Policy Statement

Allogeneic hematopoietic cell transplantation (HCT) using a myeloablative conditioning regimen may be considered medically necessary to treat any of the following conditions:

I. Poor- to intermediate-risk acute myeloid leukemia (AML) in first complete remission (CR1) (see Policy Guidelines section for information on risk stratification)

II. AML that is refractory to standard induction chemotherapy but can be brought into CR with intensified induction chemotherapy

III. AML that relapses following chemotherapy-induced CR1 but can be brought into CR2 or beyond with intensified induction chemotherapy

IV. AML in patients who have relapsed following a prior autologous HCT, but can be brought into CR with intensified induction chemotherapy and are medically able to tolerate the procedure

Allogeneic HCT using a reduced-intensity conditioning regimen may be considered medically necessary as a treatment of AML in patients who are in complete marrow and extramedullary remission (CR1 or beyond), and who for medical reasons would be unable to tolerate a myeloablative conditioning regimen (see Policy Guidelines section).

Autologous HCT may be considered medically necessary to treat AML in CR1 or beyond, or relapsed AML, if responsive to intensified induction chemotherapy in patients who are not candidates for allogeneic HCT.

Allogeneic and autologous HCT are considered investigational in patients not meeting any of the above criteria.

The transplantation of Hepatitis C Virus (HCV)-viremic solid organs (kidney, lung, heart, liver, small bowel, pancreas) to a HCV non-viremic recipient with a plan to use direct-acting antiviral treatment for HCV is considered investigational.

NOTE: Refer to Appendix A to see the policy statement changes (if any) from the previous version.

Policy Guidelines

The American Society of Transplantation Consensus Conference on the use of hepatitis C viremic donors in solid organ transplantation concluded that the transplantation of organs from HCV viremic donors into HCV-negative recipients should be conducted only under monitored IRB-approved protocols and studies. (See Supplemental Information).

Primary refractory acute myeloid leukemia (AML) is defined as leukemia that does not achieve a complete remission after conventionally dosed (nonmarrow ablative) chemotherapy.

In the French-American-British (FAB) criteria, the classification of AML is solely based on morphology as determined by the degree of differentiation along different cell lines and the extent of cell maturation.

Clinical features that predict poor outcomes of AML therapy include, but are not limited to, the following:

- Treatment-related AML (secondary to prior chemotherapy and/or radiotherapy for another malignancy)
- AML with antecedent hematologic disease (e.g., myelodysplasia)
- Presence of circulating blasts at the time of diagnosis
- Difficulty in obtaining first complete remission with standard chemotherapy
- Leukemias with monocyteid differentiation (French-American-British classification M4 or M5)

**World Health Organization Classification**

The newer, currently preferred, World Health Organization (WHO) classification of AML incorporates and interrelates morphology, cytogenetics, molecular genetics, and immunologic markers. It attempts to construct a classification that is universally applicable and prognostically valid. The World Health Organization system was adapted by National Comprehensive Cancer Network (NCCN) to estimate individual patient prognosis to guide management, as shown in Table PG1.

**Table PG1. Risk Status of AML Based on Genetic Factors**

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Genetic Abnormality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Favorable</td>
<td>t(8;21)(q22;q22.1); RUNX1-RUNX1T1</td>
</tr>
<tr>
<td></td>
<td>inv(16)(p13.1q22) or t(16;16)(p13.1;q22); CBFB-MYH11</td>
</tr>
<tr>
<td></td>
<td>Biallelic mutated CEBPA</td>
</tr>
<tr>
<td></td>
<td>Mutated NPM1 without FLT3-ITD or with FLT3-ITD&lt;sub&gt;low&lt;/sub&gt;</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Mutated NPM1 and FLT3-ITD&lt;sub&gt;high&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>Wild-type NPM1 without FLT3-ITD or with FLT3-ITD&lt;sub&gt;low&lt;/sub&gt; (without adverse-risk genetic lesions)</td>
</tr>
<tr>
<td></td>
<td>t(9;11)(p21.3;q23.3); MLL3-KMT2A</td>
</tr>
<tr>
<td></td>
<td>Cyto genetic abnormalities not classified as favorable or adverse</td>
</tr>
<tr>
<td>Poor/Adverse</td>
<td>t(6;9)(p23;q34.1); DEK-NUP214</td>
</tr>
<tr>
<td></td>
<td>t(v;11q23.3); KMT2A rearranged</td>
</tr>
<tr>
<td></td>
<td>t(9;22)(q34.1;q11.2); BCR-ABL1</td>
</tr>
<tr>
<td></td>
<td>inv(3)(q21.3q26.2) or t(3;3)(q21.3q26.2); GATA2,MECOM(EVI1)</td>
</tr>
<tr>
<td></td>
<td>-5 or del(5q); -7; -17/abn(17p)</td>
</tr>
<tr>
<td></td>
<td>Complex karyotype, monosomal karyotype</td>
</tr>
<tr>
<td></td>
<td>Wild-type NPM1 and FLT3-ITD&lt;sub&gt;high&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>Mutated RUNX1 (if not co-occurring with favorable-risk AML subtypes)</td>
</tr>
<tr>
<td></td>
<td>Mutated ASXL1 (if not co-occurring with favorable-risk AML subtypes)</td>
</tr>
<tr>
<td></td>
<td>Mutated TP53</td>
</tr>
</tbody>
</table>

AML: acute myeloid leukemia; ITD: internal tandem duplication.

The relative importance of cytogenetic and molecular abnormalities in determining prognosis and guiding therapy is under investigation.

The ideal allogeneic donors are human leukocyte antigen- (HLA) identical siblings, matched at the HLA-A, -B, and -DR loci (6 of 6). Related donors mismatched at 1 locus are also considered suitable donors. A matched, unrelated donor identified through the National Marrow Donor Registry is typically the next option considered. Recently, there has been interest in haploidentical donors, typically a parent or a child of the patient, for which there usually is sharing of only 3 of the 6 major histocompatibility antigens. Most patients will have such a donor; however, the risk of graft-versus-host disease and overall morbidity of the procedure may be severe, and experience with these donors is not as extensive as that with matched donors.

**Coding**

In 2003, CPT centralized codes describing allogeneic and autologous hematopoietic cell support services to the hematology section (CPT 38204-38242). Not all codes are applicable for each stem cell support procedure. For example, Plans should determine if cryopreservation is performed. A range of codes describes services associated with cryopreservation, storage, and thawing of cells (38208-38215).
Thawing and washing of cryopreserved cells:
- **38208**: Transplant preparation of hematopoietic progenitor cells; thawing of previously frozen harvest, without washing, per donor
- **38209**: Transplant preparation of hematopoietic progenitor cells; thawing of previously frozen harvest, with washing, per donor

Types of cells being depleted:
- **38210**: Transplant preparation of hematopoietic progenitor cells; specific cell depletion within harvest, T-cell depletion
- **38211**: Transplant preparation of hematopoietic progenitor cells; tumor cell depletion
- **38212**: Transplant preparation of hematopoietic progenitor cells; red blood cell removal
- **38213**: Transplant preparation of hematopoietic progenitor cells; platelet depletion
- **38214**: Transplant preparation of hematopoietic progenitor cells; plasma (volume) depletion

Plasma cell concentration:
- **38215**: Transplant preparation of hematopoietic progenitor cells; cell concentration in plasma, mononuclear, or buffy coat layer

**Description**

Acute myeloid leukemia (AML) refers to leukemias that arise from a myeloid precursor in the bone marrow. There is a high incidence of relapse, which has prompted research into various post-remission strategies using either allogeneic (allo-) or autologous hematopoietic cell transplantation (HCT). HCT refers to a procedure that infuses hematopoietic stem cells to restore bone marrow function in cancer patients who receive bone-marrow-toxic doses of drugs with or without whole-body radiotherapy.

**Related Policies**

- Genetic Testing for FLT3, NPM1, and CEBPA Variants in Cytogenetically Normal Acute Myeloid Leukemia
- Placental and Umbilical Cord Blood as a Source of Stem Cells

**Benefit Application**

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates (e.g., Federal Employee Program [FEP]) prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.

**Regulatory Status**

The FDA 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.
**Rationale**

**Background**

Complete remission can be achieved initially using induction therapy, consisting of conventional doses of combination chemotherapy. A complete response is achieved in 60% to 80% of adults younger than 60 years of age and 40% to 60% in patients older than 60 years of age. However, the high incidence of disease relapse has prompted research into a variety of post-remission (consolidation) strategies, typically using high-dose chemotherapy with autologous hematopoietic cell transplantation (HCT) or high-dose or reduced-intensity chemotherapy with allogeneic HCT (allo-HCT). The 2 treatments autologous HCT and allo-HCT represent 2 different strategies. The first, autologous HCT, is a “rescue,” but not a therapeutic procedure; the second, allo-HCT, is a “rescue” plus a therapeutic procedure.

**Hematopoietic Cell Transplantation**

HCT is a procedure in which hematopoietic stem cells are intravenously infused to restore bone marrow and immune function in cancer patients who receive bone marrow-toxic doses of cytotoxic drugs with or without whole-body radiotherapy. Hematopoietic stem cells may be obtained from the transplant recipient (autologous HCT) or a donor (allo-HCT). They can be harvested from bone marrow, peripheral blood, or umbilical cord blood shortly after delivery of neonates. Cord blood transplantation is discussed in detail in Blue Shield of California Medical Policy: Placental and Umbilical Cord Blood as a Source of Stem Cells.

Immunologic compatibility between infused hematopoietic stem cells and the recipient is not an issue in autologous HCT. In allogeneic stem cell transplantation, immunologic compatibility between donor and patient is a critical factor for achieving a successful outcome. Compatibility is established by typing of human leukocyte antigens (HLA) using cellular, serologic, or molecular techniques. HLA refers to the gene complex expressed at the HLA-A, -B, and -DR (antigen-D related) loci on each arm of chromosome 6. An acceptable donor will match the patient at all or most of the HLA loci.

**Conditioning for Hematopoietic Cell Transplantation**

**Conventional Conditioning**

The conventional (“classical”) practice of allo-HCT involves administration of cytotoxic agents (e.g., cyclophosphamide, busulfan) with or without total body irradiation at doses sufficient to cause bone marrow ablation in the recipient. The beneficial treatment effect of this procedure is due to a combination of the initial eradication of malignant cells and subsequent graft-versus-malignancy effect mediated by non-self-immunologic effector cells. While the slower graft-versus-malignancy effect is considered the potentially curative component, it may be overwhelmed by existing disease in the absence of pretransplant conditioning. Intense conditioning regimens are limited to patients who are sufficiently medically fit to tolerate substantial adverse effects. These include opportunistic infections secondary to loss of endogenous bone marrow function and organ damage or failure caused by cytotoxic drugs. Subsequent to graft infusion in allo-HCT, immunosuppressant drugs are required to minimize graft rejection and graft-versus-host disease, which increases susceptibility to opportunistic infections.

The success of autologous HCT is predicated on the potential of cytotoxic chemotherapy, with or without radiotherapy, to eradicate cancerous cells from the blood and bone marrow. This permits subsequent engraftment and repopulation of the bone marrow with presumably normal hematopoietic stem cells obtained from the patient before undergoing bone marrow ablation. Therefore, autologous HCT is typically performed as consolidation therapy when the patient’s disease is in complete remission. Patients who undergo autologous HCT are also susceptible to chemotherapy-related toxicities and opportunistic infections before engraftment, but not graft-versus-host disease.
Reduced-Intensity Conditioning Allogeneic Hematopoietic Cell Transplantation

RIC refers to the pretransplant use of lower doses of cytotoxic drugs or less intense regimens of radiotherapy than are used in traditional full-dose myeloablative conditioning treatments. Although the definition of RIC is variable, with numerous versions employed, all regimens seek to balance the competing effects of relapse due to residual disease and non-relapse mortality. The goal of RIC is to reduce disease burden and to minimize associated treatment-related morbidity and non-relapse mortality in the period during which the beneficial graft-versus-malignancy effect of allogeneic transplantation develops. RIC regimens range from nearly total myeloablative to minimally myeloablative with lymphoablation, with intensity tailored to specific diseases and patient condition. Patients who undergo RIC with allo-HCT initially demonstrate donor cell engraftment and bone marrow mixed chimerism. Most will subsequently convert to full-donor chimerism. In this review, the term reduced-intensity conditioning will refer to all conditioning regimens intended to be nonmyeloablative.

A 2015 review in the New England Journal of Medicine summarized recent advances in the classification of acute myeloid leukemia, the genomics of acute myeloid leukemia and prognostic factors, and current and new treatments.1.

Literature Review

Evidence reviews assess the clinical evidence to determine whether the use of a technology improves the net health outcome. Broadly defined, health outcomes are length of life, quality of life, and ability to function, including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of a technology, 2 domains are examined: the relevance and the quality and credibility. To be relevant, studies must represent 1 or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. Randomized controlled trials are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

Allogeneic Hematopoietic Stem Cell Transplant with Myeloablative Conditioning for Cytogenic or Molecular Intermediate- or Poor-Risk Acute Myeloid Leukemia in Complete Remission Clinical Context and Therapy Purpose

The purpose of allogeneic hematopoietic cell transplantation (allo-HCT) with myeloablative conditioning (MAC) in patients who have cytogenetic or molecular intermediate- or poor-risk acute myeloid leukemia (AML) in first complete remission (CR1) is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: Does allo-HCT with MAC improve net health outcomes in patients who have cytogenetic or molecular intermediate- or poor-risk AML in CR1? The following PICO was used to select literature to inform this review.

Populations

The relevant population of interest is patients with cytogenetic or molecular intermediate- or poor-risk AML in CR1. Patients with cytogenetic or molecular intermediate- or poor-risk AML are actively managed by oncologists and hematologists in a tertiary care setting.
**Interventions**

The therapy being considered is allo-HCT with MAC. Allogeneic HCT with MAC is an option for post-remission or consolidation therapy in cytogenic or molecular intermediate- or poor-risk AML. The purpose of post-remission therapy is to destroy undetectable leukemia cells remaining after induction chemotherapy.

**Comparators**

The following therapies are currently being used to make decisions about cytogenetic or molecular intermediate- or poor-risk AML in CR1: conventional chemotherapy.

**Outcomes**

The general outcomes of interest are survival outcomes (overall survival [OS], disease-specific survival [DSS], and disease-free survival [DFS]), relapse rates, and treatment-related morbidity. The median survival of patients with AML varies with several known prognostic factors related to patient and tumor characteristics such as age, performance status, and karyotype. Overall, the median survival for patients with AML without chemotherapy or HCT is less than 10 months; the median survival in patients with chemotherapy but without HCT is approximately 20 months. Patients are followed up throughout their lifespan.

**Study Selection Criteria**

Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess long-term outcomes and adverse effects, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.

**Review of Evidence**

**Systematic Reviews**

A 2015 meta-analysis examined prospective trials of adults with intermediate-risk AML in CR1 who underwent HCT. The analysis included 9 prospective, controlled studies that enrolled 1950 patients between the years 1987 and 2011 (sample range, 32 to 713 patients). In this meta-analysis, allo-HCT was associated with significantly better relapse-free survival (RFS), OS, and relapse rate than autologous HCT and/or chemotherapy (hazard ratio [HR], 0.68; 95% confidence interval [CI], 0.48 to 0.95; HR, 0.76; 95% CI, 0.61 to 0.95; HR, 0.58; 95% CI, 0.45 to 0.75, respectively). Treatment-related mortality was significantly higher following allo-HCT than autologous HCT (HR, 3.09; 95% CI, 1.38 to 6.92). However, a subgroup analysis, which used updated criteria to define intermediate-risk AML, showed no OS benefit for allo-HCT over autologous HCT (HR, 0.99; 95% CI, 0.70 to 1.39).

A 2009 systematic review incorporated data from 24 trials involving 6007 patients who underwent allo-HCT in CR1. Among the total, 3638 patients were stratified and analyzed according to cytogenic risk (547 good-, 2499 intermediate-, 592 poor-risk patients with AML) using a fixed-effects model. Compared with either autologous HCT or additional consolidation chemotherapy, the HR for OS among poor-risk patients across 14 trials was 0.73 (95% CI, 0.59 to 0.90; p<0.01); among intermediate-risk patients across 14 trials, the HR for OS was 0.83 (95% CI, 0.74 to 0.93; p<0.01); and among good-risk patients across 16 trials, the HR for OS was 1.07 (95% CI, 0.83 to 1.38; p=0.59). Interstudy heterogeneity was not significant in any of these analyses. Results for DFS were very similar to those for OS in this analysis. These results are in line with those from another meta-analysis on the use of allo-HCT as consolidation therapy for AML.

A 2005 meta-analysis of allo-HCT in patients with AML in CR1 pooled data from 5 studies (N=3100 patients). Among those patients, 1151 received allo-HCT, and 1949 were given alternative therapies including chemotherapy and autologous HCT. All studies employed natural
randomization based on donor availability and intention-to-treat analysis, with OS and DFS as outcomes of interest. This analysis showed a significant advantage for allo-HCT regarding OS for the entire cohort (fixed-effects model HR, 1.17; 95% CI, 1.06 to 1.30; p = 0.003; random-effects model HR, 1.15; 95% CI, 1.01 to 1.32; p = 0.037) even though none of the individual studies did so. Meta-regression analysis showed the effect of allo-HCT on OS differed depending on the cytogenetic risk groups of patients, suggesting a significant benefit for poor-risk patients (HR, 1.39, 95% CI not reported), an indeterminate benefit for intermediate-risk cases, and no benefit in better-risk patients compared with alternative approaches. Reviewers cautioned the compiled studies used different definitions of risk categories than other groups (e.g., SWOG, Medical Research Council, European Organisation for Research and Treatment of Cancer, Gruppo Italiano Malattie Ematologiche dell'Adulto). Although the statistical power of the meta-regression analysis was limited by small numbers of cases, the results of this meta-analysis are supported in general by data from other reviews.

Evidence from the meta-analysis suggests patients with better prognosis (as defined by cytogenetics) may not realize a significant survival benefit with allo-HCT in CR1 that outweighs the risk of associated morbidity and nonrelapse mortality. However, there is considerable genotypic heterogeneity within the 3 World Health Organization cytogenetic prognostic groups that complicates generalization of clinical results based only on cytogenetics. For example, patients with better prognosis disease (e.g., core-binding factor AML) based on cytogenetics, and a variant in the KIT gene of leukemic blast cells, do just as poorly with post-remission standard chemotherapy as patients with cytogenetically poor-risk AML. Similarly, patients with cytogenetically normal AML (intermediate prognosis disease) can be subcategorized into groups with better or worse prognosis based on the mutational status of the nucleophosmin gene (NPM1) and the FLT3 gene (the FLT3 gene is a gene that encodes FMS-like receptor tyrosine kinase 3, a growth factor active in hematopoiesis). Thus, patients with variants in NPM1 but without FLT3 internal tandem duplications have post-remission outcomes with standard chemotherapy that are similar to those with better prognosis cytogenetics; in contrast, patients with any other combination of variants in those genes have outcomes similar to those with poor prognosis cytogenetics. It follows that, because the earlier clinical trials compiled in the meta-analysis described here did not account for genotypic differences that affect prognosis and alter outcomes, it is difficult to use the primary trial results to draw conclusions on the role of allo-HCT in different patient risk groups.

A meta-analysis by Buckley et al (2017) evaluated the relationship between minimal residual disease (MRD) at the time of HCT and posttransplantation outcomes. The literature search, conducted through June 2016, identified 19 studies (N = 1431 patients) for inclusion. Risk of bias was assessed using a modified version of the Quality of Prognostic Studies instrument, which focused on: prognostic factor measurement, study confounding, and statistical analysis and reporting. Five studies were considered at high-risk for bias, 9 were at moderate-risk, and 5 were at low-risk. The following variables were collected from each study: age, follow-up, adverse-risk cytogenetics, conditioning type (myeloablative or reduced-intensity), MRD detection method, and survival. Reviewers reported that the presence of MRD at the time of transplantation was associated with higher relapse and mortality. This association was seen regardless of patient age and type of conditioning, which suggests that an intense conditioning regimen may not be able to overcome the adverse impact of MRD.

Prospective Studies
A 2014 study compared outcomes of 185 matched pairs from a large multicenter trial (AMLCG99). Patients younger than 60 years of age who underwent allo-HCT in CR1 were matched to patients who received conventional post-remission chemotherapy. The main matching criteria were AML type, cytogenetic risk group, patient age, and time in CR1. In the overall pairwise-compared AML population, the projected 7-year OS rate was 58% for allo-HCT and 46% for the conventional post-remission treatment group (p = 0.037). The RFS rate was 52% in the allo-HCT group and 33% in the control group (p < 0.001). The OS was significantly longer for allo-HCT patient subgroups with unfavorable chromosomal aberrations, patients older than
45 years, and patients with secondary AML or high-risk myelodysplastic syndrome. For the entire patient cohort, post-remission therapy was an independent factor for OS (HR, 0.66; 95% CI, 0.49 to 0.89 for allo-HCT vs. conventional chemotherapy) among age, cytogenetics, and bone marrow blasts after the first induction cycle.

Retrospective Studies
Heidrich et al (2017) conducted retrospective analyses of subgroups from 2 prospective clinical trials, including 497 patients with intermediate-risk AML who did not present with NPM1, CEBPA, or FLT3 internal tandem duplication variants. During the initial analysis (donor vs. no-donor), RFS rates were better for patients who had an available sibling donor (n=83) than for those who lacked a matched sibling donor (49% vs. 26%; HR, 0.5; 95% CI, 0.3 to 0.9; p=0.02); a similar improvement was seen for OS, although not statistically significant (p=0.08). The authors also conducted a time-dependent multivariate analysis to account for the significantly longer time-from-CR1 observed in patients treated with allo-HCT (median, 115 days) compared with those treated with post-remission chemotherapy (median, 78 days; p<0.001). Rates of OS after 5 years were superior for the group who received allo-HCT than for those receiving chemotherapy (OS, 66% vs. 46%, respectively; HR, 0.58; 95% CI, 0.37 to 0.9; p=0.02), as were rates of RFS (5-year RFS, 55% vs. 31%; HR, 0.51; 95% CI, 0.34 to 0.76; p=0.001). The investigators acknowledged that 38% of the group assigned to post-remission chemotherapy received allo-HCT following a relapse, which might have contributed to a crossover effect.

Section Summary: Allogeneic Hematopoietic Cell Transplant with Myeloablative Conditioning for Cytogenic or Molecular Intermediate- or Poor-Risk Acute Myeloid Leukemia in Complete Remission
Evidence for the use of allo-HCT for patients with AML in CR1 consists of RCTs and matched cohort studies. Some studies have compared allo-HCT with autologous HCT or with post-remission chemotherapy. The OS and DFS rates were favorable for allo-HCT compared with conventional chemotherapy. In a paired comparison with patients receiving chemotherapy, patients receiving allo-HCT experienced significantly higher RFS rates. Two retrospective studies analyzed subgroups of allo-HCT patients who did not present with several common genetic variants or who presented with hyperleukocytosis. Survival rates appear to be associated with the presence of MRD and cytogenetic prognosis groups.

Allogeneic Hematopoietic Cell Transplant with Myeloablative Conditioning for Acute Myeloid Leukemia Refractory to Standard Induction Chemotherapy
Clinical Context and Therapy Purpose
The purpose of allo-HCT with MAC in patients who have AML refractory to standard induction chemotherapy is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: Does allo-HCT with MAC improve net health outcomes in patients with AML refractory to standard induction chemotherapy? The following PICO was used to select literature to inform this review.

Populations
The relevant population(s) of interest is patients with AML refractory to standard induction chemotherapy. Patients with AML are actively managed by oncologists and hematologists in a tertiary care setting.

Interventions
The therapy being considered is allo-HCT with MAC. Allogeneic HCT is an option for AML refractory to standard induction chemotherapy. The purpose is to destroy leukemia cells remaining after induction chemotherapy.
Comparators
The following therapies are currently being used to make decisions about AML refractory to standard induction chemotherapy: conventional chemotherapy.

Outcomes
The general outcomes of interest are survival outcomes (OS, DSS, and DFS), relapse rates, and treatment-related morbidity. The median survival of patients with AML varies with several known prognostic factors related to patient and tumor characteristics such as age, performance status, and karyotype. Overall, the median survival for patients with AML without chemotherapy or HCT is less than 10 months; the median survival in patients with chemotherapy but without HCT is approximately 20 months. Patients are followed up throughout their lifespan.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:

- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- To assess long-term outcomes and adverse effects, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Studies with duplicative or overlapping populations were excluded.

Review of Evidence
Retrospective Studies
Conventional dose induction chemotherapy will not produce remission in 20% to 40% of patients with AML, connoting refractory AML. An allo-HCT using a matched related donor or matched unrelated donor represents the only potentially curative option for these patients. In several retrospective studies, OS rates have ranged from 30% at 3 years to 13% at 5 years, although this procedure is accompanied by nonrelapse mortality rates of 25% to 62% in this setting. For patients who lack a suitable donor (matched related donor or matched unrelated donor), alternative treatments include salvage chemotherapy with high-dose cytarabine or etoposide-based regimens, monoclonal antibodies (e.g., gemtuzumab ozogamicin), FLT3 antagonists, IDH1/IDH2 inhibitors, and clinical trial enrollment. Because it is likely that stem cell preparations will be contaminated with malignant cells in patients whose disease is not in remission, upfront autologous HCT has no role in patients who fail induction therapy.

Section Summary: Allogeneic Hematopoietic Cell Transplant with Myeloablative Conditioning for Acute Myeloid Leukemia Refractory to Standard Induction Chemotherapy
Evidence for the use of allo-HCT for individuals with primary AML refractory to chemotherapy consists of retrospective studies compiled from data from phase 3 trials and registries. The OS rate estimates are 30% at 3 years and 13% at 5 years; however, the procedure is accompanied by high rates of nonrelapse mortality (estimated range, 25% to 62%). Nonetheless, these results may provide a clinically meaningful benefit for such patients who do not have other treatment options. Autologous HCT is not recommended for patients who have failed induction therapy, because malignant cells may be included in the stem cell preparation process.

Allogeneic or Autologous Hematopoietic Cell Transplant with Myeloablative Conditioning for Relapsed Acute Myeloid Leukemia After Chemotherapy-Induced Remission
Clinical Context and Therapy Purpose
The purpose of allogeneic or autologous HCT with MAC in patients who have relapsed AML after standard induction chemotherapy-induced CR1 is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: Does allo-HCT or autologous HCT with MAC improve net health outcomes in patients with relapsed AML after standard induction chemotherapy-induced CR1?
The following PICO was used to select literature to inform this review.

**Populations**
The relevant population(s) of interest is patients with AML who relapsed after standard induction chemotherapy-induced CR1. Patients with AML are actively managed by oncologists and hematologists in a tertiary care setting.

**Interventions**
The therapy being considered is allo-HCT or autologous HCT. Allogeneic or autologous HCT are options for treatment of relapsed AML after chemotherapy-induced remission. The purpose of HCT is to destroy leukemia cells associated with recurrent AML.

**Comparators**
The following therapies are currently being used to make decisions about relapsed AML after chemotherapy-induced remission: conventional chemotherapy.

**Outcomes**
The general outcomes of interest are survival outcomes (OS, DSS, and DFS), relapse rates, and treatment-related morbidity. The median survival of patients with AML varies with several known prognostic factors related to patient and tumor characteristics such as age, performance status, and karyotype. Overall, the median survival for patients with AML without chemotherapy or HCT is less than 10 months; the median survival in patients with chemotherapy but without HCT is approximately 20 months. Patients are followed up throughout their lifespan.

**Study Selection Criteria**
Methodologically credible studies were selected using the following principles:
- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess long-term outcomes and adverse effects, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.

**Review of Evidence**

**Retrospective Studies**
Most patients with AML will experience disease relapse after attaining a CR1. Conventional chemotherapy is not curative in most patients following disease relapse, even if a second complete remission (CR2) can be achieved.

A study by Breems et al (2005) evaluated retrospective data from 667 patients who had relapsed, among a total of 1540 patients entered in 3, phase 3 trials who had received HCT during CR1. The analysis suggested that use of allo-HCT among relapsed patients can produce 5-year OS rates of 26% to 88%, depending on cytogenetic risk stratification.21

Allo-HCT is often performed as salvage therapy for patients who have relapsed after conventional chemotherapy or autologous HCT. The decision to attempt reinduction to allo-HCT is based on the availability of a suitable stem cell donor and the likelihood of achieving remission, the latter being a function of cytogenetic risk group, duration of CR1, and the patient’s health status. Registry data have shown DFS rates of 44% using sibling allografts and 30% with matched unrelated donor allografts at 5 years for patients transplanted in CR2, and DFS rates of 35% to 40% using sibling transplants and 10% with matched unrelated donor transplants for patients with induction failure or in relapse following HCT.20
In a retrospective chart review, Frazer et al (2017) assessed characteristics that might predict OS, relapse rate, and nonrelapse mortality of HCT in patients with relapsed AML. Data were abstracted from 55 consecutive patients who underwent allo-HCT for AML in CR2. The OS rates at 1, 3, and 5 years posttransplant were 60%, 45%, and 37%, respectively. None of the following pretransplant variables were significantly associated with OS, relapse rate, or nonrelapse mortality: duration of first remission, patient age, cytogenetic risk category, post myelodysplastic syndrome, conditioning regimen, or donor type. Limitations of the study were its small sample size and selection parameters that included transplantations conducted across 21 years.

In patients in CR2 without an allogeneic donor or who are not candidates for allo-HCT due to age or other factors, autologous HCT may achieve prolonged DFS in 9% to 55% of patients in CR2 depending on risk category. However, because it is likely that stem cell preparations will be contaminated with malignant cells in patients whose disease is not in remission, and it is often difficult to achieve CR2 in these patients, autologous HCT in this setting is usually limited to patients who have a sufficient stem cell preparation remaining from the collection in CR1.

Section Summary: Allogeneic or Autologous Hematopoietic Cell Transplant with Myeloablative Conditioning for Relapsed Acute Myeloid Leukemia After Chemotherapy-Induced Remission

Evidence on the use of HCT for individuals with relapsed AML includes retrospective chart reviews compiling data from phase 3 trials and registries. The DFS rates ranged from 30% to 44% depending on the source of transplantation cells, and OS rates ranged from 26% to 88% depending on risk stratification. Because reinduction chemotherapy may be associated with high morbidity and mortality, HCT may be considered.

Allogeneic Hematopoietic Cell Transplant with Reduced-Intensity Conditioning for Cytogenic or Molecular Intermediate- or Poor-Risk Acute Myeloid Leukemia in Remission

Clinical Context and Therapy Purpose

The purpose of allo-HCT with reduced-intensity conditioning (RIC) in patients who have cytogenetic or molecular intermediate- or poor-risk AML in CR1 who cannot tolerate MAC is to provide a treatment option that is an alternative to or an improvement on existing therapies. The question addressed in this evidence review is: Does allo-HCT with RIC improve net health outcomes in patients with cytogenic or molecular intermediate- or poor-risk AML in CR1 who cannot tolerate MAC?

The following PICO was used to select literature to inform this review.

Populations

The relevant population(s) of interest is patients with cytogenic or molecular intermediate- or poor-risk AML in CR1 who cannot tolerate MAC. Patients with AML are actively managed by oncologists and hematologists in a tertiary care setting.

Interventions

The therapy being considered is allo-HCT with RIC. Allogeneic HCT with RIC is an option for post-remission therapy for cytogenic or molecular intermediate- or poor-risk AML. The purpose of post-remission therapy is to destroy undetectable leukemia cells remaining after induction chemotherapy.

Comparators

The following therapies are currently being used to make decisions about cytogenic or molecular intermediate- or poor-risk AML in CR1: conventional chemotherapy and allo-HCT with MAC.

Outcomes

The general outcomes of interest are survival outcomes (OS, DSS, and DFS), relapse rates, and treatment-related morbidity. The median survival of patients with AML varies with several known prognostic factors related to patient and tumor characteristics such as age, performance status,
and karyotype. Overall, the median survival for patients with AML without chemotherapy or HCT is less than 10 months; the median survival in patients with chemotherapy but without HCT is approximately 20 months. Patients are followed up throughout their lifespan.

**Study Selection Criteria**
Methodologically credible studies were selected using the following principles:
- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess long-term outcomes and adverse effects, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.
- Studies with duplicative or overlapping populations were excluded.

**Review of Evidence**
A body of evidence is accruing from clinical studies that RIC with allo-HCT may be used for consolidation therapy in patients with AML.

**Systematic Reviews**
A systematic review and meta-analysis by Rashidi et al (2016) calculated OS and RFS for patients older than 60 years of age with AML who underwent RIC HCT. A literature search, conducted through September 2015, identified 13 studies (N=749 patients) for inclusion. Pooled estimates for RFS at 6 months, 1 year, 2 years, and 3 years were 62% (95% CI, 54% to 69%), 47% (95% CI, 42% to 53%), 44% (95% CI, 33% to 55%), and 35% (95% CI, 26% to 45%), respectively. Pooled estimates for OS at 6 months, 1 year, 2 years, and 3 years were 73% (95% CI, 66% to 79%), 58% (95% CI, 50% to 65%), 45% (95% CI, 35% to 54%), and 38% (95% CI, 29% to 48%), respectively.

A 2014 meta-analysis compared RIC with MAC regimens for allo-HCT in patients with AML. The analysis included 23 clinical trials reported between 1990 and 2013, with approximately 15000 adults. Eleven studies included AML and myelodysplastic syndrome, and 5 included AML only. A subanalysis from 13 trials in patients with AML or myelodysplastic syndrome revealed that OS was comparable in patients who received either RIC or MAC transplants, and the 2-year or less and 2-year or greater OS rates were equivalent between both conditioning groups. The 2- to 6-year progression-free survival, nonrelapse mortality, and acute and chronic graft-versus-host disease (GVHD) rates were reduced after RIC HCT, but the relapse rate was increased. Similar outcomes were observed regardless of disease status at transplantation. Among the RIC HCT recipients, survival rates were superior if patients were in CR at transplantation.

**Randomized Controlled Trials**
A randomized comparative trial in matched patient groups compared the net health benefit of allo-HCT with RIC or with MAC. In this phase 3 trial, patients (18 to 60 years) were randomized to 4 doses of RIC (n=99) at 2 gray of total body irradiation plus fludarabine 150 mg/m², or to 6 doses of standard conditioning (n=96) at 2 gray of total body irradiation plus cyclophosphamide 120 mg/kg. All patients received cyclosporine and methotrexate as prophylaxis against GVHD. The primary endpoint was the incidence of nonrelapse mortality analyzed in the intention-to-treat population. This unblinded trial was stopped early because of slow accrual of patients. The incidence of nonrelapse mortality did not differ between the RIC and standard conditioning groups (cumulative incidence at 3 years, 13% [95% CI, 6% to 21%] vs. 18% [95% CI, 10% to 26%]; HR, 0.62; 95% CI, 0.30 to 1.31, respectively). Relapse cumulative incidence at 3 years was 28% (95% CI, 19% to 38%) in the RIC group and 26% (95% CI, 17% to 36%; HR, 1.10; 95% CI, 0.63 to 1.90) in the standard conditioning group. The DFS rates at 3 years were 58% (95% CI, 49% to 70%) in the RIC group and 56% (95% CI, 46% to 67%; HR, 0.85; 95% CI, 0.55 to 1.32) in the standard conditioning group. The OS rates at 3 years were 61% (95% CI, 50% to 74%) in the RIC group and 58% (95% CI, 47% to 70%; HR, 0.77; 95% CI, 0.48 to 1.25) in the standard conditioning group. No outcomes differed significantly between groups. Grade 3 and 4 oral mucositis was less common in the RIC group (50 patients) than in the standard conditioning
group (73 patients); the frequency of other adverse events such as GVHD and increased concentrations of bilirubin and creatinine did not differ significantly between groups. A phase 2 single-center, randomized toxicity study (2013) compared MAC with RIC in patients who received allo-HCT to treat AML. Adults 60 years of age or younger with AML were randomized (1:1) to treatment with RIC (n=18) or MAC (n=19) for allo-HCT. A maximum median mucositis grade of 1 was observed in the RIC group compared with grade 4 in the MAC group (p<0.001). Hemorrhagic cystitis occurred in 8 (42%) of the patients in the MAC group and none (0%) in the RIC group (p<0.01). Results of renal and hepatic tests did not differ significantly between groups. The RIC-treated patients had faster platelet engraftment (p<0.01) and required fewer erythrocyte and platelet transfusions (p<0.001) and less total parenteral nutrition than those treated with MAC (p<0.01). Cytomegalovirus infection was more common in the MAC group (14/19) than in the RIC group (6/18; p=0.02). Donor chimerism was similar in the 2 groups for CD19 and CD33 but was delayed for CD3 in the RIC group. Five-year treatment-related morbidity was approximately 11% in both groups, and rates of relapse and survival did not differ significantly. Patients in the MAC group with intermediate cytogenetic AML had a 3-year survival rate of 73% compared with 90% among those in the RIC group.

Comparative Trials
In a 2016 comparative study by the European Society for Blood and Marrow Transplantation, long-term survival was evaluated among patients with AML who underwent allo-HCT with RIC or with MAC regimens. Data from 701 patients receiving MAC and 722 patients receiving RIC were analyzed. Survival, relapse, and GVHD rates are summarized in Table 1. In a multivariate analysis, the following factors predicted nonrelapse mortality: RIC, age older than 55 years, advanced disease, and female donor to male recipient. Factors predicting chronic GVHD (a surrogate outcome for quality of life) were in vivo T-cell depletion, advanced disease, and peripheral blood cell transplantation.

Table 1. Comparison of 10-Year Outcomes for Reduced-Intensity Conditioning and Myeloablative Conditioning Regimens in Patients Undergoing Allogeneic Hematopoietic Cell Transplant

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>RIC (n=722) Rate (95% CI), %</th>
<th>MAC (n=701) Rate (95% CI), %</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonrelapse mortality</td>
<td>20 (17 to 24)</td>
<td>35 (31 to 39)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Relapse</td>
<td>48 (44 to 52)</td>
<td>34 (31 to 38)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Leukemia-free survival, overall</td>
<td>32 (28 to 35)</td>
<td>31 (27 to 35)</td>
<td>0.57</td>
</tr>
<tr>
<td>Age 50-55 y</td>
<td>40 (33 to 46)</td>
<td>36 (32 to 41)</td>
<td>0.32</td>
</tr>
<tr>
<td>Age &gt;55 y</td>
<td>20 (14 to 26)</td>
<td>28 (24 to 32)</td>
<td>0.02</td>
</tr>
<tr>
<td>Overall survival</td>
<td>35 (32 to 39)</td>
<td>33 (29 to 37)</td>
<td>0.57</td>
</tr>
<tr>
<td>GVHD-free, relapse-free survival</td>
<td>21 (18 to 24)</td>
<td>22 (18 to 25)</td>
<td>0.79</td>
</tr>
</tbody>
</table>


In a comparative study by Bitan et al (2014), outcomes were compared for children with AML who underwent allo-HCT using RIC regimens or MAC regimens. A total of 180 patients were evaluated; 39 underwent RIC and 141 received MAC regimens. Univariate and multivariate analyses showed no significant differences in the rates of acute and chronic GVHD, leukemia-free survival, and OS between treatment groups. The 5-year probabilities of OS with RIC and MAC regimens were 45% and 48%, respectively (p=0.99). Moreover, relapse rates were similar for RIC (39%) and MAC regimens (39% p=0.95), and recipients of MAC regimens were not at a higher risk for transplant-related mortality (16%) than recipients of RIC regimens (16% p=0.73).

Noncomparative Studies
In a phase 2 study by Devine et al (2015), 114 patients ages 60 to 74 years with AML in CR1 were treated with RIC and allo-HCT. Patients were followed for 2 years. The primary endpoint was DFS, and secondary endpoints were nonrelapse mortality, GVHD, relapse, and OS. Two years
after transplantation, the following rates were recorded: DFS, 42% (95% CI, 33% to 52%); OS, 48% (95% CI, 39% to 58%); nonrelapse mortality, 15% (95% CI, 8% to 21%); grades 2, 3, or 4 acute GVHD, 10% (95% CI, 4% to 15%); grades 2, 3, or 4 chronic GVHD, 28% (95% CI, 19% to 36%); and cumulative incidence of relapse, 44% (95% CI, 35% to 53%).

Section Summary: Allogeneic Hematopoietic Cell Transplant With Reduced-Intensity Conditioning for Cytogenetic or Molecular Intermediate- or Poor-Risk Acute Myeloid Leukemia in Remission
Evidence for the use of RIC and allo-HCT to treat patients with AML consists of 2 RCTs, 2 meta-analyses, and numerous comparative and noncomparative studies. In general, compared with MAC, RIC has comparable survival estimates (leukemia-free, overall), though relapse rates appear higher among patients receiving RIC in some studies.

Autologous Hematopoietic Cell Transplant for Acute Myeloid Leukemia in Remission With Chemotherapy-Responsive Consolidation
Clinical Context and Therapy Purpose
The purpose of autologous HCT in patients with AML in remission who do not have a suitable allo-HCT donor is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: Does autologous HCT improve net health outcomes in patients with AML in remission who do not have a suitable allo-HCT donor? The following PICO was used to select literature to inform this review.

Populations
The relevant population of interest is patients with AML in remission who do not have a suitable allo-HCT donor. Patients with AML are actively managed by oncologists and hematologists in a tertiary care setting.

Interventions
The therapy being considered is autologous HCT.
For patients with AML in remission without an acceptable allo-HCT donor, autologous HCT is an option for consolidation therapy.

Comparators
The following therapies are currently being used to make decisions about the treatment of AML in remission when no suitable allo-HCT donor is available: conventional chemotherapy.

Outcomes
The general outcomes of interest are survival outcomes (OS, DSS, and DFS), relapse rates, and treatment-related morbidity. The median survival of patients with AML varies with several known prognostic factors related to patient and tumor characteristics such as age, performance status, and karyotype. Overall, the median survival for patients with AML without chemotherapy or HCT is less than 10 months; the median survival in patients with chemotherapy but without HCT is approximately 20 months. Patients are followed up throughout their lifespan.

Study Selection Criteria
Methodologically credible studies were selected using the following principles:
- To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies;
- To assess long-term outcomes and adverse effects, single-arm studies that capture longer periods of follow-up and/or larger populations were sought;
- Studies with duplicative or overlapping populations were excluded.
Review of Evidence
Systematic Reviews
A meta-analysis published by Nathan et al (2004) compared survival outcomes for autologous HCT in CR1 with standard chemotherapy or no further treatment in AML patients ages 15 to 55 years. \textsuperscript{45} Two types of studies were eligible: (1) prospective cohort studies in which patients with an available sibling donor were offered allo-HCT (biologic randomization) with random assignment of all others to autologous HCT or chemotherapy (or no further treatment); and (2) randomized trials that compared autologous HCT with chemotherapy in all patients. Among a total of 4058 patients included in 6 studies, 2989 (74%) achieved CR1; 1044 (26%) were randomized to HCT (n=524) or to chemotherapy (n=520). Of the 5 studies for which OS data were available, outcomes with autologous HCT were better in 3, and outcomes with chemotherapy were better in 2. None of the differences were statistically significant, nor was the pooled estimate (fixed-effects model survival probability ratio, 1.01; 95% CI, 0.89 to 1.15; p=0.86). In all 6 studies, DFS was numerically superior using autologous HCT compared with chemotherapy (or no further treatment), but only 1 reported a statistically significant DFS probability associated with autologous HCT. The pooled estimate for DFS showed a statistically significant probability in favor of autologous HCT at 48 months posttransplant (fixed-effects model survival probability ratio, 1.24; 95% CI, 1.06 to 1.44; p=0.006). This review comprised studies performed between 1984 and 1995, during which transplant protocols and patient management evolved significantly, particularly compared with current care.

A second meta-analysis, published by Wang et al (2010), evaluated autologous HCT plus further chemotherapy or no further treatment for patients with AML in CR1. \textsuperscript{46} Nine randomized trials involving 1104 adults who underwent autologous HCT and 1118 patients who received additional chemotherapy or no additional treatment were identified. Analyses suggested that autologous HCT in CR1 is associated with statistically significant reduction of relapse risk (relative risk, 0.56; 95% CI, 0.44 to 0.71; p=0.001) and significant improvement in DFS (HR, 0.89; 95% CI, 0.80 to 0.98), but at the cost of an increased nonrelapse mortality rate (relative risk, 1.90; 95% CI, 1.34 to 2.70; p=0.023). There were more deaths during the first remission among patients assigned to autologous HCT than among the chemotherapy recipients or further untreated patients. As a consequence of the increased nonrelapse mortality rate, no statistical difference in OS (HR, 1.05; 95% CI, 0.91 to 1.21) was associated with the use of autologous HCT, compared with further chemotherapy or no further therapy. These results are concordant with the earlier meta-analysis.

Randomized Controlled Trials
The RCTs published after the meta-analyses will be reviewed here. A prospective, randomized phase 3 trial by Vellenga et al (2011) compared autologous HCT with intensive consolidation chemotherapy among patients (range, 16 to 60 years) with newly diagnosed AML of similar risk profiles in CR1. \textsuperscript{47} After 2 cycles of intensive chemotherapy (etoposide and mitoxantrone), patients in CR1 who were not candidates for allo-HCT were randomized to a third consolidation cycle of the same chemotherapy (n=259) or autologous HCT (n=258). The HCT group experienced an upward trend toward superior RFS (38%) compared with the chemotherapy group at 5 years (29%; p=0.065). The HCT patients also had a lower relapse rate at 5 years (58%) compared with chemotherapy recipients (70%; p=0.02). The OS did not differ between the HCT group (44%) and the chemotherapy group (41%; p=0.86). Nonrelapse mortality rates were higher in the autologous HCT group (4%) than in the chemotherapy consolidation group (1%; p=0.02). Despite this difference in nonrelapse mortality, the relative equality of OS rates was attributed by the investigators to a higher proportion of successful salvage treatments/second-line chemotherapy, autologous or allo-HCT, in the chemotherapy consolidation recipients that were not available to the autologous HCT patients. This large trial has shown an advantage for post-remission autologous HCT in reducing relapse, but similar OS rates secondary to better salvage of chemotherapy-consolidated patients.

Miyamoto et al (2018) reported results of a randomized, multicenter phase 3 trial conducted in 24 centers in Japan from 2003 to 2011 that compared autologous HCT versus high-dose cytarabine (HiDAC) consolidation as post-remission therapy in AML. \textsuperscript{48} This trial enrolled 240
patients between 15 and 64 years of age with newly diagnosed favorable- and intermediate-risk AML and Eastern Cooperative Oncology Group (ECOG) performance status of <3; 87 of those who achieved CR1 were randomized to autologous HCT or HiDAC. The study was powered to include 122 patients with 5 years of accrual and 3 years of post-accrual follow-up to detect a difference in DFS at 3 years of 40% versus 65%. Approximately one-third of the patients had favorable risk AML and the remaining two-thirds had intermediate-risk AML. The median age was 48 years. Median follow-up was approximately 4.5 to 5 years. Three-year DFS rate was 41% (95% CI, 27 to 55) in the HiDAC group and 55% (95% CI, 38 to 68) in the autologous HCT group (p=0.25). Three-year OS was 77% (95% CI, 61 to 87) versus 68% (95% CI, 52 to 80) (p=0.67). Cumulative incidence of relapse was 54% versus 41% (p=0.22). There were no differences between the HiDAC and autologous HCT groups in the incidence of liver or renal dysfunction. The incidence of life-threatening infectious complications (p=0.003) and mucositis/diarrhea (p=0.002) was significantly higher in the autologous HCT group.

Section Summary: Autologous Hematopoietic Cell Transplant for Acute Myeloid Leukemia in Remission With Chemotherapy-Responsive Consolidation

Evidence for the use of autologous HCT for patients with AML who do not have a suitable allogeneic donor or who cannot tolerate an allogeneic procedure consists of RCTs comparing autologous HCT with chemotherapy and prospective cohort studies. Meta-analyses of these studies and trials were reported improved DFS and relapse but did not find a significant improvement in OS. A potential explanation for this discrepancy between DFS and OS is the increased nonrelapse mortality rate experienced by patients in the transplantation group.

Summary of Evidence

For individuals who have cytogenetic or molecular intermediate- or poor-risk AML in first complete remission (CR1) who receive allo-HCT with myeloablative conditioning (MAC), the evidence includes randomized controlled trials (RCTs) and matched cohort studies. Relevant outcomes are overall survival (OS) and disease-specific survival (DSS). The evidence has revealed that allo-HCT is better at improving OS and DSS rates in patients with AML in CR1 than conventional chemotherapy. All trials employed natural randomization based on donor availability and intention-to-treat analysis. Survival rates appear to be associated with the presence of minimal residual disease and risk category. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have AML refractory to standard induction chemotherapy who receive allo-HCT with MAC, the evidence includes retrospective data compiled from patients entered in phase 3 trials and registry data. Relevant outcomes are OS and DSS. The evidence would suggest that allo-HCT improves OS and DSS rates in patients who are refractory to induction chemotherapy better than conventional chemotherapy. While there are some limitations to the evidence, which include its retrospective nature, lack of rigorous randomization, and general pitfalls of registry data, these results may provide a clinically meaningful benefit for patients who do not have other treatment options. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have AML who relapsed after standard induction chemotherapy-induced CR1 who receive allo-HCT or autologous HCT with MAC, the evidence includes retrospective data compiled from patients entered in phase 3 trials and registry data. Relevant outcomes are OS and DSS. The evidence has shown that allo-HCT improves OS rates in patients with relapsed AML better than conventional chemotherapy. Limitations of the evidence include its retrospective nature, lack of rigorous randomization, and pitfalls of registry data. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome. For individuals who have cytogenetic or molecular intermediate- or poor-risk AML in CR1 and for medical reasons cannot tolerate MAC who receive allo-HCT with reduced-intensity conditioning, the evidence includes 2 RCTs, 2 meta-analyses, and other comparative and noncomparative studies. Relevant outcomes are OS, DSS, and treatment-related morbidity. The RCTs compared reduced-intensity conditioning with MAC and reported similar rates in nonrelapse mortality,
relapse, and OS though1 of the trials was stopped prematurely due to slow accrual of patients. Two retrospective comparative studies found no difference in OS or leukemia-free survival between the conditioning regimens. It appears unlikely that additional comparative evidence will be generated. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have AML in CR1 or beyond without a suitable allo-HCT donor who receive autologous HCT, the evidence includes prospective cohort studies in which patients with an available sibling donor were offered allo-HCT (biologic randomization) with random assignment of all others to autologous HCT or chemotherapy (or no further treatment); and randomized trials comparing autologous HCT with chemotherapy in all patients. Relevant outcomes are OS and DSS. Compared with chemotherapy, patients undergoing autologous HCT experienced reduced relapse and improved disease-free survival rates. The OS did not differ between the groups. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

Supplemental Information

Practice Guidelines and Position Statements

The American Society of Transplantation (2017) convened a consensus conference of experts to address issues related to the transplantation of hepatitis C virus (HCV) viremic solid organs into HCV non-viremic recipients.52 Key findings and recommendations are summarized in Table 2.

Table 2. American Society of Transplantation Consensus Conference - Use of HCV Viremic Donors

<table>
<thead>
<tr>
<th>Content Area</th>
<th>Key Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Definition of HCV positive</td>
<td>HCV –viremic reflecting a positive NAT should be adopted</td>
</tr>
<tr>
<td>2 Data interpretation</td>
<td>HCV antibody status alone limits interpretation of outcomes of transplantation of HCV “positive” organs</td>
</tr>
<tr>
<td>3 Transmission and Treatment</td>
<td>Highest risk for unexpected HCV transmission is associated with organ donation from a person who injected drugs within the eclipse or pre-viremic period</td>
</tr>
<tr>
<td>4 OPTN policy</td>
<td>No current policies prevent transplantation of HCV-viremic organs into HCV non-viremic recipients</td>
</tr>
<tr>
<td>5 Ethical considerations</td>
<td>Transplantation of HCV-viremic organs into HCV non-viremic recipients should be conducted under site specific IRB approved protocols with multi-step informed consent.</td>
</tr>
</tbody>
</table>

American Society for Transplantation and Cellular Therapy

In 2020, the American Society for Transplantation and Cellular Therapy published expert panel recommendations on the role of hematopoietic cell transplant (HCT) in newly-diagnosed adult acute myeloid leukemia.49 Recommendations were generated based on findings from a systematic review and graded based on prespecified criteria. Expert panel recommendations regarding allogeneic HCT (allo-HCT) and autologous HCT and the grades of the recommendations are as follows:

- Patients with unfavorable-risk in first remission (CR1) should undergo allo-HCT. (Grade A)
- Patients with intermediate-risk in CR1 should undergo allo-HCT. (Grade B)
- Patients with favorable-risk in CR1 should not undergo allo-HCT. (Grade C)
- The role of secondary mutational abnormalities in selecting a patient for allo-HCT is unclear. (Grade N/A)
- The presence of measurable residual disease at the end of induction therapy should be considered an indication to offer allo-HCT. (Grade C)
- The role of allo-HCT is unclear in patients with induction failure. (Grade N/A)
- Patients with secondary acute myeloid leukemia in CR1 should undergo allo-HCT. (Grade D)
- Patients with therapy-related acute myeloid leukemia in CR1 should undergo allo-HCT. (Grade D)
- Patients ≥ 60 years in CR1 should undergo allo-HCT. (Grade B).
• Autologous HCT is a good alternative to chemotherapy consolidation in patients who are not eligible for allo-HCT. (Grade B)
• Myeloablative conditioning should be the preferred type of conditioning in patients who are fit for myeloablative conditioning, but reduced-intensity conditioning is an acceptable alternative in unfit patients. (Grade D)

In 2015, the American Society for Transplantation and Cellular Therapy (formerly The American Society for Blood and Marrow Transplantation) published guidelines on indications for autologous HCT and allo-HCT. Although a formal systematic review was not conducted, evidence was partly used as the basis for the recommendations. The publication reported that none of the authors had any relevant financial conflicts of interest to declare. Table 2 summarizes recommendations for HCT in acute myeloid leukemia.

Table 3. Recommendations for the Use of Hematopoietic Cell Transplantation to Treat Acute Myeloid Leukemia

<table>
<thead>
<tr>
<th>Indication</th>
<th>Allo-HCT</th>
<th>Autologous HCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>AML, age &lt;18 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First CR, low risk</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>First CR, intermediate risk</td>
<td>C</td>
<td>N</td>
</tr>
<tr>
<td>First CR, high risk</td>
<td>S</td>
<td>N</td>
</tr>
<tr>
<td>Second or greater CR</td>
<td>S</td>
<td>N</td>
</tr>
<tr>
<td>Not in remission</td>
<td>C</td>
<td>N</td>
</tr>
<tr>
<td>AML, age ≥18 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First CR, low risk</td>
<td>N</td>
<td>C</td>
</tr>
<tr>
<td>First CR, intermediate risk</td>
<td>S</td>
<td>C</td>
</tr>
<tr>
<td>First CR, high risk</td>
<td>S</td>
<td>C</td>
</tr>
<tr>
<td>Second CR</td>
<td>S</td>
<td>C</td>
</tr>
<tr>
<td>Third or greater CR</td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Not in remission</td>
<td>C</td>
<td>N</td>
</tr>
</tbody>
</table>

a Recommendations were classified as follows: S, standard of care (well-defined and generally supported by evidence in the form of high quality clinical trials and/or observational studies); C, standard of care, clinical evidence available (large clinical trials are not available; however, sufficiently large cohort studies have shown efficacy with acceptable risk of morbidity and mortality); N, not generally recommended allo-HCT: allogeneic hematopoietic cell transplantation; AML: acute myeloid leukemia; CR: complete response; HCT: hematopoietic cell transplantation

**National Comprehensive Cancer Network**

The National Comprehensive Cancer Network clinical guidelines (v.2. 2021) for acute myeloid leukemia state that allo-HCT is recommended for patients aged <60 years after standard-dose cytarabine induction with induction failure or significant residual disease without a hypocellular marrow. It is also recommended after high-dose cytarabine induction with induction failure, or as post-remission therapy in those with intermediate-risk or poor-risk cytogenetics. Allo-HCT is identified as a "reasonable option" for patients aged ≥60 years after standard-dose cytarabine induction with residual disease or induction failure or following complete response (preferably in a clinical trial). In addition, allo-HCT is recommended for relapsed or refractory disease. According to the guidelines, the role of autologous HCT is diminishing due to improvements in allo-HCT that have expanded the pool of potential donors outside the family setting. Autologous HCT should not be a recommended consolidation therapy outside the setting of a clinical trial.

**U.S. Preventive Services Task Force Recommendations**

Not applicable.

**Medicare National Coverage**

The Centers for Medicare & Medicaid Services have the following national coverage determination on the use of cell transplantation for acute myeloid leukemia:

- Allogeneic: "...for the treatment of leukemia, leukemia in remission..."
- Autologous: "Acute leukemia in remission who have a high probability of relapse and who have no human leukocyte antigens (HLA)-matched."

Ongoing and Unpublished Clinical Trials
Some currently unpublished trials that might influence this review are listed in Table 3.

Table 3. Summary of Key Trials

<table>
<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
<th>Planned Enrollment</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpublished</td>
<td>Prospective Controlled Clinical Study of Allogeneic Stem Cell Transplantation with Reduced Conditioning versus Best Standard Care in Acute Myeloid Leukemia in First Complete Remission</td>
<td>340</td>
<td>Jul 2018 (Completed)</td>
</tr>
</tbody>
</table>

NCT: national clinical trial.

References

44. Devine SM, Owzar K, Blum W, et al. Phase II Study of Allogeneic Transplantation for Older Patients With Acute Myeloid Leukemia in First Complete Remission Using a Reduced-Intensity Conditioning Regimen: Results From Cancer and Leukemia Group B 100103 (Alliance for Clinical Trials in Oncology)/Blood and Marrow Transplant Clinical Trial Network 0502. J Clin Oncol. Dec 10 2015; 33(35): 4167-75. PMID 26527780


**Documentation for Clinical Review**

Please provide the following documentation:

- History and physical from referring physician
- Bone marrow transplant consultation report and/or progress notes documenting:
  - Diagnosis (including disease staging) and prognosis
  - Specific transplant type being requested
  - Synopsis of alternative treatments performed and results
- Surgical consultation report and/or progress notes
- Results of completed transplant evaluation including:
  - Clinical history
  - Consultation reports/letters (when applicable)
  - Correspondence from referring physicians (when applicable)
  - Identification of donor for allogeneic related bone marrow/stem cell transplant (when information available)
  - Specific issues identified during the transplant evaluation
- Medical social service/social worker and/or psychiatric (if issues are noted) evaluations including psychosocial assessment or impression of patient’s ability to be an adequate candidate for transplant
- Radiology reports including:
  - Chest x-ray (CXR)
  - PET scan, CT scan and bone survey (as appropriate)
- Cardiology procedures and pulmonary function reports:
  - Cardiac echocardiogram
  - EKG
  - Pulmonary function tests (PFTs)
- Biopsy/Pathology reports including:
  - Bone marrow biopsy; Lymph node biopsy (as appropriate)
- Laboratory report(s)
## Coding

This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy. Inclusion or exclusion of codes does not constitute or imply member coverage or provider reimbursement.

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT®</td>
<td>38204</td>
<td>Management of recipient hematopoietic progenitor cell donor search and cell acquisition</td>
</tr>
<tr>
<td></td>
<td>38205</td>
<td>Blood-derived hematopoietic progenitor cell harvesting for transplantation, per collection; allogeneic</td>
</tr>
<tr>
<td></td>
<td>38206</td>
<td>Blood-derived hematopoietic progenitor cell harvesting for transplantation, per collection; autologous</td>
</tr>
<tr>
<td></td>
<td>38207</td>
<td>Transplant preparation of hematopoietic progenitor cells; cryopreservation and storage</td>
</tr>
<tr>
<td></td>
<td>38208</td>
<td>Transplant preparation of hematopoietic progenitor cells; thawing of previously frozen harvest, without washing, per donor</td>
</tr>
<tr>
<td></td>
<td>38209</td>
<td>Transplant preparation of hematopoietic progenitor cells; thawing of previously frozen harvest, with washing, per donor</td>
</tr>
<tr>
<td></td>
<td>38210</td>
<td>Transplant preparation of hematopoietic progenitor cells; specific cell depletion within harvest; T-cell depletion</td>
</tr>
<tr>
<td></td>
<td>38211</td>
<td>Transplant preparation of hematopoietic progenitor cells; tumor cell depletion</td>
</tr>
<tr>
<td></td>
<td>38212</td>
<td>Transplant preparation of hematopoietic progenitor cells; red blood cell removal</td>
</tr>
<tr>
<td></td>
<td>38213</td>
<td>Transplant preparation of hematopoietic progenitor cells; platelet depletion</td>
</tr>
<tr>
<td></td>
<td>38214</td>
<td>Transplant preparation of hematopoietic progenitor cells; plasma (volume) depletion</td>
</tr>
<tr>
<td></td>
<td>38215</td>
<td>Transplant preparation of hematopoietic progenitor cells; cell concentration in plasma, mononuclear, or buffy coat layer</td>
</tr>
<tr>
<td></td>
<td>38230</td>
<td>Bone marrow harvesting for transplantation; allogeneic</td>
</tr>
<tr>
<td></td>
<td>38232</td>
<td>Bone marrow harvesting for transplantation; autologous</td>
</tr>
<tr>
<td></td>
<td>38240</td>
<td>Hematopoietic progenitor cell (HPC); allogeneic transplantation per donor</td>
</tr>
<tr>
<td></td>
<td>38241</td>
<td>Hematopoietic progenitor cell (HPC); autologous transplantation</td>
</tr>
<tr>
<td>HCPCS</td>
<td>S2140</td>
<td>Cord blood harvesting for transplantation, allogeneic</td>
</tr>
<tr>
<td></td>
<td>S2142</td>
<td>Cord blood-derived stem-cell transplantation, allogeneic</td>
</tr>
<tr>
<td></td>
<td>S2150</td>
<td>Bone marrow or blood-derived stem cells (peripheral or umbilical), allogeneic or autologous, harvesting, transplantation, and related complications; including: pheresis and cell preparation/storage; marrow ablative therapy; drugs, supplies, hospitalization with outpatient follow-up; medical/surgical, diagnostic, emergency, and rehabilitative services; and the number of days of pre and post-transplant care in the global definition</td>
</tr>
</tbody>
</table>

## Policy History

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/07/2011</td>
<td>BCBSA Medical Policy adoption</td>
</tr>
</tbody>
</table>
Definitions of Decision Determinations

**Medically Necessary:** Services that are Medically Necessary include only those which have been established as safe and effective, are furnished under generally accepted professional standards to treat illness, injury or medical condition, and which, as determined by Blue Shield, are: (a) consistent with Blue Shield medical policy; (b) consistent with the symptoms or diagnosis; (c) not furnished primarily for the convenience of the patient, the attending Physician or other provider; (d) furnished at the most appropriate level which can be provided safely and effectively to the patient; and (e) not more costly than an alternative service or sequence of services at least as likely to produce equivalent therapeutic or diagnostic results as to the diagnosis or treatment of the Member’s illness, injury, or disease.

**Investigational/Experimental:** A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

**Split Evaluation:** Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

**Prior Authorization Requirements (as applicable to your plan)**

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member’s health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member’s eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department at (800) 541-6652, or the Transplant Case Management Department at (800) 637-2066 ext. 3507708 or visit the provider portal at www.blueshieldca.com/provider.

Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.
### Appendix A

<table>
<thead>
<tr>
<th>POLICY STATEMENT</th>
<th>BEFORE</th>
<th>AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hematopoietic Cell Transplantation for Acute Myeloid Leukemia 8.01.26</strong></td>
<td><strong>Policy Statement:</strong> Allogeneic hematopoietic cell transplantation (HCT) using a myeloablative conditioning regimen may be considered <strong>medically necessary</strong> to treat any of the following conditions:</td>
<td><strong>Policy Statement:</strong> Allogeneic hematopoietic cell transplantation (HCT) using a myeloablative conditioning regimen may be considered <strong>medically necessary</strong> to treat any of the following conditions:</td>
</tr>
<tr>
<td></td>
<td>• Poor- to intermediate-risk acute myeloid leukemia (AML) in first complete remission (CR1) (see Policy Guidelines section for information on risk stratification)</td>
<td>I. Poor- to intermediate-risk acute myeloid leukemia (AML) in first complete remission (CR1) (see Policy Guidelines section for information on risk stratification)</td>
</tr>
<tr>
<td></td>
<td>• AML that is refractory to standard induction chemotherapy but can be brought into CR with intensified induction chemotherapy</td>
<td>II. AML that is refractory to standard induction chemotherapy but can be brought into CR with intensified induction chemotherapy</td>
</tr>
<tr>
<td></td>
<td>• AML that relapses following chemotherapy-induced CR1 but can be brought into CR2 or beyond with intensified induction chemotherapy</td>
<td>III. AML that relapses following chemotherapy-induced CR1 but can be brought into CR2 or beyond with intensified induction chemotherapy</td>
</tr>
<tr>
<td></td>
<td>• AML in patients who have relapsed following a prior autologous HCT, but can be brought into CR with intensified induction chemotherapy and are medically able to tolerate the procedure</td>
<td>IV. AML in patients who have relapsed following a prior autologous HCT, but can be brought into CR with intensified induction chemotherapy and are medically able to tolerate the procedure</td>
</tr>
</tbody>
</table>

Allogeneic HCT using a reduced-intensity conditioning regimen may be considered **medically necessary** as a treatment of AML in patients who are in complete marrow and extramedullary remission (CR1 or beyond), and who for medical reasons would be unable to tolerate a myeloablative conditioning regimen (see Policy Guidelines section).

Autologous HCT may be considered **medically necessary** to treat AML in CR1 or beyond, or relapsed AML, if responsive to intensified induction chemotherapy in patients who are not candidates for allogeneic HCT.

Allogeneic and autologous HCT are considered **investigational** in patients not meeting any of the above criteria.

**The transplantation of Hepatitis C Virus (HCV)-viremic solid organs (kidney, lung, heart, liver, small bowel, pancreas) to a HCV non-viremic patient.**
<table>
<thead>
<tr>
<th>POLICY STATEMENT</th>
<th>BEFORE</th>
<th>AFTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>(No changes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>recipient with a plan to use direct-acting antiviral treatment for HCV is considered <strong>investigational.</strong></td>
<td>recipient with a plan to use direct-acting antiviral treatment for HCV is considered <strong>investigational.</strong></td>
<td></td>
</tr>
</tbody>
</table>