation with patients and develop effective screening and management procedures to minimise or prevent fractures. Research clearly shows that effective OP intervention can reduce the risk of sustaining a fracture by up to 50% in the general population.[44] A combination of regular screening of BMD, weight bearing exercise and pharmacological interventions are recommended.[47] Vitamin D deficiency has been reported to be very common in persons with SCI[49] and furthermore calcium intake may also be lower.[50] Weight bearing exercises, including walking and Functional Electrical Stimulation (FES) cycling, have been shown to increase BMD in the femoral neck. Pharmacological intervention may include a combination of supplements and medications, including calcium, vitamin D, bisphosphonates and calcitonin.

Poor compliance and limited persistence with interventions leads to an increase in incidence of fractures after one year of treatment. Adherence to preventative treatment for OP should include long-term nurse lead follow-up.[44] Educational programs, easier to follow medication regimes and close monitoring may help to maintain compliance with long-term treatment. The development of options for intermittent medication, e.g. monthly oral medication or medication injected at longer intervals, may also improve long-term adherence to treatment and help to decrease OP related fractures and complications for the persons with SCI. Some improvements in bone density have been found with acute use of bisphosphonates in some sites of the body in people with spinal cord injury.[51] There is a need for further study, with attention to specific populations and uniform BMD measurement sites before the extent of the effectiveness of this modality can be known.

6.5 Respiratory System

Disorders of the respiratory system are among the most common causes of mortality and morbidity in people with SCI and age is a contributory factor.[52] For example, people with SCI often have an ineffective cough, due to the loss of major expiratory abdominal and intercostal muscles. This causes the inefficient clearance of lung and airway secretions, increasing the risk of atelectasis and recurrent respiratory tract infections. During normal ageing there is a natural gradual decline in immune function contributing to an increase in susceptibility to respiratory conditions, including infections, lung disease and pneumonia,[53] thus combining the ageing process with an SCI exacerbates the susceptibility to respiratory infections. In addition to encouraging cessation of smoking and maintaining a healthy body weight, people with SCI should have their respiratory function and lung vital capacity periodically assessed. Recommended treatments include manual assisted coughing and mechanical cough assistance, positive-pressure ventilation to prevent respiratory failure in some individuals with very

limited respiratory capacity, and resistance training of the inspiratory and expiratory muscles to improve function. The use of antibiotics to treat infections,[16] annual influenza vaccinations and pneumococcal disease vaccination are also recommended. Long-term administration of salmeterol has also been shown to improve cough effectiveness.[54]

Obstructive sleep apnoea is known to be exacerbated with SCI due to various factors, including increased neck circumference and body weight, decreased lung volume capacity and longer duration spent lying in a supine position.[55] Although there appears to be no clear relationship between the age of the person with SCI and problems with sleep,[56] difficulties with sleep can contribute to poorer health outcomes. Current therapeutic approaches include continuous positive airway pressure (CPAP) although this may not be well tolerated due to discomfort from the mask.[57]

6.6 Gastrointestinal System

Dysfunction of the GI system occurs quickly after injury, with reduced GI tract peristalsis and loss of coordination of large propagating contractions causing increased colonic transit time. This frequently leads to problems with faecal incontinence and constipation, which if left unmanaged contribute to a poor quality of life. As well as changes to muscle function, stomach pH increases and the blood flow to the liver and cytochrome P450 levels decrease[58] affecting the synthesis and metabolism of various endogenous biomediators and drugs.

There is little evidence to show that the GI system prematurely ages in people with SCI,[9] although it is known that GI system function naturally declines with age in the general population, involving a slowing of gut and colon motility with increased water absorption from the colon that can lead to constipation and hard stools. In older people with SCI and in those who have been injured for longer, constipation and other bowel-related problems such as impaction with spurious diarrhoea, abdominal bloating and pain, AD and rectal bleeding from haemorrhoids are more prevalent.[59] Proposed management strategies include regular bowel care with digital rectal stimulation timed appropriately after meals, high fibre diet, an adequate fluid intake (2 to 3L water/day), combined with use of bulking agents and/or surface softening or osmotic laxatives, although these treatments can be ineffective and expensive. Transanal irrigation shows potential in treating bowel dysfunction.[60, 61] Colostomy is another option that should be considered in those with severe, intractable bowel symptoms, as this procedure has resulted in reduced bowel care time (from 10.3 to 1.9hrs/week), greater independence and improved quality of life, with a majority wishing the stoma had been offered earlier rather than as a last resort.[62] More effective bowel clearance prior to colonoscopy in persons with neurogenic bowel dysfunction after SCI (allowing better visualisation of the bowel wall) has recently been reported through the use of Moviprep® and Pulsed Irrigation Enhanced Evacuation (PIEE) with or without neostigmine/glycopyrrolate.[63] This improved clearance advances the detection of polyps, which can be difficult to detect in people with SCI.

6.7 Genitourinary System

SCI interrupts the normal coordination of the detrusor and sphincter reflexes that allow reciprocal control of the bladder and its outlet for low pressure filling and efficient voiding. While there may be some recovery in function over time, the person with SCI is often left with bladder complications including bladder overactivity, detrusor-external sphincter dyssynergia, bladder weakness, incontinence and loss of bladder control, which affect quality of life. Effects of ageing interact with alteration of lower urinary tract physiology, bladder management technique and duration since injury, leading to more problems occurring over time. Bladder infections are most common amongst people with SCI using an indwelling catheter which can be exacerbated as they age due to the natural diminishing capacity of the bladder, increase in involuntary bladder contractions, decline in kidney function and weakening of the immune system. Increased frequency of urinary tract infections can also be associated with reflex voiding and less efficient emptying of the bladder and high residual volumes as the person ages and may develop prostatic hypertrophy. Since the risk of urinary tract infections and kidney stones is greater in the SCI population and this risk increases with age, it is recommended to initially screen annually, then screen every two to three years for deterioration of the urinary tract and ultrasound or CT scans for detection of kidney stones.

People with SCI who use an indwelling catheter for a prolonged period of time have been reported to be at a higher risk of bladder cancer compared to the general population[64] and are typically younger at the age of onset. The incidence of bladder cancer in people with SCI may increase as life expectancy improves after SCI. Screening has been proposed for detecting a malignancy early in people with SCI since by the time they are diagnosed, the cancer cells are often metastatic and

invasive.[16] However, the benefits of screening need to be weighed up against the potential risks and inconvenience this screening may cause for people with SCI. The risk of bladder cancer can be minimised by avoiding use of indwelling catheters and other risk factors such as smoking cessation, limiting exposure to aromatic amines (such as pesticides, smoke and exhaust fumes) and reducing the risk of and treating urinary tract infections and bladder stones. Anticholinergic medications may be useful in controlling bladder symptoms by blocking the receptors of the detrusor muscle. This reduces the frequency, urgency and incontinence of the urinary system in those performing intermittent catheterisation or with a permanent catheter.[65]

It has been reported that males with SCI have a lower risk of prostate cancer due to impaired testosterone levels compared to the general population.[9] However, although there is a lower incidence of prostatic cancer in men with SCI, it has also been suggested that prostate cancer in this group may be detected later at a more advanced stage and more likely to have a poorer outcome, so screening is important and should be recommended.

6.8 Skin

Pressure injuries (PIs) are common secondary complications amongst people with SCI who are susceptible to skin breakdown due to factors including immobility, impaired sensation and prolonged periods of sitting. This increase in interface pressure can be relieved by recommending frequent repositioning or regular pressure relief manoeuvres (leaning forwards or to the side in the wheelchair for two minutes to allow tissue reoxygenation) be incorporated into the person's everyday lifestyle. The use of suitable pressure redistribution cushions in prescribed wheelchairs and mattresses after personalised assessment using pressure-mapping systems is also crucial.[66, 67] PIs are more prevalent post injury with a history of previous PIs being an indicator that more PIs are likely to develop.[16] In addition, as skin collagen degrades over the years, the skin becomes thinner and loses elasticity making it more susceptible to PIs, blisters and other skin breakdown. Persistent monitoring of the skin and preventative education in a person with SCI as they age is necessary. Recommended measures include cessation of smoking to improve skin blood flow, assistance with keeping the skin clean and dry, adequate nutrition for skin integrity, frequent pressure relief, periodic review of equipment and transfer techniques and consideration of a different pressure mattress/cushion is recommended.

6.9 Immunological System

The immune system is compromised early after an SCI and although it is well known that the immune system declines with age,[68] little is known about how ageing with SCI affects this system. Nonetheless, the risk of infection has been shown to increase the longer the duration since SCI.[69] In the initial stages after an SCI, systemic inflammation is elevated during which inflammatory cells infiltrate the tissues in response to the damage.[70] Inflammatory cells include neutrophils, monocytes and macrophages which secrete and activate pro-inflammatory cytokines such as interleukin-1β (IL-1β), IL-2, IL-6, interferon-γ (IFN-γ) and tumour necrosis factor (TNF). An increase in systemic inflammation is also associated with the prevalence of PIs and increased circulating triglycerides, in particular C-reactive protein, linked with abdominal obesity.[14] People with SCI need to be educated to maintain their health and identify infections at an early stage for treatment, as well as keeping their immunisations up-to-date, particularly as they age.

6.10 Nervous System

The nervous system is comprised of two systems: the central nervous system (CNS) which is composed of the brain and spinal cord, and the peripheral nervous system (PNS) which consists of peripheral nerves. The PNS acts as a means of communication between the CNS and the limbs, organs and tissues of the body, transmitting signals between different areas of the body to coordinate actions. This reaction time deteriorates during the ageing process. There is little evidence to show that neither the PNS nor CNS prematurely declines in people with SCI,[37] although age-related dropout of anterior horn cells is presumed to play a role in late onset weakness or sensory loss. Nervous system dysfunction in people with SCI contributes to 8.1% of deaths, and 27% as contributing to the cause of death.[17]

Neuropathic pain is common following SCI and can substantially reduce the person's ability to function and their quality of life. Neuropathic pain typically occurs at or below the level of the lesion being characterised by burning, stabbing and/or shooting pain, which may be intermittent or constant and may fluctuate in intensity. Neuropathic pain can be exacerbated by other conditions including urinary tract infections and bowel dysfunction,[71] but there is no evidence to suggest that neuropathic pain increases with age.

Early onset of pain in people with SCI is a strong predictor of future pain. Approximately two-thirds of people with

SCI experience some form of pain, with one-third of these reporting severe pain.[72] People with pain related to their SCI are often unable to gain significant relief from pharmacological medications or have to discontinue their use due to side-effects.[72] In addition, pharmacological management of pain may be affected due to the pharmacokinetics and pharmacodynamics of drugs changing as the body ages,[58] thus medications must be reviewed regularly and adjusted accordingly.

Psychosocial and environmental factors have been shown to play a key part in the experience of chronic pain in people with SCI.[73] Returning to work and involvement in social interactions and activities have been reported to reduce pain, thus it is recommended for all health care providers to assist in providing opportunities and encourage involvement in these activities.

Post traumatic cystic myelopathy (syringomyelia), a progressive enlargement of a cystic cavity (or syrinx) which originates at the site of injury in the spinal cord, may also occur in people with SCI, causing neurologic deterioration.[74] Onset may take months to years after injury, being heralded by changes in neuropathic pain, or spasticity, deterioration in function with an ascending sensory loss with or without motor weakness, or sometimes autonomic symptoms such as increased sweating. Detection of a syrinx is by MRI scan and neurosurgical management by de-tethering of spinal arachnoid scarring with or without shunting may be indicated to relieve the symptoms associated with the cyst or prevent further progression.

6.11 Mental Health and Cognition

Changes in brain function occur naturally over time with age, but SCI does not appear to accelerate this deterioration. However, cognitive changes may be associated with SCI related to concomitant traumatic brain injury, obstructive sleep apnoea and possibly altered cardiovascular control and cerebral artery blood flow.[75] It has been reported that people with SCI, aged typically between mid-twenties to late forties, are more likely to experience depression compared to those younger and older, probably due to the extra stresses concerning career, children and finances.[14] Younger people are potentially quicker to adapt to the life changes associated with SCI, whilst people who are older and have had their injury for a long time have had time to adapt psychologically to the challenges having a SCI can bring. However, during the ageing process, further physical limitations can occur leading to increased dependency on carers, thus older generations with SCI have a greater tendency to become depressed than those of the general population.

Health care providers need to look out for the signs and symptoms of psychological stress and provide quality information and support to people in a time appropriate manner. Recommendations for maintaining psychological health include maintaining social connections and being pro-active within the community, doing physical activity, encouraging the uptake of a hobby/activity and making sure the person with SCI knows when to ask for help should they need it. If it is suspected that someone has a significant psychological disorder, it is important to seek treatment by referral to a specialist for assessment and treatment whether through medication or psychotherapy. Guidelines for treatment of depression, anxiety and other post-traumatic stress disorders can be found on the Australian Centre for Post Traumatic Mental Health website: http://www.acpmh.unimelb.edu.au/resources/resources-guidelines.html (Accessed May 2014).

6.12 Psychosocial, Family and Caregiver Issues

Time affects our bodies, leading to a physical decline. However, these changes need not have a negative effect on those with SCI if they are able to adapt and maintain their functional abilities. It is important to acknowledge how an individual perceives the physical changes associated with ageing along with being able to adapt their lifestyle accordingly.[16]

The most important issue for psychosocial health is independence. Maintaining independence may become increasingly difficult for a person ageing with a SCI. In fact, ageing is a predictor for functional decline and increased physical dependency in the SCI population.[16] It is also more common for this age associated physical decline to occur at a comparatively younger age in those with SCI than those in the general population.

SCI can affect the whole family and close friends, including the community, both physically and emotionally. It is known that those with SCI will most likely require more assistance as they age, however it must also be taken into consideration that carers and family members are also ageing and may develop health issues of their own. With this is mind, people with SCI may also become affected by the health issues concerning their carers and family members.

Informal social networks are essential in filling the gaps that exist in the formal health care system for individuals with SCI.[76] It is thought that a good social support system can improve both the health and function of a person with SCI, however the extent to which social networks are able to influence health requires further study.

In order to effectively manage any secondary health complications that may arise, activities may need to be modified as ageing occurs. The introduction of adaptive equipment or technology will help maintain as much independence for as long as possible. When physical assistance becomes necessary, it is important that the individual is still making decisions and directing their own care as much as possible. Regular assessment of family and carers' mental and physical health is also very important. Respite care for people with SCI can provide assistance for all members of the social support network.

It is recommended that care should not always be provided by a spouse, family member or parent. Care by a spouse in particular may be perceived negatively with increasing age[16] and it is important to maintain a cooperative approach between the individual, family members and caregivers to increase the success of ageing for the individual with SCI. Systematic surveillance by an SCI team to identify potential problems at their earliest onset may be set in place and ongoing education for health care providers regarding the physical, psychological and social consequences of ageing is necessary.

6.13 Injury/Falls

People with SCI have a long life expectancy and falls may increase with advancing age.[77] This is a primary health concern for older people in the general population [78] including those with SCI who are ambulatory. A decrease in balance and gait, as well as muscle weakness and a general decline in other body systems, all contribute to the increase in falls seen in the ageing population. A history of falling is an important risk factor for future falls and a fear of falling can lead to reduced activity, which in turn can contribute to loss in balance, muscle weakness and decreased gait. Up to 75% of all participants with SCI who were ambulatory have at least one fall.[78] This usually occurred in the home and was more frequent towards the end of the day. Falls from a wheelchair are also more likely to happen in the home at the end of the day,[79] with people in a wheelchair being found to have more frequent falls than other groups, including those with neurological conditions such as Parkinson's disease and peripheral neuropathy. It has also been reported that people with SCI are more likely to suffer from fractures due to decreased bone density and 45% of those who fall were more likely to participate less in community activities due to the risk and consequences of falling. The main cause of falling was reported as a loss of balance in a hazardous environment.[79]

There is a need to identify the risk factors and provide interventions to decrease the risk of falling and prevent injury in the SCI population and since ambulation is a highly coveted goal for those with SCI, rehabilitation must therefore address the importance of safety. A full history and assessment must be done including a falls history, clinical testing and physical assessments to try and identify any factors, in addition to ageing, that may increase the risk of falling.

7. SUMMARY OF RECOMMENDATIONS

It is important for primary care physicians to be familiar with the needs of those with SCI and to have a coordinated approach to be accessible and work together with other medical specialists.[32] It is useful for those with SCI and their health care team to be aware of which changes to expect with ageing and to identify preventative strategies to minimise the effects of ageing.[16] It is important to allow the management of SCI and its comorbidities to be a proactive, coordinated approach.[32] Recommendations for health surveillance are summarised in the following table.

Recommendations	
Cardiovascular System	• Primary care physicians should have a coordinated approach, be accessible and work with other medical specialists. • Routine analysis of blood lipids and glucose levels. • Regularly monitor weight, blood pressure (in sitting and supine lying), diet, physical activity, smoking and alcohol consumption.
Endocrine System	• Education is vital for a balanced diet to help maintain body weight and for identifying symptoms of endocrine dysfunction.
Musculoskeletal System	• Long-term and routine equipment evaluations, regular upgrades of equipment and periodic review by a physiotherapist or occupational therapist of the mechanics of mobility and modification of daily activities to suit. • Educational programs geared towards injury prevention. • Exercise prescription to prevent or improve muscle imbalance.
Bone Metabolism/ Osteoporosis	• BMD assessments, weight bearing exercises and pharmacological interventions for management and prevention. • Encourage adherence to preventative treatment with long-term nurse follow-up.
Respiratory System	• Encourage cessation of smoking and maintenance of a healthy body weight. • Periodical assessment of respiratory function and lung vital capacity. • Recommended treatments include: o manual assisted coughing or mechanical cough assistance; o resistance training of the inspiratory and expiratory muscles to improve function; o antibiotics to treat infections, annual influenza vaccinations and pneumococcal disease vaccination; o use of Salmeterol.
Gastrointestinal System	• Proposed management strategies include promoting a regular bowel routine with appropriate timing and rectal stimulation, a high fibre diet, good fluid intake and judicious use of stool bulking agents and/or softening laxatives.
Genitourinary System	• Screen for urinary tract deterioration initially yearly, then every two to three years. • Ultrasound or CT scans for detection of kidney stones, if suspected. • Consider malignancies – risks minimised by avoiding use of indwelling catheters, smoking cessation, limiting exposure to aromatic amines, and reducing the risk of and treating urinary tract infections.

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Recommendations	
Skin	• Use of pressure mattresses and cushions as well as frequent repositioning/pressure relief manoeuvres. • Persistent monitoring of the skin. • Preventative education, e.g. cessation of smoking, keeping skin clean and dry, and adequate nutrition.
Immunological System	• Education to maintain health and identify infections at an early stage for treatment. • Keep immunisations up-to-date.
Nervous System	• Review medications and adjust as necessary. • Health care providers to assist in providing opportunities and encourage involvement in these activities.
Mental Health and Cognition	• Health care providers to look out for the signs and symptoms of psychological stress and provide information to those who need it. • Maintain social connections and be pro-active within the community, physical activity, encourage uptake of a hobby/activity and make sure the person with SCI knows when to ask for help should it be needed.
Psychosocial, Family and Caregiver Issues	• Informal social networks are essential. • Activities may need to be modified as ageing occurs. • Adaptive equipment or technology will help maintain independence. • Family and carers mental and physical health should be regularly assessed. • Care should not always be provided by a spouse, family member or parent. • SCI team to identify potential problems at their earliest onset.
Injury/Falls	• Take a full history for falls, and assess clinically and physically to identify factors that increase the risk of falling.

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