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Post-transplant care guidelines

Long-term care recommendations

Screening • Immunization • GVHD

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Recommended post-transplant care

After your patient leaves the transplant center and returns to your care, your support is critical to their long-term recovery and survival. This three-part guide contains post-hematopoietic cell transplant (HCT) care guidelines developed in partnership with leading transplant organizations and based on peer-reviewed publications.

Part 1: Long-term screening

Includes a list of recommended post-transplant screening and preventive practices.

Consult this section at a patient's follow-up appointments.

Part 2: Vaccinations

Provides a recommended vaccination schedule.

Consult this prior to a patient's first appointment after transplant and as needed at future appointments.

Part 3: Screening for chronic GVHD

Identifies clinical manifestations and symptoms of chronic graft-versus-host disease (GVHD) and includes a photo atlas.

Consult this section when chronic GVHD is suspected or to review the full range of chronic GVHD manifestations.

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Part 1: Long-term screening

Recognizing complications early when there are more effective treatment options is critical to the well-being of transplant recipients.

Complications from HCT can develop long after a patient leaves a transplant center and returns to a primary physician. Use these guidelines to deliver the specialized care transplant patients need to prevent late complications and to reduce morbidity.

These long-term screening guidelines are based on **International Recommendations for Screening and Preventative Practices for Long-Term Survivors of Transplantation and Cellular Therapy: A 2023 Update**, developed by experts across 29 international transplant institutions.[1]

Use the following charts to:

- Become aware of the specialized care transplant recipients need
- Plan for tests and treatments
- Trigger discussions with patients on proper self-care

Use our app to access the long-term screening guidelines when you need them.
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1. Rotz SJ, Bhatt NS, Hamilton BK, et al. International recommendations for screening and preventative practices for long-term survivors of transplantation and cellular therapy: A 2023 update. *Transplantation and Cellular Therapy*. 2024;30(4):349-385. doi: **10.1016/j.jtct.2023.12.001**.

Cardiac and vascular

	Frequency	Notes
Tests/procedures		
Lipid panel	• LR: At 6 months and then annually • HR: Every 3–6 months	• Less frequent testing reasonable for children • Multimodal weight loss program for obese adults
Hemoglobin A1c	• LR: At 3–6 months and then annually • HR: Every 6 months	• Less frequent testing reasonable for children
Echocardiogram	**Adults:** • Within 1 year if anthracyclines ≥250 mg/m2, or with lower exposure and additional cardiomyopathy risk factors • As needed if without anthracycline exposure **Children:** • Screening according to COG guidelines (**survivorshipguidelines.org**)	• Additional surveillance based on risk factors • Referral to cardiology if abnormal imaging and/or concerning symptoms • If available, consider referring to cardio-oncology program for those at very high risk
Recommendations		
Management of dyslipidemia	• According to AHA/ACC recommendations or local guidance	
Management of hypertension	• According to population guidance	• Measurement of blood pressure, weight and BMI at each survivorship visit
Other considerations		
Hurler syndrome	• Close monitoring for cardiopulmonary dysfunction after HCT	
Amyloidosis	• Close monitoring of cardiac function for longer-term	

Note: LR=low risk; HR=high risk; AHA=American Heart Association; ACC=American College of Cardiology; BMI=body mass index

Dermatologic

	Frequency	Notes
Tests/procedures		
Dermatologic exam	• Risk factor dependent	• Frequency/extent of examination tailored to individual risk factors: prior or present GVHD, sun exposure and radiation history, voriconazole exposure, family history, and history of skin cancer • Regular skin self-examination; refer to a dermatologist for further evaluation of suspicious lesions • Regular skin exam involves exposure of all body areas and includes manual palpation to detect sclerosis
Recommendations		
Discuss risk of dermatologic complications	• At comprehensive survivorship visits	• Particularly related to chronic GVHD, medications and radiation • Advise to seek medical attention for non-healing skin lesions, skin tightening or other changes
Discuss sun exposure	• At comprehensive survivorship visits	• Advise to avoid direct sun exposure without appropriate protection: proper clothing, hats, applying UVA/UVB sunscreen to exposed areas • Particularly important for patients on immunosuppression, voriconazole, with a history of TBI or skin chronic GVHD

Note: TBI=total body irradiation

Endocrine

	Frequency	Notes
Tests/procedures		
Thyroid function test	• At 1 year post-transplant or sooner if symptomatic, and annually thereafter	• TSH and free T4 recommended • CNS radiation therapy is a risk factor for central hypothyroidism
Recommendations		
Assessment of suspected growth abnormality	• Routine monitoring	• Should be evaluated and treated by an endocrinologist, weighing clinical risks vs. benefits of hormonal therapy • Routine assessment of growth velocity including height, weight and BMI should be performed for children
Assessment of gonadal dysfunction	• Annually	• Assessment of menarche/menstrual history and menopausal symptoms • Routine assessment of onset/progression of puberty with tanner staging for children; increasing frequency when approaching puberty or with concerns • Gonadal assessment at 1-year post-HCT in adults; subsequent frequency according to clinical needs • Involvement of appropriate subspecialties for potential HRT
Assessment for adrenal insufficiency	• Monitoring as needed	• ACTH stimulation test for patients on long-term corticosteroids when weaning corticosteroids

Note: TSH=thyroid stimulating hormone; CNS=central nervous system; BMI=body mass index; HRT=hormone replacement therapy; ACTH=adrenocorticotropic hormone

Gastrointestinal

	Frequency	Notes
Tests/procedures		
Liver function testing (transaminases, total bilirubin, alkaline phosphatase)	• Those without risk factors: Every 1–2 months for the first year and then annually • With chronic hepatitis, chronic GVHD tapering IST beyond first year: More frequent monitoring	
Other considerations		
HBV infection	• Chronic HBV: Lifelong monitoring of HBV DNA at least every 2 months; HBV DNA and ALT every month after withdrawing antivirals; prophylactic anti-HBV therapy should be considered regardless of HBV DNA levels to prevent reactivation; continue at least 1 year after IST withdrawal • Resolved HBV: HBV DNA monitoring at least every 2 months for at least 3 years after stopping IST; prophylactic anti-HBV therapy if unable to monitor HBV DNA, continue at least 3 years after IST withdrawal	
HCV infection	• Chronic HCV: Routine HCV RNA testing at baseline and if getting HCV antiviral therapy or has unexplained ALT elevation; antiviral therapy if available and check LFTs and CBC every 6–12 months	• More information: **hcvguidelines.org**
Cirrhosis	• Monitor for varices, HCC and other sequalae	• Referral to hepatologist for monitoring
Dyskeratosis congenita	• Frequent LFTs	• Hepatologist referral if abnormalities noted

Note: IST=immune suppression therapy; HBV=hepatitis B virus; ALT=alanine aminotransferase; HCV=hepatitis C virus; LFT=liver function tests; CBC=complete blood count; HCC=hepatocellular carcinoma

Hematologic

	Frequency	Notes
Tests/procedures		
CBC	• At each visit for at least 10 years post-HCT	• If abnormal, repeat as needed
Ferritin	• Regular monitoring until normalized	• Non-specific, initial screening test for iron overload
MRI (iron quantification)	• To assess liver and cardiac iron levels when concern; follow-up as needed to follow progress after treatment	• Risk based on transfusion history and HCT indication
Post-HCT phlebotomy	• With confirmed iron overload; duration dependent on response	• Consider iron chelation if ineligible for phlebotomy • Resumption of menses in females may reduce iron
Recommendations		
VTE prophylaxis in patients with multiple myeloma	• When receiving immunomodulatory imide drugs and chemotherapy and/or dexamethasone after HCT	
Bleeding risk assessment	• Prior to initiating anticoagulation	
Other considerations		
Hemoglobinopathy	• Perform chimerism at least every 3 months in year 1 post-HCT and every 6 months thereafter • Further chimerism based on previous results	
Hurler syndrome	• Neurologic screening for spinal canal narrowing and carpal tunnel syndrome	
Inherited bone marrow failure syndromes	• Require specialized follow-up with a multidisciplinary specialist team	

Note: CBC=complete blood count; MRI=magnetic resonance imaging; VTE=venous thromboembolism

Immunity and infections

	Frequency	Notes
Recommendation		
Vaccination	• Consider beginning inactivated vaccines at 3–6 months post-HCT (See Part 2: Vaccinations for vaccination recommendations)	• According to published guidelines, considering patient age and country recommendations • Includes patients with GVHD and/or on IST given higher risk of infection
Other considerations		
Asplenia/functional asplenia	• Vaccinate for S. pneumoniae and N. meningitidis (MCV4, group B) • Educate on sepsis/fever management • Consider antimicrobial prophylaxis	
Hypogammaglobulinemia	• Supplemental IVIg may be considered for selected HCT recipients with IgG <400 mg/dL (4 g/L): patients with recurrent sino-pulmonary infections; patients with very low levels (<200 mg/dL); or receiving anti-B cell or CAR-T therapy	
Multiple myeloma	• Specific anti-myeloma medications warrant specific antimicrobial prophylaxis	
Inborn errors of immunity	• Pay careful attention to immune reconstitution and mixed chimerism • Assess lymphocyte subsets, mitogen proliferation, immunoglobulin levels and antibody responses every 3–6 months until normalized and as needed	

Note: IST=immune suppression therapy; MCV=meningococcal vaccine; IVIg=intravenous immunoglobulin

Muscular

	Frequency	Notes
Recommendation		
Assess range of motion	• At each clinic visit for patients with chronic GVHD	• Ideally with medical photos for subsequent comparison • Encourage patients to also perform self-assessment
Other considerations		
Glucocorticoids	• Routinely evaluate patients on glucocorticoid treatment for glucocorticoid-induced myopathies; observe patient rising from a squatting position • Patients with/at risk for steroid myopathy should engage in physical activity and physical therapy; physiatry referral may be beneficial, low resistance exercise to prevent/slow loss of muscle mass	
Myalgia/weakness	• Chronic GVHD-associated polymyositis, statin toxicity or myasthenia gravis should be included in differential diagnosis of myalgia/weakness if persistent or progressive • CPK, aldolase, anti-acetylcholine antibodies are a reasonable next step; if negative, muscle MRI, EMG or muscle biopsy may be considered	

Note: CPK=creatine phosphokinase; MRI=magnetic resonance imaging; EMG=electromyography

Neurologic and cognitive

	Frequency	Notes
Tests/procedures		
Clinical assessment for PNS and CNS dysfunction	• At 6 and 12 months post-HCT, ≥yearly thereafter	• Earlier and more frequent evaluation to be considered in high-risk patients • Careful history/examination/review of systems/medication history and assessment of time of onset of neurological signs and symptoms during survivorship visits
Audiologic evaluation	• Within first year post-HCT	• Patients with exposures to head and neck irradiation, platinum chemotherapy, aminoglycosides or an inherited condition associated with hearing disability • Follow-up evaluations as clinically warranted
Neurocognitive testing	• Pediatrics: Within first year post-HCT • Adults: As needed	• Strongly consider before returning to work/school, major changes in school (i.e., moving from elementary to middle school), or changes in school performance
Recommendations		
Council on hearing loss prevention	• At initial survivorship visit	• Council patients about hearing loss prevention and to seek assessment for new symptoms • Hearing loss may be present in ADA deficiency prior to HCT and require developmental support, regular otolaryngology and audiological assessment post-HCT

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Pediatrics: Discuss/monitor development/cognition	• Annually	• Can be performed by pediatrician • Educational/vocational progress assessment recommended
Adult: Screen for cognitive changes	• At comprehensive survivorship visit	• Query for cognitive function changes (may be subtle) • Inquire about difficulties multitasking, attention, remembering things or whether thinking feels slow • Exclude reversible causes of cognitive decline: depression, fatigue, insomnia, medication • Neurocognitive testing and imaging should be considered if functional impairment
Geriatric: Comprehensive geriatric assessment	• At 6 and 12 months post-HCT	• To identify patients more likely to benefit from enhanced toxicity risk-prediction and aid treatment decision-making
Council on hearing loss prevention	• At initial survivorship visit	• Council patients about hearing loss prevention and to seek assessment for new symptoms • Hearing loss may be present in ADA deficiency prior to HCT and require developmental support, regular otolaryngology and audiological assessment post-HCT
Other considerations		
Sickle cell disease	• All patients undergoing HCT for sickle cell disease should be offered neurocognitive testing post-therapy, if available	

Note: PNS=peripheral nervous system; CNS=central nervous system; ADA=adenosine deaminase deficiency

Ocular

	Frequency	Notes
Tests/procedures		
Ocular exam	• At onset of any chronic GVHD, dry eye symptoms, changes in vision or other eye symptoms	• NIH Consensus Development Project recommends consultation with an eye specialist every 3 months during the first year post-HCT and then at longer intervals thereafter • Monitoring of IOP important in patients receiving any form of glucocorticoids
Recommendations		
Question about eye concerns	• At comprehensive survivorship visits	• Advise to report dryness, light sensitivity, excessive tearing, foreign body sensation, pain, redness, swelling, mucoid aggregates, vision changes • Inform about risk of premature cataracts for TBI recipients
Recommendations		
Hurler syndrome	• Ongoing ophthalmologic assessment for glaucoma, cataracts, progression of corneal clouding	

Note: IOP=intraocular pressure; TBI=total body irradiation

Oral and dental

	Frequency	Notes
Tests/procedures		
Evaluation by a dentist or oral medicine specialist	• At 6 and 12 months post-HCT, ≥yearly thereafter	• Earlier and more frequent evaluation to be considered in high-risk patients (e.g., Fanconi anemia, radiation to the head or neck, or refractory chronic GVHD)
Recommendations		
Screen for chronic GVHD, high-risk habits	• At comprehensive survivorship visit	• Avoid smoking, vaping and chewing tobacco • Decrease regular intake of sugar containing beverages • Avoid intra-oral piercing
Perform a thorough head, neck and oral exam	• At comprehensive survivorship visit	• To identify patients more likely to benefit from enhanced toxicity risk-prediction and aid treatment decision-making
HPV vaccination	• According to published guidelines, considering patient age and country recommendations	
Other considerations		
Children	• Perform oral and radiologic assessment for tooth development	
Xerostomia	• Should receive meticulous oral hygiene, undertake preventive measures for dental/ periodontal disease, and receive aggressive treatment of oral infections • Avoid trauma to oral mucosa	

Note: HPV=human papillomavirus

Psychosocial

	Frequency	Notes
Tests/procedures		
Mental health screening with standardized questionnaire	• At comprehensive survivorship visits	• e.g., NCCN distress thermometer, survivorship questionnaire • No gold standard for screening mental health after HCT; take care to not overburden patients with PRO tools • To guide clinical investigations or behavioral or psychological support, particularly if multiple somatic complaints, new GVHD, major life events or treatment changes
Recommendations		
Review psychosocial and mental health	• Day +100, +180, +365, then annually	• Review current symptom patterns, distress, medications, co-morbidities and physical activity • Regularly inquire to level of spousal/caregiver psychological adjustment, family functioning, education, vocational activities and financial toxicity • Appropriate referral if necessary • Offer peer support and return to work/school programs
Discuss medication adherence	• Ongoing	

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Discuss healthy lifestyle	• At comprehensive survivorship visits	• Set incremental goals for healthy diet (i.e., vegetables, fruits, whole grains, low in excess sugars, dried foods, red/processed meat and dietary supplements), activity, weight management • Encourage adequate sleep and age-appropriate preventative measures
Other considerations		
Adolescents and young adults	• Provide transition of care education and plans	
Persons with disabilities	• Assess those with significant physical, visual or auditory disabilities for appropriate support services and medical equipment needs	

Note: PRO=patient reported outcomes

Renal and urinary

	Frequency	Notes
Tests/procedures		
Renal function testing	• At 6 months, 1 year, and at least annually thereafter	• Includes complete urinalysis, urine albumin to creatinine ratio, BUN/creatinine • More frequent monitoring for multiple myeloma and amyloidosis • Possible renal anomalies predisposing to CKD among patients with bone marrow failure syndromes, IEM or Artemis deficiency
Recommendations		
Management of hypertension	• According to population guidance	• Measurement of blood pressure, weight and BMI at each survivorship visit

Note: BUN=blood urea nitrogen; CKD=chronic kidney disease; IEM=inborn errors of metabolism

Respiratory

	Frequency	Notes
Tests/procedures		
PFT screening	• At every 3 months for the first year after HCT, every 6 months for the second year, and then annually for 5 years after HCT (or until final adult height in children, whichever occurs later)	• Spirometry and hemoglobin corrected DLCO age • Age <6 years: if unable to perform, can consider alternative screening with pulse oximetry, multiple breath washout testing, parametric mapping by CT
CT chest imaging	• At onset of pulmonary symptoms or abnormal PFTs	
Recommendations		
Pulmonary consultation	• At onset of pulmonary symptoms or abnormal PFTs	• Especially in setting of irreversible airflow obstruction
Vaccination against respiratory pathogens	• Consider beginning inactivated vaccines at 3–6 months post-HCT	• According to published guidelines, considering patient age and country recommendations
Counsel on avoidance of tobacco, smoking, vaping	• At comprehensive survivorship visit	
Other considerations		
Dyskeratosis congenita	• Perform PFTs at regular intervals post-HCT • Refer to pulmonologist with any abnormalities	
Chronic GVHD	• PFTs at initial diagnosis then at least spirometry every 3–6 months until discontinuation of all systemic immunosuppressive therapy	

Note: PFT=pulmonary function test; DLCO=diffusing capacity of the lungs for carbon monoxide; CT=computed tomography

Sexual health, fertility and pregnancy

	Frequency	Notes
Tests/procedures		
Fertility assessment	• As age appropriate and for those contemplating future parenthood	• Semen analysis or assessment of ovarian function • Discussion about risk of premature menopause • Fertility specialist consult for those desiring pregnancy to understand fertility potential and options (i.e., IVF, donor gamete) • Contraception advised for those wishing to avoid parenthood
Recommendations		
Sexual activity	• As appropriate	• Counseling regarding safe sex practices and contraceptive options
Sexual function	• Discuss at 3–6 months post-HCT and then continue annually	• Prompt referral for medical or psychosocial needs for patient and partner as necessary • Assessment of hypogonadism and/or urogenital GVHD with appropriate gynecology or genitourinary team referral
Pregnancy	• As appropriate	• Patients should be followed throughout pregnancy by expert in high-risk obstetrics and may require review by an anesthetist prior to delivery

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Other considerations		
Pregnant women with systolic dysfunction/cardiac risk factors	• Cardiology follow-up during pregnancy	
Those with underlying genetic disorder/cancer predisposition syndrome	• Genetic counseling prior to pregnancy	
Women exposed to uterine radiation and desiring pregnancy	• Counsel on risk of uterine factor infertility	

Skeletal

	Frequency	Notes
Tests/procedures		
DEXA	• SR: At 1 year post-HCT • HR: At 3 months post-HCT	• If abnormal, repeat 1–2 years, sooner if ongoing risks or response assessment • <5 years old, lumbar spine BMD may be measured; DEXA hip measurements less reliable for age <13 • FRAX and VFA may help evaluation/management
Recommendations		
Optimize Ca and vitamin D intake	• At comprehensive survivorship visits	• Vitamin D may be measured regularly in those at deficiency risk
Recommend weight-bearing exercise	• At comprehensive survivorship visits	• According to published guidelines, considering patient age and country recommendations
Discuss hormone replacement therapy	• As needed	• Patients with hypogonadism if age-appropriate, and not otherwise contraindicated
Other considerations		
Bisphosphonates	• Consider bisphosphonates in high-risk patients, significant abnormalities on DEXA or FRAX assessments or fragility fractures • Bisphosphonate choice made with consideration of the patient's presentation, renal function and respective adverse events • For patients with MM, supportive management with use of bisphosphonates for at least 2 years	

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AVN	• Maintain a high index of suspicion for AVN risks include prior AVN, radiation exposure or prolonged glucocorticoids • Routine imaging screening for asymptomatic AVN not indicated • Symptomatic patients: Non-contrast MRI is the most sensitive way to confirm and stage AVN; once diagnosis of AVN prompt referral to orthopedic specialist recommended
Hurler syndrome	• Neurologic screening for spinal canal narrowing and carpal tunnel syndrome

Note: DEXA=dual energy X-ray absorptiometry; SR=standard risk; HR=high risk; BMD=bone mineral density; FRAX=fracture risk assessment tool; VFA=vertebral fracture assessment; MM=multiple myeloma; AVN=avascular necrosis

Subsequent malignant neoplasm

Tests/procedures	Frequency	Notes
Note: If risk not otherwise modified by HCT history, screen as regionally and clinically indicated based on other underlying medical, family and genetic history		
CBC/tMN screening	• HR: Annually for ≥10 years	• HR: Consider more frequent screening (i.e., chemotherapy, age; autologous HCT) • Attention to unexplained cytopenias, macrocytosis or cellular atypia
EBV-DNA screening	• Variable	• For prevention of PTLD in high-risk patients (e.g., ATG, alemtuzumab, ex-vivo T-cell depletion)
Cervical cancer screening/pap smear	• Most: Variable • FA: Annually	• For most, screening interval based on attained age and risk factors • FA: Starting in adolescence
Oral exam	• Most: Annually • HR: Every 6 months	• HR for oral cancer: Oral chronic GVHD, tobacco use, FA • Advise reporting non-healing lesions, leukoplakia, localized pain, changes in mucosal color/texture
EGD	• Variable	• Endoscopic screening for esophageal cancer may be considered in high-risk patients (chronic GVHD receiving prolonged immunosuppression, symptoms of gastroesophageal reflux, dysphagia)
Colonoscopy/CRC	• Variable	• According to published guidelines, considering patient age and country recommendations

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Breast cancer/mammography/ breast MRI	• Variable	• Female recipients of TBI or chest RT should begin breast cancer screening with mammogram and breast MRI (if available) at age 25 or 8-years post-RT, whichever occurs later, but no later than age 40 • Survivors without additional risk factors should participate in regular annual mammogram/clinical breast exam according to general population guidelines for geographical region and individual risk factors including FHx
Thyroid exam	• Annually	• Patients should have an annual thyroid exam and review of potential symptoms of thyroid cancer • As part of shared decision making, consider ultrasound screening in patients who received thyroid RT; routine use of thyroid ultrasound may not provide additional benefit; some groups recommended • Screen patients with inherited thyroid CPS (e.g., multiple endocrine neoplasia, FAP) based on underlying condition
Recommendations		
General counseling	• At comprehensive survivorship visits	• Based on treatment exposures, time from exposure, chronic GVHD history and other modifying factors • Encourage to avoid high-risk behaviors, unhealthy diet (e.g., tobacco and vaping, passive tobacco exposure, alcohol abuse, high fat/low fiber diet)

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Breast cancer risk counseling	• At comprehensive survivorship visits	• In high-risk individuals, discussion with appropriate experts on risk reduction strategies (i.e., prophylactic mastectomy, prophylactic medical therapies, lifestyle) – Counsel on additional breast cancer risk factors (i.e., BRCA1/2, FHx)
Other considerations		
EBV viremia	• Recommend pre-emptive treatment with Rituximab • Note: PTLD evaluation includes LN palpation, review of B-symptoms (fever, drenching night sweats, ≥10% weight loss over 6 months)	
HPV	• HPV vaccination according to country-specific general population recommendations, unless otherwise contraindicated • Note: HPV role in mucocutaneous/genital cancers post-HCT unclear	
FA	• Survivors with mutations in BRCA2 (FANCD1) or PALB2 (FANCN) require screening for specific solid cancers	

Note: CBC=complete blood count; tMN=therapy-related myeloid neoplasms; HR=high risk; PTLD=post-transplant lymphoproliferate disorder; FA=Fanconi anemia; EGD=esophagogastroduodenoscopy; CRC=colorectal cancer; RT=radiation therapy; TBI=total body irradiation; FHx=family history; CPS=Cancer Predisposition Syndrome; HNPCC=hereditary nonpolyposis colorectal cancer; FAP=familial adenomatous polyposis; DBA=Diamond Blackfan anemia; MRI=magnetic resonance imaging; CNS=central nervous system; LN=lymph node; HPV=human papilloma virus

Part 2: Vaccinations

Routine administration of vaccinations is vital for prevention of infectious complications in transplant recipients.

Transplant recipients may remain immunocompromised far beyond 2 years post-transplant, especially individuals with chronic GVHD. Therefore, patients should be routinely revaccinated after transplant until they regain immune competence.

These vaccination recommendations[1,2] are based on international consensus guidelines[3,4] for preventing infectious complications among all transplant recipients and are recommended for both autologous and allogeneic HCT recipients.

Use the following chart to:

- Become aware of the vaccinations transplant recipients need
- Plan for administration of vaccines

This information is also accessible through the Transplant Guidelines app. Search for "transplant guide" in the Apple or Android app store to download.

1. Rotz SJ, Bhatt NS, Hamilton BK, et al. International recommendations for screening and preventative practices for long-term survivors of transplantation and cellular therapy: A 2023 update. *Transplantation and Cellular Therapy*. 2024;30(4):349-385. doi: **10.1016/j.jtct.2023.12.001**.

2. Carpenter P, Boeckh M, Deeg J, et al. Long-term follow-up after hematopoietic stem cell I transplant general guidelines for referring physicians. Fred Hutchinson Cancer Center. Published 2023. **https://www.fredhutch.org/content/dam/www/research/patient-treatment-and-support/ltfu/LTFU_HSCT_guidelines_physicians.pdf**

3. Tomblyn M, Chiller T, Einsele H, et al. Guidelines for preventing infectious complications among hematopoietic cell transplantation recipients: a global perspective. *Biol Blood Marrow Transplant*. 2009;15(10)1143-1238. doi: **10.1016/j.bbmt.2009.06.019**.

4. Ljungman P, Cordonnier C, Einsele H, et al. Vaccination of hematopoietic cell transplant recipients. *Bone Marrow Transplant*. 2009;44(8):521-526. doi: **10.1038/bmt.2009.263**.

Vaccine	Recommended for use after HCT	Months post-HCT to initiate vaccine[a]	No. of doses[b]	Comments
PCV20	Yes	3–6	3–4 based on titers	3 doses, each 2 months apart. If first dose at 3 months, then give a fourth dose at least 6 months after the third dose.
DTaP	Yes	6–12	3	"Pediatric" DTaP favored over Tdap for all ages.
Hib	Yes	6–12	3	
MCV4	Yes	6–12	2	
IPV	Yes	6–12	3	
Hepatitis B	Yes	6–12	3–4	4 double-doses of Engerix for adults (0, 1, 2, 6 months from initiation) or 4 standard doses of Heplisav-B (0, 1, 2, 6 months from initiation). Children receive 3 standard doses of Engerix.
Inactivated influenza (high-dose)	Yes	4–6	2+	In flu season. Two doses of high-dose IIV4 at least for the first post-transplant flu season.
HPV9	Yes	6–12	3	Age 9–26 (up to age 45 with shared medical decision-making).
MMR	Yes	24	2	All ages get 2 doses, 1 month apart as a combination vaccine. Do not give unless also >1 year off IST and <8 months since last dose of IVIG.
Varicella	Yes	24	2	If VZV seronegative after transplant. Can be given as combined MMR-V.
SHINGRIX (Zoster)		12	2	Age ≥8 years, at least 1-year post-transplant and at least 8 months of IST without GVHD flareups (autologous recipients generally have also completed maintenance immunotherapy which prolongs the duration of acyclovir prophylaxis). Only give if patient is VZV seropositive (at least 8 months off IVIG); if seronegative, should instead first complete live attenuated varicella series per above recommendation.
COVID	Yes	3	3–4	Use the most current COVID vaccine (0, 1, 3, 5 months from initiation).

See references on previous page for vaccinations considered optional or not recommended for HCT recipients and for vaccinations for family, close contacts and health care workers.

a Depends on overall level of basic numeric immune reconstitution (rule of thumb CD4>200/microliter, CD19>20/microliter and not needing immunoglobulin replacement therapy because IgG levels adequately well maintained).

b A uniform specific interval between doses cannot be recommended, as various intervals have been used in studies. As a general guideline, a minimum of 1 month between doses may be reasonable.

Part 3: Screening for chronic GVHD

Early detection of chronic graft-versus-host disease (GVHD) can help prevent irreversible organ damage and increase the quality of life of your transplant recipient.

Chronic GVHD, an immune response of the donor-derived T cells against recipient tissues, occurs in approximately 30–70% of patients receiving an allogeneic transplant.

This is a serious, potentially life-threatening post-transplant complication. Uncontrolled chronic GVHD is associated with increased non-relapse mortality, significant morbidity and lower health-related quality of life. However, with ongoing surveillance, judicious management and multidisciplinary care, most cases of chronic GVHD resolve within 5 years and the median duration of treatment is 2–3 years.

GVHD that is characterized by red rash, diarrhea, and elevated liver tests, and that usually starts before day 100, is called acute GVHD. When people develop GVHD symptoms in their mouth, eyes, skin or other organs, it is called chronic GVHD. When symptoms appear, the treatment recommendation is: ***Collaborate with the transplant center to confirm the diagnosis and develop a treatment plan***.

The following guidelines are based on published diagnostic criteria from the National Institutes of Health (NIH) Consensus Development Project on Chronic GVHD[1,2,3] (see references on page 49).

Use the following chart to:

- Identify clinical manifestations that are potential early indicators of chronic GVHD
- Trigger prompt clinical action if GVHD is suspected

If GVHD is suspected, it is recommended that you collaborate with the patient's transplant center to confirm the diagnosis and to develop a treatment plan. Your early detection and actions to manage chronic GVHD can help minimize permanent damage and improve the quality of life of your transplant patient.

Important care principles

- Early detection and definitive diagnosis are essential for successful treatment
- Definitive diagnosis of chronic GVHD requires excluding other diagnoses such as infection, drug effects, malignancies, and residual post-inflammatory damage and scarring
- Involvement of a multidisciplinary team is essential
- Both topical and/or systemic treatment may be appropriate
- Infection prophylaxis and prompt and effective management of infections are crucial; infection is a leading cause of death in chronic GVHD
- Long-term follow-up is required to monitor for late sequelae

Access in the app

Use our app to access the chronic GVHD guidelines and photo atlas.

Search for "transplant guide" in the Apple or Android app store to download.

Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Skin	**Patient-reported symptoms and signs** • Itching • Dry skin • Limited mobility • Rash • Sores • Changes in skin coloring or texture • Edema **Clinical examination** • Complete visual examination of the skin with particular attention to pigmentary changes, rashes, textural changes, tightness, areas of thickening or skin breakdown, ulcers or erosions • Palpation for areas of sclerosis or fasciitis **Diagnostic testing** • Skin biopsy	Poikiloderma	Atrophic, pigmentary changes and telangiectasia	1
		Lichen planus-like features	Erythematous/violaceous flat-topped papules or plaques with or without surface reticulations or a silvery or shiny appearance	4, 5
		Sclerotic features	Smooth, waxy, indurated, thickened or tight skin and soft tissues caused by deep and diffuse sclerosis over a wide area	8, 9, 10
		Lichen sclerosus-like features	Discrete to coalescent, gray to white, moveable papules or plaques, often with follicular plugs, with a shiny appearance and wrinkled texture	6
		Morphea-like features	Localized patchy areas of moveable smooth or shiny skin with leather-like consistency, often with dyspigmentation	2
		Depigmentation*	Loss of normal pigmentation (vitiligo)	8
		Papulosquamous lesions*	Scaly skin, with plaques and/or papules	
		Sweat impairment**	May manifest as heat intolerance due to loss of sweat glands	
		Ichthyosis**	Rough, thick and scaly skin	
		Hypopigmentation**	Diminished pigmentation of the skin	8
		Hyperpigmentation**	Darkening of the skin due to pigment deposition	4, 7, 8
		Keratosis pilaris**	Pale to erythematous perifollicular papules with spiny keratotic plugs within the follicular openings	3

Continued on the next page

* Distinctive but insufficient alone to establish an unequivocal diagnosis of chronic GVHD without further testing or additional organ involvement.
** Rare, controversial, or non-specific features of chronic GVHD.
*** Common in both acute and chronic GVHD.
[3] See references on page 49.

Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Skin	**Patient-reported symptoms and signs** • Itching • Dry skin • Limited mobility • Rash • Sores • Changes in skin coloring or texture • Edema **Clinical examination** • Complete visual examination of the skin with particular attention to pigmentary changes, rashes, textural changes, tightness, areas of thickening or skin breakdown, ulcers or erosions • Palpation for areas of sclerosis or fasciitis **Diagnostic testing** • Skin biopsy	Maculopapular rash***	Raised and flat small, red lesions	12
		Erythema***	Abnormal redness of the skin	
		Pruritus***	Localized or generalized itching	
		Erosion[3]	Localized skin lesion characterized by complete or partial loss of only the epidermis	11
		Ulcer[3]	Localized skin lesion in which the whole of the epidermis and at least part of the dermis has been lost. May extend into the subcutaneous fat	

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[3] See references on page 49.

Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Nails	**Patient-reported symptoms and signs** • Brittle nails • Increased ridging in nails • Splitting nails • Nail loss **Clinical examination** • Visual inspection of nails **Diagnostic testing** • None	Dystrophy*	Longitudinal ridging, splitting or brittleness	13
		Onycholysis*	Loosening of a nail from the nail bed beginning at the free edge and proceeding to the root	
		Nail loss*	Usually symmetric; affects most nails	
		Pterygium unguis*	Forward growth of the cuticle over the nail	
Scalp/ body hair	**Patient-reported symptoms and signs** • Premature gray or thinning hair • Itchy scalp • Hair loss **Clinical examination** • Visual inspection of scalp hair/body hair for changes in hair distribution, consistency and color **Diagnostic testing** • None	New onset of scarring or non-scarring scalp alopecia*	After initial recovery following chemotherapy or radiotherapy	14
		Loss of body hair*		
		Scaling*	An eruption composed of papules and scales	
		Thinning scalp hair**	Typically patchy, coarse or dull (not explained by endocrine or other causes)	
		Premature gray hair**		

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Eyes	**Patient-reported symptoms and signs** • Dry, burning, gritty eyes • Itching • Orbital pain • Difficulty opening eyes in the morning • Sensitivity to light and wind • Excessive tearing • Diminished visual acuity and/or blurring **Clinical examination** • Visual inspection of the conjunctivae and sclerae • Ophthalmologic exam **Diagnostic testing** • Schirmer's tear test • Slit-lamp examination	New onset dry, gritty or painful eyes*	New ocular sicca documented by low Schirmer's test values with a mean value of both eyes ≤5 mm of wetting at 5 minutes, but note that Schirmer's test values are not useful for follow-up of ocular GVHD due to poor correlation with symptom change	
		Cicatricial conjunctivitis*	Fibrous tissue scaring and inflammation	22, 23
		Keratoconjunctivitis sicca (KCS)*	Inflammation of cornea and conjunctivae, with dryness, grittiness and/or orbital pain. Slit lamp exam with mean Schirmer's test values of 6 to 10 mm, not due to other causes	
		Confluent areas of punctate keratopathy*	Closely spaced, non-inflamed pinpoint defects indicating loss of corneal epithelium, and observed with fluorescein staining	
		Photophobia**	Increased sensitivity to light	
		Periorbital hyperpigmentation**	Excess pigmentation in the tissues surrounding or lining the orbit of the eye	
		Blepharitis**	Erythema and edema of the eyelids and telangiectasia of lid margin	24

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Mouth	**Patient-reported symptoms and signs** • Dryness • Chapped lips • Ulcers • Swelling, redness, pain and/or bleeding of gums • Sensitivity to spicy foods, toothpaste or soda pop • Pain **Clinical examination** • Visual inspection of the entire mouth **Diagnostic testing** • Oral biopsy	Lichen planus-like changes	Hyperkeratotic white lines and lacy-appearing lesions on the buccal mucosa and tongue, palate or lips	16
		Xerostomia*	Abnormal dryness of the mouth	
		Mucoceles*	Vesicle-like or raised masses due to minor salivary gland inflammation and damage	17
		Mucosal atrophy*	Thinning of mucosal tissue	19
		Pseudomembranes*	Loosely adherent fibrinous exudate on the surface of a mucous membrane	20
		Ulcers*	Open sore inside mouth caused by a break in mucous membrane or epithelium on lips or surrounding mouth	20, 21
		Erythema***	Severity of erythema or “redness” can vary from mild to severe	17, 18, 19, 20
		Gingivitis***	Mucosal fiber damage causes smooth/ inflamed gingival surface, in contrast to the dimpled or stippled appearance of normal gingivae. Entire width of the attached gingivae will be erythematous	
		Mucositis***	Inflammation of mucous membrane	
		Pain***		

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Lungs	**Patient-reported symptoms and signs** • Difficulty breathing • Wheezing • Shortness of breath at rest and/or with exertion • Dry cough **Clinical examination** • Chest auscultation • Pulse oximetry **Diagnostic testing** • Pulmonary function testing (PFT) • Expiratory CT • Lung biopsy	Bronchiolitis obliterans diagnosed using PFT	Obstructive lung defect. May include dyspnea on exertion, cough or wheezing	
		Air trapping and bronchiectasis on chest CT*	Evidence of air trapping on expiratory CT, small airway thickening	
		Cryptogenic organizing pneumonia**	Inflammation of the bronchioles and surrounding tissue in the lungs	

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Muscles, fascia, joints	**Patient-reported symptoms and signs** • Muscle cramps • Muscle pain • Muscle weakness • Joint stiffness • Restricted range of motion • Tightened muscles, tendons and fascia • Contractures **Clinical examination** • Palpation for areas of thickening, tightening, shortening of muscles or fascia; muscle tenderness • Evaluate range of motion • Muscle strength testing • Inspection for signs of edema or peau d'orange skin changes • Visual inspection for grooving, ridging **Diagnostic testing** • Creatinine kinase • Aldolase • Electromyography	Fasciitis	Stiffness, restricted range of motion	9
		Joint stiffness or contractures (secondary to fasciitis or sclerosis)	Groove sign, dimpling	
		Myositis or polymyositis*	Muscle tenderness and elevated muscle enzymes. Evaluate with electromyography and measurement of creatinine phosphokinase and aldolase. Muscle/sural nerve biopsies should be considered in the absence of other manifestations of GVHD to rule out other causes of myositis	
		Edema**	Present in extremities, with or without erythema and peau d'orange skin	15
		Muscle cramps**	May be present with increased muscle enzymes	
		Arthralgia or arthritis**	Uncommon, occasionally associated with the presence of autoantibodies	

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
GI tract	**Patient-reported symptoms and signs** • Anorexia • Nausea • Vomiting • Abdominal pain • Diarrhea • Bloating • Cramping • Weight loss • Painful swallowing • Difficulty swallowing dry foods/pills **Clinical examination** • Examination of mouth and hypopharynx **Diagnostic testing** • Endoscopy • Barium contrast radiograph • Swallowing study • Stool test for fecal fat • Biopsy • Amylase • Lipase	Esophageal web	Smooth, circumferential ring of squamous mucosa; documented by endoscopy or barium contrast radiograph	
		Upper esophageal strictures or stenosis	Narrowing of the upper to mid third of the esophagus; documented by endoscopy or barium contrast radiograph	
		Pancreatic exocrine insufficiency**	Pancreatic atrophy and exocrine insufficiency leading to inability to properly digest food due to a lack of digestive enzymes; often improves with enzyme supplementation	
		Anorexia*** Nausea*** Vomiting*** Diarrhea*** Weight loss*** Failure to thrive (infants and children)***		

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Liver	**Patient-reported symptoms and signs** • Jaundice • Malaise • Itching • Fatigue **Clinical examination** • Assess for hepatomegaly and right upper quadrant abdominal tenderness **Diagnostic testing** • Total and direct bilirubin • Alkaline phosphatase • ALT: Alanine aminotransferase • AST: Aspartate aminotransferase • GGT: Gamma glutamyl transpeptidase • 5′-NT: 5′-nucleotidase • Liver biopsy may be needed in the absence of GVHD in another organ	Hepatitis***	Rise in serum alanine aminotransferase, >2x upper limit of normal, with or without jaundice	
		Progressive cholestatic features***	The flow of bile from the liver is blocked; total bilirubin, alkaline phosphatase >2x upper limit of normal; elevated gamma-glutamyl transpeptidase, followed by jaundice	

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Genitalia	**Patient-reported symptoms and signs** • Itching • Painful intercourse • Dryness • Painful urination • Burning **Clinical examination** • Visual inspection of genitalia • Pelvic exam **Diagnostic testing** • Biopsy	Lichen planus-like features	Erythematous/violaceous tissue changes	
		Lichen sclerosus-like features	White, atrophic papules that may coalesce into plaques	
		Females: Vaginal scarring or clitoral/ labial agglutination	A narrowing of the vagina, often with accompanying tissue changes such as dryness, loss of elasticity and resilience, adhesion and scar tissue	
		Males: Phimosis or urethral/meatus scarring or stenosis		
		Fissures*	A break or slit in tissue typically appearing at the junction of skin and mucous membrane	
		Erosions*	Localized destruction or loss of the epidermis	
		Ulcers*	Localized destruction or loss below the epidermis	

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Organ/ sites	Evaluation	Clinical manifestation	Description of clinical manifestation	Photo atlas
Hematopoietic/ immune	**Patient-reported symptoms and signs** • None **Clinical examination** • None **Diagnostic testing** • Complete blood count and differential • Test for presence of autoantibodies • Quantitative immunoglobulin levels	Thrombocytopenia**	Persistent decrease in the number of blood platelets; <100,000/µL	
		Eosinophilia**	Abnormal increase in the number of eosinophils; >500/µL	
		Lymphopenia**	Reduction in the number of lymphocytes; <500/µL	
		Hypo- or hyper-gammaglobulinemia**	Deficiency or excess of gamma globulins in the peripheral blood	
		Autoantibodies**	Autoimmune hemolytic anemia (AIHA). Idiopathic thrombocytopenic purpura (ITP). Autoantibodies may develop, including antinuclear antibody, anti-centromere antibody, anti-mitochondrial antibody, anti-ENA screen, anti-double stranded DNA antibody, anticardiolipin antibody	
Other	For these manifestations, chronic GVHD is often a diagnosis of exclusion	Raynaud's phenomenon**	Disruption of blood flow to digits and skin	
		Pericardial or pleural effusions** Ascites** Peripheral neuropathy** Nephrotic syndrome** Myasthenia gravis** Cardiac conduction abnormality or cardiomyopathy**	Although these manifestations cannot be used to establish a diagnosis of chronic GVHD, a wide range of organ system manifestations including neurologic complications, nephrotic syndrome and cardiac abnormalities have been described in association with chronic GVHD and may represent chronic GVHD manifestations. If after careful differential diagnosis no alternative etiologic factor is identified, it may be concluded that these manifestations represent chronic GVHD disease activity.	

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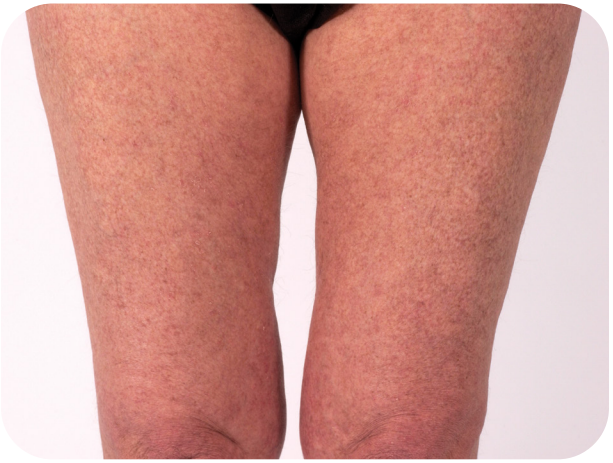
Chronic GVHD photo atlas

This photo atlas contains pictorial representations of various clinical manifestations of chronic GVHD. Refer to the information in the preceding chart for a full description of all manifestations.

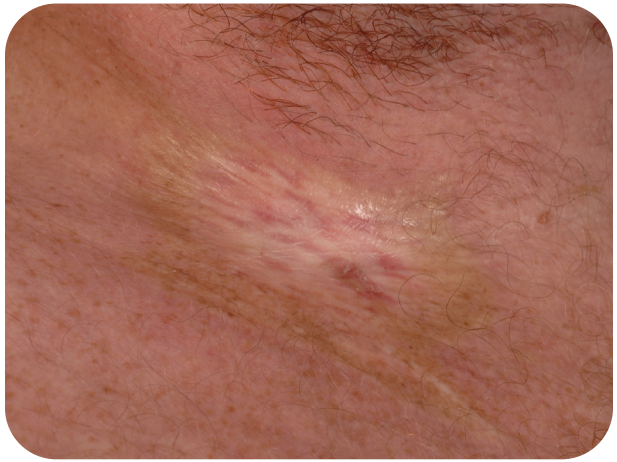
Photo atlas: Skin



1. Poikiloderma

Hypo- and hyper-pigmentary changes with erythema and atrophy.

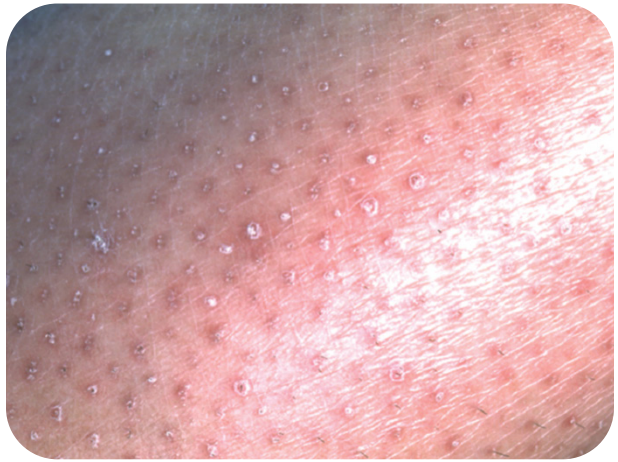
See chart page 30



2. Morphea-like

Localized patchy area(s) of moveable smooth or shiny skin with a leather-like waxy or hardened consistency. Note the fibrotic, hypopigmented area in the center of the plaque with a slightly hyperpigmented border.

See chart page 30

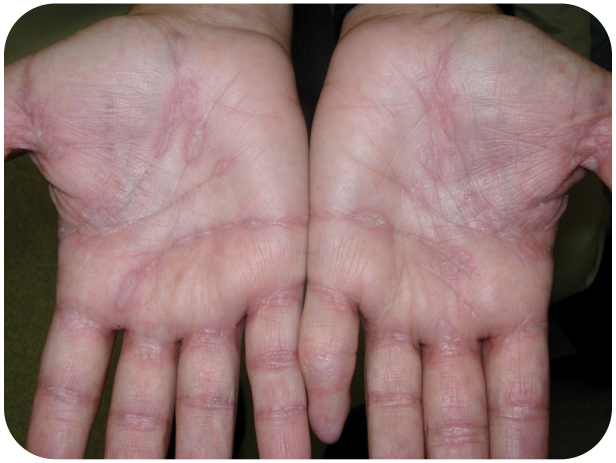


3. Keratosis pilaris

Skin-colored to erythematous perifollicular papules with spiny keratotic plugs within the follicular openings.

See chart page 30

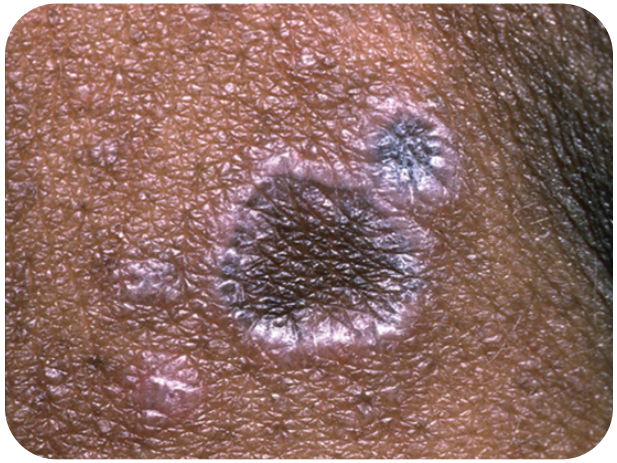
Photo atlas: Skin



4. Lichen planus-like

Hyperpigmented/purple papules which may coalesce into annular (ring-like) small plaques. These lesions closely resemble the dermatologic disease lichen planus.

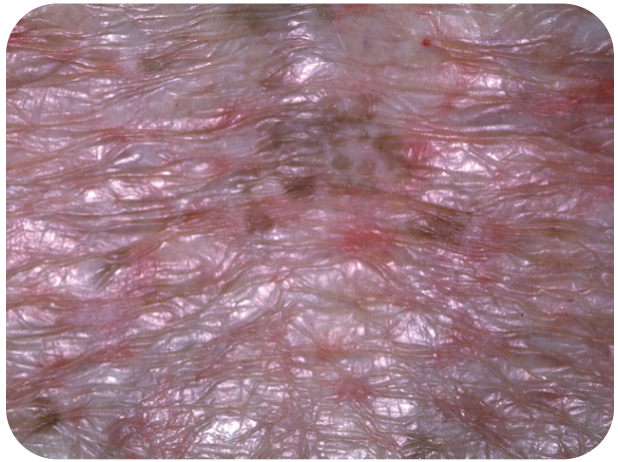
See chart page 30



5. Lichen planus-like

Discrete to coalescent gray to white moveable papules or plaques.

See chart page 30

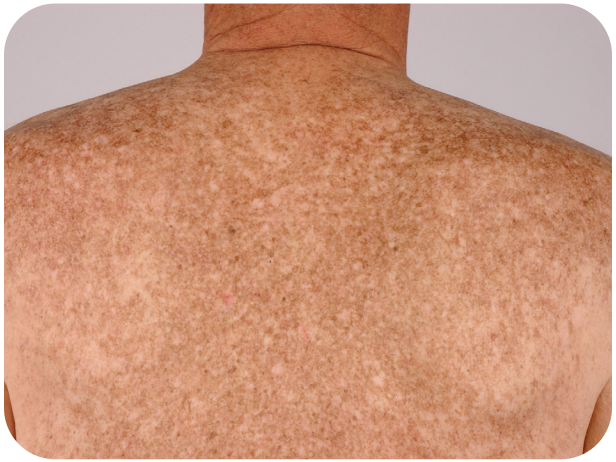


6. Lichen sclerosus-like

Close-up showing wrinkled texture and shiny appearance. Lesions tend to be grouped in discrete patches.

See chart page 30

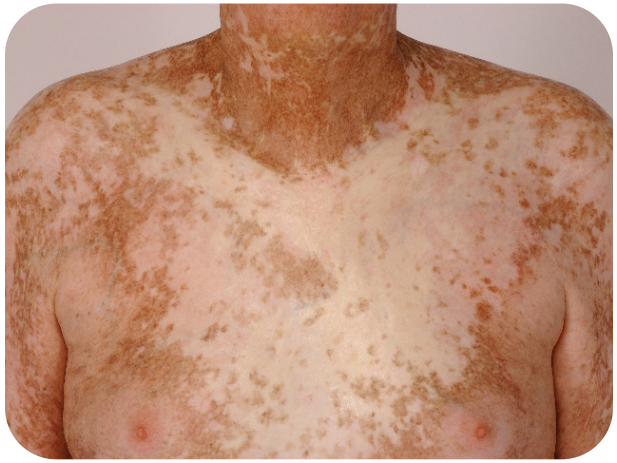
Photo atlas: Skin



7. Hyperpigmentation

Excess pigmentation in the skin; may manifest in a widespread reticulated pattern.

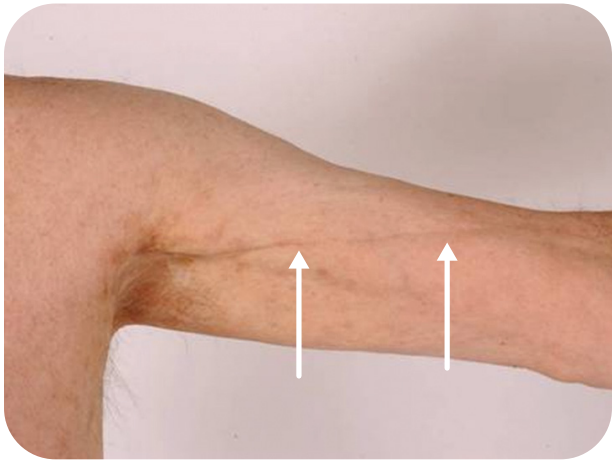
See chart page 30



8. Hypopigmentation, hyperpigmentation, depigmentation, sclerosis

Diminished (hypo-) or excess (hyper-) pigmentation in the skin. Sclerotic tissue is hard and fibrous, with a decreased ability to pinch. Superficial sclerosis is moveable upon palpation, while deep sclerosis is hidebound and fixed.

See chart page 30

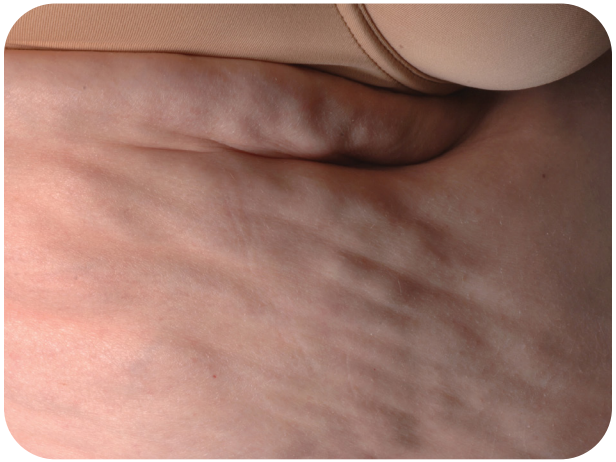


9. Sclerosis, fasciitis

Subcutaneous sclerosis/fasciitis can be detected by a "groove sign" seen here.

See chart page 30, 36

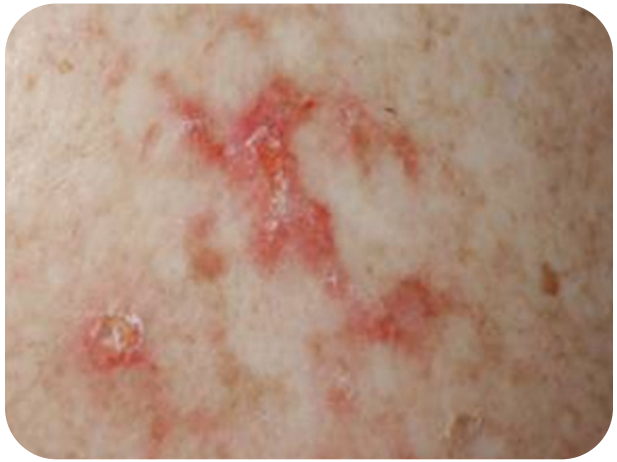
Photo atlas: Skin



10. Sclerosis

Subcutaneous sclerosis can be manifested by rippling, dimpling of the skin and a resultant cellulite-like appearance.

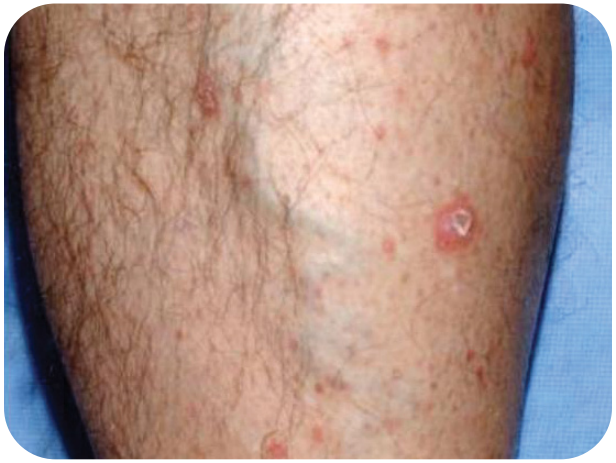
See chart page 30



11. Erosion

Localized tissue destruction characterized by complete or partial loss of only the epidermis.

See chart page 31

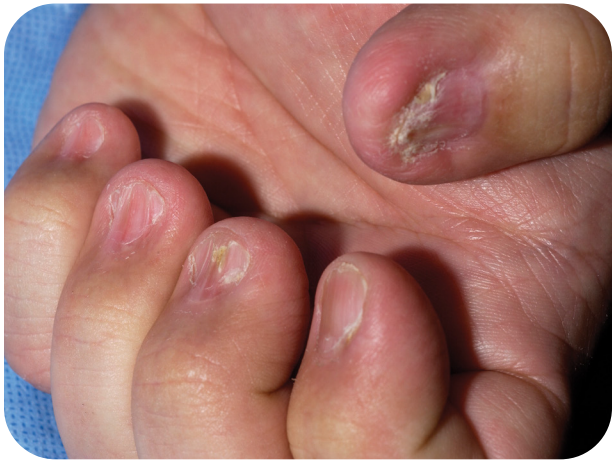


12. Maculopapular

Raised and flat small, red lesions.

See chart page 31

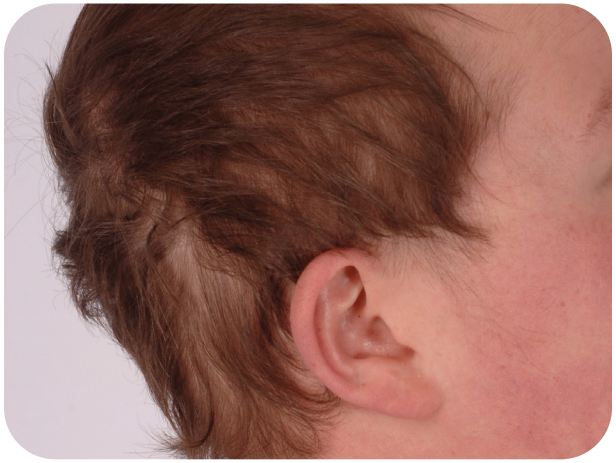
Photo atlas: Nails, scalp, muscles



13. Nail dystrophy

Longitudinal ridging, splitting, or brittle features of nails. Note periungual erythema.

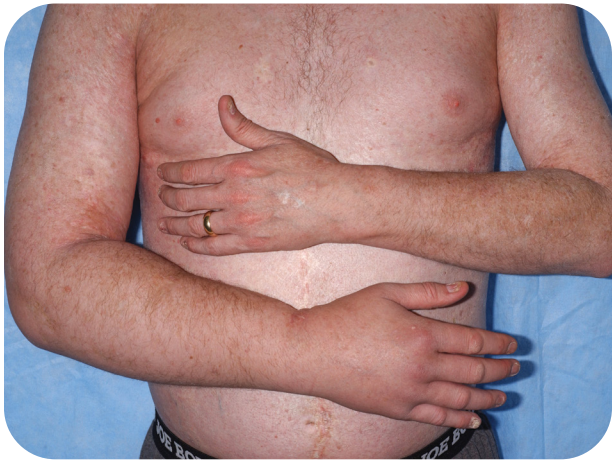
See chart page 32



14. Alopecia

Patchy alopecia is shown. May also include loss of body hair (after initial recovery of hair growth following chemotherapy or radiotherapy).

See chart page 32

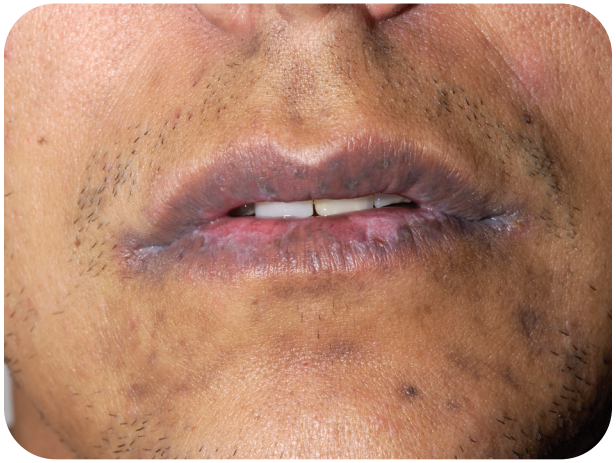


15. Edema

Edema in the extremities can be bilateral or unilateral (shown). May be present with erythema and peau d'orange skin. Edema may be associated as prodromal symptom to subcutaneous sclerosis and fasciitis.

See chart page 36

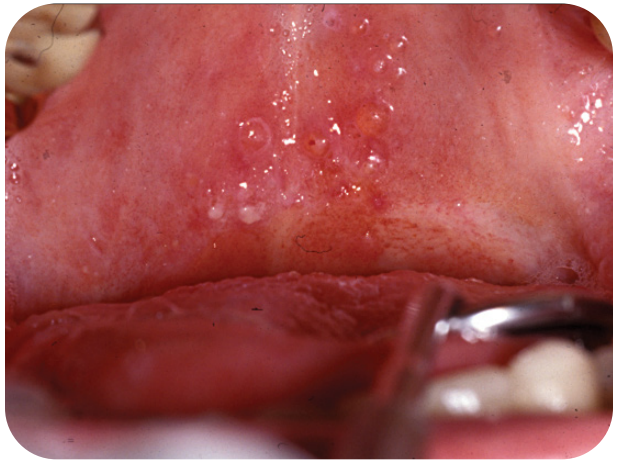
Photo atlas: Mouth



16. Lichen planus

Lichenoid changes extending from the labial mucosa to the lip. Cheilosis (surface scaling and fissures in the corners of the mouth) is also present.

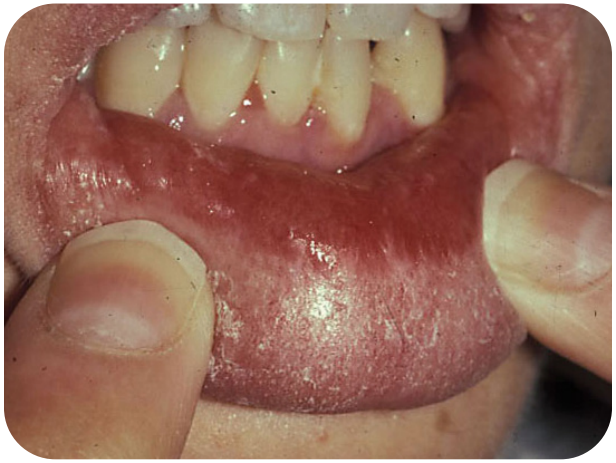
See chart page 34



17. Mucoceles

Numerous vesicle-like mucoceles are seen along the center of the soft palate. Patchy white lichenoid hyperkeratosis and interspersed moderate erythematous changes are also evident across soft palate.

See chart page 34

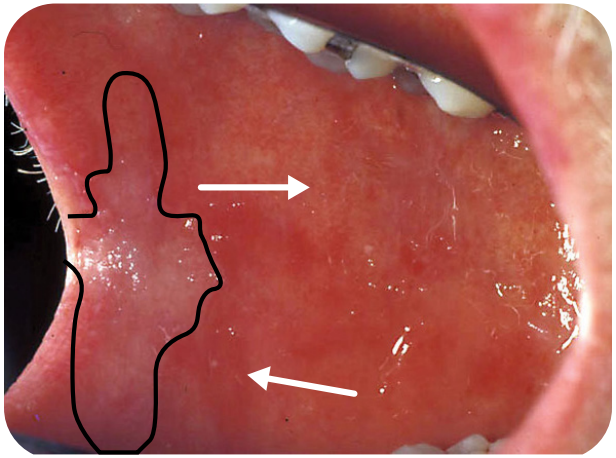


18. Erythema

Chapping and erythema of the vermillion lip. Erythema of labial mucosa.

See chart page 34

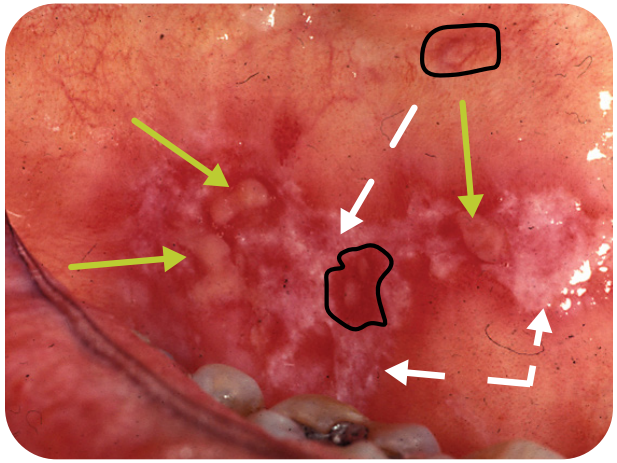
Photo atlas: Mouth



19. Erythema, hyperkeratinization

Patchy erythema (arrows) and sheet-like hyperkeratinization (black outline). Also note atrophy of buccal mucosal tissues.

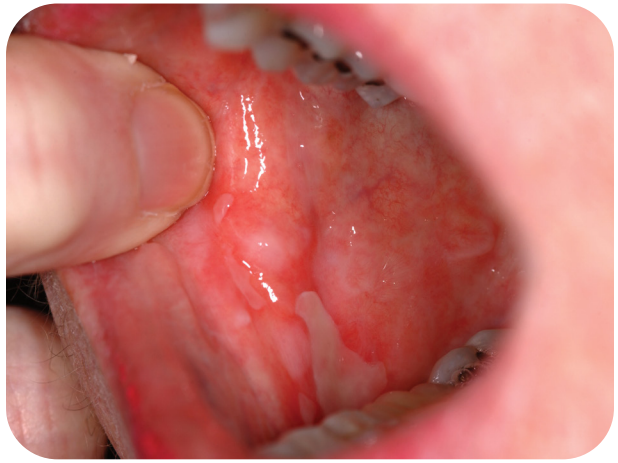
See chart page 34



20. Erythema, ulcerations, hyperkeratinization

Mixed pseudomembranous fibrin exudate (green arrows). Lichenoid hyperkeratotic changes (white arrows) involving the buccal mucosa. Erythema (black outline) surrounding pseudomembranous ulcerations.

See chart page 34

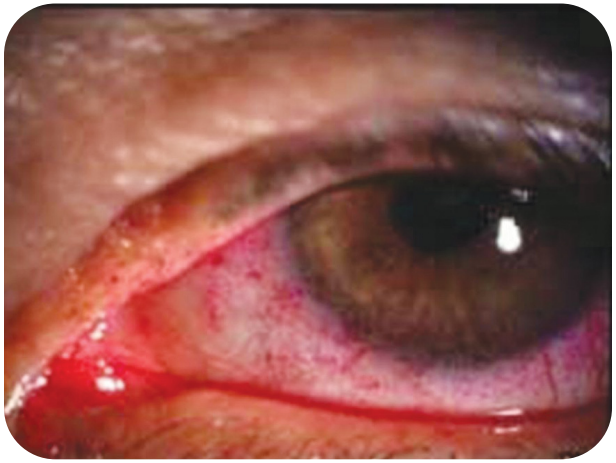


21. Ulcerations

White patchy pseudomembranous ulcerations.

See chart page 34

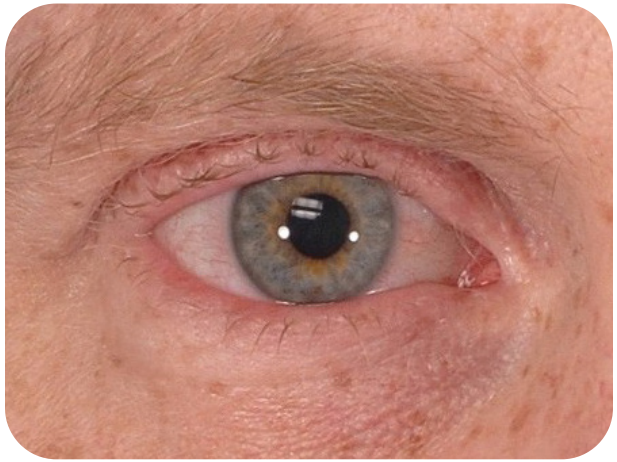
Photo atlas: Eyes



22. Keratoconjunctivitis sicca

Inadequate tear production (measured by Schirmer's test) and conjunctival erythema. Also note scleral injection and chemosis (conjunctival edema).

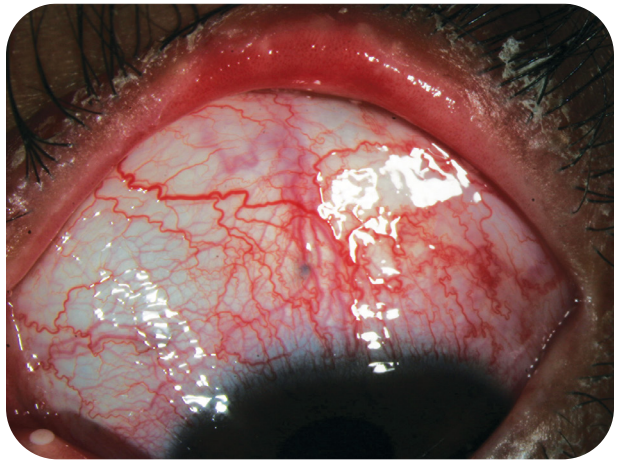
See chart page 33



23. Keratoconjunctivitis sicca

Note scleral injection and conjunctival erythema.

See chart page 33



24. Blepharitis

Thickened, edematous and erythematous eyelid margins. Also note plugging of meibomian gland orifices (along the eyelid margin) and significant conjunctival hyperemia/injection.

See chart page 33

Photo credits:
Photos 3, 4, 8, 9, 11, 12: Maria L. Turner, MD; Edward W. Cowen, MD; Dermatology Branch, National Cancer Institute, NIH, Bethesda, Md.
Photos 1, 2, 5–7, 10, 13–15: Edward W. Cowen, MD; Dermatology Branch, National Cancer Institute, NIH, Bethesda, Md.
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[1] Jagasia MH, Greinix HT, Arora M, et al. National Institutes of Health Consensus Development Project on Criteria for Clinical Trials in Chronic Graft-versus-Host Disease: I. The 2014 Diagnosis and Staging Working Group Report. *Biol Blood Marrow Transplant*. 2015;21(3):389-401. doi: **10.1016/j.bbmt.2014.12.001**.

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[3] These guidelines have been developed by NMDP[SM] in consultation with Seth Rotz, MD, Cleveland Clinic; Rachel Phelan, MD, Children's Wisconsin and Medical College of Wisconsin; and Neil Bhatt, MD, and Paul Carpenter, MD, Fred Hutchinson Cancer Center.

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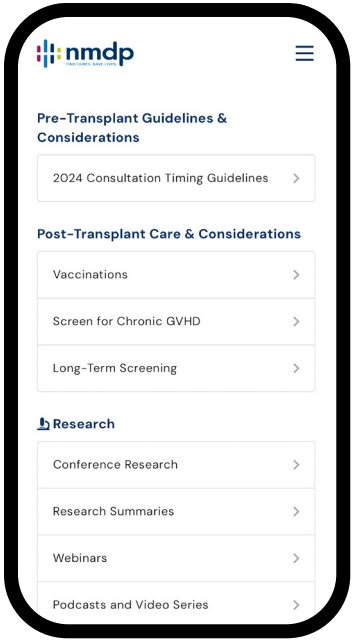

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