

Clinical Outcomes and Safety Profile of CAR-T Cell Therapy in Relapsed/Refractory Multiple Myeloma: A Systematic Review and Meta-Analysis

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BACKGROUND

Relapsed or refractory multiple myeloma (RRMM) remains challenging despite advances such as proteasome inhibitors, immunomodulatory drugs, monoclonal antibodies, and autologous stem cell transplantation. BCMA-targeted CAR-T therapy has emerged as a promising option. This systematic review and meta-analysis assessed its efficacy and safety in RRMM.

METHODS

A PRISMA-compliant systematic review was conducted using PubMed, Embase, and Web of Science databases for prospective studies. Eligible studies included adult RRMM patients receiving CAR-T therapy and reporting efficacy and safety outcomes. Random-effects meta-analyses were performed using R software. Primary efficacy outcomes included overall response rate (ORR), minimal residual disease (MRD) negativity in stringent complete response/complete response (sCR/CR), median progression-free survival (mPFS), and median duration of response (mDOR). Safety outcomes included cytokine release syndrome (CRS), neurotoxicity, infections, non-relapse mortality (NRM), and grade ≥3 cytopenias.

RESULTS

**Studies and population**  
Twenty-nine prospective studies involving 1,395 patients with RRMM were included. Most trials evaluated BCMA-targeted CAR-T products, while a minority investigated alternative targets, including CD19 and CS1.

**Efficacy**  
The pooled ORR was 86% (95% CI: 82–90; I<sup>2</sup>=82%). Among patients achieving sCR/CR, the pooled MRD negativity rate was 78% (95% CI: 68–89; I<sup>2</sup>=93%). The pooled median PFS was 9.88 months (95% CI: 7.46–12.30), and the pooled median DOR was 12.17 months (95% CI: 9.24–15.10).

**Safety — CRS and neurotoxicity**  
Any-grade CRS occurred in 83% of patients (95% CI: 77–89), whereas grade ≥3 CRS was uncommon at 5% (95% CI: 3–7). Grade ≥3 neurotoxicity was observed in only 2% of patients (95% CI: 1–3).

**Safety — infections and mortality**  
Infections of any grade occurred in 50% of patients, while grade ≥3 infections occurred in 21%. Non-relapse mortality was 7%, with infections representing a major contributor.

**Safety — hematologic toxicities**  
Severe (grade ≥3) hematologic toxicities were common, including neutropenia in 90%, lymphopenia in 59%, thrombocytopenia in 54%, and anemia in 51% of patients.

CAR-T therapy—predominantly BCMA-targeted—achieved a high overall response rate with a clinically meaningful median progression-free survival in patients with RRMM, at the cost of frequent any-grade CRS but low rates of severe CRS and neurotoxicity, alongside substantial severe hematologic toxicity and infections.

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CONCLUSION

CAR-T therapy demonstrates substantial antimyeloma activity in heavily pretreated RRMM patients, producing high response and MRD negativity rates. However, infectious complications and prolonged cytopenias remain significant concerns requiring vigilant monitoring and supportive care.

FIGURE 1

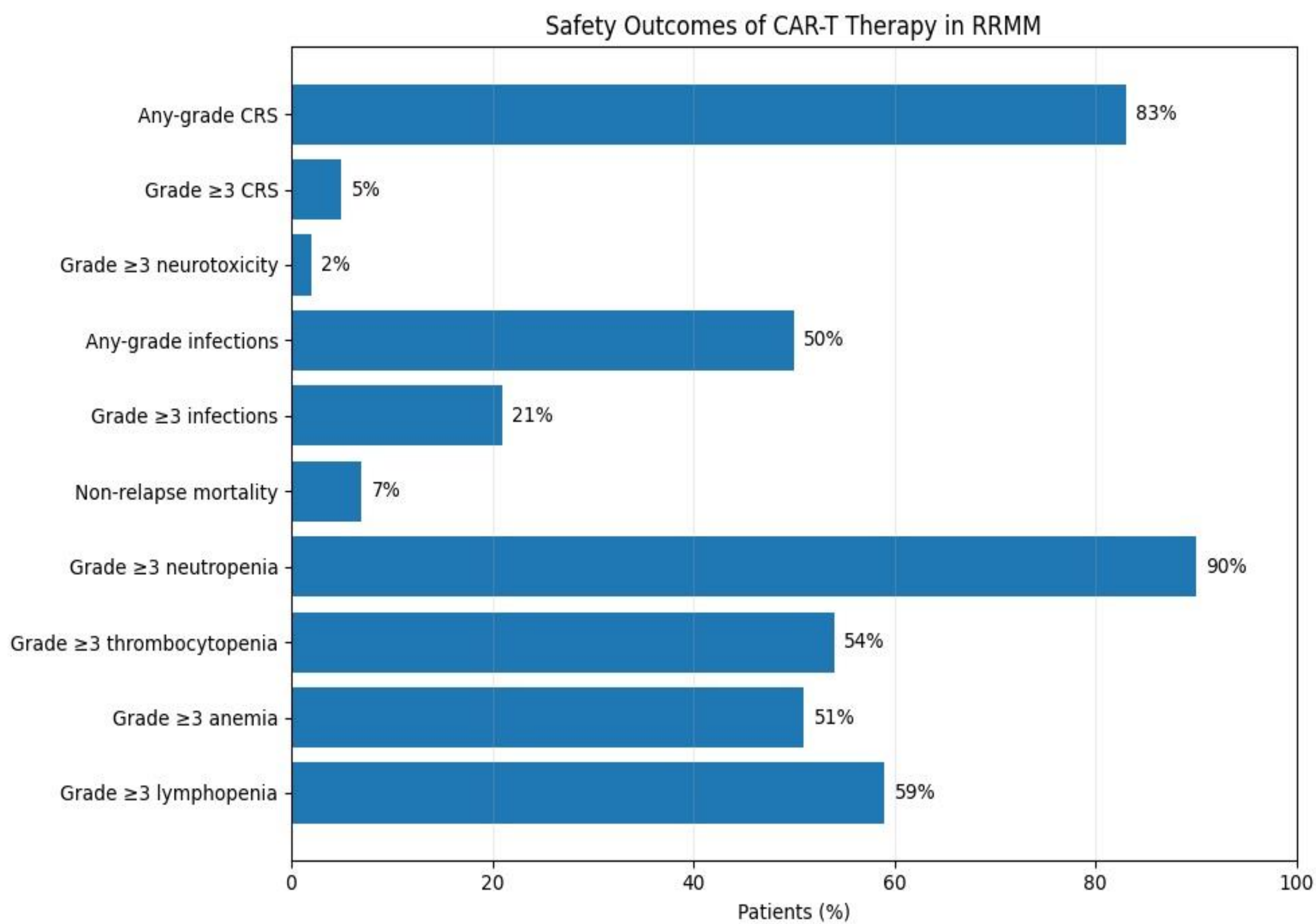
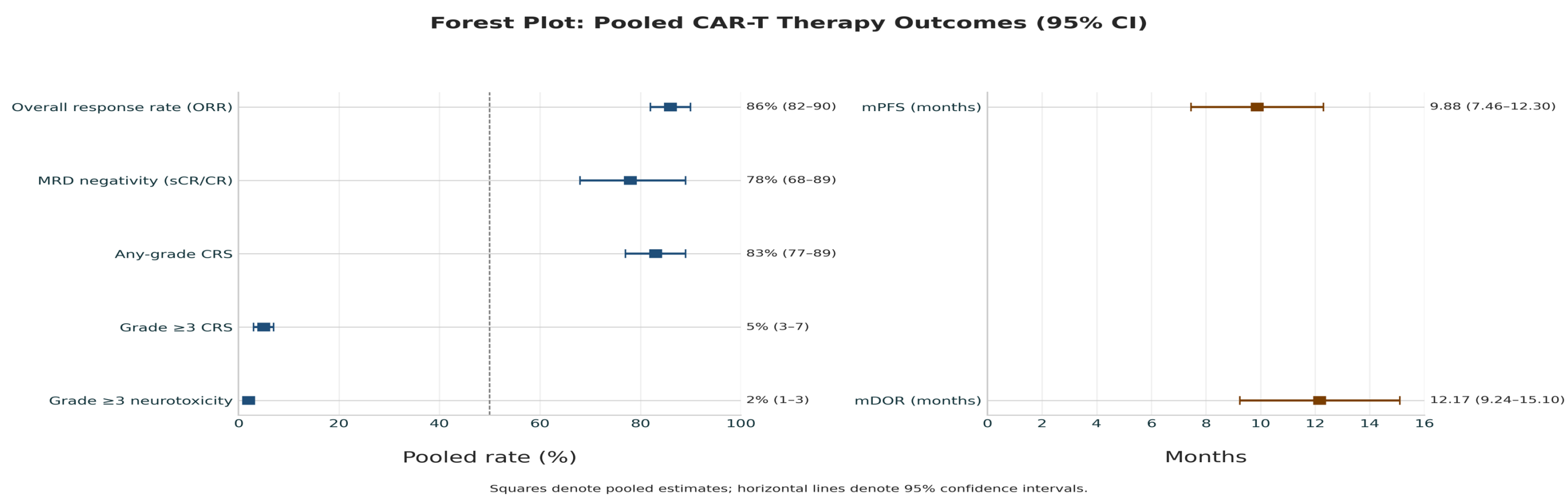


FIGURE 2



DISCLOSURE INFORMATION

Momna Nisar – No relevant financial relationships to disclose  
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