EDITORIAL

Cost of gene therapy

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Since its earliest days and during the ensuing 5–6 decades, the field of human gene therapy has been characterized by exhilarating promise and tantalizing results, some crashed exaggerated expectations, technical setbacks and missteps and disappointingly slow scientific and public acceptance. That history has taken place against a background of inexorable and steady maturation of the underlying scientific and medical landscapes that has made eventual success inevitable. This complex development has now finally allowed delivery of gene-based therapies to the bedside, to real patients with real disease. It has even made it possible to imagine, without embarrassment, the reality of "genetic cure" of otherwise intractable disease.

As is true of many fields of Medicine, the road to success has not been without its diversions and detours from the earliest simplistic conceptualizations. But, as described in this series of papers in this issue of Gene Therapy [1–5], the glittering early promise of this new field of Medicine is now slowly but surely being realized. The genes responsible for many human diseases have been identified, their mechanisms for disturbing normal cellular and physiological function are coming to be understood and techniques and tools for interfering with their pathogenic effects or restoring normal function are being developed. Remarkable among both small incremental and major groundbreaking advances have been the improved understanding of pathogenesis of many human diseases, the development of efficient and safe transducing virus vectors and non-viral techniques for introducing new genetic information into cells and the various astonishing techniques for making designed and targeted changes in the DNA genome and the various RNA machineries of the cell—"genome editing" (see the perspective by Melinda Kliegman and colleagues [2] in identifying solutions for the CRISPR space learning from established business models).

As reviewed by Donald Kohn and colleagues [1] in this issue, these techniques have led to the development, regulatory approval and marketing of a handful of gene therapies in the past decade. It is clear that we can confidently expect many more will be developed in ever increasing numbers in the coming months and years. Because the underlying technologies are improving and developing at such a rapid pace, we are confident that the number and scope of clinical applications will grow and assume an increasingly prominent role in the armamentarium of Medicine.

But in the wake of all of this conceptual and clinical success a new and troublesome and possibly even more difficult set of issues has appeared—that of ensuring these stunning medical advances can be fairly and equitably delivered to desperate patients and families. The solution to many technical and scientific problems and the resulting medical advances have allowed the emergence of sociopolitical dilemmas that are likely in the future to interfere with our societies and our society's health care delivery programs designed to ensure just, equitable and affordable access to these remarkable preventive therapeutic methods and future health care innovations. In their discussion below, Steve Joffe and colleagues [3] describe some ways in which academia can influence fair and affordable access to gene-based therapies. Sadly, severe pricing problems have already begun to emerge that challenge accessibility and affordability, not only to patients but also to health care and insurance institutions. To underscore this issue, one need only realize that a number of recently approved gene therapies have appeared on the market at very high prices—several million dollars—certainly out of reach for most patients that put enormous financial burden on privatized/governmental insurance industries, not to mention the variations in approval procedures between countries (see perspective by Aaron Kesselheim and colleagues [4] in this issue. Such prohibitive prices have been rationalized by some medical economists and industrial providers as being just and fair since they may represent potential economic savings to societies and should be acceptable to patients and families based on lives-saved-at-any-cost principle and on anticipated lifetime earnings potential of successfully-treated patients. But many patients will certainly find that they are not covered by their medical insurance programs and will surely lose homes and life savings in order to obtain needed therapies (as reviewed by Rena Conti and colleagues [5] in this issue).

The editors of *Gene Therapy* are deeply concerned that the technologies and clinical applications of gene-based therapies must be made accessible and affordable, not only in societies in which universal health care is available, as in much of the world, but also in countries such as the United States where health care insurance is not available or affordable to millions of patients and families as a matter of national policy but rather is built upon the complexities, vagaries and inequities in the range from private to governmental health care insurance systems. In June of last year, 50 years after one of us in collaboration with Richard Roblin [6] raised some of the potential scientific and ethical dilemmas associated with gene therapy, we invited leaders in the field of gene therapy, genome editing, medical economics and public policy to a webinar to discuss a simple topic, "why does gene therapy cost so much?". Collectively, the group were asked to examine the current state of pricing of gene-based therapies, and how it is likely to evolve during the expected explosive growth of the field of genetic Medicine. The five papers [1–5] in this special issue of Gene Therapy reflect some of these analyses, thoughts and recommendations. We and they hope that careful examination of this problem and development of solutions will help our societies catch up socially and ethically with the rapid technical growth of the field.

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