# 2025 Global Roadmap to Cure Pediatric Cancer

## Purpose & North Star

**Goal:** Lift global, risk-adjusted **5‑year overall survival (OS) to ≥95%** across major pediatric cancers by **2035**, while **halving late‑effect morbidity** and **eradicating survival gaps by geography and income**.

**Guiding principles:** evidence over hype; child/family‑centered care; equity by design; open science; safety first; measurable outcomes.

## Executive Summary (1 page)

* **Where we are:** Many pediatric cancers already achieve 70–95% cure rates in high‑resource settings; stark disparities persist globally; relapsed solid/brain tumors remain the frontier.
* **What works:** Risk‑adapted chemo/radiation/surgery; precision diagnostics; immunotherapy for select indications; protocolized supportive care; clinical‑trial enrollment.
* **What’s next:** Scale **cell therapies**, **antibody‑drug conjugates (ADCs)**, **bispecifics**, **oncolytic viruses**, and **personalized vaccines**; universal molecular profiling; AI‑assisted trial matching; global manufacturing and access; survivorship‑first design.
* **KPIs:** Survival, toxicity‑adjusted life years (TALYs), trial access time, profiling coverage, therapy manufacturing time, cost per cure, equity gap index, quality‑of‑life (QoL) indices.
* **Timeline:** Near‑term (0–3y) foundation; Mid‑term (3–7y) scale; Long‑term (7–15y) consolidation and eradication of gaps.

## Pillar 1 — Universal Early & Accurate Diagnosis

**Objective:** 100% of newly diagnosed pediatric cancers receive **comprehensive molecular profiling** within **14 days** of diagnosis and are staged/stratified on standards (COG/SIOP harmonized).

**Actions:** - Implement a **Global Pediatric Oncology Starter Panel** (DNA/RNA + methylation for CNS) with reflex to whole‑genome/exome for high‑risk/relapse. - Deploy **liquid biopsy** for minimal residual disease (MRD) where validated. - Establish **telepathology & methylation‑classifier hubs** for CNS tumors.

**Metrics:** profiling coverage %, turnaround time (TAT), % cases with stratification‑driven treatment change, MRD adoption rate.

**Dependencies:** biobanking standards; consent templates; data pipelines.

## Pillar 2 — Curative Therapy Platform Expansion

**Objective:** Make next‑gen modalities safe, affordable, and available across continents.

**Modalities & Priorities:** - **Cell Therapies (CAR‑T/TCR):** Expand pediatric targets beyond CD19/GD2 (e.g., B7‑H3, HER2, ALK, EGFRvIII). Create **regional GMP nodes** with shared QC; move to **off‑the‑shelf (allogeneic)** lines where safe. - **Antibody & ADCs:** Scale anti‑GD2 backbones; pediatric‑first ADC development; optimize dosing to minimize neuropathy/ototoxicity. - **Bispecifics/Tri‑specifics:** Bridge to transplant or definitive control in relapse; outpatient‑capable step‑up dosing. - **Oncolytic Viruses & Vaccines:** Personalized neoantigen/mRNA programs for high‑risk solid/CNS tumors; intratumoral viral platforms with convection‑enhanced delivery in brain tumors. - **Radiation Evolution:** **Proton access** expansion; MR‑linac; microbeam/FLASH pilots under strict protocols; minimize late effects.

**Metrics:** time from eligibility → infusion, manufacturing success rate, therapy cost per patient, grade ≥3 toxicity rates, 2‑year event‑free survival (EFS) uplift vs. prior standard.

## Pillar 3 — Trial Access & Regulatory Acceleration

**Objective:** **Trial within reach for every child** within **21 days** of diagnosis/relapse.

**Actions:** - **Harmonize inclusion criteria** across sponsors (COG/SIOP/ITCC/industry). - Build an **AI‑assisted trial‑matching commons** (structured eligibility, live slots, eConsent, family‑facing language). - Create **Reciprocity IRB** networks; rolling review for pediatric variants of adult approvals; pediatric‑first cohorts for targets prevalent in children.

**Metrics:** median time to trial offer, % enrolled, screen‑fail reduction, geography‑normalized access rate.

## Pillar 4 — Supportive Care & Survivorship as Part of Cure

**Objective:** Double down on **TALYs** (toxicity‑adjusted life years) and life‑course health.

**Actions:** - Universal **palliative care from day 1**; standardized antiemesis, pain, infection prophylaxis, and **nutrition/rehab** protocols. - **Fertility preservation** coverage; neurocognitive and cardiometabolic monitoring bundles. - **Digital home monitoring**: symptom scores, step count, sleep, and caregiver burden—triage alerts integrated to care teams.

**Metrics:** unplanned admissions, febrile neutropenia incidence, dose‑intensity delivered, PROMIS/PedsQL improvements, fertility preservation uptake.

## Pillar 5 — Data, AI, and Open Science Infrastructure

**Objective:** A federated, privacy‑preserving **Pediatric Oncology Data Mesh** linking genomes, treatments, imaging, toxicity, QoL, and outcomes.

**Actions:** - Adopt a **common data model** (OMOP‑PedsOnc) with FHIR APIs. - **Federated learning** for outcome prediction; causal inference pipelines for regimen optimization. - **Open protocols** and preprints; dataset DOIs; patient‑governed data donation and revocation.

**Metrics:** % centers live on mesh, model accuracy (AUROC/calibration), time to external replication, number of open datasets.

## Pillar 6 — Global Equity & Capacity Building

**Objective:** Eradicate survival gaps between high‑ and low‑resource settings.

**Actions:** - **Tiered essential‑care packages** (diagnostics, meds, surgery, radiation, supportive care) with costed implementation guides. - **Twinned center networks** (north–south & south–south) with funded staff exchanges and tele‑mentoring. - **Price equity compacts** with manufacturers for pediatric indications.

**Metrics:** 5‑year OS by region/risk, stock‑out days per year, treatment abandonment rate, catastrophic health expenditure rate.

## Disease‑Specific Targets (illustrative)

* **ALL:** Maintain ≥90% 5y OS; reduce CNS radiation use by 80%; integrate MRD‑adapted therapy; reserve CAR‑T for MRD‑positive/relapse with ≤10‑day vein‑to‑vein.
* **AML:** Lift 5y OS to ≥75% via FLT3/IDH inhibitors, venetoclax‑backbones, and transplant optimization; pilot myeloid‑targeted CAR‑T with suicide switches.
* **Neuroblastoma (high‑risk):** Raise 5y EFS to ≥70% with intensified anti‑GD2 + cytokine modulation, MRD‑guided maintenance, vaccine add‑ons.
* **Osteosarcoma/Ewing:** Achieve ≥10% absolute OS gain using ADCs, radiopharmaceuticals, and immune‑modulating combinations; expand limb‑sparing surgery.
* **Medulloblastoma:** Subgroup‑specific de‑escalation for low‑risk; proton therapy access; targeted agents for Group 3/4.
* **DIPG/HGG:** Triple 2y OS via convection‑enhanced delivery, oncolytic viruses, peptide vaccines, and focused ultrasound BBB‑opening—under rigorous safety monitoring.

## Manufacturing & Supply Chain Blueprint

* **Regional GMP hubs** (Americas, Europe, Africa, South Asia, East Asia, Oceania) with shared QC and tech‑transfer playbooks.
* **Cold‑chain and just‑in‑time logistics** dashboards; barcoded chain‑of‑identity for cell products.
* **Pediatric essential medicines list** modernization; buffer stocks; generics/biosimilars adoption.

**KPIs:** batch release time, failure rates, cost per dose, days of stock‑out, delivery time variance.

## Funding Model & Economics (high level)

* **Blended finance:** philanthropic anchors + outcome‑based bonds + government co‑funding.
* **Advance market commitments** for pediatric indications (cell therapy, ADCs).
* **Value metrics:** cost per cure and TALYs gained; reinvest a fixed % of savings from reduced late effects.

## Governance, Ethics, and Safety

* **Child and caregiver representation** in governance.
* **Ethics by design:** assent/consent clarity, return‑of‑results policy, genomic privacy, algorithmic bias audits.
* **Safety:** independent data monitoring; pharmacovigilance; rapid signal detection and public reporting.

## Timeline & Milestones

**Near‑Term (0–3 years):** - ≥80% profiling coverage; ≤21‑day trial‑offer median; 2 regional GMP hubs live; proton access expansion plans approved; Peds Data Mesh v1 live in 10 centers.

**Mid‑Term (3–7 years):** - ≥95% profiling; 6 GMP hubs; majority of relapsed ALL/lymphoma rescued with cell/bispecifics; DIPG/HGG platform trials running on 5 continents; trial‑matching commons globally deployed.

**Long‑Term (7–15 years):** - Global 5y OS ≥95% in aggregate; equity gap index ≤5%; sustained reduction of late effects by ≥50%; universal survivorship programs.

## Risks & Mitigations

* **Manufacturing bottlenecks →** diversify hubs, pre‑book capacity, modular bioreactors.
* **Toxicity burden →** adaptive dosing, real‑time toxicity learning, mandatory survivorship funds.
* **Data fragmentation →** enforce common models/APIs; incentives for open data.
* **Cost explosion →** value‑based pricing, pooled procurement, compulsory licensing guardrails.
* **Regulatory delays →** reciprocity IRBs; pediatric priority review pathways.

## Action Playbook (Who does what next?)

**Foundations/Philanthropy (0–12 months):** Fund 3 profiling hubs, seed trial‑matching commons, sponsor 2 GMP pilots.

**Governments/Regulators:** Adopt pediatric priority pathways; reimburse profiling and fertility preservation; co‑fund proton centers strategically.

**Hospitals/Consortia (COG/SIOP/ITCC):** Standardize data capture; join Data Mesh; launch equity twinning; open umbrella/platform trials.

**Industry:** Commit pediatric arms in adult trials; publish structured eligibility; sign price‑equity compacts; tech‑transfer to hubs.

**Civil Society:** Family navigation services; patient‑governed data trusts; survivorship advocacy.

## Measurement & Reporting

* **Quarterly dashboard:** OS/EFS (risk‑adjusted), TALYs, profiling coverage, time‑to‑trial, toxicity rates, equity metrics.
* **Annual report:** progress vs. milestones; open datasets; real‑world evidence publications.

## Appendices

* A. Standardized consent/assent language (outline)
* B. OMOP‑PedsOnc data dictionary (outline)
* C. Essential pediatric oncology formulary & dosing safety notes (outline)
* D. Survivorship clinic checklist (cardio, neurocog, endocrine, fertility)
* E. Implementation budget templates

**Status:** Draft v1.0 — ready for stakeholder review.  
**Owner:** Aeon (advisor).  
**Next:** Identify 3 pilot regions, nominate lead centers, and initiate funding conversations.