parison includes the larger groups of patients both in CR and VGPR, two groups that have had similar outcomes in previous studies of ABMT,[20] the 4-year PFS rate for the allogeneic is 27%, compared with 57% for the autologous BMT patients (P = .02). Using the Cox regression method, a 95% confidence interval for an event (relapse or death) after autologous BMT ranges from 26% to 102% of that for patients who received an allogeneic BMT. The risk of relapse after autologous BMT ranges from 25% to 122% of that for patients who received an allogeneic BMT. The estimated cumulative relapse rate 4 years post-BMT is 69% for allogeneic and 46% for autologous patients (P = .14) (Fig 3).

Sites of Relapse

Eleven patients relapsed in the allogeneic group a median of 12 months post-BMT and 15 relapsed in the autologous group a median of 13 months post-BMT. Sites of relapse are listed in Table 5. The relapse rate at the primary tumor site in the allogeneic group (toxic deaths excluded) was three of 16 patients at risk (19%), compared with eight of 33 in the autologous group (24%). The relapse rates in bone were 31% and 12%, respectively, for allogeneic and autologous, 31% and 9% in bone marrow, 0% and 3% in lung, and 25% and 9% were a mixture of other sites. There were three patients in the allogeneic group with detectable tumor in bone marrow just before BMT; they had 113, 162, and 326 tumor cells per 100,000 bone marrow cells by immunocytology, respectively. Of these, one had a toxic death and the other two both relapsed in bone marrow. Six of the autologous BMT patients had tumor detectable by immunocytology at the time of BMT, but all had less than 0.1% tumor cells. Of these, three had disease recurrence, including two in bone marrow and one in bone. The sites of relapse in the allogeneic group were four in both primary and distant sites, and seven in distant sites only. Sites in the autologous group included five primary alone, three primary and distant, and six distant only.

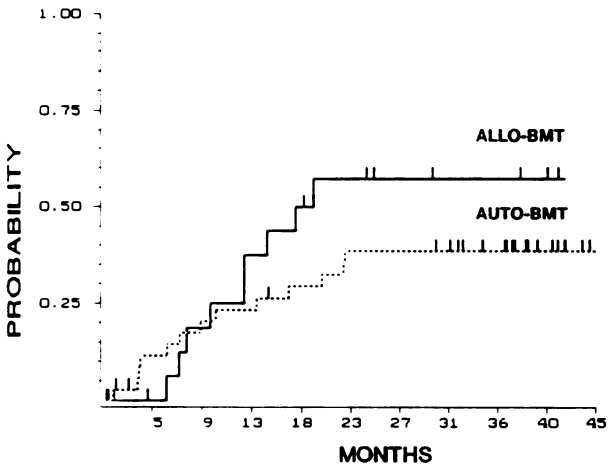

Fig 3. Estimated relapse rate after allogeneic v autologous purged BMT. Allogeneic group (——), n = 20; autologous group (- - -), n = 36. P = .14.

Table 5. Sites of Relapse After BMT

Site of Relapse	Allogeneic BMT	Autologous BMT
Primary	3	8
Bone	5	4
Bone marrow	5	3
Lung	0	1
CNS	0	1
Other	3	2
Unknown	1	0

DISCUSSION

Myeloablative therapy followed by BMT has been tested as an alternative to chemotherapy for patients with high-risk neuroblastoma. Allogeneic bone marrow has been used less frequently for BMT, because HLA-compatible sibling donors are available for only 20% of patients and because of concerns about increased toxicity due to GVHD and its prophylaxis. Previous reports of allogeneic BMT for neuroblastoma have been flawed by heterogeneity of patient population, often a mixture of patients before and after disease progression, and by a multiplicity of myeloablative pre-BMT conditioning regimens.[21-23] However, autologous bone marrow may contain neuroblastoma cells with the potential for growth after infusion, which raises the possibility that some relapses may be due to infusion of tumor cells. Thus, most studies have included treatments of autologous marrow ex vivo designed to remove tumor cells. To address these issues, we compared toxicity, engraftment, relapse rate, and PFS for patients receiving identical induction chemotherapy and undergoing autologous or allogeneic BMT after the same pretransplant myeloablative chemoradiotherapy.

The toxic death rate was greater with allogeneic BMT than with autologous BMT (20% v 8%), although this difference was not significant (P = .21). An even higher toxic death rate was reported in a previous CCG series, with six of 12 toxic deaths after allogeneic transplant for neuroblastoma, and a rate of 33% in the survey of 92 allogeneic transplants reported by Dini et al.[21,22] The percentage of grade 3 and 4 hepatic toxicity was also higher