Regenerative medicine: curing rather than simply treating diseases

Some scientists refer to the latest developments in the field of regenerative medicine as the "next revolution in medicine". With the help of gene therapies or stem cells, regenerative medicine aims not only to treat disease symptoms, but to cure them at source. Some approaches are already being used to treat patients and several others are close to application. However, there are concerns that certain social and political issues could have a negative effect on regenerative medicine. Big pharma, which is currently less active in this field than other players, would be well advised to think about becoming involved in the field of regenerative medicine to ensure that it does not miss out on the many opportunities.

The cultivation of stem cells is one of the most important techniques used in regenerative medicine.
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Many diseases can already be treated effectively, but only a very small number of diseases can be cured completely. This is especially true for age-related diseases that are caused by diminishing organ function or dying cells. One of the latest biomedical developments, regenerative medicine, has the potential to improve this situation. Regenerative medicine uses the natural self-healing power of a person’s own body to cure diseases.

A succinct definition of this new concept of medicine is difficult to find as it encompasses a large number of different life science disciplines. The term "regenerative medicine" covers all innovative therapeutic approaches aimed at restoring or replacing diseased tissue, functional systems or even entire organs. The concept is based on using techniques of various biomedical areas such as stem-cell and gene therapy, tissue engineering and innovative biomaterials. The indications cover all medical disciplines and range from wound healing and the treatment of hereditary diseases and cancer to the transplantation of entire organs.

The market for regenerative therapies will grow enormously

Most regenerative approaches are currently still in the research phase. A study published by the Roland Berger consultancy* in 2016 evaluated data stored in public databases and found that around 300 stem-cell and gene therapy approaches are currently in industrial development around the world. In addition, it is estimated that research is being carried out into between 30 and 90 other therapies at academic research institutions. The Roland Berger consultants expect the global regenerative medicine market to expand rapidly, growing from a value of around EUR 20 billion in 2016 to a value of around EUR 130 billion by 2025.

However, the study also found that big pharmaceutical companies are involved in the development of less than 20 percent of all stem-cell and gene therapies that are currently in the pipeline. Roland Berger therefore advises such companies to decide whether they want to actively participate in this development so as not to risk missing out on a slice of this new market. The study additionally emphasises the importance of being aware that the new developments in regenerative medicine may force therapies with a more traditional mode of action out of the market.

Big pharmaceutical companies are not involved

The Roland Berger study concludes that the lack of involvement of big pharma in the regenerative medicine market is not only due to the relatively high financial risk, but also to a very different pharmaceutical value chain than that adopted for developing chemical and biological drugs. As far as the development of stem-cell and gene therapies is concerned, early drug development phases are more difficult to plan because numerous parameters such as gene expression and cell viability have to be optimised through elaborate processes. Companies see the clinical phases, approval procedures and the protection of intellectual property involved in regenerative medicine as far more complex than those associated with conventional therapies. Berger found that these issues raise previously unasked questions, such as how to determine the dose of a cell product.

The same applies to the production of patient-specific and extremely sensitive products that need to be processed and then administered to recipients without delay. This requires the production of stem-cell and gene products to be located in close vicinity to patients and physicians. A similar challenging situation is also expected to arise for healthcare systems when it comes to reimbursing the cost of stem-cell and gene therapies: A completely new and complex reimbursement system will have to be developed. At the same time, ways will have to be found to ensure that the funds for covering the costs of provision of regenerative therapies will be available over the long term. All this
has to be resolved before a regenerative therapy is placed on the market.

Good examples for successful regenerative therapies are already available

Despite all the uncertainties surrounding the new technologies, there are a number of examples that nicely illustrate the successful application of stem-cell and gene therapies. One example is the case of a seven-year-old with a rare genetic condition that destroyed most of his skin. A team of physicians from Bochum produced a skin graft grown from the boy’s own stem cells. The graft was used to replace most of the boy’s skin, so that today, almost two years after gene therapy, the boy can lead a normal life despite his severe illness.

According to experts, this is still an isolated case, but the regeneration of skin is an excellent example to show that the new techniques have already reached the patient. Prof. Dr. Konrad Kohler, director of the Center for Regenerative Biology and Medicine at Tübingen University Hospital, commented: “The production of skin grafts from stem cells is still a highly specialised procedure and so costly that such treatment cannot be used routinely in clinics. Another problem is that health insurance companies usually do not reimburse such innovative cell therapies.”

Baden-Württemberg is at the forefront of regenerative medicine applications

Kohler regards oncological therapies involving stem cells as the “stars” of regenerative medicine. Blood stem cell transplants, for example, are used to restore healthy bone marrow in patients with
leukaemia. As Kohler says, “stem cell transplants have been used for treating leukaemia for decades and are increasingly used for other oncological conditions.” Autologous chondrocyte transplantation (ACT), which is a procedure for treating traumatic cartilage injuries of the knee joint, is another method that is successfully applied in patients. Kohler comments: “As a matter of fact, ACT was largely developed in Baden-Württemberg. A company from Reutlingen called TETEC AG and the BG Hospital in Tübingen are pioneers in this field. Baden-Württemberg is a well-known medical technology region that plays a leading role in the field of regenerative medicine, both nationally and internationally. This is especially true when it comes to cooperation between the region’s research institutions, hospitals and small- and medium-sized companies.

Kohler goes on to explain that ACT is being further developed on a continual basis, and in the not-too-distant future it will be extended to the repair of shoulder damage or damage to smaller joints. Kohler is confident that, in future, it will be possible to improve the treatment of arthrosis using regenerative medicine. Although no evidence-based studies are yet available, patients can request their health insurance companies to cover the cost of this type of treatment. “Research on the reconstruction of intervertebral discs has come a long way; the first clinical trials have commenced,” says Kohler. “I expect that we will be able to treat such disorders with regenerative therapies within the next four to five years.”

Research into regenerative therapies for the liver and eye has also made considerable progress. “The liver has a remarkable capacity to regenerate. However, in cases when it is no longer able to do so, one technique for treating the condition is to inject healthy liver cells into the defective liver tissue. The healthy liver cells then act as a kind of “biological factory” and help the liver remove toxins from the blood. As far as treatment of eye diseases is concerned, a variety of approaches are being
Gene therapy is still in the experimental stage

“The CRISPR/Cas has a huge potential as a tool for treating a broad range of medical conditions with a genetic component. However, the application of this tool is still in the experimental stage,” said Kohler. Prof. Dr. Toni Cathomen, director of the Institute for Transfusion Medicine and Gene Therapy at the Freiburg University Medical Centre, agrees with Kohler. He commented: “Unfortunately, very little is currently happening in the field of clinical research using gene therapy in Germany. A couple of years ago some patients died after being treated with gene-based experimental medical treatments at the Hannover Medical School which is likely to have affected the development of such therapies in Germany. The attitude towards gene therapies in other countries is far more positive.”

However, studies on using patients’ own immune cells for the therapy of tumours of the haematopoietic system have come a long way and a concrete immunotherapy application can be expected in the not-too-distant future. “Much is happening in this field and I am sure that many researchers have an application up their sleeve, but nobody is talking about it,” said Cathomen. Prof. Dr. Cathomen and his group of researchers are currently preparing a clinical study to assess the use of gene editing tools for the treatment of HIV infections. “At first, we have to contact the regulatory authorities but we hope to be able to start the planned trials in 2019. We hope that an 18-month clinical trial with patients will provide us with as many positive results as possible.”


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**Further information**

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The article is part of the following dossiers

- Cell and gene therapies: from bench to bedside
- Adult stem cells – hope for regenerative therapies
- Regenerative medicine makes use of patients’ own resources