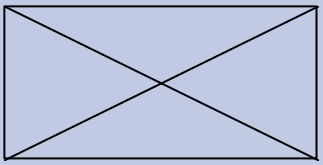


TA 32A/1999

SOMATISCHE GENTHERAPIE: DIE KRANKHEIT AN DER WURZEL PACKEN

Kurzfassung der TA-Studie “Gentherapie”

LA THÉRAPIE GENIQUE SOMATIQUE: ATTAQUER LE MAL À LA RACINE

Résume de l’étude TA “Thérapie génique”

SOMATIC GENE THERAPY: STRIKING TO THE ROOTS OF DISEASE

Short version of the TA-study “Gene therapy”

Schweizerischer Wissenschaftsrat • Conseil suisse de la science • Swiss Science Council

Editorial in german only

Diese Reihe der TA-Publikationen enthält die Ergebnisse der Studien, die im Rahmen des TA-Programms des Schweizerischen Wissenschafts- und Technologierates (SWTR) durchgeführt wurden.

Mit TA (Technology Assessment / Technologiefolgen-Abschätzung) werden dabei Projekte bezeichnet, welche zum Ziel haben, die gesellschaftlichen Auswirkungen neuer Technologien möglichst umfassend zu untersuchen. Es geht darum, die allfälligen positiven und negativen Einflüsse der Technologie auf soziale, politische, wirtschaftliche und ökologische Systeme und Abläufe abzuschätzen.

Nach einer Pilotphase von 4 Jahren haben der Bundesrat und das Parlament den SWTR beauftragt, die TA-Aktivitäten für die Periode 1996-1999 weiterzuführen.

Um diese Aufgabe zu erfüllen, wurde vom SWTR ein TA-Leitungsausschuss aus Fachleuten von Wissenschaft, Industrie, Politik und NGO's (Nichtstaatliche Organisationen) eingesetzt, welcher die massgeblichen Themen und Fragen definiert, die es im TA-Programm zu behandeln gilt.

Ende 1999 wurde vom Parlament beschlossen, die Technologiefolgen-Abschätzung zu institutionalisieren. Dies ist im Bundesgesetz über die Forschung vom 8. Oktober 1999 festgehalten.

Die materielle Verantwortung für den Bericht liegt bei der Autorin:

Dr. Anne Eckhardt
Basler und Hofmann AG
Forchstrasse 395
CH-8029 Zürich

Betreuung des Projektes:
Dr. Adrian Rüegsegger, TA-Geschäftsstelle, Bern

Redaktion der Kurzfassung:
Dr. Lucienne Rey, TA-Geschäftsstelle, Bern

Der ausführliche Bericht "Gentherapie" kann bezogen werden bei:

TA-Programm Schweiz
Schweizerischer Wissenschaftsrat
Inselgasse 1
CH-3003 Bern

Tel +41 31/322 99 63
Fax +41 31/323 36 59

RAY OF HOPE

A large number of diseases originate in the genetic constitution of the patient. Advances in the science of genetics over recent years have made it possible to more accurately localise several of these diseases within the human genotype. This development has given cause for hope that hereditary afflictions can in future be treated by the targeted manipulation of the genetic programme in the affected cells. The technique under review is known as somatic gene therapy.

She cannot keep up with the other children running across the field, but drops back coughing and gasping for breath. She brings along a rucksack filled with therapeutic apparatus to the holiday camp. Several times a day, she has to breathe through a respirator that creates a negative pressure to loosen the mucus that has accumulated in her bronchia. Unlike most children of her age, Silvie is very familiar with medical terms: chronic bronchitis, antibiotics therapy, cardiac arrhythmia – cystic fibrosis. Silvie, at the age of ten, knows that the disease will be her lifelong companion. She will have to forget her dream of becoming a flight attendant, and will not only be dependent on health insurance for the rest of her life, but possibly also need the financial support of a disability pension.

Cystic fibrosis (CF) is one of the most common congenital metabolic diseases. In Europe, an average of 1 out of 2,000 new-born babies are afflicted with it. In Switzerland alone, there are some 900 to 1,000 sufferers. CF is attributable to a defective chromosome, which causes a malfunctioning of the body's glands. The substances secreted by impaired glands are often more viscous, and their chemical composition also differs from the body fluids found in healthy persons. The lungs, in particular, are more susceptible to chronic inflammatory diseases. In time, damage to the lungs and the constant strain on the heart shorten the life expectancy of CF patients. Today, CF sufferers can expect to live to the age of 25 or 30. In the past, children afflicted with CF usually did not survive infancy.

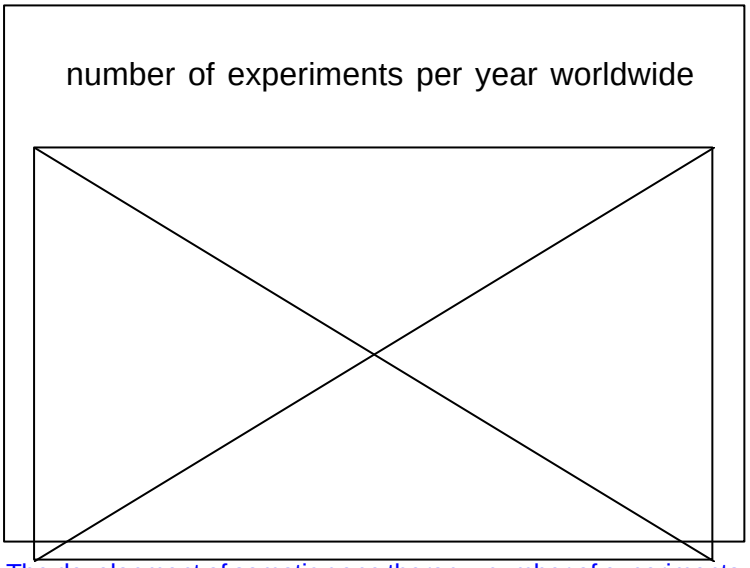
CF is an inheritable disease, controlled by a recessive gene. This means that a child will be affected only if both parents have a hereditary, pathological disposition to CF. If there have been no recorded cases of CF in the family, parents often do not know that they carry the defective gene. This disastrous inheritance begins to manifest itself in the sick infant's symptoms. It does not gain enough weight, suffers from respiratory and digestive ailments, and perspires heavily. Worried parents occasionally find saline deposits on their baby's skin.

For some time, the domains of medical science and molecular biology have been involved in developing techniques to improve the treatment of CF. Gene therapy is a source of hope that one day this disease will be cured at its origin.

Initial findings of the experimental phase

After approximately twenty years of preliminary work carried out in basic research, somatic gene therapy was first tested in clinical studies in the early 1990s.

In 1990, a curative gene was transferred to the blood cells of a four-year-old patient suffering from a severe immunodeficiency disorder. This experiment, which was performed in the USA, showed promising results and met with international acclaim from both the media and the public. At present, approximately 300 clinical experiments are being carried out worldwide to investigate this new medical technique. Since the inception of research endea-



The development of somatic gene therapy: number of experiments per year

vours into somatic gene therapy, Switzerland has played a prominent role within the international research community. Of the 46 studies that were in progress in Europe in 1996, nine – some of them in advanced stages of completion – were being carried out in Switzerland. By the end of 1998, the Swiss authorities had approved a total of 17 clinical research studies into somatic gene therapy.

With the support of the French company Transgène, the Cantonal University Hospital in Geneva began a project in 1995 to combat **cystic fibrosis** by applying somatic gene therapy. The methodology of this project involved introducing a healthy version of the otherwise defective gene responsible for CF into the nasal mucous membrane of the subject. The objective was to ascertain whether a healthy gene thus introduced would lead to the organism's production of healthy protein to replace the defective protein found in CF patients, and thereby favourably influence the course of the disease.

Cystic fibrosis is only one of several diseases that can be counteracted by somatic gene therapy. **AIDS** research also utilises this new technique. The HIV virus that leads to AIDS attacks cells of the endogenic immune system. In time, the organism becomes so weakened that even those pathogens that are usually resisted by a healthy immune system cause infection. Disorders of the nervous system, tumours and infections ultimately lead to death. From 1995 to 1997, a clinical study was carried out at the University Hospital in Zurich to determine whether a gene vaccine could be successfully applied against the HIV virus. This vaccine contains fragments of the genetic information found in the HIV virus and was injected into subjects that were infected with the virus, but as yet showed no symptoms of the disease. The vaccination is intended to stimulate the endogenic immune response, thereby strengthening and enabling the immune system to better combat the continual proliferation of the virus.

In the fight against **cancer**, medical science is also optimistic about new techniques. Worldwide, about two-thirds of the gene therapy experiments currently in progress are addressing cancer. In the case of glioblastoma, a particularly dangerous kind of brain tumour, it is usually impossible to surgically remove all the tumorous growth without risking serious impacts such as paralytic symptoms, impaired vision or speech, and other serious complications. After the surgical removal of the tumour, gene therapy could be applied to effectuate the dying off of those cells, which would continue to multiply. In the brain, these would be limited to the remaining cancer cells. Although this approach sounds convincing, it – as well as nearly all other gene therapy techniques – has yet to prove successful.

Recently, further perspectives for the application of somatic gene therapy have opened. So, for example, influencing the **growth of blood vessels**. This technique could be implemented to restore damaged blood vessels, and possibly save limbs in cases of diabetes or frostbite, where exceedingly poor blood circulation may even indicate amputation.

As somatic gene therapy basically makes the modification of cells possible, thereby enabling them to produce active substances (e.g. hormones), diseases such as diabetes could in future be treated with ‚**artificial glands**' that react to endogenic signals.

Warning against too high hopes

In view of the very broad spectrum of seemingly spectacular applications for somatic gene therapy, sceptics urgently warn against an overly optimistic outlook in terms of cures. A therapeutic effect could not yet be attributed to gene therapy.

In the Geneva study of cystic fibrosis therapy, the actual gene transfer into the nasal mucous membrane of the subject was validated. The therapeutic effect, however, was negligible. In the fight against glioblastomata, initially encouraging signs gave way to disappointment. To date, gene therapy has not markedly improved the quality of life or life expectancy of brain tumour patients. It has merely been demonstrated that gene therapy is hardly linked to unpleasant side effects.

Critics argue against investing a disproportionate amount of hope in somatic gene therapy, while neglecting the development of alternative treatment interventions and prophylactic measures. The human body is much more than the sum of its genes. For this reason, complex interactions within the organism will often oppose a successful implementation of gene therapy.

Somatic gene therapy vs. germ-line gene therapy

Somatic gene therapy is focused on cells whose genetic constitution will not be transferred to the following generation. The effects of this therapy technique are, therefore, limited to the individual receiving treatment.

In contrast, in germ-line gene therapy, cells that transfer genetic information from one generation to the next are treated. Among these are the precursors of ova and spermia, fertilizable ova and spermia as well as cells in the early embryonic stage of human development – for at the beginning of embryo development, germ and soma are indistinguishable.

Germ-line gene therapy has largely met with disapproval in Europe, and the Swiss Constitution (Art. 24 novies, Para. 2) expressly prohibits its application in the Swiss Confederation. Apart from the intrinsic and substantial technical difficulties that remain unresolved, serious ethical considerations further obstruct the implementation of this technique. The fate of future generations could be manipulated by germ-line gene therapy, and without the benefit of informed consent. Moreover, this technique infringes upon the cultural and moral concept of the inviolability of human life. There could be no irrevocable guarantee that germ-line gene therapy might not one day be misused for breeding humans that possess certain physical attributes.

Notably in the USA, the question of why generation after generation should suffer from inheritable diseases when these could be eliminated by one single germ-line gene therapy is the subject of an ongoing debate. Before somatic gene therapy could ever become an established technique in clinical practice, extensive clarification pertaining to its legal, moral and ethical aspects would be essential.

2

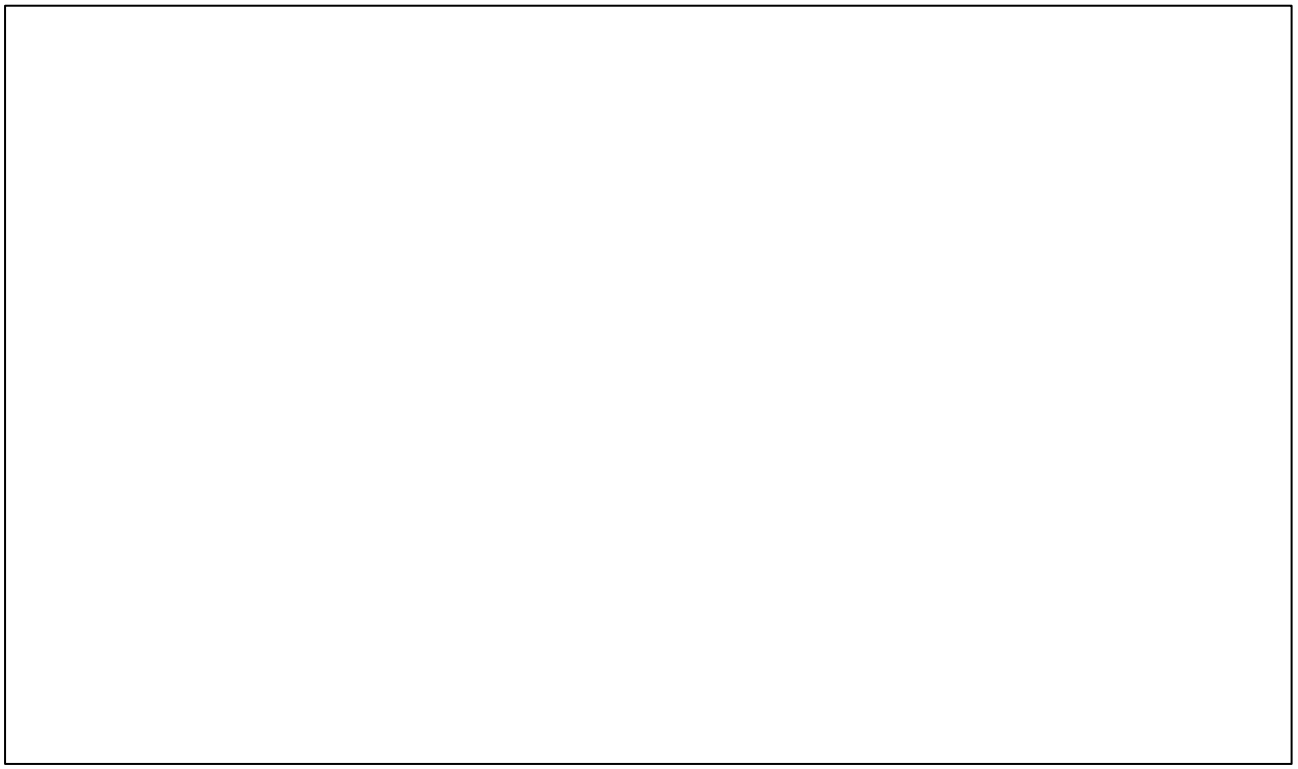
HEALTHY THROUGH INFECTION

‚Genetic bullets' are fired at the ‚target tissue' to be treated and foreign genes are smuggled into sick cells by viruses. No holds are barred in the fight for health, and somatic gene therapy does not shrink from using subtle martial tactics in its crusade.

The current most effective method of transferring genes into the body of a patient is by viral ‚infection' – an occurrence frequently observed in nature. Experts term this procedure ‚gene transfer by viral vectors'. In this procedure, genes, which are to infiltrate the target tissue, are implanted into the genome of a virus. Harmless pathogens – such as a cold virus – are particularly suited to the job of gene ‚carrier'. Genetic engineering techniques are used to change the viruses so that they can no long multiply in the recipient's body. These viral carriers insert the therapeutic gene into the host cell. In some cases, the gene is passed on to the offspring of a cell when it multiplies, in other cases, the gene is lost after a certain time – comparable to the elimination of the drug in medication therapy.

Because the ‚collaboration' with viruses is not always easy, research teams are now investigating alternative vehicles to transport a therapeutic gene into damaged tissue. One promising method is using microscopically small fat particles (so-called liposomes), in which genes have been deposited. These fat particles melt into the cell membrane so that the gene is released into the interior of the cell.

Other experiments focus on introducing ‚naked', or unpackaged, genetic information directly into the cell. ‚Genetic bullets', for ex-



Different procedures to infiltrate target tissue

ample, consist of fine gold particles that have been coated with genetic material; they are ‚fired' into the target tissue under gas pressure. This method, however, has only been tested on laboratory animals and in cell cultures.

Medical science differentiates among three procedures to infiltrate target tissue:

- In so-called ‚*ex vivo* therapies', cells from the target organ of a patient are removed and treated outside the body with gene therapeutic measures. Once the cells have multiplied, they are re-transplanted into the body. This procedure is technically difficult to perform and quite costly.
- In ‚*in vivo* therapy', the gene carrier must find the target more or less on its own, similar to the path taken by medication. The major drawback to this technically simple procedure is that the carrier is not always unerring. In other words, vectors dock unnecessarily on numerous cells that they encounter on their way to the target organ.
- In the case of ‚*in situ* therapy', on the other hand, the gene carrier or the naked gene is introduced directly into the tissue. This is done either by means of an injection or by inserting the carrier into an incision after a surgical operation. However, even this procedure, which is aimed precisely at the target organ, leaves much to be desired.

"With regard to risks and side effects....."

The risk of infection can never be entirely excluded if viruses are used as carriers to introduce a foreign gene into an organism. This hazard persists, although generally viruses are used that are weakened, no longer fertile, and often in their original state not pathogenic or able to cause infection. In that the genetic material of the viruses fuses with that of the host cells, fertile and pathogenic viruses could, under certain circumstances, develop.

Reactions of the endogenic immune system pose another problem in gene therapy. The immune system is activated once it identifies the vector as a foreign body. The intensity of this reaction increases in proportion to the number of antibodies already circulating in the blood stream. These may be present due to a previously administered, similar gene therapy. Common side effects are inflammation and fever.

Gene transfer by viral vectors

Some of the interventions carried out in gene therapy can promote the development of cancer in the long term. Certain viral messengers merge coincidentally with genetic material of the host cells. This gives rise to the danger of a gene that was assigned to the prevention of tumorous growth being destroyed.

In comparison to the side effects that can occur in the conventional therapy of severe illnesses, the risks associated with somatic gene therapy would seem tolerable. In the treatment of cancer, for example, both chemotherapy and radiation therapy generally create more pronounced adverse effects on the state of health, quality of life, and future perspectives of the patient than does somatic gene therapy. Nonetheless, before every application of this new form of treatment, it is imperative to carefully weigh the contingent risks against the possible benefits. This critical approach is most particularly indicated when diseases that are neither severe nor life-threatening are to be treated with gene therapy.

3

WHO PAYS FOR GENE THERAPY?

Numerous complex issues will have to be clarified, before a widespread application of somatic gene therapy in Switzerland can be envisioned. It has proved extremely difficult to estimate the economic consequences, not least due to the conflicting interests of various groups involved in gene therapy.

The Swiss are prepared to pay dearly for their health and well-being. The cost of health services in Switzerland swallows more than ten percent of the gross national product. In 1996, the inhabitants of Switzerland spent approximately USD 2,500 per capita in their fight against illness, and ranked second among all the OECD nations, right behind the USA (with USD 3,900). An assessment of the impact of somatic gene therapy on health costs is highly problematical – particularly because the therapeutic effects of this new technique vary from case to case.

Footing the bill

On the one hand, gene therapy techniques offer the potential to cure diseases for which no other suitable form of therapy is yet available. Cystic fibrosis is one example. Gene therapy could be used to more effectively treat widespread diseases such as arteriosclerosis and diabetes. These aspects could lighten the burden on health and disability insurances.

On the other hand, new forms of therapy will probably reinforce the strongly prevalent trend towards raising the average life expectancy. This aspect would heighten the burden on the social security system.

How the widespread application of somatic gene therapy would effect private households is open to conjecture. At present, these contribute with some 65 percent the largest share towards health care costs. Approximately one-third of this percentage is allotted to direct payments, the remainder represents payments settled by health insurance companies. Somatic gene therapy, in conjunction with other innovative medical techniques, may well have financial consequences for private households. Whether health costs consequently will rise or fall, depends upon the answers to a multitude of questions. Some of these are: which conventional therapy approaches will be superseded by gene therapy; how frequently must a given gene therapy technique be administered; must the patient's state of health be constantly monitored; and, will the need for nursing care be reduced, or even become superfluous. For the present, however, somatic gene therapy has not yet reached the stage of development to respond conclusively to these questions.

Gene therapy and the labour market

Establishing somatic gene therapy as routine practice could mean, first, the creation of new jobs. The need for specialists, familiar with the new therapy techniques, would arise not only in the pharmaceutical industry, but also in the public health sector and among supplier companies. To meet this demand, medical staff would have to be specially trained in gene therapy, and the further development and refining of the new techniques would afford an extensive field of activity for highly skilled specialists.

In the medium term, however, it is probable that somatic gene therapy would not only fill the existing therapeutic gaps, but also supplant conventional therapy approaches and lead to job displacement. One thing is certain – the new labour market that would emerge thanks to somatic gene therapy would primarily benefit a highly qualified and accredited workforce.

The development and marketing of gene therapy techniques

The economic impact of gene therapy would not only be felt in private households and in insurance companies, but also reverberate in the public households, the universities, and in the pharmaceutical industry.

Manifold research projects focusing on somatic gene therapy are currently being carried out in Swiss universities and institutes of technology. Since 1996, a National Research Programme (NRP 37), which is limited to five years, has been in progress to investigate somatic gene therapy. Within the framework of the NRP, primarily basic research was conducted from 1996 to 1998. From 1999 to 2000, the emphasis will shift to applied research.

The universities could provide the impulse for the emergence of small companies specialised in gene therapy. This symbiosis is easily envisaged, since not only would specialists be recruited from the universities, but these institutes would also be the source of the requisite expertise and knowledge needed to produce marketable products.

Among the major Swiss pharmaceutical companies, Novartis is ahead in researching somatic gene therapy. This research work is mainly carried out in Novartis' foreign branch offices and in partner companies. In contrast, the Hoffmann-La Roche pharmaceutical company is adopting a more wait-and-see strategy. It maintains points of contact regarding gene therapy through partnerships with other companies.

The experiences of other countries, especially the USA, show that small gene engineering companies play a decisive role in contributing to the innovative force of a nation's economy. These small-scale companies act as interfaces between the universities and the pharmaceutical industry, and therefore contribute to the exchange of ideas among the public educational system, research institutes and private enterprise. Until recently, there were no small biotechnology companies developing therapeutic agents in Switzerland. Since 1996/97, however, Modex Thérapeutiques S.A. in Lausanne has been manufacturing cell implants. At the beginning of 1997, this young company boasted a staff of ten. Another biotechnology company, Prionics, grew from the University of Zurich in 1997.

The technology transfer agency Biotectra promotes the founding and development of small companies in the biotechnology sector. So far however, no companies specialising in gene therapy domiciled in Switzerland.

Success stories of a different description

The following fictitious accounts show that the effects of gene therapy may differ according to its application and the individual disease. These short case histories illustrate the inherent difficulties in the assessment of the economical impact of gene therapy.

- Ms. Staub was diagnosed with breast cancer. After her operation, she was treated with a combination of chemotherapy and radiation therapy. These measures did not effect a cure, but did lessen the symptoms. Although Ms. Staub was no longer able to work, her general condition considerably improved until shortly before her death.
- Mr. Kuhn, who suffered from leukaemia, was cured. In his case, the comparatively less expensive gene therapy could be administered like medication. Without having to worry about undergoing protracted treatment, he was able to go back to work and resume his life as before.

It is obvious that cost-benefit considerations cannot derive solely from economic criteria. In the case of Mr. Kuhn, the benefit factor equates favourably with the cost factor, and satisfies economic aspects. Whereas in the case of Ms. Staub, the cost factor outweighs the likelihood of a sustainable enhancement in the quality of life.

Unsettled questions

Even after the medical and technical problems of implementing somatic gene therapy have been solved, and a viable prognosis of the economic consequences has been reached, there will still be a series of issues demanding clarification:

- To what extent should research into somatic gene therapy be endorsed and the founding of small gene therapy companies be promoted?
- How would society deal with new medical technologies such as gene therapy that could enhance the quality of life and extend life expectancy, but probably also mean higher health care costs and an additional burden on the social security system?
- How would gene therapy as routine clinical practice affect public health services? Would, for example, a new division of labour between hospitals and pharmaceutical companies result?

SCATTERED LEGISLATURE

Somatic gene therapy is not comprehensively regulated under Swiss law. Diverse ordinances and laws govern each different phase in the development of the new therapy techniques. In addition, relevant guidelines, such as those of the Swiss Academy of the Medical Sciences (SAMW), also apply.

Somatic gene therapy touches upon different provisions of the law, which are briefly outlined below:

- The ordinance pertaining to „clinical trials with immunobiological products" is aimed at the **protection of patients**. This decree protects the rights of the patient sample in clinical trials, and governs the quality standards of the trials. In particular, two stipulations must be complied with before a clinical trial is authorised: an ethics commission must approve the trial, and the project must be submitted to the Federal Office of Public Health. Furthermore, certain passages of the Federal act governing the „control of blood, blood products and transplants" must be observed when cells with an altered genotype are to be introduced into the human body. The Swiss Civil Code and Federal Code of Obligations regulate the legal rights of the individual and the statutory liability, applicable in cases where a patient has suffered damage attributable to gene therapy.
- The law on epidemics prescribes the measures to be taken to protect the **population** against contagion. This law also stipulates the prerequisite of obtaining a licence for the production, import and distribution of immunobiological products.
- Regulations are in effect to protect medical personnel and the staff of pharmaceutical companies from the danger of infection and disease. Thus, article 6 of the legislation on labour obliges employers to take all the necessary precautions to protect the health of their **employees**. The law regulating accident insurance could also come into force if employees assisting in the application of somatic gene therapy were harmed.
- Numerous laws and ordinances regulate the protection of the **environment**, and thereby the safety of the populati-

Protection and preservation of	Laws, ordinances and guidelines
Health of the population	Law on epidemics Law on the preservation of the environment Federal law on health insurance Swiss Federal Code of Obligations Regulations of the IKS Guidelines of the SAMW and the SKBS
Health of patients	Ordinance on clinical trials with immunobiological products Federal act on the control to blood, blood products and transplants Federal law on product liability Swiss Federal Code of Obligations Regulations of the IKS Guidelines of the SAMW and the SKBS
Health of employees	Law on epidemics Law on accident insurance Legislation on labour Swiss Federal Code of Obligations Guidelines of the SAMW and the SKBS
Human dignity	Ordinance on clinical trials with immunobiological products Swiss Federal Code of Obligations Swiss Civil Code Guidelines of the SAMW and the SKBS
Environment	Law on the preservation of the environment Guidelines of the SAMW and the SKBS
Laboratory animals	Law on the protection of animals Guidelines of the SAMW and the SKBS
Intellectual property	Federal law on patents
Data protection	Law on the protection against the misuse of personal data

SAMW = Swiss Academy of the Medical Sciences; SKBS = Swiss Commission for Biological Safety; IKS = Intercantonal Control Office for Pharmaceutical Preparations

What the most pertinent laws, ordinances and guidelines protect

on. Of interest in this connection is Article 29 of the law on environment protection, which states the obligation to obtain a permit from the Executive Federal Council before gene-manipulated organisms may be released into the environment. Whether gene therapy should be thus construed is contested.

- A major concern for pharmaceutical and biotechnology companies engaged in the development of somatic gene therapy is, of course, that their **research endeavours** will be legally protected and recognised. Patents are of central importance here, in that they prevent competitors from putting a similar product on the market without first having performed the requisite preliminary work. For the most part, Switzerland has adopted the regulations and provisions valid in the rest of Europe. According to Article 2 of the Federal law on patents, „surgical procedures, therapy and diagnostics, which are performed on or applied to humans or animals“ may not be patented. Nevertheless, some elements of somatic gene therapy, such as, for example, the therapeutic gene, the method of gene transfer, and the therapeutic strategy as a whole, may, in principle, be patented.

A glimpse of the future

Somatic gene therapy encompasses a wide area of activities that extend from basic research to an ultimate routine implementation of this new technique. All of these domains are constantly subjected to changes brought about by new findings and insights. Future laws governing gene therapy should be given a correspondingly flexible orientation. The legislation planned for the coming years will delve more deeply into the issues relevant to gene therapy. Important regulations however will also in future be scattered throughout various ordinances and guidelines, which complicates matters for the layman, for instance the clinician.

GENE THERAPY AND ETHICS: ON THE SLIPPERY SLOPE?

Somatic gene therapy opens promising avenues for the treatment of severe illnesses. Nonetheless, the misuse of these new therapy techniques cannot be entirely excluded. For this reason, somatic gene therapy must be the object of careful deliberation, involving active public debate, and be implemented in stages.

Who is considered healthy, and who not, has nothing to do with Mother Nature, but rather is determined by cultural conventions and semantics. There is no such thing as a ‚sick' gene, simply a diversity of genetic information. What the social order proclaims to be ‚normal', and how rigorously it condemns the ‚abnormal' is another matter. Julius Caesar was, despite his epilepsy, an eminent strategist and statesman. Many biographers have implied that his ‚fits' served to enhance the reputation of this great Roman.

Medical science undoubtedly has accomplished much towards relieving human suffering by enlarging its arsenal of remedies over the past years. However, this high-tech medical progress can also turn into a two-edged sword: patients with inherited diseases could suffer from increasing social pressure and even stigmatisation because they refuse gene therapy treatment. New medical techniques permitting the detection of ‚physical defects' at an early stage, and their treatment, may backfire. There could be an escalating intolerance of those illnesses that are popularly felt should be ‚easily overcome' or not exist in the first place.

Medicine's dilemma

Be it the mood-stabiliser Prozac, the potency-booster Viagra or the diet pill Xenical, countless people reach for the medicine cabinet each day in their quest for vitality, virility, and a better figure. Many might see somatic gene therapy as yet another quick remedy - against baldness, for example. If gene therapy compares favourably with the more expensive hair transplantation method, or the time-consuming regimen of taking medication - it could become the method of choice. If even exemplary athletes do not hesitate to run the risk of ruining their health by doping, it is conceivable that gene therapy would find a ready market in the world of sports. The borders between doping and gene therapy, and between lifestyle drugs and medication could become blurred. Gene therapy might serve to further accelerate the trend, prevalent in modern medicine, towards quantifying the human body by the common denominators of optimal performance and efficiency. Human diversity, which also includes a multitude of variations on the theme of ‚what is normal', is no longer in vogue.

Distribution of resources - Assignment of possibilities

The further development of gene therapy would necessarily absorb funds and resources, making these unavailable to other forms of treatment. In a time of economy measures and government spending cuts in the Swiss public health sector, the problem regarding an equitable apportionment of the scanty resources immediately arises. Is the funding of a new technique such as gene therapy justified, particularly when its potential for success is still uncertain? Might it not be wiser to support existing, less costly alternatives, or invest in simple prophylactic measures?

The question of whether an investment of resources in gene therapy is legitimate will be decided not least by the balance of benefits

for the individual and for society as a whole. Short-term advantages for a few must not be allowed to jeopardise long and medium-term advantages for many. Several arguments, however, indicate that gene therapy would foster social equality because a large segment of society would benefit from it:

- This technique has the potential to effectively treat diseases for which no form of therapy is yet available.
- It can cure diseases for which the only form of therapy has been the treatment of symptoms, and thereby even increase the chances for all patients.
- Some gene therapy applications, e.g. the vaccination with genetic material, could particularly benefit countries in the Third World, and here, once again, contribute to equal opportunities for industrial and developing countries alike.

Diversity is in demand

As is the case with all innovative technologies, gene therapy opens up new prospects to mankind, but also compels its members to make additional decisions.

Many patients hope that somatic gene therapy will one day ease their suffering. This hope enriches the quality of life for many of them, and is a source of confidence that gene therapy will give them a new lease on life.

There are patients, on the other hand, who view their illness as an integral part of their personal destiny. Quite often, they feel that living with their illness has helped them to greater maturity, inner peace, and a more positive outlook on life.

This ability to accept one's fate is significant. Ethical discussions in this connection often attest the right to imperfection. A ‚duty to imperfection', of course, cannot be decreed. Nor may the chance of a cure be withheld from the seriously ill. Those who choose to interpret illness and physical imperfections as an inseparable part of their lives must not expect others to relinquish their chance of a health-restoring cure.