LAYMAN SUMMARY

Our immune system is designed to recognize and destroy harmful cells, but cancer cells can find clever ways to hide. Chimeric antigen receptor (CAR)-T cell therapy is a promising cancer treatment that boosts the immune system by reprogramming the patient's own T cells, which are specialized immune cells that fight disease. In CAR-T cell therapy, T cells are genetically modified to express special receptors called CARs, which enable them to specifically recognize and destroy cancer cells. Despite being a very promising therapy, there are still some challenges. Currently, the CAR gene is introduced into T cells using modified viruses, which makes the process expensive, complex and raises safety concerns. Our research explored safer and less complex non-viral methods to engineer these cancer-fighting CAR-T cells. Specifically, we studied lipid nanoparticles (LNPs), which are tiny fat bubbles that can deliver genetic material into cells. Because T cells are difficult to modify, we explored how to fine-tune these LNPs. We found that certain LNP designs were more efficient in transferring the genetic message needed to produce CAR-T cells. These findings contribute to the development of next-generation CAR-T cell therapies that are safer, faster to produce, and more accessible to patients worldwide.