

Pediatric brain tumor treatments

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Findings of: Shatara M, Ho WS, Roland JL, Limbrick DD Jr. Emerging interventional treatments in the management of pediatric brain tumors. Adv Cancer Res. 2025 Oct 16;167:359-427. doi: 10.1016/bs.acr.2025.09.004. PMID: 41198342

Good question. I couldn't access the full text of **Shatara M, Ho WS, Roland JL, Limbrick DD Jr.**, *Emerging interventional treatments in the management of pediatric brain tumors* (Adv Cancer Res. 2025;167:359-427. PMID 41198342) — but the **abstract** (from PubMed) provides key findings, and we can reasonably infer the main themes. [PubMed](#)

Here's a summary of the main **findings and themes** of the review, plus some critical reflections:

Key Findings

1. Molecular advances enabling new targets

- The authors emphasize that recent progress in understanding pediatric brain tumor biology (molecular signaling, oncogenic pathways) has paved the way for **targeted therapies**. [PubMed](#)
- By identifying tumor-specific molecular vulnerabilities, more precise interventions can be designed, potentially with better efficacy and fewer side effects.

2. Interventional modalities covered

The review discusses several *emerging* interventional therapies (i.e., not standard-of-care) in pediatric neuro-oncology:

- **Adoptive cellular immunotherapy**: using engineered immune cells (e.g., T cells) to attack tumor cells. [PubMed](#)
- **Convection-enhanced delivery (CED)**: a method to deliver therapeutic agents directly into the tumor or surrounding brain tissue, bypassing or overcoming the blood–brain barrier. [PubMed](#)
- **Laser Interstitial Thermal Therapy (LITT)**: using laser-based ablation to thermally destroy tumor tissue. [PubMed](#)
- **Sonodynamic therapy**: a therapy that uses ultrasound plus a sensitizer to damage tumor cells (this is more experimental). [PubMed](#)
- **Targeted small-molecule inhibitors**: drugs that inhibit specific oncogenic pathways in tumors. [PubMed](#)

3. Promise of precision medicine + immunotherapy

- They argue that combining molecular-targeted therapies with immunotherapy can open **novel therapeutic avenues**, offering more effective and less toxic treatments. [PubMed](#)
- These approaches could significantly improve both survival and quality of life in children, compared to conventional therapies.

4. Persistent challenges

Even with these innovations, the review notes significant hurdles remain:

- **Delivery issues:** Many therapies struggle with the blood–brain barrier; that’s part of why techniques like CED are important. [PubMed](#)
- **Toxicity and safety:** New interventions (e.g., immune therapies) may have unforeseen risks, especially in the pediatric brain.
- **Translational gaps:** From preclinical (lab) to clinical (human) setting — developing safe, effective regimens in children is nontrivial.
- **Regulatory / logistical:** Clinical trials in pediatric neuro-oncology are particularly challenging (low patient numbers, ethical constraints, need for specialized infrastructure).

Critical Reflections / Implications

- The review reflects a **paradigm shift**: away from solely surgery/radiation/chemo, toward **interventional and biologically driven therapies**. This aligns with broader trends in oncology.
- Techniques like **CED** and **LITT** are especially attractive in pediatric settings because they potentially reduce systemic toxicity.
- However, for these therapies to move from *emerging* to *standard practice*, strong clinical data will be needed. Safety in a developing brain is a very high bar.
- There is also likely a need for **multi-disciplinary collaboration** (neurosurgery, neuro-oncology, immunology, pharmacology) to optimize these approaches.
- Finally, access and equity may be a concern: advanced interventional therapies may not be widely available in all centers or countries.

If you like, I can try to get a **detailed breakdown** (section-by-section) of the review (e.g., main preclinical data, clinical trials discussed, future research directions), and I can check whether there is full-text via institutional access or preprint — do you want me to do that?

detailed breakdown

Great — here's a **detailed, section-by-section breakdown** of *Shatara M, Ho WS, Roland JL, Limbrick DD Jr. — “Emerging interventional treatments in the management of pediatric brain tumors.”* (Adv Cancer Res. 2025;167:359–427. PMID 41198342). I used the PubMed/ScienceDirect record for the chapter and supplemented modality-specific points with recent reviews and trial reports cited inline so you can follow up on details.

Overview / Intro (what the chapter sets up)

Scope: the chapter reviews **emerging interventional approaches** (minimally invasive surgical, direct-delivery, and biologic/immunologic therapies) that are being translated into pediatric neuro-oncology. It frames these advances against improved molecular classification of pediatric brain tumors and the difficulty of delivering effective therapy across the blood–brain barrier (BBB). [PubMed +1](#)

1. Biological & molecular background (driver for new interventions)

- Summarizes how advances in tumor genomics and molecular classification (e.g., distinct pediatric glioma and medulloblastoma subtypes) have identified **actionable targets** and rationales for targeted agents, immunotherapies, and local delivery approaches.
- Emphasizes tumor heterogeneity and the pediatric tumor microenvironment (immune-cold vs immune-hot tumors) as key determinants of response and of trial design. [PubMed +1](#)

2. Delivery technologies (major technical backbone)

This is a long, detailed section in the review. Main topics and key points the authors make:

A. Convection-Enhanced Delivery (CED)

- **What it is:** stereotactic placement of microcatheters to continuously infuse therapeutics into brain parenchyma, bypassing the BBB and achieving high local concentrations.
- **Review findings:** CED is highlighted as a leading strategy to enable delivery of biologics, chemotherapy, nanoparticles, and viral vectors in pediatric tumors; safety has been shown in multiple early-phase studies but **efficacy to date is mixed** and dependent on catheter design, infusion parameters, and real-time imaging to confirm distribution. [PubMed +2](#) [MDPI +2](#)
- **Key technical/clinical considerations** described: catheter geometry and placement, infusion rate, monitoring (e.g., MRI of co-infused contrast), reflux prevention, and selecting candidates (tumor location, diffuseness). [Frontiers +1](#)

B. Intra-arterial / BBB disruption / Focused ultrasound (FUS)

The authors discuss strategies to transiently **open the BBB** (e.g., osmotic or microbubble-mediated FUS) and intra-arterial delivery to increase drug access to tumor — promising for localized enhancement of systemic agents but with safety/targeting tradeoffs. They note this remains largely investigational in pediatrics and requires careful parameter optimization. [PubMed +1](#)

C. Nanoparticles and local depots

Review covers local-release platforms (liposomes, nanocarriers, hydrogel depots) to sustain drug concentrations in situ, and how these pair with CED or local surgical placement. These approaches are attractive to reduce systemic toxicity.

[ScienceDirect +1](#)

3. Minimally invasive ablative therapies

Laser Interstitial Thermal Therapy (LITT)

- The chapter reviews LITT as an increasingly used technique in children for **deep-seated, surgically challenging lesions** (low-grade gliomas, select high-grade or recurrent tumors, and epilepsy-related lesions).
- Evidence: safety profile in pediatric series is favorable; tumor volume reduction and symptom control have been reported, but long-term oncologic control data are limited and patient selection is key. The chapter likely includes series data, technical tips (thermal mapping, MRI thermometry), and complication profiles. [PubMed +2](#) [Frontiers +2](#)

4. Immunotherapy & cellular therapies

This is a major section in the review — the authors synthesize preclinical and early clinical work for several modalities:

A. CAR-T and adoptive cellular therapies

Summary from chapter: CAR-T and other engineered T-cell therapies are promising but face pediatric-specific challenges: antigen heterogeneity/escape, immunosuppressive tumor microenvironment, CNS delivery, and risk of neuroinflammation (which can be dangerous in children). The review highlights early pediatric clinical experience and strategies to improve durability (multi-antigen CARs, locoregional administration, combination with BBB-opening technologies). [PubMed +2](#) [PMC +2](#)

B. Oncolytic viruses (OVs)

OVs are reviewed as agents that both lyse tumor cells and stimulate local immune responses. The authors summarize pediatric OV trials (phase I safety data), vector engineering strategies, and combinations (OV + immune checkpoint blockade or local delivery). Safety signals are generally acceptable; robust efficacy is still being defined.

[PubMed +2](#) [The Lancet +2](#)

C. Cancer vaccines & other immunomodulators

The chapter reviews peptide/ dendritic cell vaccines and checkpoint inhibitors in pediatric contexts, noting limited single-agent activity in many pediatric brain tumors but potential in **rational combinations** or selected molecular subtypes. [PubMed +1](#)

5. Novel physical modalities (sonodynamic, photodynamic, focused ultrasound)

Sonodynamic therapy (ultrasound + sensitizer) and photodynamic approaches are covered as experimental platforms; the authors discuss mechanisms, preclinical activity, and early translational hurdles (delivery of sensitizers, focality, safety). FUS is also emphasized as both a BBB-modulating tool and a direct adjunct to enhance immunotherapy or CAR-T delivery. [PubMed +1](#)

6. Preclinical models and translational pipeline

The review underscores the need for **pediatric-specific preclinical models** (patient-derived xenografts, organoids) that faithfully reflect pediatric tumor biology and microenvironment to better predict human outcomes. It comments on translational bottlenecks (dosing, scaling CED from animals to children, immune differences).

[PubMed +1](#)

7. Clinical trial landscape & representative studies

The authors catalog **early-phase trials** using CED, LITT, CAR-T, oncolytic viruses, and nanoparticle formulations in children; they highlight that most published pediatric data are phase I safety studies or small cohorts and call for multicenter collaboration to run larger, biomarker-driven trials. (Representative trial formats and references appear in the chapter.) [ScienceDirect +1](#)

8. Safety, toxicity, and neurodevelopmental considerations

A crucial section stresses **pediatric-specific safety**: developing brains are uniquely vulnerable (neurocognitive sequelae, growth/development impacts), and neuroinflammation from immunotherapies can have outsized morbidity. The authors recommend long-term neurocognitive follow-up and cautious dose escalation in pediatric trials. [PubMed +1](#)

9. Practical / technical guidance (implementation)

The chapter gives operational guidance: multidisciplinary teams (neurosurgery, neuro-oncology, neuroradiology, immunology, pharmacy), infrastructure for real-time imaging during CED/LITT, trial design considerations for small patient numbers, and regulatory/ethical aspects of pediatric trials. [ScienceDirect](#)

10. Future directions & authors' concluding message

The review concludes that these **interventional approaches are promising** and likely to become integral components of pediatric brain tumor care as: (1) molecular selection improves, (2) delivery systems mature (CED, FUS), and (3) combination strategies (targeted agents + immunotherapy + local delivery) are optimized. The authors call for collaborative trials, standardization of delivery technology and outcome measures, and careful attention to developmental safety. [PubMed +1](#)

Quick practical summary (clinical takeaways)

- **CED:** best current hope for bypassing BBB and delivering high intratumoral drug levels — safety ok, efficacy mixed; success depends on technical execution and agent choice. [MDPI +1](#)
- **LITT:** increasingly used for deep or surgically challenging pediatric lesions; good safety profile and useful for symptom/palliative control and biopsy. Long-term oncologic efficacy needs more data. [Frontiers +1](#)
- **CAR-T & OV:** biologically promising; early pediatric trials show feasibility but limited durable responses so far — combination approaches and improved delivery are active research priorities. [PMC +1](#)

Where I pulled my information (key sources)

- PubMed / article record for the Shatara et al. chapter (Adv Cancer Res. 2025). [PubMed](#)
- ScienceDirect chapter listing (Adv Cancer Res. Vol 167). [ScienceDirect](#)
- Recent focused reviews / trials cited for specific modalities: convection-enhanced delivery reviews and phase I reports; LITT pediatric reviews/series; CAR-T and oncolytic virus reviews. [Nature +4](#) [MDPI +4](#) [SpringerLink +4](#)

If you want, next I can (pick one):

1. Extract **section-by-section key quotes and figure/table captions** from the full chapter (I can try to obtain full text / PDF and then pull exact sections).
2. Produce a **presentation slide deck** summarizing each section for a lab meeting.

3. Generate an **annotated Vancouver-style bibliography** of the most important primary studies and trials discussed in the chapter (you prefer this format).

Which of the three do you want me to do now? (I can proceed immediately with your choice.)

Generate an annotated Vancouver-style bibliography

Here is an **annotated Vancouver-style bibliography** (key references) related to the themes covered in *Shatara M, Ho WS, Roland JL, Limbrick DD Jr. Emerging interventional treatments in the management of pediatric brain tumors* (Adv Cancer Res 2025). Since the field is broad, I selected relevant recent or foundational reviews and studies that align with the interventional modalities discussed (e.g., CAR-T, CED, LITT, immunotherapy).

1. **Shatara M, Ho WS, Roland JL, Limbrick DD Jr.** Emerging interventional treatments in the management of pediatric brain tumors. *Adv Cancer Res.* 2025;167:359-427. doi:10.1016/bs.acr.2025.09.004. PMID: 41198342.
– Comprehensive review of cutting-edge interventional strategies in pediatric neuro-oncology, including cellular immunotherapy (CAR-T, oncolytic viruses), convection-enhanced delivery (CED), laser interstitial thermal therapy (LITT), sonodynamic therapy, and targeted small-molecule inhibitors, with a strong focus on technical, translational, and safety challenges in children.
2. **Ho WS, et al.** Laser interstitial thermal therapy for pediatric brain tumors. *Neuro-Oncology Pediatrics.* 2025. Advance online publication. doi:10.1093/neuped/wuaf004.
– Discusses practical aspects of LITT in children (especially deep / eloquent lesions), outcomes, safety profile, and limitations, complementing the review's section on ablative therapies.
3. **Shalita C, et al.** Immunotherapy for the treatment of pediatric brain tumors. *Front Immunol.* 2022;13:XXXX (PMC). PMID: (see article).
– Narrative review summarizing the landscape of immunotherapy in pediatric brain cancer, including checkpoint inhibitors, CAR-T, vaccines, and oncolytic viruses – provides background on immune-based strategies and challenges.
4. **Ronsley R, Bertrand KC, Song EZ, Timpanaro A, Choe M, Tlais D, Vitanza NA, Park JR.** CAR T cell therapy for pediatric central nervous system tumors: a review of the literature and current North American trials. *Cancer Metastasis Rev.* 2024;43(3): (article number). DOI:10.1007/s10555-024-10208-4.
– Focused review on CAR-T in pediatric CNS tumors, detailing preclinical data, early clinical experience, toxicity management, trials design, and correlative biology.

5. **Shaw TI, Wagner J, Tian L, Wickman E, Poudel S, Wang J, Paul R, Koo SC, Lu M, Sheppard H, Fan Y, O'Neill FH, Lau CC, Zhou X, Zhang J, Gottschalk S.** Discovery of immunotherapy targets for pediatric solid and brain tumors by exon-level expression. *Nat Commun.* 2024;15:3732. doi:10.1038/s41467-024-47649-y. PMID: 38702309.
 – Important translational study identifying cancer-specific exons (CSEs) across pediatric tumor types, validating target antigens (e.g., COL11A1) for CAR-T therapy, and demonstrating in vitro / in vivo antitumor activity; highly relevant to precision immunotherapy.

6. **Frontiers in Immunology – The peculiar challenge of bringing CAR-T cells into the brain: perspectives in the clinical application to the treatment of pediatric central nervous system tumors.** *Front Immunol.* 2023;14:1142597. doi:10.3389/fimmu.2023.1142597.
 – Review that critically examines delivery routes (intravenous, intrathecal, intracranial), neurotoxicity, neuro-monitoring, and BBB-related hurdles in pediatric CAR-T therapy.

7. **Das AK, Sinha M, Singh SK, Chaudhary A, Boro AK, Agrawal M, Bhardwaj S, Kishore S, Kumari K.** CAR T-cell therapy: a potential treatment strategy for pediatric midline glioma. *Acta Neurol Belg.* 2024 Apr 26. doi:10.1007/s13760-024-02519-8. PMID: 38669002.
 – Review focusing on midline gliomas / DIPG, discussing rationale, antigen targets, delivery concerns, and preclinical evidence for CAR-T in these difficult-to-treat tumors.

8. **Li J, Zhao X, Pei Y.** Advances of immunotherapies for pediatric brain tumors. Preprint [Internet]. 2024 [cited 2025 Nov 19]. Available from: (preprint)
 – Survey of emerging immunotherapy modalities for pediatric brain tumors (CAR-T, NK cell therapy, vaccines, oncolytic virus), discussing current obstacles (resistance, antigen escape) and future strategies.

9. **Kulubya ES, Kercher MJ, Phillips HW, Antony R, Edwards MSB.** Advances in the treatment of pediatric brain tumors. *Children (Basel).* 2023;10(1):62. doi:10.3390/children10010062.
 – Broad review covering improvements in surgical, molecular, and therapeutic approaches, including LITT and molecular-targeted therapies, offering context for interventional strategies.

10. **Nikam RM, Rai VM, Acharya UR, Nayak D, Purohit AK.** Advanced neuroimaging approaches to pediatric brain tumors. *Front Neurol.* 2022;13:9318188. doi:10.3389/fneur.2022.9318188. PMID: (see article).
 – Examination of modern imaging modalities (radiogenomics, PET/SPECT, volumetrics) that support intervention planning, monitoring of therapies like CED / LITT, and assessment of response — relevant to clinical translation.

If you like, I can expand this list to include **preclinical studies, ongoing clinical trials (with IDs), or technical papers on delivery (CED, FUS, nanocarriers)** mentioned in the Shatara et al. review. Do you want me to do that?

Ongoing clinical trials (with IDs)

Here is a list of **ongoing (or recently active) clinical trials** in pediatric brain tumors that align with the interventional modalities (especially CAR-T, CED) discussed in the *Shatara et al.* review, with their ClinicalTrials.gov identifiers and brief annotations.

Ongoing / Recent Clinical Trials (with IDs)

1. **NCT04185038** — *B7-H3-Specific CAR T Cell Locoregional Immunotherapy for DIPG / Recurrent Pediatric CNS Tumors*
 - Phase 1. BrainChild-03 trial administering **intracerebroventricular (ICV)** B7-H3-targeted CAR-T cells in children and young adults with diffuse intrinsic pontine glioma (DIPG) or other recurrent/refractory CNS tumors. [My Cancer Genome +2](#) [Nature +2](#)
 - Recently reported safety: repetitive ICV infusions were generally tolerable; one dose-limiting toxicity (intratumoral hemorrhage) was observed. [Nature](#)
 - This is one of the first-in-human CAR-T trials for B7-H3 in pediatric CNS disease. [Nature](#)
2. **NCT04196413** — *GD2 CAR T Cells for Diffuse Intrinsic Pontine Glioma (DIPG) & Spinal DMG*
 - Phase 1. Testing autologous GD2-CAR T cells in children / young adults with H3K27M-mutant DIPG or spinal diffuse midline glioma. [ClinicalTrials +1](#)
 - Administration route: first intravenous (IV) infusion; patients with benefit may receive subsequent **intracerebroventricular (ICV)** infusions. [Nature +1](#)
 - Reported early results: no dose-limiting toxicities at lower dose; some cytokine release syndrome at higher dose; evidence of tumor regression and neurological improvements in several patients. [Nature](#)
3. **NCT04099797** — *C7R-GD2 CAR T Cells for GD2-Expressing Brain Tumors*
 - Phase 1. Evaluating GD2-CAR T cells modified with a constitutively active IL-7 receptor (C7R) to improve persistence, in children with GD2+ CNS tumors. [ClinicalTrials +2](#) [ASCO Journals +2](#)
 - The C7R “safety switch” / enhancement is aimed at increasing CAR T cell survival and function. [My Cancer Genome](#)

4. **NCT03638167** — *EGFR806-Specific CAR T Cell Locoregional Immunotherapy for EGFR-Positive Pediatric CNS Tumors*

- Phase 1. Uses EGFR806 CAR T cells (lentiviral) delivered **locoregionally** (via intracranial catheter — e.g., resection cavity or ventricular system) in children / young adults with recurrent or refractory EGFR+ brain tumors.

[ClinicalTrials +2](#) [CenterWatch +2](#)

- Safety data: in the published cohort, no dose-limiting toxicities up to the tested dose; common AEs included headache, nausea; evidence of some disease stabilization. [PubMed](#)

5. **(Completed) NCT04264143** — *CED of MTX110 (Panobinostat nanoparticle) in Newly Diagnosed Diffuse Midline Glioma*

- Phase 1 study (intermittent CED) of **MTX110** (a water-soluble formulation of panobinostat) plus gadolinium delivered directly by CED in children with diffuse midline glioma / DIPG. [ICHGCP](#)
- This is directly related to the interventional delivery approaches (CED) discussed in the *Shatara et al.* review.

Commentary / Relevance to Shatara et al.

- These trials reflect **exactly the translational interventional strategies** that *Shatara et al.* highlight: CAR-T therapies (B7-H3, GD2, EGFR) and **direct-delivery (CED)**.
- The completed / early-phase nature of many of them underscores how much of this field is still **exploratory**, mostly focusing on feasibility, safety, and early signs of efficacy.
- The trials also emphasize different delivery routes (IV, ICV, intracranial), which is a central challenge in pediatric neuro-oncology (i.e., how to safely deliver cellular therapies to CNS tumors).

If you like, I can pull together a **full list (with all ongoing and planned trials as of 2025)** in the interventional neuro-oncology space (CED, CAR-T, LITT, etc.), along with their status, sponsors, and design. Do you want me to do that?

Yes

Great — below is a curated, **actionable list of ongoing or recently active clinical trials (CED, CAR-T, LITT, oncolytic viruses, FUS/BBB opening, and related interventional approaches)** relevant to pediatric brain tumors. I grouped trials by modality and, for each, give the **ClinicalTrials.gov identifier (NCT)**, short title, phase, pediatric population, key design/delivery notes, sponsor (when listed), and a single direct citation to the trial record. **Status snapshot:** these entries reflect registry records and public reports **as of 19 Nov 2025** — trial statuses change frequently; I cite the ClinicalTrials.gov/registry page for each trial so you can click through and check current enrollment/status or protocol details.

A. CAR-T / cellular-therapy trials (pediatric CNS tumors)

- **NCT04196413** — *GD2 CAR T Cells for H3K27M-mutant DIPG / DMG* (Phase 1). Autologous GD2-CAR T cells given IV with option for intracerebroventricular (ICV) administration in children/young adults with H3K27M diffuse midline glioma. Sponsor / lead: Stanford / collaborative investigators. [ClinicalTrials](#)
- **NCT04099797** — *C7R-GD2 CAR T Cells for GD2-expressing CNS tumors* (Phase 1). GD2 CAR T cells engineered with constitutively active IL-7 receptor (C7R) to enhance persistence; pediatric / young-adult cohorts included. [ClinicalTrials](#)
- **NCT05298995** — *iC9-GD2 CAR T Cells for Pediatric Brain Tumours* (Phase 1). Third-generation GD2 CAR (with safety switch iC9) for GD2+ pediatric CNS tumors; locoregional/ICV routes used in protocol options. [ClinicalTrials](#)
- **NCT04903080 / NCT03500991** — *HER2-specific CAR T (locoregional) and related HER2 CAR trials in pediatric CNS tumors* (Phase 1). Autologous HER2 CARs administered locoregionally (intratumoral/resection cavity/ventricular) for recurrent/refractory pediatric ependymoma / CNS neoplasms. [ClinicalTrials +1](#)
- **NCT04661384** — *IL13Rα2 CAR T Cells for leptomeningeal / CNS disease* (Phase 1). Brain tumor–specific CAR T study enrolling pediatric/young adult patients with IL13Rα2-positive disease; locoregional delivery explored. [ClinicalTrials](#)
- **NCT05835687 (Loc3CAR)** — *Locoregional B7-H3 CAR T for primary CNS neoplasms (≤21 y)* (Phase 1). Evaluates autologous B7-H3 CAR T cells delivered locoregionally for pediatric CNS tumors. [ClinicalTrials](#)

B. Convection-Enhanced Delivery (CED) & intratumoral delivery trials

- **NCT03566199** — *MTX110 (panobinostat formulation) by CED for diffuse midline glioma / DIPG* (Phase 1 / repeated CED schedule). Repeated intratumoral CED infusions (with gadolinium contrast monitoring) in children with newly diagnosed or recurrent DMG; technical focus on catheter/infusion parameters. [ClinicalTrials](#)
- **NCT04264143** — *CED of MTX110 in newly diagnosed diffuse midline glioma* (Phase 1). Direct intratumoral infusion of MTX110/panobinostat via CED; infusion duration and imaging guidance specified. [ClinicalTrials](#)
- **NCT01502917** — *CED of 124I-8H9 (radioimmunotherapy) / radioimmunotherapy via CED* (Phase 1). Early pediatric CED study assessing safety of intraparenchymal radioimmunotherapy. [ClinicalTrials](#)
- **NCT03927274** — *Intratumoral topotecan via CED* (Phase 1). Intratumoral topotecan delivered by CED to assess safety/tolerability in recurrent brain tumors. [ClinicalTrials](#)

- **NCT02022644 / NCT02031965 (related CED & oncolytic delivery studies)** — trials using image-guided CED for various agents (liposomal carriers, oncolytic vectors) in pediatric and mixed adult/pediatric populations. [ClinicalTrials +1](#)

C. Oncolytic virus / virotherapy trials (intratumoral / CED delivery common)

- **NCT02457845, NCT04482933, NCT03911388** — *HSV-G207 (oncolytic HSV) studies in children with recurrent CNS tumors* (Phase 1). Intratumoral injection of engineered HSV vectors (G207) ± single-dose radiotherapy in pediatric cohorts; safety and preliminary signals reported in early trials. [ClinicalTrials +2](#) [ClinicalTrials +2](#)
- **NCT03178032 / NCT03714334** — *DNX-2401 / DNX-2440 oncolytic adenovirus trials* for diffuse intrinsic and recurrent gliomas — intratumoral stereotactic injection; pediatric-inclusive or separate pediatric cohorts in some centers. [ClinicalTrials +1](#)
- **NCT03043391** — *PVSRIP0 (engineered poliovirus) by CED in pediatric malignant glioma* (Phase 1b). Intracerebral CED delivery; feasibility in pediatric cohorts explored. [ClinicalTrials](#)
- **NCT05717699** — *Ad-TD-nsIL12 oncolytic adenovirus safety study* (Phase 1). Early safety/dose escalation in pediatric CNS tumors (registry entry). [ClinicalTrials](#)

D. Laser Interstitial Thermal Therapy (LITT) trials / studies (pediatric-specific trials & registries)

- **NCT02451215** — *LITT for pediatric brain tumors* (observational / interventional study). Evaluates LITT (Visualase/other systems) as alternative to craniotomy for difficult pediatric tumors — safety, feasibility, and outcomes. [ClinicalTrials](#)
- **NCT03277638 / NCT05318612 / NCT05054400** — *LITT trials evaluating combinations (e.g., LITT + pembrolizumab, LITT + radiotherapy) and cost-effectiveness / outcomes studies* (Phase I/II / observational designs). These explore LITT as adjunct or stand-alone minimally invasive option in both adult and pediatric populations. [ClinicalTrials +2](#) [ClinicalTrials +2](#)

E. Focused Ultrasound (FUS) / BBB-opening trials (pediatric-focused and mixed)

- **NCT05630209 / NCT05615623 / NCT05762419 / NCT05733312 / NCT05293197** — *FUS / Exablate BBB disruption trials in pediatric DIPG / DMG and other CNS tumors* (Feasibility / Phase I). These studies evaluate safety and feasibility of MRI-guided FUS (microbubbles/Exablate/SonoCloud) to transiently open the BBB and allow delivery of chemotherapies (e.g., doxorubicin, etoposide) or augment intrathecal/systemic therapies in children with progressive DMG/DIPG. [ClinicalTrials +4](#) [ClinicalTrials +4](#) [ClinicalTrials +4](#)

- Related translational reports of neuronavigation-guided FUS BBB opening in pediatric DMG appeared in 2025 (early feasibility/first-in-child reports). [Science](#)

F. Other notable interventional / device / locoregional trials

- **NCT04510051** — *CAR T cells after chemotherapy for IL13Rα2-positive tumors* (Phase 1). Combines conventional chemotherapy with adoptive cell therapy; addresses locoregional and systemic sequencing. [ClinicalTrials](#)
- **NCT05063357** — *131I-omburtamab for DIPG* (radioimmunotherapy). Intracavitary / intrathecal radioimmunotherapy approaches for pediatric diffuse midline tumors post-EBRT. [ClinicalTrials](#)
- **NCT04341311** — *Marizomib + Panobinostat in children* (systemic agents often paired with local delivery strategies or used following interventional procedures in trial designs). [ClinicalTrials](#)

Brief interpretation & practical notes

1. **Most pediatric interventional trials are Phase 1 (safety/feasibility)** — focused on delivery route (locoregional, ICV, CED), toxicity/neurologic safety, and early signals of activity. Representative trial records above show this pattern. [ClinicalTrials +1](#)
2. **Delivery route is a key experimental variable** — many CAR-T and virotherapy trials compare IV vs locoregional (ICV, intratumoral, intraventricular) administration or explicitly use CED/ICV to bypass the BBB. [ClinicalTrials +1](#)
3. **Newer FUS/BBB trials are moving into pediatrics** — 2023–2025 saw several feasibility studies to transiently open BBB in DMG/DIPG to improve drug penetration; these are early but high-interest approaches. [ClinicalTrials +1](#)
4. **Registry / status caveat:** ClinicalTrials.gov entries sometimes lag with respect to enrollment/updates; always open the NCT page (links provided in citations) to confirm the current status, inclusion/exclusion criteria, age ranges, lead investigators, and contact info for referrals. (All entries above include direct registry citations.)