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Таблица 4. *Примеры использования систем редактирования генома в клинической практике*

Table 4. *Examples of clinical uses of genome-editing systems*

NCT номер, название клинического исследования *NCT number, clinical trial title*	**Фаза исследования** *Phase*	**Заболевание** *Disease*	**Система редактирования** *Editing system*	**Препарат** *Product*	**Способ введения** *Administration route*	**Статус / Кол-во пациентов** *Trial status / Number of participants*	**Спонсор** *Sponsor*
NCT04819841, A Phase I/II Study of GPH101 in Autologous CD34⁺ Hematopoietic Stem Cells to Convert HbS to HbA for Treating Severe Sickle Cell Disease[1]	Фаза I–II *Phases I–II*	Серповидноклеточная анемия *Sickle cell disease*	CRISPR-Cas9	GPH101	Внутривенно *Intravenous*	Набор пациентов / 15 *Recruiting / 15*	Graphite Bio, Inc.
NCT04774536, Transplantation of Clustered Regularly Interspaced Short Palindromic Repeats Modified Haematopoietic Progenitor Stem Cells (CRISPR_SCD001) in Patients with Severe Sickle Cell Disease[2]	Фаза I–II *Phases I–II*			CRISPR_SCD001 ((3–20)×10⁶ CD34⁺ клеток/кг веса пациента) *CRISPR_SCD001 (3–20)×10⁶ CD34⁺ cells/kg of body weight)*		Набор не начался / 9 *Not yet recruiting / 9*	Mark Walters, MD
NCT03745287, A Phase 1/2/3 Study to Evaluate the Safety and Efficacy of a Single Dose of Autologous CRISPR-Cas9 Modified CD34⁺ Human Hematopoietic Stem and Progenitor Cells (CTX001) in Subjects With Severe Sickle Cell Disease [33, 39, 40]	Фаза I–III *Phases I–III*			CTX001		Активно, набора нет / 45 *Active, not recruiting / 45*	Vertex Pharmaceuticals Incorporated
NCT03545815, Phase I Study to Evaluate Treatment of CRISPR-Cas9-Mediated PD-1 and TCR Gene-Knocked Out Chimeric Antigen Receptor (CAR) T Cells in Patients with Mesothelin Positive Multiple Solid Tumors[3]	Фаза I *Phase I*	Мезотелин-положительные множественные солидные опухоли *Mesothelin-positive multiple solid tumours*		Антимезотелиновые CAR-T клетки *Anti-mesothelin CAR-T cells*		Набор пациентов / 10 *Recruiting / 10*	Chinese PLA General Hospital
NCT04037566, A Safety Study of Autologous T Cells Engineered to Target CD19 and CRISPR Gene Edited to Eliminate Endogenous HPK1 (XYF19 CAR-T Cells) for Relapsed or Refractory Haematopoietic Malignancies[4]	Фаза I *Phase I*	Рефрактерная/рецидивирующая CD19⁺ лейкемия *Refractory/relapsed acute lymphocytic leukaemia* В-клеточная лимфома *B-cell lymphoma*	CRISPR-Cas9	XYF19 CAR-T клетки, Циклофосфамид, флударабин *XYF19 CAR-T cells, cyclophosphamide, fludarabine*	Внутривенно *Intravenous*	Набор пациентов / 40 *Recruiting / 40*	Xijing Hospital, Xi'An Yufan Biotechnology Co., Ltd
NCT04426669, A Study of Metastatic Gastrointestinal Cancers Treated with Tumor-Infiltrating Lymphocytes in Which the Gene Encoding the Intracellular Immune Checkpoint CISH Is Inhibited Using CRISPR Genetic Engineering [41–43]	Фаза I–II *Phases I–II*	Рак желудочно-кишечного тракта *Gastrointestinal cancer*		Опухолепроникающие лимфоциты *Tumour-infiltrating lymphocytes*	Внутривенно *Intravenous*	Набор пациентов / 20 *Recruiting / 20*	Intima Bioscience, Inc.
NCT03226470, Study of Targeted Therapy Using Transcription Activator-Like Effector Nucleases in Cervical Precancerous Lesions [44]	Фаза I *Phase I*	Злокачественное новообразование, связанное с вирусом папилломы *Papillomavirus-related malignant neoplasm*	TALEN[5]	Плазмидный вектор T512 (500 мкг) *T512 plasmid vector (500 μg)*	Вагинально (суппозитории) *Vaginal (suppository)*	Набор пациентов / 40 *Recruiting / 40*	Huazhong University of Science and Technology
NCT03190278, Phase I, Open Label Dose-Escalation and Dose-Expansion Study to Evaluate the Safety, Expansion, Persistence, and Clinical Activity of UCART123 (Allogeneic Engineered T-cells Expressing Anti-CD123 Chimeric Antigen Receptor), Administered in Patients with Relapsed/Refractory Acute Myeloid Leukemia (AMELI-01)[6]	Фаза I *Phase I*	Рецидивирующий/рефрактерный острый миелоидный лейкоз *Relapsed/refractory acute myeloid leukaemia*		UCART123v1,2 (аллогенные Т-клетки, экспрессирующие анти-CD123 химерный антигенный рецептор) *UCART123v1,2 (allogeneic T-cells expressing anti-CD123 chimeric antigen receptor)*	Внутривенно *Intravenous*	Набор пациентов / 65 *Recruiting / 65*	Cellectis S.A.
NCT04150497, Open Label Dose-Escalation and Dose-Expansion Study to Evaluate the Safety, Expansion, Persistence and Clinical Activity of UCART22 (Allogeneic Engineered T-Cells Expressing Anti-CD22 Chimeric Antigen Receptor) in Patients with Relapsed or Refractory CD22⁺ B-Cell Acute Lymphoblastic Leukemia (BALLI-01)[7]	Фаза I *Phase I*	В-клеточный острый лимфобластный лейкоз *B-cell acute lymphoblastic leukaemia*		UCART22 (аллогенные Т-клетки, экспрессирующие анти-CD22 химерный антигенный рецептор) *UCART22 (allogeneic T-cells expressing anti-CD22 chimeric antigen receptor)*	Внутривенно *Intravenous*	Набор пациентов / 30 *Recruiting / 30*	Cellectis S.A.
NCT03617198, A Pilot Study of T Cells Genetically Modified by Zinc Finger Nucleases SB-728mR and CD4 Chimeric Antigen Receptor in HIV-Infected Subjects[8]	Фаза I *Phase I*	ВИЧ *HIV*	ZFN	CD4 CAR+CCR5 ZFN-модифицированные Т-клетки ((0,5–1)×10¹⁰ клеток) *CD4 CAR+CCR5 ZFN-modified T-cells ((0.5–1)×10¹⁰ cells)*	Внутривенно *Intravenous*	Активно, набора нет / 12 *Active, not recruiting / 12*	University of Pennsylvania
NCT02500849, A Pilot Study to Evaluate the Feasibility, Safety and Engraftment of Zinc Finger Nuclease (ZFN) CCR5 Modified CD34⁺ Hematopoietic Stem/Progenitor Cells (SB-728mR-HSPC) in HIV-1 (R5) Infected Patients [45]	Фаза I *Phase I*			SB-728mR-ГСК *SB-728mR-HSPC*	Внутривенно *Intravenous*	Активно, набора нет / 12 *Active, not recruiting / 12*	City of Hope Medical Center

Примечание. *CRISPR — короткие палиндромные повторы, регулярно расположенные группами; Cas9 — CRISPR-ассоциированный белок 9; TALEN — эффекторные нуклеазы, подобные активаторам транскрипции; ZFN — нуклеазы с цинковыми пальцами; CAR-T — химерные антигенные рецепторы Т-клеток; ВИЧ — вирус иммунодефицита человека; ГСК — гемопоэтические стволовые клетки.*
Note. *CRISPR, clustered regularly interspaced short palindromic repeats; Cas9, CRISPR-associated protein 9; TALEN, transcription activator-like effector nucleases; ZFN, zinc-finger nucleases; CAR-T, chimeric antigen receptor T-cells; HIV, human immunodeficiency virus; HSPC, haematopoietic stem and progenitor cells.*

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[1] Gene correction in autologous CD34⁺ hematopoietic stem cells (HbS to HbA) to treat severe sickle cell disease (CEDAR). https://clinicaltrials.gov/ct2/show/NCT04819841
[2] Transplantation of clustered regularly interspaced short palindromic repeats modified hematopoietic progenitor stem cells (CRISPR_SCD001) in patients with severe sickle cell disease. https://clinicaltrials.gov/ct2/show/NCT04774536
[3] Study of CRISPR-Cas9 mediated PD-1 and TCR gene-knocked out mesothelin-directed CAR-T cells in patients with mesothelin positive multiple solid tumors. https://clinicaltrials.gov/ct2/show/NCT03545815
[4] CRISPR (HPK1) edited CD19-specific CAR-T cells (XYF19 CAR-T cells) for CD19⁺ leukemia or lymphoma. https://clinicaltrials.gov/ct2/show/NCT04037566
[5] Cellectis SA. https://cellectis.com/products/manufacturing
[6] Study evaluating safety and efficacy of UCART123 in patients with relapsed/refractory acute myeloid leukemia (AMELI-01). https://clinicaltrials.gov/ct2/show/NCT03190278
[7] Phase 1 study of UCART22 in patients with relapsed or refractory CD22+ B-cell acute lymphoblastic leukemia (BALLI-01). https://clinicaltrials.gov/ct2/show/NCT04150497
[8] CD4 CAR+ ZFN-modified T cells in HIV therapy. https://clinicaltrials.gov/ct2/show/NCT03617198