Protocol

Hematopoietic Cell Transplantation for Solid Tumors of Childhood

(80134)

Medical Benefit		**Effective Date**: 10/01/18	**Next Review Date**: 05/23
Preauthorization	Yes	**Review Dates**: 04/07, 05/08, 01/10, 01/11, 09/11, 05/12, 05/13, 05/14, 05/15, 05/16, 05/17, 05/18, 05/19, 05/20, 05/21, 05/22	

Preauthorization is required and must be obtained through Case Management.

The following protocol contains medical necessity criteria that apply for this service. The criteria are also applicable to services provided in the local Medicare Advantage operating area for those members, unless separate Medicare Advantage criteria are indicated. If the criteria are not met, reimbursement will be denied and the patient cannot be billed. Please note that payment for covered services is subject to eligibility and the limitations noted in the patient's contract at the time the services are rendered.

RELATED PROTOCOL

Hematopoietic Cell Transplantation for Central Nervous System Embryonal Tumors and Ependymoma

Populations	Interventions	Comparators	Outcomes
Individuals: • With high-risk or relapsed peripheral neuroblastoma	Interventions of interest are: • Single autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Targeted therapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With high-risk or relapsed peripheral neuroblastoma	Interventions of interest are: • Tandem autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Single autologous hematopoietic cell transplantation • Targeted therapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With high-risk Ewing sarcoma	Interventions of interest are: • Single autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With high-risk Ewing sarcoma	Interventions of interest are: • Tandem autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Single autologous hematopoietic cell transplantation • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With rhabdomyo-sarcoma	Interventions of interest are: • Single autologous hematopoietic cell	Comparators of interest are: • Chemotherapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality

Populations	Interventions	Comparators	Outcomes
	transplantation		• Treatment-related morbidity
Individuals: • With Wilms tumor	Interventions of interest are: • Single autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With osteosarcoma	Interventions of interest are: • Single autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With localized retinoblastoma	Interventions of interest are: • Single autologous hematopoietic cell transplantation	Comparators of interest are: • Laser photocoagulation • Cryotherapy • Chemotherapy (local or systemic) • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity
Individuals: • With metastatic retinoblastoma	Interventions of interest are: • Single autologous hematopoietic cell transplantation	Comparators of interest are: • Chemotherapy • Surgery • Radiotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Treatment-related mortality • Treatment-related morbidity

DESCRIPTION

Hematopoietic cell transplantation (HCT) is a procedure in which hematopoietic stem cells are infused to restore bone marrow function in cancer patients who receive bone-marrow-toxic doses of drugs, with or without whole body radiotherapy. Stem cells may be obtained from the transplant recipient (autologous HCT) or harvested from a donor (allogeneic HCT). Stem cells may be harvested from bone marrow, peripheral blood, or umbilical cord blood shortly after delivery of neonates.

SUMMARY OF EVIDENCE

For individuals who have high-risk or relapsed peripheral neuroblastoma who receive single or tandem autologous HCT, the evidence includes randomized controlled trials (RCTs), systematic reviews with meta-analyses of those trials, and observational studies. The relevant outcomes are overall survival (OS), disease-specific survival (DSS), and treatment-related mortality (TRM) and morbidity. In the pooled analysis, patients with high-risk neuroblastoma treated with first-line therapy with single autologous HCT with myeloablative conditioning had significantly improved event-free survival (EFS) compared with standard therapy. Similarly, nonrandomized comparative studies, single-arm studies, and case series evaluating tandem autologous HCT showed improvements in EFS for children with high-risk neuroblastoma. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have high-risk Ewing sarcoma/Ewing sarcoma family of tumors who receive single or tandem autologous HCT, the evidence includes a systematic review with meta-analysis, an RCT, single-arm studies, and case series. The relevant outcomes are OS, DSS, and TRM and morbidity. Although early nonrandomized studies were promising, more recent prospective nonrandomized study results have been inconsistent regarding whether HCT extends survival compared with typical conventional therapy. An RCT comparing consolidation with high-dose chemotherapy (HDC) plus autologous HCT to standard chemotherapy plus whole lung irradiation

in patients with Ewing sarcoma with pulmonary and/or pleural metastases did not find a significant improvement in EFS in the group that received HCT. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have rhabdomyosarcoma (RMS) who receive single autologous HCT, the evidence includes systematic reviews and nonrandomized comparative studies. The relevant outcomes are OS, DSF, and TRM and morbidity. Available studies have not demonstrated improvements in OS or EFS with autologous HCT. Additional research is needed to demonstrate a benefit with autologous HCT for pediatric RMS. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have Wilms tumor who receive single autologous HCT, the evidence includes retrospective studies and a systematic review with meta-analysis. The relevant outcomes are OS, DSS, and TRM and morbidity. Overall 4 year survival rates were similar between patients receiving HCT and receiving chemotherapy. There was a trend suggesting that patients with lung-only stage 3 or 4 relapse might benefit from autologous HCT. However, the overall body of evidence is limited. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have osteosarcoma who receive single autologous HCT, the evidence includes case series and a prospective single-arm study. The relevant outcomes are OS, DSF, and TRM and morbidity. An interim analysis of the prospective single-arm study showed that patients receiving autologous HCT were experiencing lower EFS rates than historical controls, resulting in all patients being enrolled in the standard of care chemotherapy. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have localized retinoblastoma who receive single autologous HCT, there are no studies. The relevant outcomes are OS, DSS, and TRM and morbidity. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have metastatic retinoblastoma who receive single autologous HCT, the evidence includes small case series and case reports and a systematic review with meta-analysis. The relevant outcomes are OS, DSS, and TRM and morbidity. Results from the limited data have suggested that autologous HCT may prolong disease-free survival, particularly in patients without central nervous system involvement (stage 4A). Given the poor prognosis for this indication with conventional therapies, the incremental improvement with autologous HCT might be considered a significant benefit. However, the overall body of evidence is limited. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

POLICY

Autologous hematopoietic cell transplantation may be considered **medically necessary** for:

- initial treatment of high-risk neuroblastoma,
- recurrent or refractory neuroblastoma,
- initial treatment of high-risk Ewing sarcoma,
- recurrent or refractory Ewing sarcoma, and
- metastatic retinoblastoma.

Tandem autologous hematopoietic cell transplantation may be considered **medically necessary** for high-risk neuroblastoma.

Autologous hematopoietic cell transplantation is considered **investigational** as initial treatment of low- or in-

termediate-risk neuroblastoma, initial treatment of low- or intermediate-risk Ewing sarcoma, and for other solid tumors of childhood including, but not limited to, the following:

- rhabdomyosarcoma
- Wilms tumor
- osteosarcoma
- retinoblastoma without metastasis.

Tandem autologous hematopoietic cell transplantation is considered **investigational** for the treatment of all other types of pediatric solid tumors except high-risk neuroblastoma, as noted above.

Allogeneic (myeloablative or nonmyeloablative) hematopoietic cell transplantation is considered **investigational** for treatment of pediatric solid tumors.

Salvage allogeneic hematopoietic cell transplantation for pediatric solid tumors that relapse after autologous transplant or fail to respond is considered **investigational**.

POLICY GUIDELINES

Individual transplant facilities may have their own additional requirements or protocols that must be met in order for the patient to be eligible for a transplant at their facility.

This protocol addresses peripheral neuroblastoma arising from the peripheral nervous system (i.e., neuroblastoma, ganglioneuroblastoma, ganglioneuroma).

Hematopoietic cell transplantation refers to any source of stem cells, i.e., autologous, allogeneic, syngeneic, or umbilical cord blood.

Relapse is defined as tumor recurrence after a prior complete response.

Primary refractory disease is defined as a tumor that does not achieve a complete remission after initial standard-dose chemotherapy.

MEDICARE ADVANTAGE

If a transplant is needed, we arrange to have the Medicare–approved transplant center review and decide whether the patient is an appropriate candidate for the transplant.

BACKGROUND

SOLID TUMORS OF CHILDHOOD

Solid tumors of childhood arise from mesodermal, ectodermal, and endodermal cells of origin.[1] Some common solid tumors of childhood are neuroblastoma, Ewing sarcoma/Ewing sarcoma family of tumors (ESFT), Wilms tumor, rhabdomyosarcoma, osteosarcoma, and retinoblastoma.

GENERAL TREATMENT

The prognosis for pediatric solid tumors has improved more recently, mostly due to the application of multi-agent chemotherapy and improvements in local control therapy (including aggressive surgery and advancements in radiotherapy).[2] However, patients with metastatic, refractory, or recurrent disease continue to have

poor prognoses, and these "high-risk" patients are candidates for more aggressive therapy, including autologous hematopoietic cell transplantation (HCT), to improve event-free survival and overall survival.

Descriptions of pediatric-onset solid tumors addressed herein are as follows.

PERIPHERAL NEUROBLASTOMA

Neuroblastoma is the most common extracranial solid tumor of childhood,[1] with approximately 90% of cases presenting in children younger than five years of age. These tumors originate where sympathetic nervous system tissue is present, within the adrenal medulla or paraspinal sympathetic ganglia, but have diverse clinical behavior depending on a variety of risk factors.

Patients with neuroblastoma are stratified into prognostic risk groups (low, intermediate, high) that determine treatment plans. Risk variables include age at diagnosis, clinical stage of disease, tumor histology, and certain molecular characteristics, including the presence of the MYCN oncogene. Tumor histology is categorized as favorable or unfavorable, according to the degree of tumor differentiation, the proportion of tumor stromal component, and index of cellular proliferation.[3] It is well-established that MYCN amplification is associated with rapid tumor progression and a poor prognosis,[4] even in the setting of other coexisting favorable factors. Loss of heterozygosity (LOH) at chromosome arms 1p and 11q frequently occurs in neuroblastoma.[5] Although 1p LOH is associated with MYCN amplification, 11q is usually found in tumors without this abnormality.[5] Some recent studies have shown that 1p LOH and unbalanced 11q LOH are strongly associated with outcome in patients with neuroblastoma, and both are independently predictive of worse progression-free survival in patients with low- and intermediate-risk disease.[3] Although the use of these LOH markers in assigning treatment in patients is evolving, they may prove useful to stratify treatment.

In the early 1990s, a uniform clinical staging system based on surgical resectability and distant spread, the International Neuroblastoma Staging System, was adopted by pediatric cooperative groups (see Table 1).

Table 1. International Neuroblastoma Staging System

Stage	Description
1	Localized tumor with complete gross excision, with or without microscopic residual disease; lymph nodes negative for tumor
2A	Localized tumor with incomplete gross excision; lymph nodes negative for tumor
2B	Localized tumor with or without complete gross excision, with ipsilateral lymph nodes positive for tumor
3	Unresectable unilateral tumor infiltrating across the midline, with or without regional lymph node involvement; or localized unilateral tumor with contralateral regional lymph node involvement; or midline tumor with bilateral extension by infiltration or by lymph node involvement
4	Any primary tumor with dissemination to distant lymph nodes, bone, bone marrow, liver, skin, and/or other organs, except as defined for stage 4S
4S	Localized primary tumor as defined for stage 1, 2A, or 2B, with dissemination limited to skin, liver, and/or bone marrow (marrow involvement less than 10%), limited to children younger than 1 year of age

The low-risk group includes patients younger than one year of age with stage 1, 2, or 4S with favorable histopathologic findings and no MYCN oncogene amplification. High-risk neuroblastoma is characterized by age older than one year, disseminated disease, MYCN oncogene amplification, and unfavorable histopathologic findings.

The International Neuroblastoma Risk Group (2009) proposed a revised staging system, which incorporated pretreatment imaging parameters instead of surgical findings (see Table 2).[6]

Table 2. International Neuroblastoma Risk Group Staging System[6]

Stage	Description
L1	Localized tumor not involving vital structures as defined by the list of Image-Defined Risk Factors and confined to one body compartment
L2	Locoregional tumor with presence of one or more Image-Defined Risk Factors
M	Distant metastatic disease (except stage MS)

Stage	Description
MS	Metastatic disease in children younger than 18 months with metastases confined to skin, liver, and/or bone marrow

Treatment

In general, most patients with the low-stage disease have excellent outcomes with minimal therapy; and with International Neuroblastoma Staging System stage-1 disease, most patients can be treated by surgery alone.[7] Most infants, even with disseminated disease, have favorable outcomes with chemotherapy and surgery.[7]

For intermediate-risk disease, moderately intensive multiagent chemotherapy is the mainstay of therapy.[8] Surgery is needed to obtain a diagnosis, and the extent of resection necessary to obtain an optimal outcome is not established.[9] Patients at high-risk have historically had very low (<15%) long-term overall survival. Current therapy for high-risk disease typically includes an aggressive multimodal approach with chemotherapy, surgical resection, and radiotherapy.[10]

Treatment of recurrent disease is determined by the risk group at diagnosis and the extent of disease and age of the patient at recurrence.

EWING SARCOMA FAMILY OF TUMORS

ESFT encompasses a group of tumors that share some degree of neuroglial differentiation and a characteristic underlying molecular pathogenesis (chromosomal translocation). The translocation usually involves chromosome 22 and results in fusion of the EWS gene with one of the members of the ETS (E26 transformation-specific) family of transcription factors, either FLI1 (90%-95%) or ERG (5%-10%). These fusion products function as oncogenic aberrant transcription factors. Detection of these fusions is considered to be specific for the ESFT and helps further validate diagnosis. Included in ESFT are “classic” Ewing sarcoma of bone, extraosseous Ewing, peripheral primitive neuroectodermal tumor, and Askin tumors (chest wall).

Most commonly diagnosed in adolescence, ESFT can be found in bone (most commonly) or soft tissue; however, the spectrum of ESFT has also been described in various organ systems. Ewing is the second most common primary malignant bone tumor. The most common primary sites are the pelvic bones, the long bones of the lower extremities, and the bones of the chest wall.

Treatment

Current therapy for Ewing sarcoma typically includes induction chemotherapy, followed by local control with surgery and/or radiotherapy (dependent on tumor size and location), followed by adjuvant chemotherapy. Multiagent chemotherapy, surgery, and radiotherapy have improved progression-free survival rates in patients with the localized disease to 60% to 70%.[11] The presence of metastatic disease is the most unfavorable prognostic feature, and the outcome for patients presenting with metastatic disease is poor, with 20% to 30% progression-free survival. Other adverse prognostic factors that may categorize a patient as having “high-risk” Ewing are tumor location (e.g., patients with pelvic primaries have worse outcomes), larger tumor size, and older age of the patient. However, “high-risk” Ewing has not always been consistently defined in the literature.

RHABDOMYOSARCOMA

Rhabdomyosarcoma, the most common soft tissue sarcoma of childhood, shows skeletal muscle differentiation. The most common primary sites are the head and neck (e.g., parameningeal, orbital, pharyngeal), genitourinary tract, and extremities.[12]

Treatment

Specific treatment is based on tumor location, resection, and node status, and may involve surgery, radiotherapy, and chemotherapy.[13] Five-year survival rates for rhabdomyosarcoma increased between 1975 and 2010 from 53% to 67% in children younger than 15 years and from 30% to 51% in 15- to 19-year-olds.[12]

Approximately 15% of children present with metastatic disease, and despite the introduction of new drugs and intensified treatment, the five-year survival is 20% to 30% for this "high-risk" group.[14,15] Similarly, post-relapse mortality is very high. The prognosis of the metastatic disease is affected by tumor histology, age at diagnosis, the site of metastatic disease, and the number of metastatic sites.[12]

WILMS TUMOR

Wilms tumor is the most common primary malignant renal tumor of childhood. In the United States, Wilms tumor is staged using the National Wilms Tumor Study system, which is based on surgical evaluation before chemotherapy (see Table 3).[16]

Table 3. National Wilms Tumor Study Staging

Stage	Description
I	(a) Tumor is limited to the kidney and completely excised; (b) The tumor was not ruptured before or during removal; (c) The vessels of the renal sinus are not involved beyond 2 mm (d) There is no residual tumor apparent beyond the margins of excision
II	(a) Tumor extends beyond the kidney but is completely excised (b) No residual tumor is apparent at or beyond the margins of excision (c) Tumor thrombus in vessels outside the kidney is stage II if the thrombus is removed en bloc with the tumor
III	Residual tumor confined to the abdomen: (a) Lymph nodes in the renal hilum, the periaortic chains, or beyond are found to contain tumor (b) Diffuse peritoneal contamination by the tumor (c) Implants are found on the peritoneal surfaces (d) Tumor extends beyond the surgical margins either microscopically or grossly (e) Tumor is not completely resectable because of local infiltration into vital structures
IV	Presence of hematogenous metastases or metastases to distant lymph nodes
V	Bilateral renal involvement at the time of initial diagnosis

Adapted from Metzger and Dome (2005).[16]

Treatment

In the United States, National Wilms Tumor Study and Children's Oncology Group protocols are based on primary resection for unilateral tumors, followed by escalating levels of chemotherapy and radiotherapy depending on tumor stage and other prognostic factors. Tumor histology, tumor stage, molecular and genetic markers (e.g., LOH at chromosome 16q), and age (older than two years) are all associated with increased risks of recurrence and death. Wilms tumors are highly sensitive to chemotherapy and radiotherapy, and current cure rates exceed 85%.[17] Between 10% and 15% of patients with favorable histology and 50% of patients with anaplastic tumors, experience tumor progression or relapse.[17]

Similar risk-adapted strategies are being tested for the 15% of patients who experience a relapse. Success rates after relapse range from 25% to 45%. For patients with adverse prognostic factors (histologically anaplastic tumors, relapse less than six to 12 months after nephrectomy, second or subsequent relapse, relapse within the radiation field, bone or brain metastases), the event-free survival rate is less than 15%.[18]

OSTEOSARCOMA

Osteosarcoma is a primary malignant bone tumor and the most common bone cancer in children and adolescents; it is characterized by infiltration of bone or osteoid by the tumor cells. Peak incidence occurs around puberty, most commonly in long bones such as the femur or humerus. Osteosarcomas are characterized by variants in the TP53 tumor suppressor gene.

The prognosis of osteosarcoma has greatly improved, with five-year survival rates increasing between 1975 and 2010 from 40% to 76% in children younger than 15 years and from 56% to 66% in 15- to 19-yearolds. Prognostic

factors for patients with localized disease include site and size of the primary tumor, the presence of metastases at the time of diagnosis, resection adequacy, and tumor response to neoadjuvant chemotherapy.

Treatment

For patients with recurrent osteosarcoma, the most important prognostic factor is surgical resectability. There is a five-year survival rate of 20% to 45% in patients who had a complete resection of metastatic pulmonary tumors and a 20% survival rate for patients with metastatic tumors at other sites.[19]

RETINOBLASTOMA

Retinoblastoma is the most common primary tumor of the eye in children. It may occur as a heritable (25%-30%) or nonheritable (70%-75%) tumor.[20] Cases may be unilateral or bilateral, with bilateral tumors almost always being the heritable type.

Treatment

Treatment options depend on the extent of disease. Retinoblastoma is usually confined to the eye, and with current therapy has a high cure rate. However, once disease spreads beyond the eye, survival rates drop significantly; five-year disease-free survival is reported to be less than 10% in those with the extraocular disease, and stage 4B disease (i.e., disease metastatic to the central nervous system) has been lethal in virtually all cases reported.[21]

The strategy for nonmetastatic disease depends on the disease extent but may include focal therapies (e.g., laser photocoagulation, cryotherapy, plaque radiotherapy), intravitreal chemotherapy, intra-arterial chemotherapy, systemic chemotherapy, enucleation, or a combination.[22] For metastatic disease, intensive multimodal therapy with high-dose chemotherapy, with or without radiotherapy, is standard care.

Notes: Other solid tumors of childhood include germ cell tumors, which are considered in the Hematopoietic Cell Transplantation in the Treatment of Germ Cell Tumors Protocol. For solid tumors classified as embryonal tumors arising in the central nervous system, see the Hematopoietic Cell Transplantation for Central Nervous System Embryonal Tumors and Ependymoma Protocol.

HEMATOPOIETIC CELL TRANSPLANTATION

HCT is a procedure in which hematopoietic stem cells are infused to restore bone marrow function in cancer patients who receive bone-marrow-toxic doses of drugs, with or without whole body radiotherapy. Hematopoietic stem cells may be obtained from the transplant recipient (autologous HCT) or a donor (allogeneic HCT). They can be harvested from bone marrow, peripheral blood, or umbilical cord blood shortly after delivery of neonates. Although cord blood is an allogeneic source, the stem cells in it are antigenically “naive” and thus are associated with a lower incidence of rejection or graft-versus-host disease.

Immunologic compatibility between infused hematopoietic stem cells and the recipient is not an issue in autologous HCT. However, immunologic compatibility between donor and patient is critical for achieving a good outcome of allogeneic HCT. Compatibility is established by typing of human leukocyte antigens using cellular, serologic, or molecular techniques. Human leukocyte antigens refer to the tissue type expressed at class I and class II loci on chromosome 6. Depending on the disease being treated, an acceptable donor (except umbilical cord blood) will match the patient at all or most human leukocyte antigens loci.

REGULATORY STATUS

The U.S. Food and Drug Administration regulates human cells and tissues intended for implantation, transplantation, or infusion through the Center for Biologics Evaluation and Research, under Code of Federal Regulation, title 21, parts 1270 and 1271. Hematopoietic stem cells are included in these regulations.

Services that are the subject of a clinical trial do not meet our Technology Assessment and Medically Necessary Services Protocol criteria and are considered investigational. *For explanation of experimental and investigational, please refer to the Technology Assessment and Medically Necessary Services Protocol.*

It is expected that only appropriate and medically necessary services will be rendered. We reserve the right to conduct prepayment and postpayment reviews to assess the medical appropriateness of the above-referenced procedures. **Some of this protocol may not pertain to the patients you provide care to, as it may relate to products that are not available in your geographic area.**

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We are not responsible for the continuing viability of web site addresses that may be listed in any references below.

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