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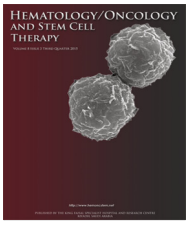

Hematopoietic cell transplantation: Training challenges and potential opportunities through networking and integration of modern technologies to the practice setting

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Abstract
Hematopoietic cell transplantation (HCT), particularly allogeneic HCT, is a complex and a high-risk procedure requiring expertise to manage potential treatment complications. Published data supports the value of quality management systems in improving post-transplant outcomes; however, there are no universally established, or agreed upon, criteria to assess adequacy of training of physicians, transplant or nontransplant, and supporting staff, among others. It is of paramount importance for transplant centers to identify the needed area(s) of expertise in order to seek appropriate training for their staff. Moreover, transplant physicians need to keep up-to-date with the rapidly occurring advances in the field. Outcomes of patients undergoing HCT are affected by various factors related to patient, disease, procedure, preventative, and supportive strategies, among others. Accordingly, availability of databases is necessary to collect information on these variables and use to benchmark future prospective clinical trials aiming at further improving clinical outcomes. Twinning with leading centers worldwide is helping to not only bridge the survival gap of patients diagnosed with cancer in the developing vis-à-vis the developed world, but eventually closing it. The advent of the World Wide Web and revolution in telecommunication has made access to information more readily available to various sectors including healthcare. Telemedicine is enabling healthcare delivery to remote and underserved geographic areas. In the setting of HCT, ensuring compliance to

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prescribed therapies and post-transplant surveillance are some areas where implementing telemedicine programs could fulfill an unmet need.

Introduction

Despite increasing availability of smart antineoplastic therapies in recent years, hematopoietic cell transplantation (HCT) remains an optimal treatment modality for various hematologic malignancies [1–3]. High-dose chemotherapy and autologous HCT (auto-HCT) are potentially curative in certain types of relapsed chemosensitive lymphomas and have improved outcomes of other subtypes when offered as frontline consolidation [4–7]. Availability of tools to prognosticate the significance of existing comorbidities (and their severity) on post-transplant outcomes has helped liberalize prior empirically established cutoffs which were used to disqualify patients from receiving the procedure, based merely on age [8]. This is also the case for allogeneic HCT (allo-HCT) which represents the only possibility of cure for a variety of hematologic malignancies and some benign blood disorders [9]. The curative potential of auto-HCT is primarily derived from administering myeloablative doses of chemotherapy or chemoradiotherapy resulting in organ toxicity and infectious complications, among others. In the case of allo-HCT, risks associated with the procedure emanate from a variety of causes including host immune suppression, alloreactivity of donor effector cells, chemotherapy and/or radiotherapy toxicity, untoward effects of therapies used for prevention of acute graft-versus-host disease, and potential side effects of other supportive therapies. This is further complicated by the possibility of resurgence of serious, and even lethal, opportunistic infections at times requiring preemptive therapeutic interventions [10,11]. Hence, HCT, particularly allo-HCT, is a complex and high-risk procedure which requires a level of expertise to manage potential treatment complications.

Implementation of quality management systems (QMS), originally developed by the Foundation for the Accreditation of Cellular Therapy in the United States, and expanded to different parts of the world by the Joint Accreditation Committee-ISCT and European Society for Blood and Marrow Transplantation (EBMT), aims at establishing a threshold for excellence in cellular therapy including HCT [12]. The presence of QMS is of particular importance in allo-HCT owing to the complex interplay of different subspecialties needed to cover the various facets of the procedure ranging from search and identification of suitable donors, assessing patient eligibility, hematopoietic cell procurement and processing, administration of chemotherapy and/or radiotherapy, and management of peri- and postallograft complications. While published data supports the value of QMS in improving post-transplant outcomes [13,14], there are no universally established, or agreed upon, criteria to assess adequacy of training of physicians, transplant or nontransplant, and supporting staff, among others.

Technologic advances through availability of the World Wide Web has resulted in increased and easy access to essential information needed to optimize care of patients with cancer, including recipients of HCT. Telemedicine is already a reality and is certainly helping facilitate the management and care of patients, including those living in remote rural areas, by means of telecommunication technology [15].

In the following sections we evaluate ways to pursue training and gain experience in the care of HCT patients. We also explore the immense potential of integrating telemedicine to enhance not only physician–patient but also physician–physician and center–center interactions aimed at improving quality of care and also advancing the field.

Training and experience

Data from the Center for International Bone Marrow Transplant Research (CIBMTR) shows a continuous increase in the number of autologous and allogeneic HCT procedures performed over the past 20 years [16]. Moreover, availability of better supportive therapies and specific tools to prognosticate the adverse impact of existing comorbidities are allowing expanding the procedure, auto-HCT, and more so allo-HCT, to patients who were deemed ineligible in the past. Specifically to allo-HCT, emergence of reduced-intensity conditioning and nonmyeloablative conditioning has also increased the number of allo-HCT recipients older than 60 years. This has definitely created a challenge to staff HCT programs with the needed number of adequately trained physicians and other supporting personnel. Gajewski et al. [17] described results of a study by the American Society for Blood and Marrow Transplantation, using membership records, showing a projected shortage of over 1300 new HCT physicians by the year 2020. Interestingly, approximately 60% of the current HCT physician workforce is $\geq$50 years of age [17].

This challenge is further compounded by development of novel approaches using mismatched related or unrelated donors, including haploidentical donors or cord blood, expansion of allo-HCT to other indications, and also an increased number of transplants performed in older patients [18–21]. A patient's age is a known risk factor for worse non-relapse mortality, hence requiring closer attention during the procedure [22]. These aforementioned situations may require additional expertise pertaining to selection of optimal cord blood unit(s), haploidentical donors, management of comorbidities and transplant-related complications in elder patients, and understanding the risks associated with existing organ impairment as is the case of iron overload in patients with thalassemia in need of allo-HCT as an example [23,24].

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