

Preservation of adaptive immunity after nonmyeloablative hematopoietic cell transplantation in adults with sickle cell disease (PROTECT study)

Authors

Elisabeth Dovern,^{1,2*} Maud Zwolsman,^{1-3*} Abraham Goorhuis,^{2,4} Bart J. Biemond,^{1,2,5} Katja C. Wolthers⁶ and Erfan Nur^{1-3,5}

¹Department of Hematology, Amsterdam UMC, University of Amsterdam; ²Amsterdam Institute for Infection and Immunity, Amsterdam UMC; ³Department of Blood Cell Research, Sanquin Research and Landsteiner Laboratory; ⁴Department of Infectious Diseases, Amsterdam UMC; ⁵Cancer Center Amsterdam, Amsterdam UMC and ⁶Department of Medical Microbiology and Infection Prevention, Amsterdam UMC, Amsterdam, the Netherlands

**ED and MZ contributed equally as first authors.*

Correspondence:

E. NUR - e.nur@amsterdamumc.nl

<https://doi.org/10.3324/haematol.2026.300480>

Received: January 7, 2026.

Accepted: March 16, 2026.

Early view: March 26, 2026.

©2026 Ferrata Storti Foundation

Published under a CC BY-NC license



Supplementary material

Table S1. Pre-transplant treatment and transplantation indications

	MSD (n=24)	Haploidentical (n=14)
<i>Treatment before transplantation</i>		
Hydroxyurea, n(%)*	24 (100%)	5 (35.7%)
Azathioprine, n(%)*	24 (100%)	NA
Chronic red blood cell transfusion, n(%)	5 (20.8%)	6 (42.9%)
<i>Indication for transplantation**</i>		
Acute chest syndrome, n(%)	14 (58.3%)	9, (64.3%)
Vaso-occlusive episodes, n(%)	17 (70.8%)	12 (85.7%)
Stroke, n(%)	3 (12.5%)	2 (14.3%)
Pulmonary hypertension, n(%)	5 (20.8%)	4 (28.6%)
Avascular osteonecrosis, n(%)	9 (37.5%)	5 (35.7%)
Chronic kidney injury, n(%)	2 (8.3%)	2 (14.3%)
Iron overload, n(%)	3 (12.5%)	3 (21.4%)
Delayed hemolytic transfusion reaction, n(%)	1 (4.2%)	0 (0%)

*all patients planned for matched sibling donor (MSD) transplantation received hydroxyurea/azathioprine preconditioning therapy during 3 months prior to transplantation.

**the majority of patients had >1 indication for transplantation

Table S2. Revaccination schedule for all allogeneic hematopoietic cell transplantation recipients at Amsterdam University Medical Centers

Timepoint	Earliest administration after hematopoietic cell transplantation (HCT)	Vaccinations
Day 0	From 4-6 months after HCT	• PCV20 (1) (20-valent conjugated pneumococcal vaccine) • COVID-19 mRNA (1)
Month 1	From 5-7 months after HCT	• PCV20 (2) • COVID-19 mRNA (2) • Influenza (current season)
Month 2	From 6-8 months after HCT	• PCV20 (3) • COVID-19 mRNA (3)
Month 5	From 9-10 months after HCT	• COVID-19 mRNA (Booster)
Month 8	From 12-14 months after HCT	• PCV20 (4) • Vaxelis® (1) (Diphtheria, Pertussis, Tetanus, Poliomyelitis, <i>Haemophilus influenzae</i> type b, Hepatitis B) • Shingrix® (1) (recombinant <i>Varicella zoster</i> vaccine)
Month 9	From 13-15 months after HCT	• Vaxelis® (2) • Nimenrix® (1) (quadrivalent meningococcal A/C/W/Y vaccine) • Bexsero® (1) (meningococcal B vaccine)
Month 10	From 14-16 months after HCT	• Vaxelis® (3) • Shingrix® (2)
Year 1	From 16-18 months after HCT	• Bexsero® (2) • Nimenrix® (2)
Year 2	From 24 months after HCT (Only in case of negative titers at year 1)	• MMR (measles, mumps, rubella) (conditions for vaccination: no immunosuppression, no GvHD, and CD4 count > 200 x 10⁶/L) • PCV20 (5)

Table S3. Timing of hepatitis B virus vaccinations

Patient	1st dose (days)	2nd dose (days)	3d dose (days)
1*	-167	- 160	-138
2*	-170	-162	-140
3	-274	-247	-219
4*	-178	-171	-156
5	Previously vaccinated		
6	Previously vaccinated		
7	Previously vaccinated		
8*	-44	-37	-24
9	Previously vaccinated		
10	-58	-45	-24
11	Previously vaccinated		
12	Previously vaccinated		
C1	Previously vaccinated		
C2	0	+56	+84
C3	0	+29	+56
C4	0	+43	+70
C5	0	+28	+64
C6	0	+49	+77

For patients 1 to 12, date of transplantation is day 0. For control (C) patients 1 to 6, date of first vaccination is day 0.

*patients who received vaccinations in a super accelerated schedule.