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REVIEW ARTICLE

Summary of the Highlights of 2019 ASTCT Meeting by iNDUS BMT Group at Chennai, India

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Abstract This article summarises the main highlights of the abstracts presented at the annual meeting of American Society of Transplantation and Cellular Therapy (ASTCT). The highlights of ASTCT meeting were organised by iNDUS BMT group in Chennai, India. The purpose of the highlight meeting was to educate the students about the latest research in the field of hematopoietic stem cell transplantation and its applicability for the developing country perspective.

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Introduction

The Transplantation and Cellular Therapy Meetings (formerly the BMT Tandem Meetings) are the combined annual meetings of the American Society of Blood and Marrow Transplantation (ASBMT) and the Center for International Blood and Marrow Transplant Research (CIBMTR). This year the meeting was held from February 20–24, in Houston, Texas, USA, and the abstracts were published in the Biology of Blood and Marrow Transplantation journal [1].

The iNDUS BMT Group was founded in 2013 at the Tandem BMT meeting in Salt Lake City, Utah, USA [2]. It includes blood and bone marrow transplantation (BMT) and cellular therapy (CT) experts of Indian and South Asian origin who practice in India, USA, Australia, Middle East and other regions. The Group is focused at learning from each other and contributes towards educational, training and charitable activities.

From 2018, iNDUS BMT group is conducting highlights of the tandem meeting in India. The first meeting was held in April 2018 at Delhi. The second meeting was held from 5 to 7th April, 2019 at Chennai.

Through this manuscript, we would like to create awareness about this group as well as summarize the main findings discussed during the meeting for the benefit of students, fellows and faculty interested in the field of stem cell transplantation.

AML and MDS

Allogeneic stem cell transplantation (allo-SCT) is the standard of care for intermediate to high-risk AML and MDS patients. Over last four decades, the treatment related mortality (TRM) has decreased from close to 40% to near 20% at the 1-year time point. However, during this time-period, the relapse rate has not decreased but has in fact increased, in part due to allo-SCT being offered to patients with more advanced disease and use of reduced intensity conditioning (RIC) regimens [3]. The goal of allo-SCT is to work towards a treatment strategy with low TRM without an increase in the risk of relapse. The broad strategies taken to achieve this objective were covered at the TCT 2019 meeting under the following broad headings (1) Improved/novel conditioning regimens (2) Better strategies to prognosticate (3) Possible role of post-transplant maintenance therapy.

Towards improving conditioning regimens, there was a large multi-center Phase III study from Europe that compared the use of treosulfan in place of busulfan in the setting of a RIC conditioning regimen for older patients and those not eligible to receive a full myelo-ablative conditioning regimen which clearly established the statistically significant advantage of the treosulfan based regimen on event free survival (EFS) and overall survival (OS) [4]. Another relatively novel approach was the use of time sequential conditioning regimens with targeted dose busulfan and post-transplant cyclophoshamide graft versus host disease (GVHD) prophylaxis, building on the earlier experience by this group with this regimen [5]. They demonstrated a low non relapse mortality (NRM) and an impressive 73% 1 year survival in a group of high risk and older patients. There have also been efforts to use various antibody based therapies in conditioning regimens, one such successful in-vivo mouse model was presented using conjugated anti-CD45-saporin (CD45-SAP) in an allogeneic minor mismatch transplant model (Balb/c donor into DBA/2 recipients) [6].

Finally, the discussion was on the role of maintenance therapy post-transplant as a strategy to improve outcomes. Early promise with phase II single center studies have not been replicated in phase III studies as in the case of the phase III study with azacytidine maintenance presented at ASH 2018 [7]. At TCT 2019 the Phase II RCT with midostaurin (RADIUS study) was presented. The therapy was well tolerated and the HR for relapse free survival was 0.46 [0.12–1.86] though this did not achieve statistically significant difference [8]. The difficulties in doing studies to demonstrate benefit of post-transplant maintenance therapy was highlighted.

Myeloma

Multiple myeloma (MM) is an incurable illness and constitutes 2% of all malignancies. The diagnostic criteria were revised in 2014 and besides the classic CRAB (Hypercalcemia, Renal failure, Anemia and bone lesions), presence of SliM (more than 60% plasma cells in bone marrow, light chain ratio of more than 100 and more than one lytic area on MRI) have been added to define active MM requiring treatment. After making the diagnosis of active MM, patients are classified into transplant eligible and ineligible. The standard induction regimen consists of triple drug combination consisting of proteasome inhibitor, immunomodulator and dexamethasone. The stem cell collection and quality are not known with newer induction regimens like KRd (Carfilzomib, lenalidomide and dexamethasone). The study by Bal et al. [9] presented at TCT meeting showed that KRd induces deeper clinical responses and greater stem cell graft purity than VRd (Bortezomib, lenalidomide and dexamethasone) without compromising stem cell yield or post-transplant engraftment kinetics, despite decreased viable CD34+ content of autografts and lower total stem cell collection. Another abstract by Srour et al. showed that melphalan 140 mg/m^2 can be used as conditioning regimen for patients who have VGPR or more response to induction regimen with similar progression free survival (PFS) and OS as compared to melphalan 200 mg/m^2. However, for patients in SD and PR, melphalan 200 mg/m^2 remains as the standard conditioning regimen prior to autologous SCT [10]. Another study by Morgan et al. showed that ixazomib once a week can be used as maintenance therapy post autologous stem cell transplantation with PFS benefit as compared to placebo. This is useful maintenance therapy specially for patients with intolerance to lenalidomide [11]. Crees et al. [12] showed the efficacy of a newer CXCR4 antagonist BL-8040 in mobilizing stem cells for autologous stem cell transplantation (ASCT). Another study by Pai et al. showed that generic melphalan is as good as innovator brand in terms of onset and severity of mucositis, day to neutrophil and platelet engraftment, as well as response status on day 100 post ASCT between patients receiving generic or innovator formulations of melphalan. Additionally, neither melphalan AUC nor clearance was significantly associated with response, relapse or toxicity. The study suggests that the PK and efficacy of the generic melphalan is comparable to the innovator formulation [13]. Another abstract showed that carfilzomib added to melphalan in the conditioning regimen is safe and feasible. Similarly another trial by Gandhi et al. [14] showed that intensive conditioning regimen with busulphan and melphalan was effective in patients achieving SD/PR prior to ASCT.

Lymphoma

Hematopoietic stem cell transplantation (HSCT) is an important component of the management of second or third relapse of Hodgkin Lymphoma (HL). There is, however, lack of a clear understanding of the exact place of allo-SCT in the management of second or later relapse of HL. Additionally, there is no consensus on the eligibility criteria, age or the conditioning regimens for allo-SCT in this situation. As the current EBMT Lymphoma database shows, the use of allo-SCT in relapse/refractory Hodgkin Lymphoma has been declining over last few years. This is because of availability of newer drugs, believed to be effective enough to improve the outcome in these patients with much less morbidity and mortality. The foremost amongst these is brentuximab vedotin (BV). It has shown a very impressive progression free survival in these high-risk patients. BV has also been shown to improve survival rates, when combined with various salvage protocols before proceeding with auto-SCT including Augmented ICE [90% PFS, 95% OS], or ESHAP [70% PFS, 90% OS], or bendamustine alone [70% PFS, 95% OS] [15]. The programmed cell death protein1 (PD-1) checkpoint inhibitors have further enriched the armamentarium against relapsed/refractory HL. Hodgkin Reid Sternberg (HRS) cells express high levels of PDL-2. Also, anti-PD1 antibodies are effective in HL patients post-transplant who relapse after or failed BV. The checkpoint inhibitors, thus have become an essential part of therapy in relapse/refractory patients [15]. It has been shown recently that allo-SCT can be safely performed in patients after checkpoint inhibitors therapy to improve the survival rates [16]. Both pembolizumab and nivolumab have shown improved survivals after allo-SCT. There is higher incidence of febrile syndrome due to cytokines release syndrome (CRS), but this responds well to tocilizumab. There are a number of complications that can occur post-transplant when nivolunab is used post-transplant. These include, nivolunab induced CRS and GVHD (acute and chronic). Even though such post-transplant events affect the post allo-SCT outcomes in the relapse/refractory HL patients, still the usage of BV and checkpoint inhibitors have allowed the relapsed/refractory HL patients to undergo allo-SCT which is the only potentially curative option in these patients [15, 16].

Haploidentical Transplants

Haploidentical transplants particularly in malignant haematological disorders have been increasingly and sometime preferentially chosen in patients who need a transplant lacking matched family donor and need transplant urgently. The TCT meeting focused on T-cell replete haploidentical transplant using Johns Hopkins protocol as a viable alternate donor [1]. Experts in the field discussed about timeline, donor selection, conditioning regimens, complications and outcomes. The major highlights can be summarized as follows. The timeline for selecting haplo donors seem to be slightly longer in US likely due to haplo donors being chosen after a failed unrelated donor search. The outcomes are better with younger donors for older patients but others like degree of match beyond haplo doesn't seem to affect outcomes. Older female donors seem to have worse outcomes. The major ABO mismatch has higher incidence of poor engraftment and graft failure. KIR mismatch likely helps in graft versus leukemia effect. The donor specific antibodies are treated with pre-transplant plasma exchange and rituximab. The bone marrow stem cell source appear to have lesser aGVHD but increasing use of peripheral blood stem cell have shown no significant additional risk. The myeloablative conditioning regimens are preferred but reduced intensity conditioning regimens with or without TBI seems to have reasonable outcomes in older patients. Viral reactivations in particular BK-JC virus induced haematuria appear to be a serious issue. The outcomes for T-cell replete haploidentical transplant with post-transplant cyclophosphamide and Chinese experience with pre-transplant high dose ATG seems comparable with matched unrelated donor transplants. The ongoing clinical trials with post-transplant cyclophosphamide in matched sibling and matched unrelated donors may offer alternate immune suppression post-transplant [1].

Acute GVHD

GVHD results from the damage caused to the host epithelial cell targets by the many immune cells and inflammatory cytokines. The primary mortality from GVHD results from its impact on the gastrointestinal (GI) tissues. While significant progress is being made in understanding the complex role of various immune cells in causing GVHD, little is known about the role played by the target tissues themselves in regulating the severity of disease. Specifically, induction of host intestinal epithelial cell (IEC) apoptosis by the alloreactive donor T cells and inflammatory cytokines causes GI GVHD; but the IEC intrinsic resilience mechanisms against allo-immune T-cell mediated damage, the epigenetic mechanisms that are critical for these mechanisms, and their regulation by the tissue resident microflora generated metabolites remains poorly understood. IEC homeostasis and resistance depends on complex interactions between the metabolic energy substrates (such as short chain fatty acids and amino

acid metabolites) and the regulation of transcription and epigenetic chromatin modifications such as histone acetylation. The significant alterations in substrates that are derived from microbial metabolites, specifically the essential short chain fatty acids (SCFA) such as butyrate and its impact on the resilience of GI tract against allo-T cell mediated damage were presented. The mechanisms of butyrate mediated GI effects in GVHD, specifically the role of surface GPCR receptors were addressed. Lastly, clinical strategies, through simple dietary modifications were presented, which were developed from the presented experimental data.

There is an increasing influence of the gut microbiome on GVHD [17]. Studies have revealed that the intestinal microbiota is significantly altered in patients with GVHD and the alterations correlate with GVHD severity and pathogenesis. Nevertheless, the direct causality of the changes in the host microbiota on GVHD severity is unclear. More relevantly, whether changes in the microbiota result in alterations in levels of microbial metabolites and by-products that have biological impact on allo-SCT remain unknown. Microbial metabolites such as short chain fatty acids (SCFA) are exclusively derived from the GI microbiota and are not made by the host. Some of these fatty acids (FAs), specifically the histone deacetylase inhibitor (HDACi) butyrate, is a preferred energy source for intestinal epithelial cells (IECs) and administration of exogenous HDACi regulates GVHD. But the impact that host indigenous microbial metabolites that function as HDACi have on GVHD remains unknown.

In their lab, Reddy et al. performed unbiased profiling of the microbial metabolome with a specific focus on targeted FAs after experimental allo-SCT. They found that only one SCFA, namely butyrate was significantly reduced in the intestinal tissue of allo-SCT recipients resulting in decreased acetylation of histone H4 within IECs. Increasing intestinal butyrate restored acetylation of histone H4, protected IECs, and decreased the severity of GVHD. Furthermore, rationally altering host GI microbiota to high butyrate producers mitigated GVHD.

This opens up another area in the field of GVHD treatment for us to consider, which is supplementation of specific agents rather than blanket therapy like fecal transplants in the treatment of GVHD [17].

Chronic GVHD

Chronic graft versus host disease (cGVHD) is the major determinant of late non-relapse morbidity and mortality after allo-SCT. cGVHD has a variable incidence of 20–85%, which has increased in the past decade due to—peripheral blood stem cells as graft source, older donors, female donors (especially multiparous) and more use of mismatched/unrelated donors. cGVHD can be very challenging to treat and besides impacting morbidity and mortality, it also compromises quality of life, often in a severe fashion [18]. Pathophysiologically, autoreactive T cells and aberrant B cell activation, including active B-cell signaling pathways (BTK, SYK, JAK) have been proposed.

cGvHD has been traditionally defined as symptoms that persist or appear after 100 days since the time of transplantation. As the types of donor, stem cell sources and conditioning regimens have changed, even aGvHD can present later than 100 days and cGVHD is better defined by its distinct clinical manifestations rather than the time of onset alone. These clinical manifestations mimics autoimmune disorders and includes skin changes (scleroderma-like lesions, hyperpigmentation, hyperkeratosis, skin atrophy, ulcerations), tissue fibrosis and limitation of joint motility, fibrosis of exocrine glands ("sicca syndrome"), fibrosis of lungs and liver, increased susceptibility to infections, immune dysregulation and autoimmunity [19].

Indian Scenario

HSCT activity is rapidly increasing in India and presently there are 85 centres registered with the Indian stem cell transplant registry. With widening indications, refined techniques, and more availability of donors, this activity is likely to further increase.

In developing countries, the problem of GVHD is further compounded by logistic, political, social issues, and limited resources for its treatment. Also access to treatment modalities like extra-corporeal photophoresis (ECP) is very limited [20]. Hence, the treatment can be extremely challenging. Most patients, actually after 3 months of follow-up at the transplant centre, revert to their places of residence, where they are taken care of, by local healthcare professionals who lack expertise to diagnose and treat cGVHD. Therein, lies the problem, as there is paucity of healthcare professionals trained to follow up HSCT patients. Most of our patients do not have access or the resources for optimal management of cGVHD. Therefore, we need to set up a system for long-term follow-up of HSCT survivors and also have a structured approach to ensure early diagnosis and treatment for cGVHD following the NIH model [20]. To make this possible, we must generate awareness and also indicate health policy programs to achieve access and treatment for all patients with GVHD adopting a multi-speciality approach with setting up of multi-disciplinary clinics. This will improve their Quality of life and decrease morbidity and mortality. Lastly, multi-centric trials should be set up to address various issues of diagnosis and management of cGVHD.

Autoimmune Diseases

Autologous transplants are increasingly being carried out in the treatment of autoimmune disorders. Total number of transplant reported in EBMT are 3000 with multiple sclerosis as a leading indication followed by systemic sclerosis (SS) [21, 22]. There is a role of both non-myeloablative and myeloablative conditioning regimes. Non-myeloablative regimens are a shade better by TRM reduction in SCOT trial [21]. There is a need to do early transplant in SS and there are biomarkers available for predicting response after auto transplant in SS. There is also a clear role of auto transplant in refractory and progressive multiple sclerosis. The take away points were that there is learning curve for transplants in SS and transplants need to be done early to reduce TRM. In India, many more centres are needed to do transplants for autoimmune disorders.

Hemoglobinopathies

Recent advances in allo-SCT and gene therapy was discussed in the context of thalassemia and sickle cell disease at the meeting. Currently, allo-SCT is the only potentially practical curative treatment option with gene therapy picking up fast. It was discussed that risk class–based transplantation approach results in overall survival and thalassemia-free survival of 94% and 87%, 84% and 81%, and 70% and 58% in class 1, 2, and 3 thalassemia patients, respectively. Due to lack of awareness and being in resource poor setup, more than 50% of patients undergoing HSCT in India are of Pesaro Class III. With the availability of alternative donor including haplo-identical, cord blood transplant and matched unrelated donor many others are attaining cure. Various approaches for HSCT preparation and conditioning to reduce incidence of graft vs host disease, veno-occlusive disease and rejection, such as intravenous busulfan (with PK monitoring), new drugs like treosulfan, thiotepa, and fludarabine, as well as intensive transfusion-chelation regimen and pre-transplantation preparatory chemotherapy and stem cell manipulation by ex vivo TCR alpha–beta and CD19 depletion, were discussed. Even up to 80–90% OS and 60–70% TFS has been documented in recent haplo-identical transplants. de la Fuente et al. [23] showed addition of thiotepa and 200 cGy TBI to the backbone of John Hopkin's protocol can result in excellent outcomes of haplo-identical transplant in thalassemia major.

The study by Long et al. [24] demonstrated safe and successful mobilization of sickle cell carrier donors with GCSF and plerixafor. Use of lentiglobin gene therapy for patients with thalassemia and sickle cell disease were promising [25, 26]. Lentiglobin gene therapy for thalassemia was discussed which showed 8/10 with β+ and 2/8 with β0 patients became transfusion free. Veno-occlusive disease post-gene therapy in thalassemia patients remains an important side effect.

Primary Immune Deficiencies (PIDs)

Indian Scenario

In India the organizations supporting PID include the Indian Society for Primary Immune Deficiency (IPSID), Foundation for Primary Immunodeficiency Diseases (FPID), co-founded by Dr. Sudhir Gupta and Dr. Abha Gupta, USA to support education, early diagnosis, genetic counselling, therapy, and research in India and USA; Indian Patients society for Primary Immunodeficiency (IPSPI); Primary Immunodeficiency Patients Welfare society (PIDPWS). ICMR has set up two Centers for Advanced Research (CAR) for PIDs, one at PGIMER, Chandigarh in January and second at the National Institute of Immunohematology, Mumbai. As per the data of the Indian Stem Cell Registry, 214 PID transplants have been performed from 2012 to 2018.

The following paragraph summarises the main highlights of the meeting on PIDs. The major focus was on improving the outcome with haploidentical HSCT. One of the approach is alloanergization of donor T cells to rebuild immunity while limiting GVHD after haploidentical HSCT. Allo-anergized haploidentical bone marrow transplantation after ex vivo co-stimulatory blockade is in phase I/II studies. BPX-501 is an allogeneic product consisting of T cells modified to express the inducible caspase-9 (Ic9) safety switch and truncated CD19 to allow monitoring and expansion of CD3+ CD19+ T cells following HSCT. BPX-501 T cells provide broad virus and tumor specific immunity; the safety switch can promptly resolve GVHD following administration of rimiducid, which leads to dimerization and activation of Cas9 leading to cell apoptosis. Administration of BPX-501 cells following αβ T and B-cell depleted haplo HSCT was shown to be a highly effective transplant strategy [27].

A non-toxic approach to target and deplete HSC using humanized monoclonal antibody, AMG 191, that binds human CD117 (c-Kit) was presented. The concept is the use of a radiation and or chemotherapy free conditioning regimen to deplete HSC and open up the niche for new stem cells engraftment. Phase I data presented the proof of concept [28].

Another abstract looked at the excellent outcomes for pediatric non-malignant diseases using umbilical cord blood transplantation following myeloablative conditioning

without serotherapy—rapid engraftment, prompt functional immune-reconstitution, and a low incidence of GVHD, correction of immune or metabolic defect including adequate B cell function in SCID patients [29].

An EBMT Inborn Errors Working Party and Scetide Study showed that busulfan/fludarabine + thiotepa or treosulfan/fludarabine ± thiotepa based conditioning regimen for patients with Wiskott-Aldrich Syndrome-HSCT with either BuFlu + TT or TreoFlu+TT conditioning reliably cures almost 90% of patients with WAS [30].

Pediatric Diseases

The key messages from the talks on pediatric transplant are summarized below. Chronic Granulomatous Disease (CGD) has good outcomes as per EBMT registry data. A retrospective study by Inborn Error Working Party of EBMT of 600 children with CGD post BMT from 101 centres has reported 87% OS and 78% EFS. Emapalumab (interferon gamma blocking antibody) can help quickly control hemophagocytic lympho-histiocytosis (HLH) in children. It's a useful bridge to BMT in HLH [31]. For inherited bone marrow failure, dyskeratosis congenita (DC), TBI and alkylating agent free conditioning (alemtuzumab/fludarabine) are feasible and successful. A total 18 children out of 20 are alive at median follow up of 24 months. This may impact on sequelae of BMT/late effects [32]. Effective lentivirus based gene therapy for X-linked CGD is curative. A total 7 out of 9 children are alive and 6 are disease free post gene therapy [33]. In conference sessions on improving conditioning and having predictable outcomes; it was highlighted that rabbit-ATG pharmacokinetics is important to have better outcomes (CD4 count > 50 within 100 days gives protection against viral reactivations) whilst alemtuzumab pharmacokinetics play an important role in BMT (high levels lead to infection and mixed chimerism and low levels lead to GVHD).

Supportive Care

The session on Supportive care and Survivorship was presented by Dr. Linda Burns, from the National Marrow Donor Program/CIBMTR, Minneapolis, USA. She highlighted the benefit of good supportive and palliative care plan that improve the quality of life of patients undergoing HSCT. The management of the transplant patient with sickle cell disease through an interdisciplinary team approach improved post-transplant outcomes [34]. Similarly, early engagement of palliative care team in HSCT lead to decreased transfer to ICU and better quality of life [35]. The older patients benefited more with the early involvement of palliative care team [36]. The World Health Organisation, EBMT and other bodies recommend palliative care for all patients undergoing HSCT. HSCT patients continue to experience a high burden of symptoms even at 1 year—with persistent or even new symptoms occurring. A survivorship clinic can capture patient-reported outcomes to better measure health status and late effects [37]. Many patients develop chronic health problems following HSCT and find difficulty in going back to work. There is a need to develop guidelines and supportive care for these individuals [38].

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict interest.

Ethical Standard The article complies with the ethical standards by declaration of Helsinki.

References

1. https://www.bbmt.org/issue/S1083-8791(18)X0014-7
2. https://www.indusbmt.org/. Accessed 3 May 2019
3. Horowitz M, Schreiber H, Elder A et al (2018) Epidemiology and biology of relapse after stem cell transplantation. Bone Marrow Transplant 53:1379–1389
4. Beelen D et al (2019) Final evaluation of a clinical phase III trial comparing treosulfan to busulfan-based conditioning therapy prior to allogeneic hematopoietic stem cell transplantation of adult acute myeloid leukemia and myelodysplastic syndrome patients ineligible to standard myeloablative regimens. Biol Blood Marrow Transplant 25:S3
5. Popat UR, Mehta RS, Bassett R et al (2018) Fludarabine with a higher versus lower dose of myeloablative timed-sequential busulfan in older patients and patients with comorbidities: an open-label, non-stratified, randomised phase 2 trial. Lancet Haematol 5:e532–e542
6. Hyzy SL et al (2019) CD45-targeted antibody drug conjugate plus post transplant cytoxan is sufficient to enable allogeneic bone marrow transplant in a minor mismatch mouse model. Biol Blood Marrow Transplant 25:S188–S189
7. Oran B, de Lima M, Garcia-Manero G, Thall PF, Lin R, Alousi AM, Hosing C, Kebriaei P, Popat U, Giralt S, Ahmed S, Shpall EJ, Andersson BS, Bashir Q, Ciurea SO, Rezvani K, Woodworth G, Champlin RE (2018) Maintenance with 5-azacytidine for acute myeloid leukemia and myelodysplastic syndrome patients. Blood 132(Suppl 1):971
8. Maziarz RT et al (2019) Radius: midostaurin [mido] plus standard of care [SOC] after allogeneic stem cell transplant [alloSCT] in patients [pts] with FLT3-internal tandem duplication [ITD]-mutated acute myeloid leukemia [AML]. Biol Blood Marrow Transplant 25:S11–S12
9. Bal S et al (2019) Stem cell mobilization and autograft purity with novel induction regimens in multiple myeloma. Biol Blood Marrow Transplant 25:S22–S23

10. Srour SA et al (2019) Melphalan dose intensity for autologous stem cell transplantation [ASCT] in multiple myeloma. Biol Blood Marrow Transplant 25:S21
11. Morgan G et al (2019) Maintenance therapy with the oral proteasome inhibitor [PI] ixazomib significantly prolongs progression-free survival [PFS] following autologous stem cell transplantation [ASCT] in patients with newly diagnosed multiple myeloma [NDMM]: phase 3 tourmaline-MM3 trial. Biol Blood Marrow Transplant 25:S19–S20
12. Crees ZD et al (2019) Genesis—a phase III randomized double-blind, placebo-controlled, multi-center trial evaluating the safety and efficacy of BL-8040 and G-CSF in mobilization of hematopoietic stem cells for autologous transplantation in multiple myeloma—lead-in period results. Biol Blood Marrow Transplant 25:S308–S309
13. Pai AA et al (2019) Pharmacokinetics and efficacy of generic melphalan is comparable to innovator formulation in patients with multiple myeloma undergoing autologous stem cell transplantation. Biol Blood Marrow Transplant 25:S196
14. Gandhi A et al (2019) Dose-intense BCNU/melphalan regimen followed by autologous hematopoietic cell transplantation [AHCT] results in prolonged PFS in myeloma patients. Biol Blood Marrow Transplant 25:S395–S396
15. Mina AA, Vakkalagadda C, Pro B (2019) Novel therapies and approaches to relapsed/refractory HL beyond chemotherapy. Cancers 11:421
16. Herbaux C, Merryman R, Devine S, Armand P, Houot R, Morschhauser F, Haverkos B (2018) Recommendations for managing PD-1 blockade in the context of allogeneic HCT in Hodgkin lymphoma: taming a necessary evil. Blood 132:9–16
17. Toubai T, Fujiwara H, Rossi C et al (2019) Host NLRP6 exacerbates graft-versus-host disease independent of gut microbial composition. Nat Microbiol 4:800–812
18. Moreno DF, Cid J (2019) Graft-versus-host disease. Med Clin (Barc) 152:22–28
19. Sarantopoulos S, Cardones AR, Sullivan KM (2019) How we treat refractory chronic graft-versus-host disease. Blood 133:1191–1200
20. Saleem MS, Aljurf M, Srivastava A, Shamsi T, Lu PH, Hamidieh AA, El Haddad A, Hashmi SK (2019) Challenges in managing graft-versus-host disease in developing countries: a perspective. Bone Marrow Transplant 54:641–647
21. Sullivan KM et al (2019) Systemic sclerosis as an indication for autologous hematopoietic cell transplantation: position statement from the american society for blood and marrow transplantation. Biol Blood Marrow Transplant 24:1961–1964
22. Sullivan KM, Goldmuntz EA, Keyes-Elstein L et al (2018) SCOT study investigators. Myeloablative autologous stem-cell transplantation for severe scleroderma. N Engl J Med 378(4):35–47.
23. de la Fuente J et al (2019) Augmenting non-myeloablative BMT with Ptcy using thiotepa or 400 Cgy TBI improves engraftment in patients with transfusion dependent thalassemia: results of a haploidentical transplant consortium for hemoglobinopathies [ICHH]. Biol Blood Marrow Transplant 25:S310–S311
24. Long BG et al (2019) Assessment of safety and efficacy of PBSC mobilization with G-CSF and CD34+ enrichment and Pbmnc [CD3+] addback in familial haploidentical [FHI] adult donors with sickle cell disease trait [SCDT] prior to allogeneic HSCT of high-risk SCD patients. Biol Blood Marrow Transplant 25:S310
25. Anurathapan U et al (2019) Lentiglobin gene therapy for transfusion-dependent β-thalassemia: outcomes from the phase 1/2 Northstar and phase 3 Northstar-2 studies. Biol Blood Marrow Transplant 25:S66–S67
26. Mapara MY et al (2019) Lentiglobin gene therapy in patients with sickle cell disease: updated interim results from Hgb-206. Biol Blood Marrow Transplant 25:S64–S65
27. Galaverna F et al (2019) Administration of BPX-501 cells following Aβ T and B-cell-depleted HLA-haploidentical HSCT [haplo-HSCT] in children with malignant or non-malignant disorders. Biol Blood Marrow Transplant 25:S13–S14
28. Agarwal R et al (2019) Toxicity-free hematopoietic stem cell engraftment achieved with anti-CD117 monoclonal antibody conditioning. Biol Blood Marrow Transplant 25:S92
29. Aguayo-Hiraldo PI et al (2019) Outcomes of umbilical cord transplant [UCBT] conditioned without serotherapy for pediatric malignant and non-malignant diseases: Texas Children's Hospital experience. Biol Blood Marrow Transplant 25:S429
30. Albert MH et al (2019) Busulfan/fludarabine- or treosulfan/fludarabine-based conditioning regimen for patients with Wiskott-Aldrich syndrome—an EBMT inborn errors working party and Scetide study. Biol Blood Marrow Transplant 25:S16
31. https://tct.confex.com/tct/2019/meetingapp.cgi/Paper/13801. Accessed 3 May 2019
32. https://tct.confex.com/tct/2019/meetingapp.cgi/Paper/13761. Accessed 3 May 2019
33. https://tct.confex.com/tct/2019/meetingapp.cgi/Paper/13690. Accessed 3 May 2019
34. Oko-Odoi A (2019) Managing the psychosocial complexities of sickle cell disease with multiple comorbidities during allogeneic hematopoietic stem cell transplantation with supportive nursing care. Biol Blood Marrow Transplant 25:S435
35. Vogel C et al (2019) End-of-life aspects in a hematopoietic stem cell transplantation unit: the integration of palliative care group in the transplant process. Biol Blood Marrow Transplant 25:S430
36. Lin RJ et al (2019) Characteristics of peri-transplant palliative supportive care consultation among older allogeneic hematopoietic cell transplant recipients. Biol Blood Marrow Transplant 25:S134
37. Ferraro CS et al (2019) Patient reported review of symptoms in survivorship clinic. Biol Blood Marrow Transplant 25:S271
38. Salit RB, Lee SJ, Burns LJ, Shaw BE, Nakano C, Majhail NS, Bhatt NS, Wood WA, Syrjala KL (2019) Guidelines and support for return to work after hematopoietic cell transplantation. Biol Blood Marrow Transplant 25(3):S376–S377