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# **GUIDELINES FOR SCREENING AND MANAGEMENT OF LATE AND LONG-TERM CONSEQUENCES OF MYELOMA AND ITS TREATMENT**

**A British Society for Haematology Guideline**

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**Running title:** Late Effects in Myeloma

## **SUMMARY**

A growing population of long-term survivors of myeloma is now accumulating the 'late effects' not only of myeloma itself, but also of several lines of treatment given throughout the course of the disease. It is thus important to recognise the cumulative burden of the disease and treatment-related toxicity in both the stable and active phases of myeloma, some of which is unlikely to be detected by routine monitoring. We summarise here the evidence for the key late effects in long-term survivors of myeloma, including physical and psychosocial consequences (in Parts 1 and 2 respectively), and recommend the use of late-effects screening protocols in detection and intervention. The early recognition of late effects and effective management strategies should lead to an improvement in the management of myeloma patients, although evidence in this area is currently limited and further research is warranted.

## METHODOLOGY

These guidelines were developed using the following stages:

- Review of key literature from 1 April 2006 to 31 March 2016 using the Cochrane database (search term: myeloma) and Medline: search terms used were [myeloma] + late effects, long term effects, frailty, geriatric assessment, infection, infection prophylaxis, vaccination, nutrition, exercise, rehabilitation, employment, endocrine, disability, late treatment consequences, cancer survivorship (for all papers); and psychological, fatigue, second primary malignancy, quality of life, infection (reviews). As organ-specific areas, such as renal and bone, have been covered in previous guidelines, searches were not re-performed.
- Development of key recommendations based on randomised, controlled trial evidence. In the absence of randomised data, recommendations were developed on the basis of literature review and a consensus of expert opinion.
- Updating of the levels of evidence and grades of recommendation using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) nomenclature for assessing the quality of evidence and providing strength of recommendations. (<http://www.gradeworkinggroup.org/index.htm>).
- Review of the manuscript was performed by the British Society for Haematology (BSH) Guidelines Committee and Haemato-Oncology Task Force, and the BSH sounding board, comprised of 50 or more members of the BSH who have reviewed this Guidance and commented on its content and applicability in the UK setting, consistent with the primary target audience of UK based multidisciplinary clinical teams treating myeloma and its complications. Involvement of patient perspectives was through Myeloma UK.

- In preparing these guidelines, the authors have considered overall cost-effectiveness and budget impact of recommended interventions as well as clinical efficacy data and the burden / impact on patients. Formal health economic assessments have not been carried out.

## INTRODUCTION

As well as aiming to prolong life, modern cancer care needs to address the side effects of treatment, comorbidities and the impact of the physical disease and its treatment on psychological and social wellbeing (Ahmedzai and Walsh, 2000). In many cancers, late physical and psychosocial consequences following completion of treatment are increasingly recognised. These 'late effects' have been defined by the US National Cancer Institute as: '*[A] health problem[s] that occur[s] months or years after a disease is diagnosed or after treatment has ended. Late effects may be caused by cancer or cancer treatment. They may include physical, mental and social problems, and second cancers*' (National Cancer Institute).

With the improved outcomes for a range of cancers, increasing attention is merited for late disease and treatment effects and their impact on patient experience (Denlinger et al, 2014). Late effects are increasingly relevant to myeloma patients, given that they can often live for over a decade post-diagnosis, have repeated lines of complex therapies and have long-term disease control in the absence of cure.

### ***Late effects in myeloma***

Life expectancy for myeloma patients has increased significantly in the last 10-20 years (Renshaw et al, 2010). The five-year relative survival rate for England rose from 19.9%/21.8% (men/women) in 1991-1995 to 37.1% (both sexes) in 2005-2009 and 42.2% (both sexes) in 2007-2011; and the ten-year rate from 8.9%/9.8% (men/women) in 1991-1995 to a level for England and Wales for 2007 of 19.0%/14.9% and 36.6%/28.1% (men/women) in England in 2010-11 (Office for National Statistics, 2011; Cancer Research UK Cancer Survival Group, 2012). Similar levels of improvement have been shown for the other countries of the UK (Woods et al, 2010), and survival rates for patients diagnosed today may be underestimated on the basis of current data (Cancer Research UK).

Increased life expectancy is mainly due to the availability of novel chemotherapeutic agents, the proteasome inhibitors and immunomodulatory agents and the adoption of haematopoietic stem cell transplantation (HSCT) (Klepin and Hurd, 2006; Bird et al, 2011; Pratt et al, 2014; Cook et al, 2014) as well as earlier diagnosis and improved supportive care (Snowden et al, 2011).

The physical health of a patient with myeloma is complex, reflecting the effects of the disease, other comorbidities, frailty and the ageing process. Myeloma treatments also have side effects, which may involve permanent organ damage. Patients with myeloma typically undergo courses of treatment followed by periods of stable remission and relapse, although the increasing use of consolidation and maintenance now means that many may remain on treatment for prolonged periods of time during disease stability. The toxicity of multi-drug regimens may combine with the effects of the disease, other comorbidities and the ageing process to diminish physical, psychological and social functioning. Fatigue and pain (predominantly neuropathic and/or bony) (Boland et al, 2013; Jordan et al, 2014; Osborne et al, 2012) are the common symptoms for myeloma patients and the drugs used to treat pain add to the burden of fatigue and other side effects, further reducing quality of life (Snowden et al, 2011; Boland et al, 2013; Jordan et al, 2014; Osborne et al, 2012; Sloat et al, 2015; Bilotti et al, **2011a**; **Bilotti et al 2011b**). Infections are common, especially during active disease and following HSCT (Snowden et al, 2011; Bilotti et al, **2011a**; **Bilotti et al 2011b**), and are a major cause of morbidity and mortality.

This leads to a complex burden for the patient and his/her family, and a high impact on psychosocial wellbeing and health-related quality of life (HRQoL). Given the extended duration of life and cumulative effects, the burden is often greatest in those with advancing age and multiply-relapsed disease.

## ***The case for screening and management of late effects in myeloma***

A key principle of the NHS-based National Cancer Survivorship Initiative (NCSI; England only) is improving management of the consequences of treatment, from diagnosis onwards (National Cancer Survivorship Initiative<sup>a</sup>). Likewise 'survivorship', defined by the US National Cancer Institute, "*focuses on the health and life of a person with cancer post treatment until the end of life. It covers the physical, psychosocial, and economic issues of cancer, beyond the diagnosis and treatment phases*" (US National Cancer Institute).

The combined late effects of myeloma and its treatment constitute a unique syndrome. Survivorship in myeloma therefore requires specialised screening, coordinated management and multidisciplinary care. BCSH/UK Myeloma Forum (UKMF) guidelines for diagnosis and management (Bird et al, 2011; Pratt et al, 2014) and for supportive care (Snowden et al, 2011) in myeloma have been published **and** NICE have also produced guidelines for myeloma management (<https://www.nice.org.uk/guidance/ng35>). **Aspects of survivorship in myeloma have been previously identified by North American authors as areas of significant need for care and screening guidelines have been developed for detection of late complications relating to novel therapies and HSCT (National Cancer Survivorship Initiative<sup>a</sup>; Bertolotti et al, 2008; Faiman et al 2008; Smith et al 2008; Tomblyn et al, 2009; Bilotti et al 2011a; Bilotti et al 2011b; Richards et al 2011; Majhail et al 2012; Majhail and Rizzo 2013). However there is no comprehensive, multidisciplinary guideline document for the screening, management and long-term care of myeloma patients.**

### ***Aims***

These guidelines highlight the key late effects and broader treatment consequences of myeloma, and make recommendations for screening and management of all patients from the start of therapy, along with other appropriate measures to optimise quality and quantity of life. They are directed primarily at myeloma clinicians and their teams in secondary care,

but also provide a reference for primary care clinicians and other hospital-based specialists who will inevitably be involved in ongoing patient management. As this is a clinical guideline, no formal economic evaluation has been performed and local arrangements will determine delivery of care.

## **PART 1. LONG-TERM PHYSICAL CONSEQUENCES**

### ***Infection and immunity in myeloma***

Myeloma causes profound immunodeficiency which varies during the disease course and for most patients lasts lifelong. The immunodeficiency involves numerical and functional defects of B cells, T-cell subsets, natural killer cells, dendritic cells (Schutt et al, 2006; Ogawara et al, 2005; Brown et al, 2001) and possibly neutrophil function. This is compounded by the immunomodulatory effects of high-dose corticosteroids and novel agents, neutropenia and host factors such as immobility.

Most myeloma patients ultimately die of infection-related causes and immunosuppression is directly related to disease activity. Approximately 10% of patients die within 3 months of diagnosis and infections are often due to encapsulated bacteria (Augustson et al, 2005). Atypical infections (e.g. cytomegalovirus (CMV), *Pneumocystis jirovecii*, cryptococcus) are increasingly seen in late-stage heavily treated patients (Teh et al, 2013). Most infections are not fatal but may have a major effect on HRQoL. These guidelines exclude the peri-HSCT period since specific guidelines already exist (Majhail and Rizzo, 2013; Rubin et al, 2014).

<b>Table 1. Myeloma timeline: Periods of severe immunosuppression and associated common pathogens</b>		
<b>Period</b>	<b>Immunological effects</b>	<b>Common pathogens</b>
At diagnosis and at times of aggressive relapse	Disease active; profound immunosuppression.	Bacterial infections, especially <i>Streptococcus pneumoniae</i> , <i>Haemophilus influenzae</i> and <i>Escherichia coli</i>
Immediate post-autologous stem cell transplant period (~one month)	Neutropenia	Bacteria associated with neutropenic sepsis
Recovery post autograft (up to ~6 months)	Gradual reconstitution of T cell-mediated immunity	<i>Pneumocystis jirovecii</i> HSV, VZV, CMV, rarely invasive fungal infection
Remission	Immunity improved	Appropriate time for elective vaccinations  Re-vaccination schedule >6 months after autograft
Multiple relapses, increasingly refractory disease	Progressive immunosuppression from underlying disease and multiple therapies	Bacteria as above, but in addition: progressive diminution in resistance to viral infections especially HSV, VZV, influenza, occasional atypical infections e.g. aspergillus, CMV, cryptococcus

Abbreviations: HSV, herpes simplex virus; VZV, varicella zoster virus; CMV, cytomegalovirus

### *Prophylactic anti-infective drugs*

Insufficient data are available to recommend prophylactic antibiotics routinely at any stage of myeloma (NICE, 2016), although their importance is well recognised in patients with other causes of immunodeficiency, such as neutropenia following chemotherapy. Trials of co-trimoxazole versus placebo or ciprofloxacin or co-trimoxazole versus placebo in newly-diagnosed myeloma patients have shown limited benefits of co-trimoxazole, but were too small to draw reliable conclusions (Oken et al, 1996; Vesole et al, 2012). The current 800-patient TEAMM trial (Tackling EARly Morbidity and Mortality in myeloma), which compares prophylactic levofloxacin with placebo in newly-diagnosed myeloma patients, may address these issues (TEAMM). Pomalidomide treatment is associated with 23-30% risk of infection and it has been suggested that prophylactic antibiotics could be given for the initial 3 months of therapy (Dimopoulos et al, 2014). Ciprofloxacin and enoxacin should be used with caution, as they can interact via cytochrome pathways, but levofloxacin, moxifloxacin, norfloxacin and ofloxacin are safe.

Myeloma patients have an increased risk of viral infections, especially herpes zoster and influenza (Blimark et al, 2015). Proteasome inhibitors, immunomodulatory drugs (IMiDs) and high-dose corticosteroids increase this risk, particularly for herpes zoster reactivation (Kim et al, 2008; Chanan-Khan, 2008). Reactivation is greatly reduced by routine antiviral prophylaxis during bortezomib and lenalidomide treatment (Kouroukis et al, 2014; Pour et al, 2009; König et al, 2014), which should be continued for at least 6 weeks after stopping treatment (Terpos et al, 2015). Consider continuing aciclovir indefinitely for patients with previous shingles (400 mg once daily (Vickrey et al, 2009; Pour et al, 2009) or 200 mg once daily in the presence of renal impairment (Minarik et al, 2012)).

Invasive fungal infection is rare in myeloma (Chanan-Khan et al, 2008; Nucci and Anaissie, 2009) but oropharyngeal candidiasis can occur with prolonged corticosteroid therapy.

Recommendations on the use of intravenous immunoglobulin in myeloma are hampered by insufficient data (NICE, 2016; Raanani et al, 2009; Chapel et al, 1994; Musto et al, 1992; Hargreaves, 1992) but suggest a possible benefit of immunoglobulin for patients in plateau phase.

Intravenous immunoglobulin can increase levels of antibodies to common pathogens in myeloma patients (Raanani et al, 2009; Sklenar et al, 1993; Thurmann et al, 2011; Kobold et al, 2012; Morell and Barandun, 1988). The appropriateness of immunoglobulin replacement should be assessed in terms of infection history, comorbidities, hypogammaglobulinaemia and failure to respond to vaccination. Immunoglobulins should be administered in accordance with national guidance (<https://www.gov.uk/government/publications/clinical-guidelines-for-immunoglobulin-use-second-edition-update>).

### *Vaccination*

The response to all vaccines is typically reduced in myeloma patients. Response is heterogeneous and despite blunted responses, there appears to be clinical benefit (Cheuk et al, 2011; Esposito et al, 2010; Musto and Carotenuto, 1997). Ideally, functional antibody levels should be used to measure response and inform further vaccination, but guidance in this area is lacking.

Clear recommendations on the timing of vaccination are impossible through lack of data, but vaccinating a myeloma patient while on treatment or with active disease is likely to be less effective (Kobold et al, 2012; Hinge et al, 2012; Schmid et al, 1981; Public Health England, 2014) than during remission off therapy. Deferring vaccination may not be practical, e.g. seasonal flu vaccination, and may still have some efficacy (Cheuk et al, 2011; Schmid et al, 1981).

Myeloma patients should only receive inactivated vaccines (Table 2). Live attenuated vaccines (BCG, measles, measles/mumps/rubella (MMR), oral typhoid, herpes zoster, rubella, yellow fever) should be avoided.

<b>Table 2. Common inactivated vaccines suitable for myeloma patients</b>
<ul style="list-style-type: none"><li>• Diphtheria, tetanus and polio*</li><li>• <i>Haemophilus influenzae</i> b (Hib)</li><li>• Hepatitis A</li><li>• Hepatitis B</li><li>• Influenza†</li><li>• Meningococcal</li><li>• Pneumococcal (PCV13 + PPV23)‡</li><li>• Typhoid injection (but NOT the vaccine given by mouth)</li><li>• Pertussis</li></ul>

\*Oral live polio vaccine (OPV) is no longer available for routine use in UK and should not be used.

† Influenza vaccines in the UK are inactivated. This may not apply in other countries.

‡ See text.

It is recommended that all myeloma patients are vaccinated yearly against influenza. Consider vaccinating close household contacts with both the influenza and the varicella-zoster vaccine (Public Health England, 2015). It is recommended that myeloma patients receive the conjugate pneumococcal vaccine (PCV13), followed by the polysaccharide PPV23 at least two months later. Those who have already received a single dose of PPV23 should be offered PCV13 at least six months after the PPV23, to reduce the risk of pneumococcal serotype-specific hyporesponsiveness (Public Health England, 2013). The *Haemophilus influenzae* type b vaccine (Hib) should also be

considered (Nix et al, 2012). Following autologous or allogeneic HSCT, patients are advised to follow a re-vaccination schedule according to the relevant guidelines for patients undergoing HSCT (NICE, 2016).

## **Recommendations**

### **Assessment**

- Offer patients education so that they can readily recognise infection, understand its implications and seek help (Grade 1C).

### **Management**

#### ***Prophylaxis***

- Routinely, antibiotic prophylaxis is not recommended (Grade 2B).
- Offer routine prolonged antiviral prophylaxis against herpes zoster to patients receiving proteasome-based treatments (until at least 6 weeks post-treatment) and post-HSCT (Grade 1A) and consider for those taking both immunomodulatory drugs with high-dose corticosteroids (Grade 1C). Consider lifelong prophylaxis for those with previous shingles (Grade 2C).
- Consider intravenous immunoglobulin replacement based on infection history, hypogammaglobulinaemia, comorbidities and vaccination response and in accordance with national guidance (Grade 1C).

#### ***Vaccination***

- Do not offer live attenuated vaccines at any stage of myeloma (Grade 1B).
- Ideally offer vaccination during periods of minimal disease and when recovered from treatment (Grade 1B).
- Offer seasonal inactivated influenza and a single course of pneumococcal vaccination (PCV13 followed by PPV23) (Grade 1C)
- Consider *Haemophilus influenzae* (Hib) vaccination (Grade 2B).
- Offer a specific schedule of re-vaccination for patients who have undergone autologous or allogeneic HSCT (Grade 2B).

- **Consider vaccination against influenza and herpes zoster for patients' close contacts (Grade 2C).**

### ***Renal and urogenital complications***

Renal impairment occurs in up to 50% of myeloma patients and is common at presentation. Patients presenting with renal failure are at high risk of early death (Augustson et al, 2005). Causes include cast nephropathy, infection, dehydration, hypercalcaemia, hyperuricaemia and renal involvement with AL amyloidosis, and possibly with use of non-steroidal anti-inflammatory drugs (Bird et al, 2011). Aggressive early management of these factors and urgent treatment of the underlying myeloma often improves renal function. However, even with initial improvement, patients presenting with renal impairment have a higher chance of developing worsening renal impairment at relapse. The risk of irreversible renal failure increases markedly with time.

Haemorrhagic cystitis may be caused by cyclophosphamide or infections, particularly after HSCT, but is usually short-lived and self-limiting. The immune defect in myeloma can make recurrent urinary tract infections problematic; these infections and their treatment can result in further deterioration of renal function.

About 10% of patients need long-term renal supportive therapy, which can have an impact on HRQoL (Tariman and Faiman, 2011), the range of available therapies for treatment of the myeloma, and survival. Chronic kidney disease (CKD) can be exacerbated by exposure to aminoglycosides, intravenous contrast agents and drugs used to treat CMV reactivation. Appropriate dose reductions need to be followed (Pratt et al, 2014), to avoid excessive toxicity such as myelosuppression. Autologous SCT is still a treatment option in patients with renal impairment, but has to be considered in the context of other frailties and comorbidities and with consideration of dose reduction in melphalan (most commonly to 140 mg/m<sup>2</sup>) (Saunders et al, 2014).

Patients with CKD are at a higher risk than other patients of extra-renal complications such as anaemia, infection and bone loss, which may best be

managed collaboratively with specialists in renal medicine. Anaemia can be treated by blood transfusion or erythropoiesis-stimulating agents (ESAs). ESAs are recommended for anaemia in patients with myeloma-associated renal impairment (Locatelli et al, 2004).

## **Recommendations**

### **Assessment**

- **Offer patients information on maintenance of renal health, and promptly investigate any deterioration in renal function not obviously due to myeloma relapse (Grade 1B).**
- **Routinely monitor patients with CKD for serum calcium, parathyroid hormone and vitamin D (Grade 1B).**
- **Investigate anaemia in myeloma patients and monitor long-term for functional iron deficiency (Grade 1C).**

### **Management**

- **Refer patients with moderate/severe renal impairment ( $\geq$ CKD stage 3), renal-related hyperparathyroidism or nephrotic syndrome to a renal specialist (Grade 1C).**
- **Optimise diabetes and blood pressure control to reduce the risk of progression to end-stage renal disease (Grade 1B).**
- **Follow recommended dose modifications for lenalidomide and bisphosphonates in the case of renal impairment and avoid nephrotoxic drugs if possible (Grade 1B).**
- **Consider ESAs for myeloma-related anaemia, with iron supplementation as necessary (Grade 1B).**

### ***Bone, endocrine and metabolic disorders***

Bone loss is a well-recognised complication of myeloma, intensive chemotherapy and corticosteroid usage; vitamin D deficiency, inactivity, hypogonadism, renal failure and secondary hyperparathyroidism and radiotherapy may also contribute. Features include pain, diffuse and localised osteopenia and osteoporosis, fractures and nerve root and cord compression. Most myeloma patients are routinely treated from the outset with bisphosphonates. Zoledronic acid, the current standard of care, has been shown to reduce skeletal-related events, preserve bone density and prolong progression-free and overall survival (Morgan et al, 2013). Preservation of bone also requires calcium and vitamin D supplementation, hormone replacement therapy and minimisation of exposure and duration of corticosteroid therapy and chemotherapy (Snowden et al, 2011; Miceli et al, 2011; Diamond et al, 2010).

Intensively-treated myeloma patients show a high frequency of endocrine abnormalities, including hypothyroidism (in 9%) and hypogonadism (65% of males). Adrenal function appears to be relatively resilient despite previous pulsed high-dose corticosteroid therapy. Menopause may be precipitated in younger female myeloma patients by chemotherapy and/or radiotherapy. The prevalence of persistent male hypogonadism following intensive treatment raises a need for routine screening and appropriate advice from endocrine specialists (Greenfield et al, 2014).

Body composition changes may add to increased frailty, poor mobility and disability (Morgan et al, 2013; Miceli et al, 2011; Narici and Maffulli, 2010): 'Sarcopenic obesity', reflecting loss of muscle mass with an increase in fat, has been reported in a high proportion of intensively treated myeloma patients (Greenfield et al, 2014), which contrasts with the picture in other advanced cancers characterised by cachexia. Proposed causes include endocrine, metabolic and nutritional factors and reduced physical activity (Saunders et al, 2014; Locatelli et al, 2004; Morley et al, 2001; Newman et al, 2003), along with myeloma itself, also classically associated with progressive loss of height. Routine measurements of weight or body mass index (BMI)

are poor proxies for assessment of body composition, although accurate assessment (e.g. by dual-energy X-ray absorptiometry (DEXA) scanning) is less accessible.

## **Recommendations**

### **Assessment**

- **Offer annual screening for endocrine disorders, for hypothyroidism, hypogonadism in males, and younger female patients for menopausal symptoms particularly following intensive (HSCT-based) treatments (Grade 2B)**
- **Assess weight, height, BMI, waist circumference, strength and frailty regularly, and blood pressure, HbA<sub>1c</sub> and full lipid profile annually, and refer to primary care for follow-up as appropriate (Grade 2B).**

### **Management**

- **Reduce bone risk with weight-bearing exercise, bisphosphonates, calcium/vitamin D supplementation and dietary advice (Grade 1B).**
- **Offer hormone replacement in both female and male patients where appropriate with specialist advice (Grade 2B).**

### ***Neurological and eye complications***

Spinal cord or nerve root compression is the most common neurological complication of newly presenting or relapsing myeloma. Chemotherapy-induced peripheral neuropathy (CIPN) is the most common neurological complication in long-term survivors, and has both peripheral and central nervous system (processing) components (Boland et al, 2014a). Polyneuropathy may also be a feature of myeloma, amyloidosis and POEMS syndrome at presentation, and/or

related to comorbidities such as diabetes mellitus, carpal tunnel and other nerve compression syndromes, CKD and vitamin deficiency.

Management of peripheral neuropathy (PN) is summarised in the BCSH Guidelines in Supportive Care in Myeloma (Snowden et al, 2011). Apart from dose or schedule adjustment, treatment for CIPN remains symptom-directed. Symptoms resolve or improve in most patients, but some are left with permanent disability. Neurotoxic drug treatments should be used with caution in patients with peripheral neuropathy from any cause. Additional investigations to identify potential causes are warranted.

The advancing age of the myeloma population and intermittent but high-dose corticosteroid usage are risk factors for cataract formation, although incidence in the myeloma population is unknown. Total body irradiation (TBI) is rare in current myeloma practice, but even in transplant patients who do not receive TBI, the incidence of cataracts may be as high as 5–20% at 10 years (Schutt et al, 2006). Risks of diabetic eye disease may be increased in myeloma patients by high-dose corticosteroids.

## **Recommendations**

### **Assessment**

- **Screen all patients with PN with thyroid function tests, vitamin B12, diabetes and renal compromise (Grade 2C).**
- **Offer a specialist neurology assessment in patients with Grade II-IV PN (Grade 2C).**
- **Consider annual ophthalmic screening for cataract and other ocular problems. (Grade 2C).**

### **Management**

- **Reduce or eliminate neurotoxic agents in CIPN and offer gabapentin or pregabalin for long-term symptom control (Grade 1B).**
- **Consider referral to a pain specialist (Grade 2C).**

### ***Cardiovascular and respiratory complications***

Clinical and sub-clinical cardiovascular and respiratory abnormalities occur at a high prevalence in intensively-treated myeloma survivors. Abnormalities of electrocardiography, echocardiography, natriuretic peptide levels and pulmonary function testing are seen in around half of patients and are associated with reduced HRQoL (Samuelson et al, 2016; Foley et al, 2010; Kozelj et al, 2013).

Impaired respiratory function results from recurrent or persistent upper and lower airway infections, thromboembolism and chemotherapy and radiation exposure, as well as from common causes such as smoking (Mankikian et al, 2014). Ventilatory function may be affected by pain and fractures due to spinal and chest wall bone disease, as well as opiate analgesia.

Sodium- and fluid-retaining effects of corticosteroids and IMiDs may add to cardiac problems, and cardiac amyloid should always be considered, especially with right-sided heart failure. Anaemia may cause cardiovascular and respiratory symptoms, as may a high BMI, and may respond to transfusion, ESAs and weight loss (Pratt et al, 2014; Boland et al, 2013; Samuelson et al, 2016).

Risk factors for cardiovascular disease (obesity, hypertension, hyperlipidaemia and hyperinsulinaemia) are common in myeloma patients. The metabolic syndrome, a complex of truncal obesity, hypertension, hyperlipidaemia, insulin resistance and type II diabetes mellitus, exists in as many as 50% of patients following HSCT (DeFilipp et al, 2016).

Given the extended life expectancy as a result of modern treatments, routine screening and lifestyle modification combined with primary and secondary preventive strategies are more justified to reduce cardiovascular disease. Dietary weight management (in overweight and obese patients) and smoking cessation should be encouraged. Physical activity, especially after HSCT, may be beneficial for both physical and psychological functioning in myeloma patients (Coleman et al, 2003; Dimeo et al, 1997). Physical activity should ideally be supervised, tailored, and form part of rehabilitation programmes.

As well as lifestyle modification, there is also a case for cardiovascular and respiratory screening for risk factors, for sub-clinical disease and in patients with symptoms, such as breathlessness and oedema, that could be attributed to other causes. Natriuretic peptide testing can be used as a 'rule out' test to select patients who need priority referral for echocardiography (Cowie et al, 2010). Although raised plasma B-type Natriuretic peptide (BNP) or N-Terminal pro-B-type natriuretic peptide (NT-BNP) levels do not diagnose heart failure, they have a high negative predictive value: and other causes for symptoms should be determined. A serum BNP level less than 100 pg/ml (29 pmol/litre) or an NTproBNP level less than 400 pg/ml (47 pmol/litre) in an untreated patient makes a diagnosis of heart failure unlikely. Patients with a BNP level above 100 pg/ml or an NTproBNP level above 400 pg/ml should have echocardiography and specialist assessment. Further guidance is provided by NICE (<https://www.nice.org.uk/Guidance/CG108>) (NICE, 2010).

## **Recommendations**

### **Assessment**

- **Offer routine screening for cardiovascular risk (Grade 2C).**
- **Check natriuretic peptide (BNP or NT-BNP) with annual screening or when clinically indicated (Grade 2C).**
- **Consider ECG, echocardiography and pulmonary function testing in patients at risk (including abnormal natriuretic peptide levels) or when clinically indicated (Grade 2C).**

### **Management**

- **Offer counselling for lifestyle modification, including diet, weight control, smoking cessation and appropriate physical activity (Grade 2C).**
- **Consider referral to specialist for patients with established cardiac and respiratory disease (Grade 2C).**

- **Consider ESAs or blood transfusion for symptomatic anaemia (Grade 1B).**

### ***Oral and dental hygiene***

Maintenance of oral and dental hygiene is relevant to all myeloma patients, whether or not they have undergone HSCT (Pratt et al, 2014; Snowden et al, 2011; Schutt et al, 2006). Regular dental review will not only help identify the risk of bisphosphonate-related osteonecrosis of the jaw (BRONJ), but should also cover a broader range of issues. Oral dryness is a common side effect of chemotherapy, radiotherapy and some supportive care drugs. Dryness and decreased salivation may lead to dental problems and infections. Patients may complain of discomfort and hypersensitivity, taste disturbances, soreness of the throat (including oral candidiasis), and/or problems in speaking and swallowing. Oral cancers may be increased in patients following HSCT and IMiD usage.

### **Recommendations**

#### **Assessment**

- **Encourage annual dental review and maintenance of oral and dental hygiene (Grade 2C).**
- **Monitor patients needing dental surgery for BRONJ (Grade 2C).**
- **Investigate non-healing lesions and consider specialist referral (Grade 2C).**

#### **Management**

- **Recommend rinses and other treatments e.g. artificial saliva to treat oral dryness and other symptoms (Grade 2C).**

### ***Gastroenterological and nutritional problems***

Bowel disturbance, particularly diarrhoea, is a common and sometimes persistent side effect of treatment with novel agents, such as bortezomib, and

histone deacetylase inhibitors such as panobinostat. Diarrhoea also occurs with lenalidomide; it is likely due to bile acid malabsorption and responds to bile acid sequestrants (Pawlyn et al, 2014). Patients with persistent diarrhoea with no obvious infectious aetiology need referral to a gastroenterologist to exclude malignancy, underlying bowel disease, AL amyloidosis and bile acid malabsorption. Constipation is common in myeloma patients and may be the result of side effects of thalidomide, opioids, anticholinergics or 5-HT<sub>3</sub> receptor antagonists, or hypercalcaemia. Laxative treatment is commonly used; a combination of a stool softener with a stimulant.

Ongoing nausea and emesis may occur due to anti-myeloma therapy, analgesics, renal failure and hypercalcaemia. Anorexia is common during HSCT, when significant weight loss and nutritional deficiencies can occur (Murray and Pindoria, 2009; Iverson et al, 2009). Correctable nutritional deficiencies may be due to poor appetite, sub-optimal diet and insufficient exposure to sunlight. In common with the general population (Greenfield et al, 2014), a substantial proportion of patients have evidence of vitamin D insufficiency, potentially compounding myeloma bone disease, fatigue and other symptoms (Diamond et al, 2010; Greenfield et al, 2014; Maier et al, 2015). Folate deficiency and reduced vitamin B12 levels are relatively common although serum paraproteins may interfere with vitamin B12 measurement (Greenfield et al, 2014; Wongrakpanich et al, 2015). Iron deficiency is rare but raised serum ferritin levels, which appear to be relatively common in patients with advanced myeloma, are likely to be multifactorial in origin. Diagnosis of iron overload therefore requires more specialised investigation (Greenfield et al, 2014).

Abnormal liver function tests may be caused by a variety of causes, including drugs, infections and lifestyle factors, including alcohol consumption (Boland et al, 2013).

## **Recommendations**

### **Assessment**

- **Routinely monitor weight, dietary intake and upper and lower gastrointestinal (GI) symptoms (Grade 2C).**
- **Routinely assess liver function tests, drug and alcohol history (Grade 2C).**
- **Consider screening annually for vitamin D, B12, folate and ferritin levels (Grade 2C).**

### **Management**

- **Correct nutritional deficiencies (Grade 2C).**
- **Consider referral to a dietician in patients losing weight (Grade 2C)**
- **Consider referring patients with unexplained weight loss, altered bowel habit or abnormal liver function tests for specialist assessment (Grade 2C).**

### ***Second primary malignancies***

An increase in therapy-related myelodysplastic syndrome (MDS) and acute myeloid leukaemia (AML) in patients with myeloma was first recognised several decades ago and again more recently in patients on lenalidomide maintenance therapy. The risk of developing MDS or AML is increased 8- to 11-fold compared to the general population (Mailankody et al, 2011; Roeker et al, 2013; Matarraz et al, 2012; Thomas et al, 2012; Barlogie et al, 2008) particularly with prolonged exposure to alkylating agents, most notably melphalan (Kyle et al, 1970; Bergsagel et al, 1979; Anon, 2000; Cuzick et al, 1987; Greene et al, 1986).

Three large randomised trials of lenalidomide maintenance have all shown a small excess of second primary malignancies (SPMs) in lenalidomide-treated patients compared to the placebo-treated patients (IFM 2005-02 (Attal et al, 2012), CALGB 100104 (McCarthy et al, 2012), and MM-015 (Palumbo et al, 2012)). Other reports have supported an incidence for SPMs of up to 6.9%

(Srivastava et al, 2013; Palumbo et al, 2014; Dimopoulos et al, 2011). However Thomas et al (2012) highlighted the limitations of current studies. The risk of secondary AML/MDS for patients with myeloma remains low and is far outweighed by the current risk of toxicity and death from myeloma. The relative risk of myeloma patients developing solid tumours appears less than that for therapy-related AML/MDS, and may not be significantly above that of the general population. However, it is likely that SPMs will increase in patients with myeloma simply due to increasing survival of this ageing population.

## **Recommendations**

### **Assessment**

- **Consider AML/MDS as a potential diagnosis in patients with persistent or worsening cytopenias (Grade 2C).**
- **Encourage vigilance for other malignancies and investigate suspicious symptoms promptly (Grade 2C).**

### **Management**

- **Encourage participation in routine NHS cancer screening (Grade 2C).**
- **Develop a system for formal recording of second primary malignancies and ongoing investigation for any possible links with treatment (Grade 2C).**

## PART 2. FRAILITY, PSYCHOSOCIAL AND REHABILITATION CONSIDERATIONS

### *Elderly and frail patients*

Myeloma has a median age at diagnosis >70 years (US National Cancer Institute Surveillance). Survival is reduced and toxicities increased in older patients (Bringinghen et al, 2013; Palumbo et al, 2015; Wildes et al, 2014), and therefore assessing the impact of ageing processes on a patient is crucial in optimising outcomes. As people age they become increasingly vulnerable to external stressors, such as infection, through a combination of frailty, disability and comorbidity (Table 3). The aim of assessment is threefold; to predict toxicity and hence modify planned treatment, provide prognostic information, and to detect disability (which may be supported). Older patients often choose HRQoL over overall survival (Fried et al, 2002; Yellen et al, 1994) and need the opportunity to make informed decisions about treatment.

**Table 3. Frailty, disability and co-morbidity**

<b>Concept</b>	<b>Definition</b>
<b>Frailty</b>	A phenotype ( $\geq 3$ of weakness, poor endurance, weight loss, low physical activity and slow gait speed (Fried et al, 2002)  <b>or</b> as the cumulative effect of individual deficits – “the more individuals have wrong with them, the more likely they are to be frail” (Rockwood and Mitnitski, 2007).
<b>Disability</b>	Difficulty or dependency in carrying out activities essential to independent living including tasks needed for self-care and living independently in a home, and desired activities important to one’s quality of life (Fried et al, 2004).
<b>Comorbidity</b>	Concurrent presence of $\geq 2$ medically diagnosed diseases in the same person, with the diagnosis of each contributing disease based on established, widely recognised criteria (Fried et al, 2004).

## ***Geriatric assessment***

A Comprehensive Geriatric Assessment (CGA) is a multidimensional, interdisciplinary diagnostic process focusing on determining an older person's medical, psychosocial and functional capabilities to develop a coordinated plan for treatment and long-term follow-up (Rubenstein et al, 1991). Geriatric assessment (GA) refers to an abbreviated assessment using a range of different shortened tools. No one tool has been shown to be better than another in oncology (Wildiers et al, 2014) and different tools emphasise different domains. None are as sensitive as a CGA (Hamaker et al, 2012).

Retrospective studies show inferior outcomes in patients who experience toxicities and treatment discontinuations (Wildes et al, 2014). These 'at risk' patients need to be identified prospectively and treatment modified (via dose reduction or regimen modification). GA can identify age-related problems missed by a routine history and physical examination in approximately half of patients, (Caillet et al, 2011) and performance status underestimates the degree of disability (Extermann et al, 1998; Repetto et al, 2002). Although using a formal assessment tool versus a standard history and examination in terms of final outcomes and identifying the most meaningful vulnerabilities is yet to be tested prospectively, a systematic method can facilitate identification and correction of a disability. Ideally, assessment and onward referral should be done in collaboration with a multidisciplinary team including elderly care medicine, nurses and therapists as well as communicating with the GP, social care, and third sector services.

A simple frailty score in myeloma includes age, comorbidities and GA. It correlates well with risk of severe toxicity (Palumbo et al, 2015). The score is simple to use, especially in the electronic format available, but may lack discriminatory power for the very frail since it was based on a trial population, of which only 2% had a performance status of 3-4. Application of this score system is expected to be used increasingly in trials and may prove useful in the clinic. As this frailty index found age >75 to be a risk factor for increased mortality and

toxicity, a reasonable minimum is to assess all patients aged  $\geq 75$  and any others with a suggestion of frailty.

## **Recommendations**

### **Assessment**

- **Consider a baseline geriatric assessment in elderly and frail patients, particularly those aged  $\geq 75$  years (Grade 2C).**
- **Consider using the outcome of an assessment to guide treatment choice and prognosis (Grade 2C).**

### **Management**

- **Engage with elderly care teams to provide geriatric assessment, optimised care plans and to make joint onward referrals when disabilities are identified (Grade 2C).**

### ***Assessment of patient concerns and information provision***

As well as physical issues, psychological problems, social factors and concern about treatments and maintaining independence, all have a significant impact on HRQoL (Froding et al, 2010; Molassiotis et al, 2011a; Molassiotis et al, 2011b). After one year of follow-up, 75% of myeloma patients have deteriorating HRQoL scores, with 37% worrying about their future health, 34% preoccupied by their disease and 21% worrying about dying (Mols et al, 2012). Most HRQoL tools (such as the EORTC QLQ-C30 and EORTC MY-20 questionnaires of the European Organisation for Research and Treatment of Cancer Quality of Life) are used in clinical research rather than in routine clinical practice (Osborne et al, 2012; Kvam et al, 2009). However, the MyPOS HRQoL questionnaire has been designed specifically for use in the clinical setting and focuses on the issues most important to patients (Osborne et al, 2012; Osborne et al, 2015).

The importance of using structured holistic needs assessments (HNA) at key stages of cancer from diagnosis is now recognised (Department of Health, Macmillan Cancer Support and NHS Improvement, 2013). The Recovery Package (National Cancer Survivorship Initiative<sup>b</sup>) recommends the use of a HNA to identify the individual needs of the person affected by cancer at key points in the care pathway and if health and social needs change; ensuring that care is responsive to changing needs, and support services are planned and accessed appropriately (National Cancer Survivorship Initiative, 2012).

The aim of an HNA is to comprehensively assess physical, emotional, mental, spiritual and social concerns experienced by the individual and to formulate an individual care or action plan (Richardson et al, 2007). Several HNA tools are available, for example the Sheffield Profile for Assessment and Referral for Care (SPARC) questionnaire (National Cancer Action Team, 2010). A recent cross-sectional study used the SPARC tool in a group of patients with advanced, multiply relapsed and heavily pre-treated but stable myeloma. The patients had a high symptom burden, were bothered and distressed by the side effects and long-term effects of treatments, and were worried about the effect their disease was having on their family or other people (Boland et al, 2014b).

## **Recommendations**

### **Assessment**

- **Consider routine HNA at the start and end of each line of treatment to identify individual patient needs and concerns (Grade 2C).**

### **Management**

- **Plan provision of support services accordingly (Grade 2C).**
- **Provide information on the late effects of potential treatments and advise patients on strategies to reduce risk and manage treatment side effects (Grade 2C).**

## ***Psychological wellbeing***

Myeloma patients are concerned by disease recurrence, loss of independence, and death. However, overall mental functioning remains preserved, suggesting effective coping mechanisms (Boland et al, 2013). In a survey of 114 patients, anxiety (8%) and depression (24%) were reported at the time of myeloma diagnosis and 51% of these patients had psychosocial intervention desires. The most common preferences were relaxation techniques, psychological counselling and peer support groups (Lamers et al, 2013). Cognitive impairment, pre-transplantation, has also been recognised leading to accentuated problems post-transplantation: mainly deficits in learning/memory, executive function, motor function and psychomotor speed (Jones et al, 2013).

Low mood, anxiety and clinical depression should be actively assessed and managed. A four-level model of psychological assessment and support is recommended by the National Institute for Health and Care Excellence (NICE) to guide escalation of professional intervention (National Institute for Health and Care Excellence, 2004). Alongside this, support groups and resources provided by cancer support organisations may reduce isolation and build sustainable support networks outside the hospital setting.

## **Recommendations**

### **Assessment**

- **Regularly assess patient mood, anxiety and cognitive status through HNA, patient presentation or concern, at least at the start and end of each line of treatment, or annually (Grade 2C).**

### **Management**

- **Escalate to psychological care or psychiatrist if clinically appropriate (Grade 2C).**
- **Alert patients to support resources and groups outside the hospital setting (Grade 2C).**

## ***Pain and fatigue***

Myeloma patients have the highest level of symptoms and the lowest level of HRQoL among patients with haematological cancers (Johnsen et al, 2009). The influence of fatigue and pain are the strongest predictors on HRQoL in myeloma (Jordan et al, 2014) and these long-term consequences of treatment are known to be the main barriers to social and participatory functions, even in stable phase disease (Boland et al, 2013; Jordan et al, 2014; Gulbrandsen et al, 2004).

A recent European multi-centre study of myeloma patients reported that depression and fatigue had a negative effect on HRQoL; fatigue and bone pain were associated with poor physical functioning whilst mental status changes were associated with a reduction in social functioning score (Jordan et al, 2014).

Fatigue occurs in the majority of myeloma patients and it is usually multi-factorial. Common treatable causes include anaemia, biochemical and endocrine abnormalities and use of sedating medication and other medicines such as corticosteroids, anti-arrhythmics, anti-hypertensives, strong analgesics and chemotherapy. When assessing fatigue, it is vital to ask for key components such as duration, and impact of rest and impact on physical and mental activity and sleep activity (BMJ Best Practice: Assessment of Fatigue). Exercise and physical activity may help; in a single arm pilot study, a tailored exercise programme was associated with increased muscle strength and improved fatigue scores (Groeneveldt et al, 2013). However, high quality trials are lacking, and existing evidence suggests that positive impacts on fatigue may be limited to the post-treatment period (Smith et al, 2015; Gan et al, 2016). Consideration should be given to referral to rehabilitation services. In extreme cases a trial of a central nervous system stimulant may be justified, but this must be delivered under specialist advice.

Detailed information is given on the assessment and management of pain in published BCSH guidelines (Pratt et al, 2014).

## **Recommendations**

### **Pain**

#### **Assessment**

- **Consider routine HNA to identify individual patient needs and concerns (Grade 2C).**
- **Take detailed history of pain using a 0-10 numerical scale, body chart and pain inventory and its impact (Grade 2B).**
- **Assess mental health status (Grade 2B).**
- **Ensure follow-up assessment as routine practice (Grade 2B).**

#### **Management**

- **Follow existing guidelines for management of pain (Grade 2C).**

### **Fatigue**

#### **Assessment**

- **Consider routine HNA to identify individual patient needs and concerns (Grade 2C).**
- **Take detailed history of energy levels and fatigue, and rule out possible causes of fatigue, including low mood (Grade 2C).**

#### **Management**

- **Consider exercise, physical activity and rehabilitation services (Grade 2C).**
- **Treat organic causes of fatigue, or in extreme cases, refer to generic chronic fatigue services. Where low mood is a factor, refer for counselling or psychological intervention (Grade 2C).**

### ***Physical fitness and functionality***

Only 20% of myeloma patients meet national physical activity guidelines post-treatment and 7% during active treatment (Jones et al, 2004; Craike et al, 2013). Commonly reported barriers to physical activity are pain, fear of fracture risk, lack of confidence and fatigue (Groeneveldt et al, 2013). Although more high quality randomised control trials (RCTs) are required in myeloma patients to determine efficacy (Gan et al, 2015; Smith et al, 2015), exercise training has been shown to be safe and feasible (Groeneveldt et al, 2013), with high attendance and adherence (Groeneveld et al, 2013; Shallwani et al, 2015) and higher physical activity levels have been associated with better quality of life both during and off active treatment (Jones et al, 2004; Groeneveld et al, 2013). Rehabilitation in myeloma patients after HSCT improves physical performance; muscle strength and aerobic capacity and immunological function; reduces fatigue and improves psychological outcomes (Groeneveldt et al, 2013; Persoon et al, 2013).

Prehabilitation has potential to improve outcomes for this group of patients (Silver and Baima, 2013; Bartels et al, 2015) and should be considered prior to the start of treatment, in order to minimise functional decline and loss of physical fitness during chemotherapy. Evidence for the benefit of prehabilitation programmes in other cancer survivors is growing (Gillis et al, 2014).

## **Recommendations**

### **Management**

- **Ensure that prehabilitation and rehabilitation are an integral part of every line of treatment in the patient care pathway (Grade 2C)**
- **Encourage regular physical activity starting from time of diagnosis and address patient concerns (Grade 2C)**
- **Encourage continual aspiration to a generally healthy lifestyle (i.e. not related to myeloma treatment), including regular exercise (Grade 2C)**

### ***Implications for work ability***

Work productivity loss through cancer has significant economic consequences for individuals, their families and society (Luengo-Fernandez et al, 2013). More than this, the ability to work maintains financial stability, social relationships, self-esteem and psychological well-being (Timmons et al, 2013; Wells et al, 2013; Horsboel et al, 2013; Goodwin et al, 2013). Two-thirds of patients with haematological malignancies return to work. However, the proportion is lowest for myeloma and acute leukaemia patients. While myeloma mainly affects older people who are closer to retirement, the relatively high symptom burden and associated drugs may also be significant. Healthcare professionals can have a key influence on the likelihood of the patient's subsequent return to work (Pryce et al, 2007) and should take opportunities to assess the impact of disease and treatment consequences have on a person's ability to maintain their working life, and as a result, their identity and financial security (Wells et al, 2014).

### **Recommendations**

#### **Assessment**

- **Consider routine HNA to identify individual patient needs and concerns (Grade 2C)**
- **Signpost patients to relevant services (Grade 2C).**
- **Ensure careful communication between the specialist team, GP and patient on suitable timing for return to work, if appropriate (Grade 2C).**

## **Conclusions: Living with myeloma**

We are entering a watershed period in which patients are expecting to live in excess of 5-10 years after a diagnosis of myeloma and issues of survivorship are becoming increasingly important. Although care of myeloma patients is traditionally based around secondary care, primary care professionals need to be empowered to manage the consequences of the disease and its treatment.

Analogies may be drawn from more developed examples of comprehensive care in other chronic but incurable diseases, such as diabetes, where both secondary and primary care work closely together with well- developed input from specialist nurses. As myeloma is a relatively rare disease state, additional training of the healthcare workforce may be indicated and communication between the secondary specialist care team and primary care is paramount. To equip patients to manage the late effects of myeloma, information on social and financial issues, return to work, travel, immunisations, relationships and sexual function, and psychological support is particularly important, as well as awareness of general health promotion strategies and routine health screening. Patients and families should have clear information on which health and social care team to contact if they have concerns.

Recommended partners in the multidisciplinary core and supporting teams for assessment and treatment of myeloma late effects are summarised in Table 4. Table 5 indicates the recommended timing and frequency for screening and assessment schedules. Table 6 compares these BSH guidelines with previously published survivorship guidelines in myeloma. Although the evidence base is currently limited, these guidelines and recommendations provide a framework for clinicians to optimise management of long-term complications as an important component of comprehensive care of myeloma as well as future areas for research and development.

**Table 4. Recommendations for core attendance of multidisciplinary team (MDT) members responsible for the care of patients following completion of treatment**

<b>Late effects core team</b>	<b>Late effects MDT associate membership</b>	<b>Social care and voluntary services</b>
Lead clinician (haematologist with expertise in late effects)	General practitioner (individual basis)	Social worker
Clinical nurse specialist	Geriatrician	Patient support group
Physiotherapist	Liaison psychiatrist	Cancer information services
Psychologist	Endocrinologist and metabolic bone physician	Citizens Advice
Occupational therapist	Cardiologist	Elderly/Cancer Charities
	Immunologist	Guidance with complementary therapy if patient expresses interest
	Renal physician	
	Gastroenterologist	
	Respiratory physician	
	Neurologist	
	Ophthalmologist	
	Dermatologist	
	Psychosexual oncology counsellor	
	Supportive/palliative care consultant	

**Table 5. Recommendations for timing and frequency of assessment of late and long-term consequences of myeloma and its treatment:**

**Long-term physical consequences**

<b>Issue</b>	<b>Assessment</b>	<b>Timing and frequency</b>
<b>OVERALL CONDITION</b>	Full physical examination	Annually as a minimum
	Weight maintenance	Each clinic visit
	Height	Annually without shoes - blunt indication of possible vertebral collapse
	Blood Pressure	Annually as a minimum
	Urinalysis	Annually as a minimum
	Holistic needs assessment	After each treatment episode and then annually
	Systems review	Annually
	Drug interaction check	To be made by a pharmacist at every treatment change
<b>INFECTION AND IMMUNITY</b>	Patient education including awareness of early signs of infection and need to seek medical attention without delay	Annually, including update of unit self-referral policy for suspected infection in immunocompromised patients whether on or off chemotherapy
	Appraisal of vaccination record, whether transplanted or not	Annually
	Influenza vaccine	Annually in season

<b>RENAL AND UROGENITAL CONDITIONS</b>	Monitoring of renal function	At every clinic visit or at least every 3 months, refer for specialist advice if persistent stage 2 CKD or greater.
<b>BONE AND ENDOCRINE DISORDERS</b>	Monitoring levels of vitamin D, calcium	Annually
	Screening for hypogonadism in males	Annual serum morning testosterone, sex-hormone-binding globulin and gonadotrophins in patients post-HSCT or if symptomatic
	Screening for menopausal symptoms in females <50 years of age	Take menopausal history and screen younger females for menopausal symptoms with serum oestradiol and gonadotrophins
	Monitoring of thyroid function	Annually or if symptomatic
<b>NEUROLOGICAL AND OCULAR COMPLICATIONS</b>	Screening for metabolic causes of peripheral neuropathy: thyroid function, vitamin B12 levels and diabetes	In all patients with peripheral neuropathy on presentation
	Identification of patients with persistent Grade II-IV peripheral neuropathy	As needed - refer to neurology for specialised assessment.
	Screening for visual acuity, cataract and other ocular problems	Annual eye check by opticians unless specific problems merit referral to ophthalmology
<b>SECOND PRIMARY MALIGNANCIES</b>	Monitoring for acute myeloid leukaemia/myelodysplastic syndrome in patients with persistent or worsening cytopenias	Full blood count (FBC) each visit or urgently on presentation of suspicious signs and symptoms
	Monitoring for non-healing oral lesions and other malignancies	Patient education regarding regular dental checks and urgent referral to specialist services if clinically indicated

<b>CARDIOVASCULAR AND RESPIRATORY COMPLICATIONS</b>	Obesity/BMI/waist circumference/blood pressure	At diagnosis and annually
	Assess risk factors for metabolic syndrome and educate patient and GP on increased risks.  Non-fasting blood glucose and HbA <sub>1c</sub> and lipid profile.	Annually, unless already on statin or primary care management for diabetes mellitus or hyperlipidaemia
	Patient and GP education on increased risks, and need for extra vigilance	At annual review
	Refer to smoking cessation services	As needed
	Physical activity and exercise, local provision such as health walks	As needed
	B-type natriuretic peptide (BNP) or N-Terminal pro-BNP (NT-BNP)	Annually and as clinically indicated
	Echocardiography/ECG	In patients at risk and repeat as clinically indicated
	Pulmonary function tests	In patients at risk and repeat as clinically indicated
<b>ORAL AND DENTAL HYGIENE</b>	Monitoring for bisphosphonate-related osteonecrosis of the jaw (BRONJ), oral cancer, candidiasis	At diagnosis and at a change in condition
<b>GASTROENTEROLOGICAL PROBLEMS AND NUTRITION</b>	Screening for iron overload	At diagnosis and annually in patients who have had blood transfusions
	Monitoring of vitamin D, folate, B12 and ferritin level	At diagnosis, and annually and as clinically indicated
	Refer to alcohol advisory services via GP	As needed

**Table 5 continued. Recommendations for timing and frequency of assessment of late and long-term consequences of myeloma and its treatment:**

**Frailty, psychosocial and rehabilitation considerations**

<b>Issue</b>	<b>Assessment</b>	<b>Timing and frequency</b>
<b>ELDERLY AND FRAIL PATIENTS</b>	Consider geriatric assessment in elderly and frail patients, particularly those aged >75 years	At baseline
<b>PSYCHOLOGICAL WELLBEING</b>	Consider routine HNA to identify individual patient needs and concerns	At the start and end of each line of treatment, or annually
	Mental health and wellbeing (mood/anxiety/clinical depression) - assessment through HNA, patient presentation or concern	At the start and end of each line of treatment, or annually, with escalation to more specialist support as indicated
<b>PAIN</b>	Consider routine HNA to identify individual patient needs and concerns	At the start and end of each line of treatment, or annually and at a change in condition
<b>FATIGUE</b>	Consider routine HNA to identify individual patient needs and concerns	At the start and end of each line of treatment, or annually and at a change in condition
<b>PREHABILITATION AND REHABILITATION</b>	<p>Ensure that prehabilitation and rehabilitation are an integral part of every line of treatment in the patient care pathway</p> <p>Encourage regular physical activity starting from time of diagnosis and address patient concerns</p> <p>Encourage continual aspiration to a generally healthy lifestyle (i.e. not related to myeloma treatment), including regular exercise</p>	At diagnosis, at start and end of line of treatment and at a change in condition.
<b>IMPACT ON WORK ABILITY</b>	Consider routine HNA to identify individual patient needs and concerns	At the start and end of each line of treatment, or annually

**Table 6. Comparison of the BSH Guidelines and other international survivorship guidelines in myeloma**

<b>BSH Guidelines for Screening and Management of Late and Long-term Consequences of Myeloma and its Treatments (2016)</b>	<b>US Nurse Leadership Board guidelines</b> (Bertolotti et al, 2008; Faiman et al 2008; Smith et al 2008; Bilotti et al 2011a; Bilotti et al 2011b; Richards et al 2011)
Multi-disciplinary writing group, including consumer representation, with professional sounding board review	Nursing-led guidelines for multidisciplinary dissemination
Emphasis on long-term disease complications and late effects of treatment along with consideration of global issues such as frailty and geriatric assessment	Emphasis on key aspects of survivorship – health maintenance, bone, renal, sexual dysfunction, mobility, as well as toxicity of novel agents
Combined medical systems and psychosocial model	Topics considered to have most impact on patient survivorship
One integrated guideline document, with systematic literature review and recommendations	Several guideline documents with recommendations for specific areas of practice

## ABBREVIATIONS

AML	acute myeloid leukaemia
BCSH	British Committee for Standards in Haematology
BMI	body mass index
BRONJ	bisphosphonate-related osteonecrosis of the jaw
BSH	British Society for Haematology
CGA	comprehensive geriatric assessment
CIPN	chemotherapy-induced peripheral neuropathy
CKD	chronic kidney disease
CMV	cytomegalovirus
CNS	central nervous system
DEXA	dual-energy X-ray absorptiometry
ECG	electrocardiogram
EORTC	European Organisation for Research and Treatment of Cancer
ESA	erythropoiesis-stimulating agent(s)
FBC	full blood count
GA	geriatric assessment
GI	gastrointestinal
GRADE*	Grading of Recommendations Assessment, Development and Evaluation ( <b>see below</b> )
Hib	<i>Haemophilus influenzae</i> type b vaccine
HNA	holistic needs assessment
HRQoL	health-related quality of life
HSCT	haematopoietic stem cell transplant
HSV	Herpes simplex virus
IMiDs	immunomodulatory drugs
MDS	myelodysplastic syndrome
MDT	multidisciplinary team
MMR	measles, mumps and rubella vaccine
NICE	National Institute for Health and Care Excellence
NCSI	National Cancer Survivorship Initiative (England)
NT pro-BNP	B-type natriuretic peptide (BNP) test

ONJ	osteonecrosis of the jaw
OPV	oral polio vaccine
PCV13	conjugate pneumococcal vaccine
PFT	pulmonary function test
PN	peripheral neuropathy
POEMS	polyneuropathy, organomegaly, endocrinopathy, monoclonal gammopathy, and skin changes syndrome
PPV23	pneumococcal polysaccharide vaccine
RCT	randomised controlled trial(s)
SCT	stem cell transplant
SPARC	Sheffield Profile for Assessment and Referral for Care
TBI	total body irradiation
TEAMM	Tackling EARly Morbidity and Mortality in myeloma
UKMF	UK Myeloma Forum
VZV	Varicella zoster virus

**\*GRADE: Grading of Recommendations Assessment, Development and Evaluation**

**STRENGTH OF RECOMMENDATIONS:**

**Strong (grade 1):** Strong recommendations (grade 1) are made when there is confidence that the benefits do or do not outweigh harm and burden. Grade 1 recommendations can be applied uniformly to most patients. Regard as 'recommend'.

**Weak (grade 2):** Where the magnitude of benefit or not is less certain a weaker grade 2 recommendation is made. Grade 2 recommendations require judicious application to individual patients. Regard as 'suggest'.

**QUALITY OF EVIDENCE**

The quality of evidence is graded as high (A), moderate (B) or low (C). To put this in context it is useful to consider the uncertainty of knowledge and whether further research could change what we know or our certainty.

**(A) High.** Further research is very unlikely to change confidence in the estimate of effect. Current evidence derived from randomised clinical trials without important limitations.

**(B) Moderate.** Further research may well have an important impact on confidence in the estimate of effect and may change the estimate. Current evidence derived from randomised clinical trials with important limitations (e.g. inconsistent results, imprecision - wide confidence intervals or methodological flaws - e.g. lack of blinding, large losses to follow up, failure to adhere to intention to treat analysis) or very strong evidence from observational studies or case series (e.g. large or very large and consistent estimates of the magnitude of a treatment effect or demonstration of a dose-response gradient).

**(C) Low.** Further research is likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate. Current evidence from observational studies, case series or just opinion.

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## REFERENCES

Ahmedzai S. and Walsh D. (2000). Palliative medicine and modern cancer care. *Semin Oncol*, 27(1), 1-6.

Anon (2000). Acute leukaemia and other secondary neoplasms in patients treated with conventional chemotherapy for multiple myeloma: a Finnish Leukaemia Group study. (No authors listed) *Eur J Haematol*, 65(2), 123-7

Attal M, Lauwers-Cances V, Marit G, Caillot D, Moreau P, Facon T, Stoppa AM, Hulin C, Benboubker L, Garderet L, Decaux O, Leyvraz S, Vekemans MC, Voillat L, Michallet M, Pegourie B, Dumontet C, Roussel M, Leleu X, Mathiot C, Payen C, Avet-Loiseau H, Harousseau JL; IFM Investigators. (2012). Lenalidomide maintenance after stem-cell transplantation for multiple myeloma. *N Engl J Med*. 366(19),1782-91.

Augustson B, Begum G, Dunn J, Barth NJ, Davies F, Morgan G, Behrens J, Smith A, Child JA, Drayson M. (2005). Early mortality after diagnosis of multiple myeloma: analysis of patients entered onto the United Kingdom Medical Research Council trials between 1980 and 2002--Medical Research Council Adult Leukaemia Working Party. *J Clin Oncol*. 23(36), 9219-26. (Epub 2005 Nov 7).

Barlogie B, Tricot G, Haessler J, van Rhee F, Cottler-Fox M, Anaissie E, Waldron J, Pineda-Roman M, Thertulien R, Zangari M, Hollmig K, Mohiuddin A, Alsayed Y, Hoering A, Crowley J, Sawyer J. (2008). Cytogenetically defined myelodysplasia after melphalan-based autotransplantation for multiple myeloma linked to poor hematopoietic stem-cell mobilization: the Arkansas experience in more than 3,000 patients treated since 1989. *Blood*. 111(1), 94-100. (Epub 2007 Sep 25).

Bartels F, Smith N, Gørløv J, Grufstedt H, Nexø C, Kehlet H, Sjøgren P, Kjeldsen L, Høgdaal N. (2015). Optimized patient-trajectory for patients undergoing treatment with high-dose chemotherapy and autologous stem cell transplantation. *Acta Oncol*. 54(5), 750-8. (Epub 2015 Mar 11).

Bergsagel D, Bailey A, Langley G, MacDonald R, White D, Miller A. (1979). The chemotherapy on plasma-cell myeloma and the incidence of acute leukemia. *N Engl J Med*. 301(14), 743-8.

**Bertolotti P, Bilotti E, Colson K, Curran K, Doss D, Faiman B, Gavino M, Jenkins B, Lilleby K, Love G, Mangan PA, McCullagh E, Miceli T, Miller K, Rogers K, Rome S, Sandifer S, Smith LC, Tariman JD, Westphal J (2008). Management of side effects of novel therapies for multiple myeloma: consensus statements developed by the International Myeloma Foundation's Nurse Leadership Board. *Clin J Oncol Nurs*., 12(3 Suppl),9-12.**

Bilotti E, Faiman B, Richards T, Tariman JD, Miceli TS, Rome SI; International Myeloma Foundation Nurse Leadership Board. (2011a). Survivorship Care Guidelines for Patients Living With Multiple Myeloma: Consensus Statements of the International Myeloma Foundation Nurse Leadership Board. *Clinical Journal of Oncology Nursing* 15(4), 5-8

**Bilotti E, Gleason CL, McNeill A; International Myeloma Foundation Nurse Leadership Board (2011b). Routine health maintenance in patients living with multiple myeloma: survivorship care plan of the International Myeloma Foundation Nurse Leadership Board. *Clin J Oncol Nurs*, 15, Suppl:25-40.**

Bird J, Owen R, d'Sa S, Snowden J, Littlewood T, Pratt G, Ashcroft J, Yong K, Cook G, Feyler S, Davies F, Cavenagh J, Low E, Behrens J on behalf of BCSH and UK Myeloma Forum. (2011). Guidelines on the diagnosis and management of multiple myeloma. *British Journal of Haematology*, 54, 32-75

Blimark C, Holmberg E, Mellqvist UH, Landgren O, Björkholm M, Hultcrantz M, Kjellander C, Turesson I, Kristinsson SY. (2015). Multiple myeloma and infections: a population-based study on 9253 multiple myeloma patients. *Haematologica*. 100(1), 107-13. (Epub 2014 Oct 24).

BMJ Best Practice: Assessment of fatigue. <http://bestpractice.bmj.com/best-practice/monograph/571.html> Accessed 9 February 2016

Boland E, Eiser C, Ezaydi Y, Greenfield DM, Ahmedzai SH, Snowden JA. (2013). Living With Advanced But Stable Multiple Myeloma: A Study of the Symptom Burden and Cumulative Effects of Disease and Intensive (Hematopoietic Stem Cell Transplant-Based) Treatment on Health-Related Quality of Life. *Journal of Pain and Symptom Management*, 46(5), 671-680

Boland E, Boland J, Ezaydi Y, Greenfield D, Ahmedzai S, Snowden JA. (2014b). Holistic needs assessment in advanced, intensively treated multiple myeloma patients. *Support Care Cancer*, 22(10), 2615-20

Boland E, Selvarajah D, Hunter M, Ezaydi Y, Tesfaye S, Ahmedzai S, Snowden J, Wilkinson ID. (2014a). Central pain processing in chronic chemotherapy-induced peripheral neuropathy: a functional magnetic resonance imaging study. *PLoS One*, 9(5): e96474. doi: 10.1371/journal.pone.0096474. eCollection 2014.

Bringhen S, Mateos M, Zweegman S, et al. (2013). Age and organ damage correlate with poor survival in myeloma patients: meta-analysis of 1435 individual patient data from 4 randomized trials. *Haematologica*, 98(6), 980-987.

Brown R, Pope B, Murray A, Esdale W, Sze D, Gibson J, Ho P, Hart D, Joshua D. (2001). Dendritic cells from patients with myeloma are numerically normal but functionally defective as they fail to up-regulate CD80 (B7-1) expression after huCD40LT stimulation because of inhibition by transforming growth factor-beta1 and interleukin-10. *Blood*, 98(10), 2992-8.

Caillet P, Canoui-Poittrine F, Vouriot J, Berle M, Reinald N, Krypciak S, Bastuji-Garin S, Culine S, Paillaud E. (2011). Comprehensive geriatric assessment in the decision-making process in elderly patients with cancer: ELCAPA study. *J Clin Oncol*. 29(27), 3636-42. (Epub 2011 Jun 27).

Cancer Research UK Cancer Survival Group, London School of Hygiene and Tropical Medicine. (2012). Survival estimates for 5-year relative survival for myeloma, England 1971-2009, and 10-year relative survival for myeloma, England 1971-2000. <http://www.cancerresearchuk.org/cancer-info/cancerstats/types/myeloma/survival/multiple-myeloma-survival-statistics>, accessed 21 July 2014 and 10 January 2016

Cancer Research UK. Myeloma survival statistics <http://www.cancerresearchuk.org/cancer-info/cancerstats/types/myeloma/survival/#source2>. Accessed 21 July 2014

Chanan-Khan A, Sonneveld P, Schuster M, Stadtmauer E, Facon T, Harousseau J, Ben-Yehuda D, Lonial S, Goldschmidt H, Reece D, Neuwirth R, Anderson K, Richardson P. (2008). Analysis of herpes zoster events among bortezomib-treated patients in the phase III APEX study. *J Clin Oncol*. 26(29), 4784-90. (Epub 2008 Aug 18).

Chapel H, Lee M, Hargreaves R, Pamphilon D, Prentice A. (1994). The UK Group for Immunoglobulin Replacement Therapy in Multiple Myeloma. Randomised trial of intravenous immunoglobulin as prophylaxis against infection in plateau-phase multiple myeloma. *Lancet*, 343(8905), 1059-63

Cheuk D, Chiang A, Lee T, Chan G, Ha S. (2011). Vaccines for prophylaxis of viral infections in patients with hematological malignancies. *Cochrane Database Syst Rev*, 16(3), CD006505.

Coleman E, Coon S, Hall-Barrow J, Richards K, Gaylor D, Stewart B. (2003). Feasibility of exercise during treatment for multiple myeloma. *Cancer Nurs*, 26(5), 410-9

Cook G, Williams C, Brown J, Cairns D, Cavenagh J, Snowden J, Ashcroft A, Fletcher M, Parrish C, Yong K, Cavet J, Hunter H, Bird J, Chalmers A, O'Connor S, Drayson M, Morris T. (2014). High-dose chemotherapy plus autologous stem-cell transplantation as consolidation therapy in patients with relapsed multiple myeloma after previous autologous stem-cell transplantation (NCRI Myeloma X Relapse [Intensive trial]): a randomised, open-label, phase 3 trial. National Cancer Research Institute Haemato-oncology Clinical Studies Group. *Lancet Oncol*, 15(8), 874-85. (Epub 2014 Jun 16).

Cowie M, Collinson P, Dargie H, Hobbs F, McDonagh T, McDonald K, Rowell N. (2010). Recommendations on the clinical use of B-type natriuretic peptide testing (BNP or NTproBNP) in the UK and Ireland. *Br J Cardiol*, 17, 76-80

Craike M, Hose K, Courneya K, Harrison S, Livingston P. (2013). Perceived benefits and barriers to exercise for recently treated patients with multiple myeloma: a qualitative study. *BMC Cancer*, 13, 319.

Cuzick J, Erskine S, Edelman D, Galton D. (1987). A comparison of the incidence of the myelodysplastic syndrome and acute myeloid leukaemia following melphalan and cyclophosphamide treatment for myelomatosis. A report to the Medical Research Council's working party on leukaemia in adults. *Br J Cancer*, 55(5), 523-9

DeFilipp Z; Duarte R; Snowden J; Majhail N; Greenfield D; Lopez-Miranda J; Arat M; Baker K; Burns L; Duncan C; Gilleece M; Hale G; Hamadani M; Hamilton B; Hogan W; Hsu J; Inamoto Y; Kamble R; Lupo-Stanghellini M; Malone A; McCarthy P; Mohty M; Norkin M; Papham P; Ramanathan M; Richart J; Salooja N; Schouten H; Schoemans H; Seber A; Steinberg A; Wirk B; Wood W; Battiwalla M; Flowers M; Savani B; Shaw B. (2016). Metabolic syndrome and cardiovascular disease following hematopoietic cell transplantation: screening and preventive practice recommendations from CIBMTR and EBMT. *Biology of Blood and Marrow Transplantation*, in press.

Denlinger C, Ligibel J, Are M, Baker K, Demark-Wahnefried W, Dizon D, Friedman DL, Goldman M, Jones L, King A, Ku G, Kvale E, Langbaum T, Leonardi-Warren K, McCabe M, Melisko M, Montoya JG, Mooney K, Morgan MA, Moslehi JJ, O'Connor T, Overholser L, Paskett E, Peppercorn J, Raza M, Rodriguez M, Syrjala K, Urba S, Wakabayashi M, Zee P, McMillian N, Freedman-Cass D. (2014). Survivorship: screening for cancer and treatment effects, version 2.2014. *J Natl Compr Canc Netw*, 12(11),1526-31.

Department of Health, MacmillanCancer Support & NHS Improvement. (2013). Living with & Beyond Cancer: Taking Action to Improve Outcomes (an update to the 2010 The National Cancer Survivorship Initiative Vision).

Diamond T, Golombick T, Manoharan A. (2010). Vitamin D status may affect the skeletal complications of multiple myeloma. *Am J Hematol*. 85(4), 302-3

Dimeo F, Tilmann M, Bertz H, Kanz L, Mertelsmann R, Keul J.(1997). Aerobic exercise in the rehabilitation of cancer patients after high dose chemotherapy and autologous peripheral stem cell transplantation. *Cancer*, 79(9),1717-22.

Dimopoulos M, Hussein M, Swern A, Weber D. (2011). Impact of lenalidomide dose on progression-free survival in patients with relapsed or refractory multiple myeloma. *Leukemia*, 25(10),1620-6. (Epub 2011 Jul 12).

Dimopoulos M, Leleu X, Palumbo A, et al. (2014). Expert panel consensus statement on the optimal use of pomalidomide in relapsed and refractory multiple myeloma. *Leukemia*, 28(8),1573-1585.

Esposito S, Cecinati V, Scicchitano B, Delvecchio G, Santoro N, Amato D, et al. (2010). Impact of influenzalike illness and effectiveness of influenza vaccination in oncohematological children who have completed cancer therapy. *Vaccine*, 28, 1558–65.

Extermann M, Overcash J, Lyman G, Parr J, Balducci L. (1998). Comorbidity and functional status are independent in older cancer patients. *J Clin Oncol*, 16(4),1582-7.

**Faiman B, Bilotti E, Mangan PA, Rogers K; IMF Nurse Leadership Board (2008). Steroid-associated side effects in patients with multiple myeloma: consensus statement of the IMF Nurse Leadership Board. Clin J Oncol Nurs. 12(3 Suppl), 53-63.**

Foley P, Hamilton M, Leyva F. (2010). Myocardial scarring following chemotherapy for multiple myeloma detected using late gadolinium hyperenhancement cardiovascular magnetic resonance. *J Cardiovasc Med (Hagerstown)*, 11(5), 386-8.

Fried L, Tangen C, Walston J, Newman A, Hirsch C, Gottdiener J, Seeman T, Tracy R, Kop W, Burke G, McBurnie M. (2001) Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. *J Gerontol A Biol Sci Med Sci*, 56(3),146-56

Fried L, Ferrucci L, Darer J, Williamson J, Anderson G. (2004). Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. *J Gerontol A Biol Sci Med Sci*, 59(3), 255-63

Fried T; Bradley E; Towle V; Allore H. (2002). Understanding the treatment preferences of seriously ill patients. *New England Journal of Medicine*. 346(14),1061-6.

Frodin U, Borjeson S, Lyth J, Lotfi K. (2010). A prospective evaluation of patients' health-related quality of life during auto-SCT: a 3-year follow-up. *Bone Marrow Transplant* 46(10),1345–1352.

Gan J, Sim C, Santorelli L. (2016). The effectiveness of exercise programmes in patients with multiple myeloma: A literature review. *Crit Rev Oncol Hematol*, 98, 275-89. (Epub 2015 Nov 17).

Gillis C, Li C, Lee L, Awasthi R, Augustin B, Gamsa A, Liberman A, Stein B, Charlebois P, Feldman L, Carli F. (2014). Prehabilitation versus rehabilitation: a randomized control trial in patients undergoing colorectal resection for cancer. *Anesthesiology*, 121(5), 937-47.

Goodwin J, Coleman E, Sullivan E, Easley R, McNatt P, Chowdhury N, Stewart C. (2013). Personal financial effects of multiple myeloma and its treatment. *Cancer Nurs*, 36(4), 301-8.

Greene M, Harris E, Gershenson D, Malkasian G Jr, Melton L 3rd, Dembo A, Bennett J, Moloney W, Boice J Jr. (1986). Melphalan may be a more potent leukemogen than cyclophosphamide. *Ann Intern Med.* 105(3), 360-7

Greenfield D, Boland E, Ezaydi Y, Ross R, Ahmedzai S, Snowden J; Late Effects Group. (2014). Endocrine, metabolic, nutritional and body composition abnormalities are common in advanced intensively-treated (transplanted) multiple myeloma. *Bone Marrow Transplant.* 49(7), 907-12.

Groeneveld I, de Boer A, Frings-Dresen M. (2013). Physical exercise and return to work: cancer survivors' experiences. *Cancer Surviv.* 7(2), 237-46. (Epub 2013 Feb 27).

Groeneveldt L, Mein G, Garrod R, Jewell A, Van Someren K, Stephens R, D'Sa S, Yong K. (2013) A mixed exercise training programme is feasible and safe and may improve quality of life and muscle strength in multiple myeloma survivors. *BMC Cancer*, 13:31.

Gulbrandsen, N, Hjermsstad, M, et al. (2004). Interpretation of quality of life scores in multiple myeloma by comparison with a reference population and assessment of the clinical importance of score differences. *Eur J Haematol*, 72(3),172-180

Hamaker M; Jonker J; de Rooij S; Vos A; Smorenburg C; van Munster B. (2012). Frailty screening methods for predicting outcome of a comprehensive geriatric assessment in elderly patients with cancer: a systematic review. *Lancet Oncology*, 13(10), e437-44.

Hargreaves R. (1992) Infection, immune responses and intravenous immunoglobulin infection prophylaxis in myeloma. *Br J Cancer*, 66,11

Hinge M, Ingels H, Slotved H, Mølle I. (2012). Serologic response to a 23-valent pneumococcal vaccine administered prior to autologous stem cell transplantation in patients with multiple myeloma. *APMIS*, 120(11), 935-40

Horsboel T, Nielsen C, Nielsen B, Jensen C, Andersen N, de Thurah A. (2013). J Type of hematological malignancy is crucial for the return to work prognosis: a register-based cohort study. *Cancer Surviv*, 7(4), 614-23. (Epub 2013 Aug 15)

Iversen P, Wisløff F, Gulbrandsen N. (2010). Reduced nutritional status among multiple myeloma patients during treatment with high-dose chemotherapy and autologous stem cell support. *Clin Nutr*, 29(4), 488-91. (Epub 2009 Dec 30).

Johnsen A, Tholstrup D et al. (2009). Health related quality of life in a nationally representative sample of haematological patients. *Eur J Haematol*, 83(2), 139-148

Jones D, Vichaya E, Wang X, Sailors M, Cleeland C, Wefel J. (2013). Acute cognitive impairment in patients with multiple myeloma undergoing autologous hematopoietic stem cell transplant. *Cancer*, 19(23), 4188-95

Jones L, Courneya K, Vallance J, Ladha A, Mant M, Belch A, Stewart D, Reiman T. (2004). Association between exercise and quality of life in multiple myeloma cancer survivors. *Support Care Cancer*, 12(11), 780-8.

Jordan K, Proskorovsky I, Lewis P, Ishak J, Payne K, Lordan N, Kyriakou C, Williams C, Peters S, Davies F. (2014). Effect of general symptom level, specific adverse events, treatment patterns, and patient characteristics on health-related quality of life in patients with multiple myeloma: results of a European, multicenter cohort study. *Support Care Cancer*, 22(2), 417-26

Kim S, Kim K, Kim B, Lee H, Kim H, Lee N, Nam S, Kwon J, Kim H, Sohn S, Won J, Lee J, Suh C, Yoon S, Kim H, Kim I, Do Y, Lee W, Joo Y, Shin H; Korean Multiple Myeloma Working Party. (2008). Bortezomib and the increased incidence of herpes zoster in patients with multiple myeloma. *Clin Lymphoma Myeloma*, 8(4), 237-40.

Klepin H and Hurd D. (2006). Autologous transplantation in elderly patients with multiple myeloma: are we asking the right questions? *Bone Marrow Transplantation*, 38, 585–592

Kobold S, Luetkens T, Bartels B, Cao Y, Hildebrandt Y, Sezer O, Reinhard H, Templin J, Bartels K, Lajmi N, Haag F, Bokemeyer C, Kröger N, Atanackovic D. (2012). Longitudinal analysis of Tetanus- and Influenza- specific IgG antibodies in myeloma patients. *Clin Dev Immunol*, 134081

König C, Kleber M, Reinhardt H, Knop S, Wäsch R, Engelhardt M. (2014). Incidence, risk factors, and implemented prophylaxis of varicella zoster virus infection, including complicated varicella zoster virus and herpes simplex virus infections, in lenalidomide-treated multiple myeloma patients. *Ann Hematol*, 93, 479–484

Kouroukis C, Baldassarre F, Haynes A, Imrie K, Reece D, Cheung M; Cancer Care Ontario Hematology Disease Site Group. (2014). Bortezomib in multiple myeloma: a practice guideline. *Clin Oncol (R Coll Radiol)*, 26(2),110-9. (Epub 2013 Dec 8).

Kozelj M, Zver S, Zadnik V. (2013). Long term follow-up report of cardiac toxicity in patients with multiple myeloma treated with tandem autologous hematopoietic stem cell transplantation. *Radiol Oncol*, 47(2),161-5.

Kvam A, Fayers P, Hjermstad M, Gulbrandsen N, Wisloff F. (2009). Health-related quality of life assessment in randomised controlled trials in multiple myeloma: a critical review of methodology and impact on treatment recommendations. *Eur J Haematol*. 83(4), 279-89. (Epub 2009 Jun 25).

Kyle R, Pierre R, Bayrd E. (1970). Multiple myeloma and acute myelomonocytic leukemia. *N Engl J Med*, 283(21),1121-5

Lamers J, Hartmann M, Goldschmidt H, Brechtel A, Hillengass J, Herzog W. (2013) Psychosocial support in patients with multiple myeloma at time of diagnosis: who wants what? *Psychooncology*, 22(10) pp2313-20

Locatelli F., Aljama P, Barany P, Canaud B, Carrera F, Eckardt K, Horl W, Macdougall I, Macleod A, Wiecek A, Cameron S. (2004). Revised European best practice guidelines for the management of anaemia in patients with chronic renal failure. *Nephrology Dialysis Transplantation*, 19(Suppl. 2), ii1–ii47.

Luengo-Fernandez R, Leal J, Gray A, Sullivan R. (2013) Economic burden of cancer across the European Union: a population-based cost analysis. *Lancet Oncol.* 14(12) pp1165-74. (Epub 2013 Oct 14).

Maier G, Horas K, Kurth A, Lazovic D, Seeger J, Maus U. (2015) Prevalence of Vitamin D Deficiency in Patients with Bone Metastases and Multiple Myeloma. *Anticancer Res*, 35(11), 6281-5.

Mailankody S, Pfeiffer R, Kristinsson SY, Korde N, Bjorkholm M, Goldin LR, Turesson I, Landgren O. (2011) Risk of acute myeloid leukemia and myelodysplastic syndromes after multiple myeloma and its precursor disease (MGUS). *Blood*, 118(15), 4086-92. (Epub 2011 Jul 27).

Majhail N, Rizzo J, Lee S, Aljurf M, Atsuta Y, Bonfim C, Burns L, Chaudhri N, Davies S, Okamoto S, Seber A, Socie G, Szer J, Van Lint M, Wingard J, Tichelli A; Center for International Blood and Marrow Transplant Research; American Society for Blood and Marrow Transplantation; European Group for Blood and Marrow Transplantation; Asia-Pacific Blood and Marrow Transplantation Group; Bone Marrow Transplant Society of Australia and New Zealand; East Mediterranean Blood and Marrow Transplantation Group; Sociedade Brasileira de Transplante de Medula Ossea. (2012) Recommended screening and preventive practices for long-term survivors after hematopoietic cell transplantation. *Bone Marrow Transplant*, 47(3), 337-41.

Majhail N, and Rizzo J. (2013). Surviving the cure: long term followup of hematopoietic cell transplant recipients. *Bone Marrow Transplant*, 48(9),1145-51. (Epub 2013 Jan 7).

Mankikian J, Lioger B, Diot E, D'Halluin P, Lissandre S, Marchand Adam S, Mercier E, Beau Salinas F. (2014) Pulmonary toxicity associated with the use of lenalidomide: case report of late-onset acute respiratory distress syndrome and literature review. *Heart Lung*, 43(2),120-3. (Epub 2013 Dec 19).

Matarraz S, Paiva B, Diez-Campelo M, López-Corral L, Pérez E, Mateos M, Giraldo P, Hernández M, San Miguel J, Orfao A; GEM Grupo Español de MM/Programa para el Estudio de la Terapéutica en Hemopatías Malignas Co-operative Study Groups. (2012). Myelodysplasia-associated immunophenotypic

alterations of bone marrow cells in myeloma: are they present at diagnosis or are they induced by lenalidomide? *Haematologica*, 97(10),1608-11. (Epub 2012 Apr 17).

McCarthy P, Owzar K, Hofmeister C, Hurd D, Hassoun H, Richardson P, Giralt S, Stadtmauer E, Weisdorf D, Vij R, Moreb J, Callander N, Van Besien K, Gentile T, Isola L, Maziarz R, Gabriel D, Bashey A, Landau H, Martin T, Qazilbash M, Levitan D, McClune B, Schlossman R, Hars V, Postiglione J, Jiang C, Bennett E, Barry S, Bressler L, Kelly M, Seiler M, Rosenbaum C, Hari P, Pasquini M, Horowitz M, Shea T, Devine S, Anderson K, Linker C. (2012) Lenalidomide after stem-cell transplantation for multiple myeloma. *N Engl J Med*, 366(19),1770-81.

Miceli T, Colson K, Faiman B, Miller K, Tariman J; International Myeloma Foundation Nurse Leadership Board. (2011). Maintaining bone health in patients with multiple myeloma: survivorship care plan of the International Myeloma Foundation Nurse Leadership Board. *Clin J Oncol Nurs*, 15 Suppl, 9-23.

Minarik J, Pika T, Bacovsky J, Langova K, Scudla V. (2012) Low-dose acyclovir prophylaxis for bortezomib-induced herpes zoster in multiple myeloma patients. *Br J Haematol*, 159(1),111-3. (Epub 2012 Jul 23).

Molassiotis A, Wilson B, Blair S, Howe T, Cavet J. (2011a) Living with multiple myeloma: experiences of patients and their informal caregivers. *Support Care Cancer*, 19,101–111

Molassiotis A, Wilson B, Blair S, Howe T, Cavet J. (2011b) Unmet supportive care needs, psychological well-being and quality of life in patients living with multiple myeloma and their partners. *Psychooncology*, 20 pp88–97

Mols F, Oerlemans S, Vos A, Koster A, Verelst S, Sonneveld P, van de Poll-Franse L. (2012). Health-related quality of life and disease-specific complaints among multiple myeloma patients up to 10 yr after diagnosis: results from a population-based study using the PROFILES registry. *Eur J Haematol*, 89(4), 311-9. (Epub 2012 Aug 1).

Morell A and Barandun S. (1988) Prophylactic and therapeutic use of immunoglobulin for intravenous administration in patients with secondary immunodeficiencies associated with malignancies. *Pediatr Infect Dis J*, 7(5 Suppl), S87-91

Morgan G, Davies F, Gregory W, Bell S, Szubert A, Cook G, Drayson M, Owen R, Ross F, Jackson G, Child J. (2013) Long-term follow-up of MRC Myeloma IX trial: Survival outcomes with bisphosphonate and thalidomide treatment. *Clin Cancer Res*,19(21), 6030-8 (Epub 2013 Aug 30).

Morley J, Baumgartner R, Roubenoff R, Mayer J, Nair K. (2001) Sarcopenia. *J Lab Clin Med*, 137, 231–243

Murray S and Pindoria S. (2009) Nutrition support for bone marrow transplant patients. *Cochrane Database Syst* (1):CD002920

Musto P and Carotenuto M. (1997) Vaccination against influenza in multiple myeloma. *British Journal of Haematology*, 97 (2), 505–6

Musto P, Brugiattelli M, Carotenuto M. (1995) Prophylaxis against infections with intravenous immunoglobulins in multiple myeloma. *Br J Haematol*, 89, 945–946.

Narici, M.V. and N. Maffulli, (2010) Sarcopenia: characteristics, mechanisms and functional significance. *Br Med Bull*, 95,139-59.

National Cancer Action Team. (2010) Holistic Needs Assessment for people with cancer – A practical guide for healthcare professionals.

National Cancer Institute, National Institutes of Health. NCI Dictionary of cancer terms. <http://www.cancer.gov/dictionary> Accessed 21 July 2014

National Cancer Survivorship Initiative. (2012) Adult survivorship: from concept to innovation.

National Cancer Survivorship Initiative<sup>a</sup> , [www.ncsi.org.uk](http://www.ncsi.org.uk). Accessed 19 January 2016

National Cancer Survivorship Initiative<sup>b</sup>. The Recovery Package. <http://www.ncsi.org.uk/what-we-are-doing/the-recovery-package/> Accessed 9 February 2016

National Institute for Health and Care Excellence. (2004) Improving supportive and palliative care for adults with cancer. *NICE cancer service guidance*. London.

Newman A, Kupelian V, Visser M, Simonsick E, Goodpaster B, Nevitt M et al. (2003) Sarcopenia: alternative definitions and associations with lower extremity function. *J Am Geriatr Soc*, 51, 1602–1609.

NICE (2016) Myeloma: diagnosis and management NICE guideline 35; Appendix G: Evidence review. <http://www.nice.org.uk/guidance/ng35/evidence/appendix-g-evidence-review-2306487279>

NICE Guidance in Heart Failure (2010) <https://www.nice.org.uk/Guidance/CG108>

NICE Guidelines for Diagnosis and Management of Myeloma. <https://www.nice.org.uk/guidance/ng35>

Nix E, Hawdon N, Gravelle S, Biman B, Brigden M, Malik S, McCready W, Ferroni G, Ulanova M. (2012) Risk of invasive *Haemophilus influenzae* type b (Hib) disease in adults with secondary immunodeficiency in the post-Hib vaccine era. *Clin Vaccine Immunol*. 19(5), 766-71. Epub 2012 Mar 7.

Nucci M and Anaissie E.(2009) Infections in patients with multiple myeloma in the era of high-dose therapy and novel agents. *Clinical Infectious Diseases*, 49(8), 1211-25.

Office for National Statistics (ONS) (2011) Cancer survival in England: Patients diagnosed 2005-2009 and followed up to 2010. London: ONS. <http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcM%3A77-320365> accessed 10 January 2016

Ogawara H, Handa H, Yamazaki T, Toda T, Yoshida K, Nishimoto N, Al-ma'Quol W, Kaneko Y, Matsushima T, Tsukamoto N, Nojima Y, Matsumoto M, Sawamura M, Murakami H. (2005) High Th1/Th2 ratio in patients with multiple myeloma. *Leuk Res*, 29(2), 135-40.

Oken M, Pomeroy C, Weisdorf D, Bennett J. (1996). Prophylactic antibiotics for the prevention of early infection in multiple myeloma. *Am J Med*. 100(6) pp624-8

Osborne T, Ramsenthaler C Ramsenthaler C, Schey S, Siegert R, Edmonds P, Higginson I. (2015) Improving the assessment of quality of life in the clinical care of myeloma patients: the development and validation of the Myeloma Patient Outcome Scale (MyPOS). *BMC Cancer*, 15,280.

Osborne T, Ramsenthaler C, Siegert R, Edmonds P, Schey S, Higginson I. (2012) What issues matter most to people with multiple myeloma and how well are we measuring them? A systematic review of quality of life tools. *Eur J Haematol*, 89(6), 437-57.

Palumbo A, Hajek R, Delforge M, Kropff M, Petrucci M, Catalano J, Gisslinger H, Wiktor-Jędrzejczak W, Zodelava M, Weisel K, Cascavilla N, Iosava G, Cavo M, Kloczko J, Bladé J, Beksac M, Spicka I, Plesner T, Radke J, Langer C, Ben Yehuda D, Corso A, Herbein L, Yu Z, Mei J, Jacques C, Dimopoulos M; MM-015 Investigators. (2012) Continuous lenalidomide treatment for newly diagnosed multiple myeloma. *N Engl J Med*, 366(19),1759-69.

Palumbo A, Bringhen S, Kumar S, Lupparelli G, Usmani S, Waage A, Larocca A, van der Holt B, Musto P, Offidani M, Petrucci M, Evangelista A, Zweegman S, Nooka A, Spencer A, Dimopoulos M, Hajek R, Cavo M, Richardson P, Lonial S, Ciccone G, Boccadoro M, Anderson K, Barlogie B, Sonneveld P, McCarthy P. (2014) Second primary malignancies with lenalidomide therapy for newly diagnosed myeloma: a meta-analysis of individual patient data. *Lancet Oncol*,15(3), 333-42.

Palumbo A, Bringhen S, Mateos M, Larocca A, Facon T, Kumar S, Offidani M, McCarthy P, Evangelista A, Lonial S, Zweegman S, Musto P, Terpos E, Belch A, Hajek R, Ludwig H, Stewart A, Moreau P, Anderson K, Einsele H, Durie B, Dimopoulos M, Landgren O, San Miguel J, Richardson P, Sonneveld P, Rajkumar S. (2015) Geriatric assessment predicts survival and toxicities in

elderly myeloma patients: an International Myeloma Working Group report. *Blood*, 125(13), 2068-74.

Pawlyn C, Khan M, Muls A, Sriskandarajah P, Kaiser M, Davies F, Morgan G, Andreyev H. (2014) Lenalidomide-induced diarrhea in patients with myeloma is caused by bile acid malabsorption that responds to treatment. *Blood*, 124(15), 2467-8.

Persoon S, Kersten M, van der Weiden K, Buffart L, Nollet F, Brug J, Chinapaw M. (2013) Effects of exercise in patients treated with stem cell transplantation for a hematologic malignancy: a systematic review and meta-analysis. *Cancer Treat Rev*. 39(6), 682-90. (Epub 2013 Feb 26.)

Pour L, Adam Z, Buresova L, Krejci M, Krivanova A, Sandecka V, et al. (2009) Varicella-zoster virus prophylaxis with low-dose acyclovir in patients with multiple myeloma treated with bortezomib. *Clin Lymphoma Myeloma*, 9, 151-3

Pour L, Adam Z, Buresova L, Krejci M, Krivanova A, Sandecka V, Zahradova L, Buchler T, Vorlicek J, Hajek R. (2009) Varicella-zoster virus prophylaxis with low-dose acyclovir in patients with multiple myeloma treated with bortezomib. *Clinical Lymphoma & Myeloma*, 9(2), 151-3.

Pratt G, Jenner M, Owen R, Snowden J, Ashcroft J, Yong K, Feyler S, Morgan G, Cavenagh J, Cook G, Low E, Stern S, Behrens J, Davies F, Bird J. (2014) Updates to the guidelines for the diagnosis and management of multiple myeloma. *Br J Haematol*, 167(1), 131-3. (Epub 2014 May 7).

Pryce J, Munir F, Haslam C. (2007) Cancer survivorship and work: symptoms, supervisor response, co-worker disclosure and work adjustment. *Occup Rehabil*, 17(1), 83-92

Public Health England. (2004) Immunisation of individuals with underlying medical conditions: the green book, Chapter 7. 2013 updated 2014. <https://www.gov.uk/government/publications/immunisation-of-individuals-with-underlying-medical-conditions-the-green-book-chapter-7>

Public Health England. (2013). Pneumococcal: The green book; Chapter 25. 2013. <https://www.gov.uk/government/publications/pneumococcal-the-green-book-chapter-25>.

Public Health England. (2015). Influenza: The green book; Chapter 19. 2013 updated 2015. <https://www.gov.uk/government/publications/influenza-the-green-book-chapter-19>

Raanani P, Gafter-Gvili A, Paul M, Ben-Bassat I, Leibovici L, Shpilberg O. (2009) Immunoglobulin prophylaxis in chronic lymphocytic leukemia and multiple myeloma: systematic review and meta-analysis. *Leuk Lymphoma*, 50(5), 764-72.

Renshaw C, Ketley N, Møller H, et al. (2010) Trends in the incidence and survival of multiple myeloma in South East England 1985-2004. *BMC Cancer*, 10, 74.

Repetto L, Fratino L, Audisio RA, Venturino A, Gianni W, Vercelli M, Parodi S, Dal Lago D, Gioia F, Monfardini S, Aapro MS, Serraino D, Zagonel V. (2002) Comprehensive geriatric assessment adds information to Eastern Cooperative Oncology Group performance status in elderly cancer patients: an Italian Group for Geriatric Oncology Study. *J Clin Oncol*, 20(2), 494-502.

**Richards TA, Bertolotti PA, Doss D, McCullagh EJ; International Myeloma Foundation Nurse Leadership Board (2011). Sexual dysfunction in multiple myeloma: survivorship care plan of the International Myeloma Foundation Nurse Leadership Board. *Clin J Oncol Nurs.*, 15, Suppl:53-65.**

Richardson A, Medina J, Brown V, Sitzia J. (2007) Patients' needs assessment in cancer care: a review of assessment tools. *Support Care Cancer*, 15, 1125–1144

Rockwood K and Mitnitski A. (2007) Frailty in relation to the accumulation of deficits. *Gerontol A Biol Sci Med Sci*, 62(7), 722-7

Roeker L, Larson D, Kyle R, Kumar S, Dispenzieri A, Rajkumar S. (2013) Risk of acute leukemia and myelodysplastic syndromes in patients with monoclonal gammopathy of undetermined significance (MGUS): a population-based study of 17 315 patients. *Leukemia*, 27(6), 1391-3. (Epub 2013 Feb 5).

Rubenstein L, Stuck A, Siu A, Wieland D. (1991) Impacts of geriatric evaluation and management programs on defined outcomes: overview of the evidence. *J Am Geriatr Soc*. 39(9 Pt 2), 8S-16S; discussion 17S-18S.

Rubin L, Levin M, Ljungman P, Davies E, Avery R, Tomblyn M, Bousvaros A, Dhanireddy S, Sung L, Keyserling H, Kang I; Infectious Diseases Society of America. (2014) 2013 IDSA clinical practice guideline for vaccination of the immunocompromised host. *Clin Infect Dis*. 58(3) pp309-18. Erratum in: *Clin Infect Dis*. 2014 59(1),144.

Samuelson C, O'Toole L, Boland E, Greenfield D, Ezaydi Y, Ahmedzai S, Snowden J. (2016) High prevalence of cardiovascular and respiratory abnormalities in advanced, intensively treated (transplanted) myeloma: The case for 'late effects' screening and preventive strategies. *Hematology*, Published online: 16 Mar 2016 <http://dx.doi.org/10.1080/10245332.2015.1122258>

Saunders I, Gulbis A, Champlin R, Qazilbash M. (2014) A Lower Dose of Melphalan (140 mg/m<sup>2</sup>) A Preparative Regimen for Multiple Myeloma in Patients >65 or with Renal Dysfunction. *Biol. Blood Marrow Transpl.* 20(2), S293–S294.

Schmid G, Smith R, Baltch A, Hall C, Schiffman G. (1981) Antibody response to pneumococcal vaccine in patients with multiple myeloma. *Journal of Infectious Diseases*, 143(4), 590-7

Schutt P, Brandhorst D, Stellberg W, et al. (2006) Immune parameters in multiple myeloma patients: influence of treatment and correlation with opportunistic infections. *Leuk Lymphoma*, 47, 1570–82.

Shallwani S, Dalzell M, Sateren W, O'Brien S. (2015) Exercise compliance among patients with multiple myeloma undergoing chemotherapy: a retrospective study. *Support Care Cancer*. 23(10) pp3081-8. (Epub 2015 Mar 6).

Silver J, and Baima J. (2013) Cancer prehabilitation: an opportunity to decrease treatment-related morbidity, increase cancer treatment options, and improve physical and psychological health outcomes. *Am J Phys Med Rehabil*, 92(8), 715-27.

Sklenar I, Schiffman G, Jonsson V, Verhoef G, Birgens H, Boogaerts M, et al. (1993) Effect of various doses of intravenous polyclonal IgG on in vivo levels of 12 pneumococcal antibodies in patients with chronic lymphocytic leukaemia and multiple myeloma. *Oncology*, 50, 466–477.

Slot S, Boland J, Snowden J, Ezaydi Y, Foster A, Gethin A, Green T, Chopra L, Verhagen S, Vissers K, Engels Y, Ahmedzai S. (2015) Side effects of analgesia may significantly reduce quality of life in symptomatic multiple myeloma: a cross-sectional prevalence study. *Support Care Cancer*, 23(3), 671-8.

**Smith LC, Bertolotti P, Curran K, Jenkins B; IMF Nurse Leadership Board (2008). Gastrointestinal side effects associated with novel therapies in patients with multiple myeloma: consensus statement of the IMF Nurse Leadership Board. *Clin J Oncol Nurs*. 12(3 Suppl),37-52.**

Smith L, McCourt O, Henrich M, Paton B, Yong K, Wardle J, Fisher A. (2015) Multiple myeloma and physical activity: a scoping review. *BMJ Open*, 5(11), e009576.

Snowden J, Ahmedzai S, Ashcroft J et al. on behalf of the Haemato-oncology Task Force of the British Committee for Standards in Haematology and UK Myeloma Forum. (2011) Guidelines for supportive care in multiple myeloma 2011. *Brit J Haematol* 154(1), 76–103

Srivastava G, Rana V, Lacy M, Buadi F, Hayman S, Dispenzieri A, Gertz M, Dingli D, Zeldenrust S, Russell S, McCurdy A, Kapoor P, Kyle R, Rajkumar S, Kumar S. (2013) Long-term outcome with lenalidomide and dexamethasone therapy for newly diagnosed multiple myeloma. *Leukemia*, 27(10), 2062-6. (Epub 2013 May 7).

Tackling EARly Morbidity and Mortality in myeloma (TEAMM). Tackling early morbidity and mortality in myeloma: assessing the benefit of antibiotic prophylaxis and its effect on healthcare associated infections. ISRCTN51731976 DOI 10.1186/ISRCTN51731976. <http://www.cancerresearchuk.org/about-cancer/find->

a-clinical-trial/a-trial-looking-antibiotic-prevent-infections-people-having-treatment-myeloma-teamm

Tariman J and Faiman B. (2011) Multiple myeloma. In: Yarbro CH, Wujcik D, Gobel BH, editors. *Cancer nursing principles and practice*. 7. Massachusetts: Jones and Bartlett. pp1513-1545

Teh B, Khot A, Harrison S, Prince H, Slavin M. (2013) A messenger at the door: cytomegalovirus retinitis in myeloma patients with progressive disease. *Transpl Infect Dis*, 15, E134–E138

Terpos E, Kleber M, Engelhardt M, Zweegman S, Gay F, Kastiris E, van de Donk N, Bruno B, Sezer O, Broijl A, Bringhen S, Beksac M, Larocca A, Hajek R, Musto P, Johnsen H, Morabito F, Ludwig H, Cavo M, Einsele H, Sonneveld P, Dimopoulos M, Palumbo A; European Myeloma Network. (2015) European Myeloma Network guidelines for the management of multiple myeloma-related complications. *Haematologica*, 100(10),1254-66.

Thomas A, Mailankody S, Korde N, Kristinsson S, Turesson I, Landgren O. (2012) Second malignancies after multiple myeloma: from 1960s to 2010s. *Blood*, 119(12), 2731-7. (Epub 2012 Feb 6).

Thurmann P, Sonnenburg C, Valentova K, Gregora E, Freischlager F, Lissner R. (2011) Pharmacokinetics of viral antibodies after administration of intravenous immunoglobulin in patients with chronic lymphocytic leukaemia or multiple myeloma. *European Journal of Clinical Pharmacology*, 57(3), 235-41

Timmons A, Gooberman-Hill R, Sharp L. (2013)The multidimensional nature of the financial and economic burden of a cancer diagnosis on patients and their families: qualitative findings from a country with a mixed public-private healthcare system. *Support Care Cancer*, 21(1),107-17. (Epub 2012 Jul 20)

Tomblyn M, Chiller T, Einsele H, Gress R, Sepkowitz K, Storek J, Wingard JR, Young J-A H, Boeckh MJ (2009).Guidelines for preventing infectious complications among hematopoietic cell transplant recipients: a global perspective. *Bone Marrow Transplantation*, 44, 453–558

US National Cancer Institute Surveillance, Epidemiology, and End Results Program. <http://seer.cancer.gov/statfacts/html/mulmy.html>

US National Cancer Institute. NCI Dictionary of cancer terms. <http://www.cancer.gov/publications/dictionaries/cancer-terms?cdrid=445089>

Vesole D, Oken M, Heckler C, Greipp P, Katz M, Jacobus S, Morrow G; University of Rochester Cancer Center and the Eastern Cooperative Oncology Group. (2012) Oral antibiotic prophylaxis of early infection in multiple myeloma: a URCC/ECOG randomized phase III study. *Leukemia*, 26(12), 2517-20. (Epub 2012 May 8).

Vickrey E, Allen S, Mehta J, Singhal S. (2009) Acyclovir to prevent reactivation of varicella zoster virus (herpes zoster) in multiple myeloma patients receiving bortezomib therapy. *Cancer*, 115, 229– 32.

Wells M, Amir Z, Cox T, Eva G, Greenfield D, Hubbard G, Kyle R, McLennan S, Munir F, Scott S, Sharp L, Taskila T, Wiseman T (the CANWORK research group) (2014) Time to act: The challenges of working during and after cancer, initiatives in research and practice. Guest Editorial. *European Journal of Oncology Nursing*, 18, 1-2.

Wells M, Williams B, Firnigl D, Lang H, Coyle J, Kroll T, MacGillivray S. (2013) Supporting 'work-related goals' rather than 'return to work' after cancer? A systematic review and meta-synthesis of 25 qualitative studies. *Psychooncology*. 22(6),1208-19. (Epub 2012 Aug 10)

Wildes T, Rosko A, Tuchman S. (2014) Multiple myeloma in the older adult: better prospects, more challenges. *J Clin Oncol*. 32(24), 2531-40

Wildiers H, Heeren P, Puts M, Topinkova E, Janssen-Heijnen M, Extermann M, Falandry C, Artz A, Brain E, Colloca G, Flamaing J, Karnakis T, Kenis C, Audisio R, Mohile S, Repetto L, Van Leeuwen B, Milisen K, Hurria A. (2014) International Society of Geriatric Oncology consensus on geriatric assessment in older patients with cancer. *Clin Oncol*, 32(24), 2595-603.

Wongrakpanich S, George G, Chaiwatcharayut W, Candelario N, Mittal V, Pomerantz S, Varadi G. (2015) Frequency of folate deficiency in multiple myeloma patients: a 10-year retrospective study. *Int J Lab Hematol*, [Epub ahead of print]

Woods L, Rachet B, Shack L et al. with the UK Association of Cancer Registries. (2010) Survival from twenty adult cancers in the UK and Republic of Ireland in the late twentieth century. *Health Stat Q*, (46), 5-24.

Yellen S, Cella D, Leslie W. (1994) Age and clinical decision making in oncology patients. *J Natl Cancer Inst*, 86(23), 1766-70.