

# Value and Pricing Models for Gene Therapy Replacements: The Current State of Affairs

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## Introduction

Gene therapies have emerged as new treatments with the power to transform disease trajectory by addressing the underlying genetic cause of disease. In the universe of drug therapies, these genetic treatments are unique. They require a new paradigm for valuing and pricing medical treatments as potentially one-time interventions that treat diseases for years or even lifetimes. Due to our current reimbursement system, one-time treatments offering long-term benefits incur a high upfront cost. This proposition contrasts with current reimbursement systems that were built for chronic medications valued and priced based on monthly utilization, year after year, over a lifetime.

Additional challenges to creating new valuation and pricing models appropriate to gene therapy include the precise and individualized nature of these therapies, which reduce market size considerably. In addition, manufacturing and development of gene therapies are more expensive and require much more upfront investment in new technology and infrastructure. Finally, regulatory guidance for approval of gene therapies suggests clinical endpoints that may not be feasible for therapies that modify a disease over a lifetime. In totality, such challenges put financial pressure on companies that research and develop gene therapies and threaten future investment and innovation.<sup>1-4</sup>

In this paper, we review the enormous potential value of gene therapy and the equally large threat of using dated financial models that can limit the growth of this critical new area of medicine.

Figure 1. Types of gene therapies.

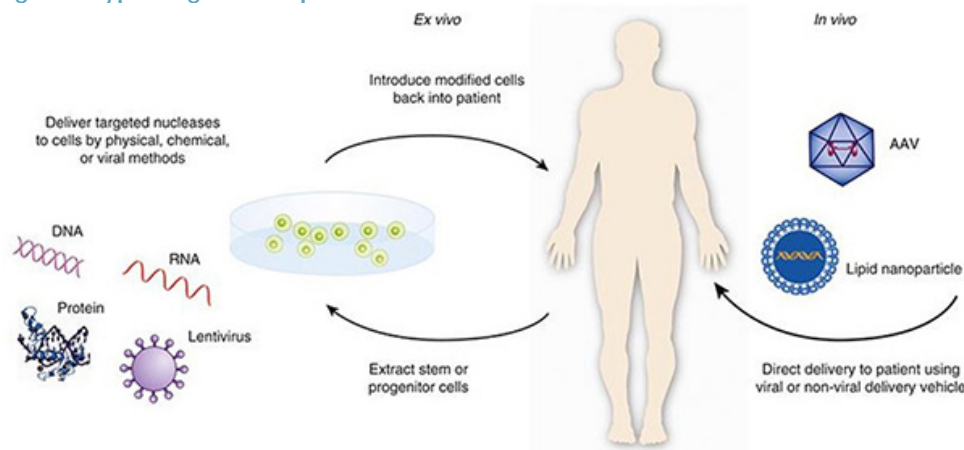


Image source: U. S. Food and Drug Administration. What is Gene Therapy? <https://www.fda.gov/vaccines-blood-biologics/cellular-gene-therapy-products/what-gene-therapy>

## Defining Gene Therapy

The field of gene therapy is relatively new and still rapidly developing, with the first gene therapy approval in the U.S. occurring only six years ago.<sup>5</sup> As has been extensively reviewed, different modalities with different routes of administration have overlapping and unique complexities related to development, clinical trials, manufacturing, regulatory issues, pricing, and cost-benefit analyses.

Gene therapy can be broadly defined<sup>6</sup> as the use or modification of genetic material to treat disease by:

1. introducing or increasing the production of a protein with a therapeutic function, such as an oncolytic (cancer-killing) gene;
2. replacing a dysfunctional gene with a functional copy; or
3. silencing a dysfunctional gene or gene mutation.

Gene therapies have emerged as new treatments with the power to transform disease trajectory by addressing the underlying genetic cause of disease.

These effects can be achieved in multiple ways. In cell-based gene therapy, cells are taken from a patient, DNA is edited or introduced, and the cells are then re-transplanted back into that patient. Other gene therapies introduce DNA or RNA into a patient's cells using a viral vector, which is given as an infusion into the blood or spinal fluid or as an intramuscular injection.<sup>7-11</sup> A small molecule that silences a dysfunctional gene has also been approved by the Food and Drug Administration (FDA),<sup>5</sup> and others are in development. See Figure 1 for an overview of the different types of gene therapies approved to date.

This paper focuses on gene therapies that replace a dysfunctional gene via a viral vector.

## The Revolutionary Value of Gene Replacement Therapies

Genetic medicine is considered by many to be the next frontier for improving health.<sup>12</sup> Gene replacement therapy (GRT) exemplifies genetic medicine because therapies are used only in patients with mutations in the gene replaced by that specific therapy.<sup>13-18</sup> The transformative effects of these therapies include regaining sight with Luxturna (voretigene neparvec-rzyl; Spark Therapeutics), which treats a rare inherited retinal dystrophy (IRD) that causes blindness.<sup>19,20</sup> Zolgensma (onasemnogene abeparvec-xioi; Novartis) treats a rare disease, spinal muscular atrophy (SMA) Type 1, that, without treatment, typically causes death before the age of two years.<sup>18,21</sup>

The ability of GRTs to replace a dysfunctional or missing protein that lies on the causal path of disease makes these therapies particularly useful for rare and ultra-rare diseases or specific subsets of diseases. As such, the number of people who can benefit from any gene therapy is often small (Table 1). For example, there are approximately 10,000 children in the U.S. with Duchenne muscular dystrophy (DMD),<sup>22</sup> for which the gene therapy Elevidys (delandistrogene moxeparvec-rokl; Sarepta Therapeutics) was approved in 2023 under the accelerated approval pathway for children with DMD at ages four through five years.<sup>23</sup> Additionally, fewer than 500 children with DMD are born each year.<sup>24</sup> Luxturna treats a subset of IRDs that cause progressive vision loss and eventual blindness early in life.<sup>15,25</sup> Fewer than 2,000 people in the U.S. are affected by the rare disease Luxturna treats.<sup>26</sup> Approximately 33,000 people in the U.S. are affected by hemophilia A,<sup>27</sup> for which the gene therapy Roctavian (valoctocogene roxaparvec-rvox; Biomarin Pharmaceutical) can be used to treat adults with severe cases.<sup>16</sup>

Genetic medicine is considered by many to be the next frontier for improving health.

Table 1. Approved In Vivo Gene Replacement Therapies

Therapy	Approved	Disease treated	Prevalence at approval	Annual incidence	Projected 7-year market
ELEVIDYS (delandistrogene moxeparvec-rokl)	June 2023	Duchenne muscular dystrophy	1,050	500	4,550
HEMGENIX (etranacogene dezaparvec-drlb)	Nov 2022	Hemophilia type B	8,000	100	8,700
LUXTURNA (voretigene neparvec-rzyl)	Dec 2017	RPE65-associated retinal dystrophy	1,000–2,000	150	2,050–3,050
ROCTAVIAN (valoctocogene roxaparvec-rvox)	June 2023	Hemophilia type A	33,000	350	35,275
VYJUVEK (beremagene geperpavec)	May 2023	Dystrophic epidermolysis bullosa	1,100	75	1,625
ZOLGENSMA (onasemnogene abeparvec-xioi)	May 2019	Spinal muscular atrophy	800	370	3,200

Note: Both ELEVIDYS and ZOLGENSMA are, respectively, indicated for use in children 4–5 and 0–2 years old. Prevalence at approval is age-adjusted accordingly for both these therapies.

Although these populations are small, treating these diseases, especially with therapies that may have to be given only once, is transformative, disease-modifying, and life-altering for those individuals. As detailed further in the section on **Pricing Considerations for Gene Replacement Therapies**, successfully treating the root causes of these diseases also substantially decreases healthcare costs, caregiver burdens, and overall disease burden. There are also improvements in quality of life and other societal contributions these individuals could make that can be meaningful. These medical and societal savings and quality-of-life improvements must be considered when evaluating the price of gene therapies.

The transformative power of GRTs includes providing the first-ever treatment for some rare pediatric diseases with significant unmet medical needs, such as IRD. The magnitude of GRT effects is also transformative: returning sight to blind children and preventing death in infancy.<sup>28,29</sup> Children with IRD who were blind regained enough vision to move around their environment without bumping into anything after treatment with Luxterna.<sup>28</sup> Children with spinal muscular atrophy (SMA) Type 1 treated with a single dose of Zolgensma are living and meeting developmental milestones at the age of eight when, without gene therapy, they typically would have died by the second year of life.<sup>29</sup> Contrast SMA Type 1, a fast progressing fatal neuromuscular disease, to a slow progressing and fatal neuromuscular disease, like Duchenne. In Duchenne, patients experience irreversible loss of muscle function over the course of decades with certain death in the third decade of life. Therefore, measuring the impact of Elevidys infused at the age of four in delaying disease progression, such as the loss of ambulation or extending survival, will take years.<sup>30</sup> Treatment with Elevidys has shown functional improvement more than four years after receiving treatment.<sup>30</sup> Importantly, gene therapies can halt disease progression but do not reverse the damage that has already been done by a disease, making it critical to get these treatments to patients expediently.

All but one of the GRTs approved by the FDA to date were designed to be one-time treatments. Because the first US approval of GRT was only six years ago,<sup>5</sup> it will take more time to assess if redosing is necessary. Additionally, scientific advances are still needed in order to redose to overcome the challenge of suppressing antibodies to the viral vector that develop after gene therapy administration.<sup>32</sup> Regardless, the potential ability to treat a disease in a single dose is another transformative aspect of these therapies that can substantially reduce the treatment burden.

Notably, the treatment burden is even substantially reduced with the one approved GRT designed to be re-administered, Vyjuvek (beremagene geperpavec-svdt; Krystal Biotech). Vyjuvek treats dystrophic epidermolysis bullosa (EB),<sup>17</sup> a severely disabling and disfiguring disease in which the skin forms blisters and tears easily.<sup>39</sup> Wounds can be several inches in diameter and cause scarring and tissue damage. Vyjuvek is applied to the skin wounds every two weeks until healing occurs. In clinical trials, wounds treated with Vyjuvek were three times more likely to heal completely. Vyjuvek-treated wounds also healed more quickly and with less pain.<sup>40</sup> Patients with dystrophic EB who previously may have required months-long treatment in a burn unit<sup>41</sup> now can achieve significantly faster healing, fewer skin infections and less pain and scarring with office-based outpatient treatment.

The evidence shows that GRTs that address the root cause of disease are transformative. These treatments can prolong life, reduce disability, and lower the burden of treatment for rare diseases with high unmet need. Together, these features create a new value proposition. As we will discuss, GRTs also have unique development costs, manufacturing processes, and regulatory considerations that should be reflected in any cost-benefit or pricing analysis.

## Pricing Considerations for Gene Replacement Therapy

The novel aspects of GRTs command a different pricing paradigm. Pricing a one-time dose that only hundreds or a few thousand patients will use vastly differs from pricing for medications that

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may be used for diseases treating a larger population on an ongoing basis and paid for gradually throughout a patient's lifetime. In addition, many GRTs treat conditions for which no treatments previously existed (e.g., IRD) or for which there were no or limited disease-modifying treatments (e.g., DMD, SMA, EB, and hemophilia). In this context, it is difficult—if not impossible—to set prices based on cost savings compared to other treatments.

To date, the longest duration of GRT treatment after FDA approval is with Luxturna, for which no other treatments are available for cost comparison.<sup>16</sup> The next longest duration is with Zolgensma for SMA, which is four years.<sup>19</sup> At the time Zolgensma was priced, the only other treatment available for comparison was Spinraza (nusinersen; Novartis), which is an antisense oligonucleotide that increases production of functional protein and requires administration into the spinal fluid every three-to-four months. The price for five years of Spinraza treatment is approximately \$2 million, and the Zolgensma price is \$2.1 million for a one-time treatment.<sup>41</sup> Time will tell whether this is an equivalent price or cost savings as we learn if Zolgensma is, as hoped, effective as a one-time treatment.

The FDA approved Hemgenix (etranacogene dezaparvovec-drlb; UniQure, CSL Behring) in 2022 for treating hemophilia B,<sup>14</sup> for which other previously available treatments exist. Because Hemgenix is also designed as a one-time treatment, we again compare the costs of five years of medication with the clotting factor. Before the advent of Hemgenix, treatment for hemophilia B necessitated multiple infusions of clotting factor each week to prevent potentially life-threatening bleeding events. Clotting factor prophylaxis costs \$300,000 to \$776,000 annually,<sup>42,43</sup> or \$1.5 to \$3.8 million for five years. One-time treatment with Hemgenix is priced at \$3.5 million,<sup>44</sup> which falls within the upper bound of clotting factor prophylaxis.

When considering cost-benefit analyses for any medical condition, it is essential to consider more than the price of a medication. Other direct medical costs include physician visits, hospitalizations, procedures, and laboratory tests. Indirect medical costs to the patient and society should also be considered. These costs can consist of needed modifications to homes and vehicles for the patient and family, caregiver burden, and decreased productivity for both patient and caregiver, among other important factors. Some cost-effectiveness models do not consider the value of making patients productive members of society, which is a significant omission. Pioneer has written extensively on the flaws in certain cost-effectiveness methodologies and their potential to discriminate against large classes of patients including those living with disabilities, rare diseases, cancers, and other conditions. Lastly, it is crucial to include benefits to quality of life, daily functioning, and psychosocial well-being.

Between 2011 and 2019, patients with hemophilia B had direct healthcare utilization costs 25 times higher than average for healthy individuals, including mean direct annual medical costs of \$614,886 per patient.<sup>42-46</sup> Hemophilia B patients report that one of their two most important outcomes is the ability to participate fully in family life, recreational activities, school, and work, which they frequently are unable to do due to actual bleeding events and the fear of bleeding events.<sup>46,47</sup> Overall, patients report a 26 percent lower quality of life than healthy individuals.<sup>45</sup> In clinical trials, treatment with Hemgenix reduced bleeding events by 80 percent,<sup>48</sup> making it likely that these costs will be lower with Hemgenix. Indirect costs of chronic disease in the form of lost wages, care partner costs, and more can also be extremely burdensome, especially for diseases that cause substantial disability. For example, the indirect costs of IRD range from \$1.4 to \$2.5 million over the course of a lifetime.<sup>49</sup> In 2014, the indirect costs of DMD were estimated at \$80,000 to 121,000 for each patient yearly plus \$58,000 to \$72,000 yearly for their household.<sup>50</sup>

Finally, when considering cost-benefit analyses and pricing decisions, there is the reality that these treatments meaningfully extend and may save patients' lives. Treatment with Zolgensma for SMA Type 1 has resulted in children living four times longer than without treatment.<sup>51</sup> The value of this time together for patients and their families is profound. With time, if Zolgensma

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treatment maintains its expected durability, we may also see individuals with SMA making contributions to society that would have otherwise been impossible. The same can be said for DMD, who for the majority of those living with the disease are currently not eligible for disease modifying treatments that can potentially extend their lives beyond their 20s.<sup>30</sup>

## Development Costs of Gene Replacement Therapy

Innovators of GRTs face unique challenges compared with more traditional drug development. Drug developers must consider drug targets, mechanisms of action, pharmacodynamics (how the drug affects the patient), pharmacokinetics (how the patient processes the drug), drug elimination rates, and administration routes. Developers of GRTs must evaluate these elements for *both* the delivery vector and the genetic material delivered *and* the two in combination, tripling the complexity of development. Furthermore, the ability to deliver the vector to the specific tissue where the replacement gene needs to be expressed must be optimized. In addition, GRT developers must consider the response of a patient's immune system to the vector, the genetic material, and the cells that incorporate that material. These factors further increase the complexity and cost of GRT development, as do the related intellectual property and regulatory considerations for each of the multiple and repeated steps.<sup>52-54</sup>

Although each new GRT may use some of the same elements of previously approved therapies, each treatment targets a different gene such that the exact makeup of the vector and transgene is unique. As such, the current regulatory paradigm requires safety studies for every new GRT with no potential to extrapolate from studies of other GRTs that leverage some of the same components. The preclinical safety testing is extensive, the lowest initial doses in humans are often very small, and the time to escalate to a higher dose can be long. In recognition of the significant challenge this presents, the National Center for Advancing Translational Sciences (NCATS) has initiated a project to design a “platform vector” that would enable such extrapolations when using the same vector to target the same tissue with a different transgene.<sup>55</sup> Safety studies are also complicated by the one-time treatment design of GRT, which is an advantage for treatment efficacy but also requires a higher bar for measuring safety. As a result, trials are lengthier and costlier than for other types of medications.

The high costs of developing GRTs, as described in **Manufacturing Costs**, combined with the smaller populations for whom these treatments are effective (Table 1), make it much more difficult to recoup the money invested in developing GRTs. At the same time, the overall cost to society is not necessarily higher, considering the price multiplied by the small number of people affected. In other words, a budget-impact analysis demonstrates that the overall healthcare budget may not be significant. For example, Luxturna is priced at \$850,000 and is indicated for a population of 2,000 people in the U.S.,<sup>27</sup> with just a few new cases each year,<sup>56</sup> giving it a maximum impact of less than \$2 billion *for more than a decade of treatment*. For comparison, we consider the small molecule treatments Xalcori (crizotinib, Pfizer) and Alunbrig (brigatinib, Takeda Pharmaceuticals), which are both for a rare type of non-small cell lung cancer (NSCLC). The incidence of the treated disease is approximately 10,000 per year and the treatments are priced around \$240,000 per year for an impact of \$2.5 billion *for just one year of treatment*.<sup>57,58</sup> Considering that this disease has onset in the seventh decade of life and preliminary data suggest the median survival is longer than five years,<sup>59</sup> treatment could increase years lived by 12 years at a cost of \$2.8 million. In contrast, gene therapies with similar life-time medication costs may provide larger increases in life expectancy to deliver more cost-effective care.

Costs to society for developing each new GRT may also be offset by “scientific spillover,” which is “the potential for healthcare interventions to have consequences beyond those initially intended.”<sup>60</sup> In the case of GRT, potential positive spillover includes improvements in safety monitoring,



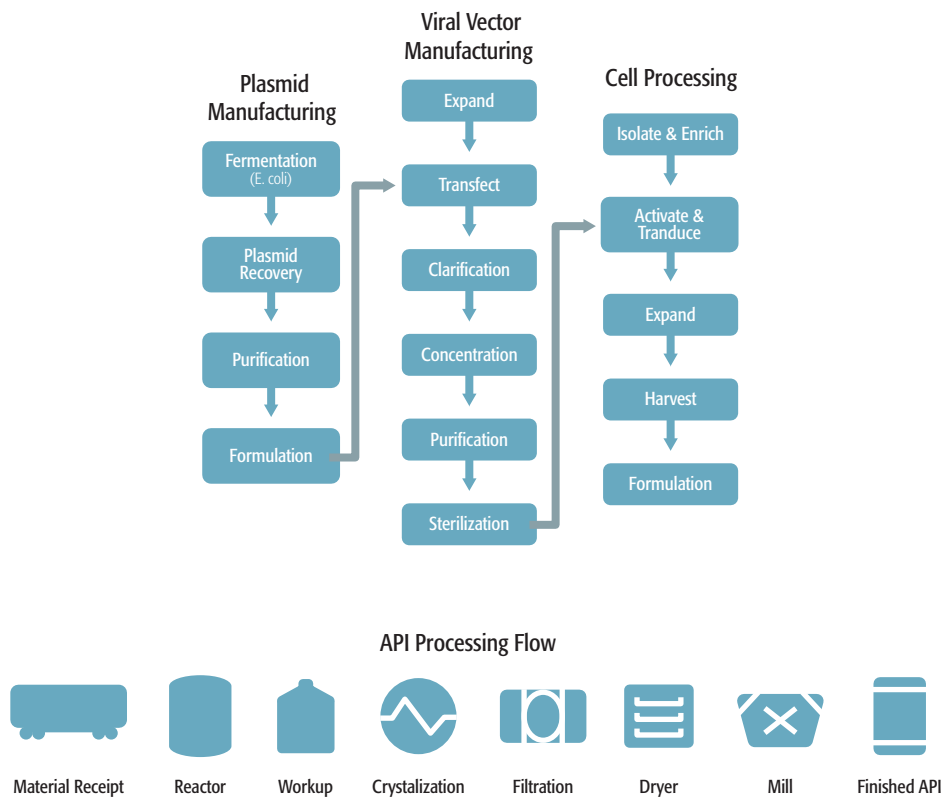
outcome assessment, dose evaluation, patient selection, and engineering of gene constructs and carriers.<sup>61</sup> The potential spillover from each new GRT can accelerate advancement of future GRT development, especially for rare diseases, in which it is challenging to develop therapies in isolation. Considering the spillover effect, it may be that investment in early gene therapies will lead to lower costs of producing these in the future. Therefore, it is reasonable to reward investment in GRT with higher valuations and pricing.

### Manufacturing Costs for Gene Replacement Therapy

Producing GRTs requires many complex phases, each with more steps than manufacturing small molecules (Figure 2).<sup>62</sup> A highly trained workforce is also required. First, vector and transgene constructs are produced, and cells that will be used to replicate the vector and transgene are grown. Next, the GRT materials are inserted into cells that must be grown in dishes or flasks and kept in incubators. As cells grow and divide, they produce more GRT, take up more space and use more incubators. Maintaining the cells requires a sterile technique with multiple complexities.<sup>63</sup> Once enough GRT is produced, the cells are burst open or lysed, and the resulting solution is purified to achieve maximal purity and yield of the GRT. Multiple rounds of purification are required, and there is a substantial reduction in the yield of GRT at each round.<sup>53</sup> As shown in Figure 2, this is in contrast to small molecule production in which chemicals are put into giant containers to synthesize a medication, which then is granulated, dried, blended, and compressed or encapsulated with no product loss during the process.<sup>64</sup> Because of these differences, the overall cost of manufacturing a single dose of GRT is significantly higher than that of a small molecule.

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Figure 2. Production of small molecule therapies typically takes eight steps with minimal loss of product throughout the process, whereas production of gene therapy typically takes eighteen steps with multiple rounds of purification during which some product is lost.



Further, growing enough cells to replicate GRTs at scale requires a large manufacturing facility and infrastructure capabilities that may differ from one GRT to another, creating the need for bespoke manufacturing processes and training. The dose and volume for each GRT also varies based on the replaced gene's role in the body. For example, a smaller dose and volume of Luxturna is needed for IRD, in which only the eye is targeted, compared with hemophilia or DMD, in which weight-based doses are required and given systemically.<sup>51,65</sup> This adds to the cost for these treatments, both directly in that a higher volume of treatment costs more and because they require a large amount of manufacturing infrastructure, much of which remains to be built.<sup>66,67</sup> Although the associated costs are expected to decrease as infrastructure and capacity are built, the up-front investment in manufacturing GRT requires considerable capital.<sup>66</sup>

## Current Policies May Discourage Innovation and Development of New Gene Replacement Therapies

Despite the high value of GRTs and the potential cost-effectiveness of these one-time or infrequently dosed disease-modifying treatments, current policies may discourage future investment and innovation in this field. These include how cost-benefit analyses are conducted, FDA regulations regarding manufacturing and clinical trials, and the different revenue generation curves for these treatments.

Most cost-effectiveness analyses compare the healthcare-related direct medical costs of one medication vs. another.<sup>68</sup> However, these are typically reduced with disease-modifying therapies.<sup>69</sup> Such an environment puts downward pressure on pricing, making it difficult for investors in GRT to recoup their sunk costs in a reasonable amount of time. Particularly when looking at gene therapies, it is essential to capture all medical costs as well as societal costs associated with the disease. It is also necessary to understand what the patient population in question values and what treatment benefits they view as meaningful. When this is ignored, we can undervalue treatments that bring huge value and advances to patients or overvalue treatments that ultimately do not provide meaningful value to patients.

Current FDA regulations require using commercially representative material early in the clinical trial process. Thus, GRT developers must invest in large-scale manufacturing capabilities requiring significant capital investment before having signs of clinical efficacy in humans. In addition to the burden of up-front investment in manufacturing, such regulatory policies prevent developers from taking advantage of new manufacturing innovations. Recent FDA guidance states that even when manufacturing changes improve therapeutic agents, the agency may not view a product produced with a different process as comparable to those produced with previous processes. Under this policy, even improvements in GRT manufacturing that could decrease the high manufacturing costs, improve product yield, or improve safety may require a new investigational drug (IND) application, new safety studies, and new clinical trials. These policies disincentivize companies from innovating or improving their manufacturing processes to avoid delays associated with preparing a new IND or conducting new clinical studies. An alternative would be to consider using the International Harmonization of Technical Requirements for Pharmaceuticals for Human Use (ICH) standards that evaluate manufacturing processes' compliance with best quality, safety, and efficacy practices.<sup>70</sup>

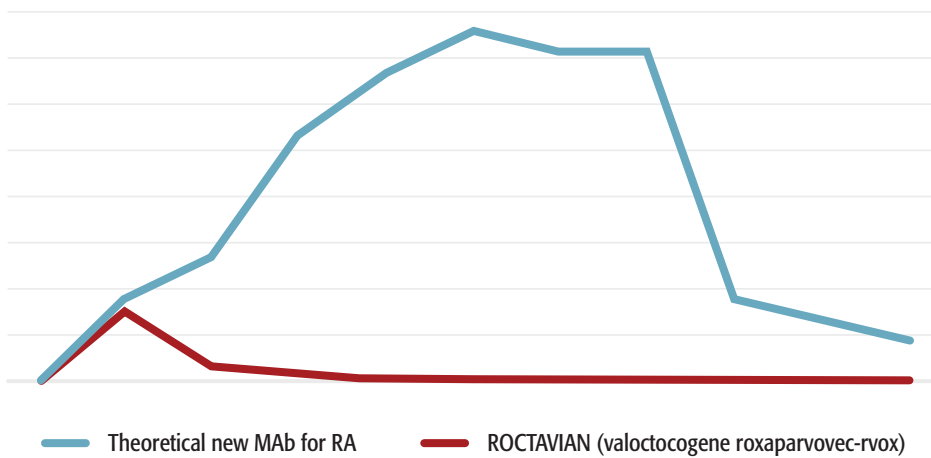
The FDA also strongly recommends placebo-controlled clinical trials that make patient recruitment challenging and more costly, especially for rare, serious diseases with extremely small patient populations for which the window of opportunity to provide disease-modifying treatment may be narrow. In the context of slow, irreversibly progressive diseases, requiring patients to be on a placebo also presents ethical challenges as patients will continue to irreversibly progress during the trial. As recruitment becomes more complex, more clinical sites have to be added

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to trials, increasing costs and time to completion of the trial. Such policies increase the risks of developing GRTs and disincentivize further innovation and development. The use of novel trial designs, such as single-arm studies with an external control (e.g., a natural history comparator), has successfully been leveraged as an alternative to traditional, double-blind placebo-controlled randomized trials.<sup>71</sup>

The FDA prefers traditional trial designs, which can be challenging to statistically power for rare diseases because of the small pool of potential participants who could be treated with a new GRT. Smaller cohorts make it more difficult to show the statistical significance of any effect of medication. Additionally, diseases with a genetic basis often have highly variable symptoms between individuals,<sup>72</sup> making it difficult to identify the appropriate clinical endpoint for all participants. Finally, many fatal genetic diseases are slow progressing, such that the mandate to reach a clinical endpoint extends the length of the trial (i.e. 10-year trial), again increasing costs and risks and most especially would delay the patient community from getting access to an FDA-approved drug. This makes many of these treatments ideal candidates for the FDA's Accelerated Approval Pathway.<sup>73</sup> Accelerated approval allows earlier approval of medications that fill an unmet medical need based on a surrogate endpoint. Using a surrogate endpoint can significantly shorten the time needed in a trial to show benefit, ultimately allowing the innovator to bring the treatment to patients sooner. Once approved via accelerated approval, the innovator is still required to complete confirmatory trials to show the drug does provide the asserted benefit to patients.

**Figure 3. Potential revenue curves for a gene therapy for ultra-rare conditions, such as hemophilia A, which affects ~33,000 people in the U.S. (red) vs a monoclonal antibody for a rare condition, such as rheumatoid arthritis, which affects ~1.3 million people in the U.S.**



Misguided federal and state drug pricing pressures, high costs related to manufacturing, and regulatory uncertainty deter investors, creating significant barriers to the revenue generation curve of GRTs compared to traditional medications (Figure 3). In addition, high interest rates have made it harder for biotech companies to raise capital. In 2023, the number of biotech bankruptcies reached a new height, primarily due to the inability to raise capital and finance debt.<sup>74</sup> Large biotech companies have been discontinuing gene therapy programs, in part because of perceived risk and poor return on investment. Most gene therapies are developed by small companies, making it essential that investors see benefit in the prospect of a successful gene therapy and continue to invest in these companies and products. Without such investments, these small and often start-up organizations cannot continue developing GRT, leaving patients with unmet medical needs. Medications that are needed across the lifespan have a more gradual rise in revenue that continues until most eligible patients are using the drug and then plateaus at a predictable rate based on the

number of people starting or discontinuing treatment for any reason. After this time, the potential revenue drops rapidly to reflect the incidence of the rare disease treated, creating a lower plateau. This different revenue generation model demands a deep pipeline and faster development of new agents for GRT companies to remain in business, support new research and development, and provide a return to their investors. Regulations that disincentivize innovation and lengthen the time to market for GRTs make this problematic and may drive investors away. To ensure a robust pipeline of gene therapies and that patients can access these promising treatments in the future, the regulatory and reimbursement environments must adapt to address the complexities of bringing gene therapies to market.

## Conclusion

Replacing a dysfunctional gene with a functional version is transformative. These treatments improve quality of life, return function, and decrease burdensome symptomatic and ancillary care. All GRTs are disease-modifying by nature as they target the causal path of disease. GRTs can reduce the lifetime costs of caring for people with rare and debilitating diseases. Some also have the priceless quality of prolonging and perhaps even saving lives.

There is downward pressure on pricing as those who analyze costs and benefits must adapt to a one-time vs chronic treatment model. New models and pricing paradigms need to be developed to fully account for the transformative value of GRTs so that they continue to be developed and innovation can occur. Such novel economic evaluation will ultimately help realize the potential of these treatments and can transform how we treat chronic conditions, substantially reducing the burden of illness.

The high costs of developing GRTs due to their inherent complexity, development, and manufacturing costs, as well as significant regulatory burdens, are barriers to investment. Lowering investment risks by addressing development costs, modernizing pricing evaluation, and easing regulatory burdens will likely attract more investors and companies. Such forward-thinking policies can breed competition and accelerate innovation for these high-value treatments for patients looking for cures or long-term management of their disease.

## Recommended Considerations

- **Pricing** - Assessing the price of the gene therapies must consider the lifetime of value of those therapies.
- **Price comparison** - To compare the price of gene therapy to traditional biopharmaceuticals utilized chronically, overall cost reductions throughout a patient's lifetime must be considered.
- **Investment** - Long-term viability of gene therapy research requires long-term investment by both the public and private sector
- **Patients** - The evaluation of the impact of gene therapy should involve reduced lifetime burden on patients and caregivers compared to chronic management of patients' disease, which may not be as effective.
- **Research/Development/Manufacturing** - The viability of the gene therapy market involves a different regulatory approach than the one typically utilized to manage traditional biopharmaceuticals.

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