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Extracorporeal Devices: Leading Applications in Medical Textiles

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Abstract: The use of textiles in the medical field is becoming increasingly prevalent. The medical, hygiene, and healthcare sectors comprise a substantial and expanding part of the textile industry. Textile materials are a desirable choice for medical devices due to their diverse range of product designs and flexibility. Textiles are used in both 2D and 3D shapes, with permutations limited only by the imagination. The applications are numerous and diverse, ranging from a single thread stitch to sophisticated composite constructions for bone replacement, and from a simple cleaning wipe to advanced barrier textiles utilized in Operation Theater. The primary goal of this research is to investigate the advanced characteristics, problems, and future possibilities of various extracorporeal devices employed in the medical industry, such as artificial kidneys, artificial livers, and artificial lungs. In this study, we considered several types of raw materials used as well as the production procedure of these extracorporeal medical devices made from textile materials.

Keywords: Extracorporeal Devices, implantable materials, Bio-artificial Liver**,** Mechanical lung, Artificial kidney

1. Introduction:

Medical textiles are often called Healthcare Textiles. The medical textile sector has expanded with new materials and inventive designs. Medical textile devices may now be used in a variety of ways thanks to advances in polymer technology. Medical textile goods are available in woven, knitted, and non-woven structures depending on the region of use. These items are increasingly being manufactured with synthetic fibers. In the field of modern medicine, textiles have become essential materials that have revolutionized the design of medical equipment for a variety of purposes. Thanks to their natural flexibility, plasticity, and creative potential, textiles have made significant progress in the medical, hygiene, and healthcare industries. Textiles provide a wide range of solutions to meet a variety of medical demands, from simple single-thread stitches to intricate composite constructions intended for bone replacements. The investigation and creation of extracorporeal devices, which are essential to the management and treatment of serious medical disorders, are at the center of this emerging subject. The cornerstone of medical textile applications are extracorporeal devices, which include artificial livers, kidneys, and lungs. These devices reflect cutting-edge technology intended to assist and even replace patients' important organ functions. The intrinsic biocompatibility of textiles makes them a prime choice for extracorporeal devices. By imitating real tissues and organs, textile materials may be made more immunologically rejection-resistant and biologically system-compatible. This biocompatibility is essential for reducing hazards connected with medical operations utilizing foreign materials, such as infection and clot formation.Additionally, textiles provide better performance qualities that are necessary for extracorporeal uses. Their optimal operation and endurance under physiological circumstances may be ensured by customizing them to satisfy certain mechanical and structural requirements. The therapeutic effectiveness of devices such as artificial kidneys and lungs depends on the efficient gas exchange, filtration, and fluid and solute transport provided by textile-based membranes and scaffolds. Furthermore, scalability and cost-effectiveness in the production of devices are facilitated by the variety of textile manufacturing techniques. Exact control over the form and characteristics of materials is made possible by techniques like knitting, weaving, and electrospinning. This makes it easier to include functional components like medication delivery systems and sensors into extracorporeal devices. These developments facilitate the creation of next-generation medical devices that are both economically feasible and technologically sophisticated enough for widespread clinical use. Medical textiles can be characterized in a variety of ways, according to David Rigby Associates."The Medical Textile or Medtech application area "embraces all those technical textiles used in health and hygiene products". Textile Terms & Definitions defines Medical Textiles as - "A general term which describes a textile structure which has been designed and produced for use in any of a variety of medical applications, including implantable applications". In the field of extracorporeal devices, medical textiles are very important in today's healthcare. Hemodialyzers, oxygenators, and cardiopulmonary bypass machines are only a few examples of the equipment that mostly depends on specialty textiles to perform essential tasks outside of the body. The biocompatibility, durability, and functionality required for safe and effective patient care are ensured by the use of medical textiles. Medical textiles are extensively employed in extracorporeal devices; this research looks at their design principles, material developments, and clinical applications. Understanding the intricate relationship between textiles and device functioning can help healthcare professionals improve treatment results and patient care. The fact that issues with material biocompatibility and infection control persist despite these advancements highlights the need for more study and development in this field.This study aims to highlight the crucial role that medical textiles play in creating extracorporeal technologies, which will impact medical treatments and patient care in the future.

1.2 Classification of Medical Textiles:

The medical textiles could be classified into various categories based on types of fibers, type of textile structures, and area of application. The classification of medical textiles based on area of application is presented here.

- **a)** Non-implantable materials: These materials use in external application on the body and may or may not make contact with the skin. Such as Bandages, Plasters, Gauzes, Lint, Wadding etc.
- **b)** Implantable materials: These materials used in effecting a repair to the body whether it be wound closure (sutures) or replacement surgery (vascular grafts, artificial ligaments, artificial cartilage, etc.).
- **c)** Extracorporeal devices: Extracorporeal devices are the artificial organs that remain outside the body while treating a patient. Extracorporeal devices are useful in hemodialysis and cardiac surgery.
- **d)** Healthcare/hygiene products: Healthcare and hygiene products are a rising sector in the field of medicine and surgery. The range of products available is vast, but typically they are used either in the operating theatre or on the hospital ward for the hygiene, care, and safety of staff and patients. Such as uniform, absorbent pads, surgical gown, etc.

2.1 Extra Corporeal Devices Used in Medical Textiles

These are extracorporeal devices that assist the function of important organs such as the kidney, liver, lung, and cardiac pacemaker. Extracorporeal devices are mechanical organs used to purify blood, such as the artificial kidney (dialyzer), artificial liver, and mechanical lung. Fiber and textile technology helps these gadgets work and perform better (Pino and Humes 2017). Table 1. shows the fibres and fabrics used for making extra corporeal devices with functions

2.2 Extra Corporeal Devices

Table 1. Extracorporeal devices

Extra Corporeal Devices	Fiber Type	Fabric Type	Function
Artificial kidney	Hollow viscose, hollow polyester	highly porous fabrication	Remove waste products from patient’s body.
Artificial Liver	Hollow viscose and PVA	woven, non-woven, knitted	Separate and dispose of patients plasma, and supply fresh plasma
Mechanical lung	Hollow polypropylene	woven, non-woven, knitted	Remove carbon dioxide from patients hollow silicone, and supply fresh blood membrane

3.1 Artificial Kidney:

The artificial kidney introduced after World War II remained experimental and was used mainly in exploratory attempts to sustain the lives of selected patients with acute kidney injury through the 1950s. The need for repeated access to the circulation limited the use of hemodialysis to the short term only in patients with acute kidney injury. Even in patients with acute kidney injury with delayed recovery, prolonged dialysis presented insurmountable problems that led to its abandonment before kidney function had recovered(Eknoyan 2019).

A fully implantable artificial kidney device is a complex undertaking, which includes additional clinical regulatory hurdles associated with biomaterial implantation. As the technical aspects of the therapy and durability of cells are being assessed in the extracorporeal version of the BRECS and in the WeBAK, an initial proof of concept of the implantable artificial kidney was undertaken .An implantable BAHF to initiate new tissue formation with a capillary bed surrounding synthetic hollow fibers without EC lining was successfully fabricated and implanted.72 UF draining into an artificial bladder in a rat with protein perm-selective properties was produced from this implant device.72 Other programs are also evaluating an implantable BAK based on nanofabricated membranes and renal tubule progenitor cells.73 Long-term biocompatibility of the implantable artificial kidney and maintenance of the associated capillary bed are key technical hurdles to be addressed in the future. Although research into the ideal implantable artificial kidney is ongoing, and many of the required technologies are in their infancy, this is a potentially promising future approach to renal replacement.

3.2 Textile fibersused for Artificial Kidney

- **Polysulfone Derivatives:** Polysulfone allows easy manufacturing of membranes, with reproducible properties and controllable size of pores down to 40 nanometers. Such membranes can be used in applications like hemodialysis, waste water recovery, food and beverage processing, and gas separation. Polysulfone is also used for filter housings and caps due to high physical strength and clarity. These applications require materials that must withstand steam sterilization. Polysulfone has been used for the outer shell of implantable catheter ports used for venous access in oncology.
- **Polyacrylonitrile:** functional medical textile materials could be improved from modified products using the different bioactive compounds. In this study, enzymatic modification of the polyacrylonitrile (PAN) fabric that use in the textile industry were performed and a new product that has antibacterial properties via tetracycline immobilization was developed. For this purpose, first, enzymatic modification of PAN fabric was performed.
- **Polymethylmethacrylate:** PMMA has been used for (a) bone cements; (b) contact and intraocular lens; (c) screw fixation in bone; (d) filler for bone cavities and skull defects; and (e) vertebrae stabilization in osteoporotic patients. PMMA is used as bone cement and a denture base because it demonstrates high scratch and impact resistance. In addition, a recent study demonstrated that PMMA-coating reduced charge fluctuations in metal oxide nanowires, and PMMA-coating stabilized the electrical characteristics. Therefore, PMMA may be a new biocompatible coating material that possesses better characteristics compared with PDMS for use in electronic sensors, which move freely in the bladder.

Ethyl vinyl-acetate copolymer: Ethylene vinyl acetate copolymer (EVA) has a successful commercial history in the pharmaceutical industry as a controlled release excipient. The usage covers a wide spectrum of parenteral applications ranging from transdermal drug delivery, contraceptive insertions, subcutaneous implants and mucosal contact forms.

3.2 Working Principle of Artificial Kidney

The implantable bio artificial kidney is about the size of a coffee cup and consists of two main components that work together to get rid of wastes. First, the hemofilter, or blood filter, processes incoming blood to create "ultrafiltrate" that contains dissolved toxins, sugars, and salts. Second, a bioreactor containing kidney cells processes the ultrafiltrate and concentrates it into "urine," which is directed to the bladder.

Fig 1. demonstrates the artificial kidney and functions. The artificial kidney is designed to work like the natural kidney, filtering the blood and maintaining the body's fluid balance so that dialysis is not necessary. The first versions of the device will not provide as much kidney function as a transplant or a healthy natural kidney, but enough to keep patients off dialysis. Device performance will improve in later versions with advances in technology(Akkaya and Ozseker 2019).

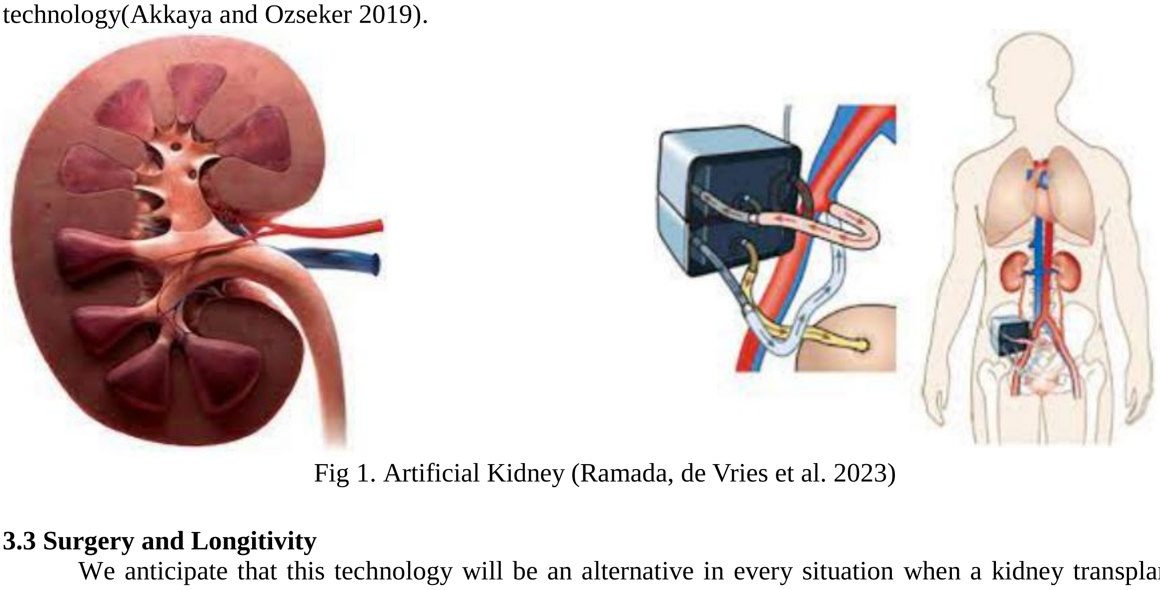

Fig 1. Artificial Kidney (Ramada, de Vries et al. 2023)

3.3 Surgery and Longitivity

We anticipate that this technology will be an alternative in every situation when a kidney transplant is required. Nonetheless, the implantation process will include a hospital stay and general anesthesia, much like kidney transplant surgery. The gadget is designed to last a lifetime. According to study and testing, the gadget should be able to function for many years without breaking down. If problems arise, minimally invasive surgery may be used to replace the filter and/or cells.

3.4 For Whom and Side Effects

This device is intended for patients with ESKD (End-Stage Kidney Disease), defined as a GFR of 15 ml/min or less. It is possible that eligibility could eventually be broadened to patients not yet in renal failure. Some risks will be similar to those associated with other procedures involving implanted medical devices. These include potential complications like infections, surgical trauma, and scars. We will know more about possible side effects once we begin clinical trials.

3.5 Advanced Features of Artificial Kidney

An important feature of the artificial kidney device is that it does not use water, dialysate solutions or dialyzers, eliminating the need for large reverse osmosis water tanks and large storage space for home modalities. This potentially will save billions of gallons of water each year.

3.6 Limitations of Artificial Kidney

Some obstacles have hindered the development of artificial kidney. The primary impediment has been a lack of effective strategies to enable toxin removal without using substantial volumes of dialysate a limitation that is applicable to both haemodialysis and peritoneal dialysis.

3.7 Future Prospect of Artificial Kidney

The need of the hour is to develop an ideal artificial kidney that would be wearable or implantable and would be able to perform the complete excretory, filtration, tubular, endocrine, and metabolic functions of the kidney while preserving the quality of life and minimizing complications.

4.1 Mechanical Lung

The passage highlighted the significance of artificial lung in our modern age using textile fiber material instead of other material. There is a huge medical cases where artificial lungs playing a vital role for their patients. At first it gives us idea in introduction point. Then it discussed the scope of new generation artificial lung. After that it highlighted the textile material needed for artificial lung. At last it shows the successful medical trial and the working principle of artificial lung. This article maybe helpful for those who want to know about the basic knowledge of textile related artificial fiber along with its history and present situation.

There exists a growing demand for new technology that can take over the function of the human lung, from assisting an injured or recently transplanted lung to completely replacing the native organ. Artificial lungs are medical devices designed to take over or supplement the respiratory function of the lung, oxygenating the blood and removing carbon dioxide. They are generally classified as extracorporeal, Para corporeal, intravascular, or intrathoracic devices. The artificial lungs used clinically today are extracorporeal blood oxygenators, primarily used in operations requiring cardiopulmonary bypass, but also used less frequently for support of patients with respiratory failure. Many obstacles must be overcome to achieve the lofty goals and expectations of such a device. An artificial lung must be able to sustain the gas exchange requirements of a normal functioning lung. Pursuant to this purpose, the device must maintain appropriate blood pressure, decrease injury to blood cells and minimize clotting and immunologic response(Zhang, Du et al. 2022).

4.2 Types of Fiber Used in Mechanical Lung

- **Hollow silicone membrane** to develop a gas-exchange system that consists of silicone-based membrane lungs with methacryloyloxyethyl phosphorylcholine (MPC) polymer coating and tubing system for a longer-term use. The newly developed MPC polymer-coated silicone-based lungs could be used stably for more than 50 days.
- **Polypropylene fiber** A porous polypropylene hollow fiber membrane of a circular cross section 150 to 300 µm in inside diameter and 10 to 150 µm in wall thickness for use in an artificial lung, which hollow fiber membrane is characterized by having an inner surface aperture ratio in the range of 10 to 30%, a porosity in the range of 10to 60%, and an oxygen flux in the range of 100 to 1,000 liters/min.m2.atm. and inducing no leakage of blood plasma within 20 hours' use in the external circulation of blood there through.
- **Poly-4-methylpentene-1 (PMP)** Poly (4-methyl-1-pentene) (PMP) emerged as the most practical membrane material for possible few weeks usage, possessing high gas exchange, low diffusion resistance and absent plasma leakage. poly(4-methyl-1-pentene) (PMP) is the most widely used commercial

oxygenation membrane material. Synthetic PMP polymer is a semi crystalline non-polar polyolefin resin, which has the lowest density (0.835 g/cm3) among all thermoplastic polymers used in medical applications. Meanwhile, PMP also exhibits superior heat resistance, chemical resistance, and low surface tension, which makes it a good oxygenation membrane candidate for use in ECMO system.

- **Polydimethylsiloxane (PDMS)** Polydimethylsiloxane (PDMS) has been thoroughly investigated from its chemical structures to chemo-physical properties. It is widely used in medicine, food, daily necessities, construction, electronics and other fields due to its naturally good gas permeability, physiochemical stability and biological inertness. The dense PDMS membranes were the first oxygenation membranes used in ECMO system. However, the relatively large thickness of the membrane due to low mechanical strength of PDMS material resulted in low gas exchange efficiency, which made its use in ECMO diminished and eliminated.

4.3 Working Principle of Artificial Lung

ECMO, or extracorporeal membrane oxygenation, pumps blood through a device that adds oxygen to it and then pumps it back into the patient's body, performing the function of the heart and lungs. ECMO, which can be used for both adults and children, provides long-term management of heart and/or lung failure while the patient recovers or awaits a transplant or ventricular assist device. ECMO is sometimes also called ECLS, or extracorporeal life support. ECMO can be used in two different ways – venovenous (VV) and venoarterial (VA).

4.3.1 Venoarterial (VA) method

Venoarterial ECMO takes blood from a central vein or the right atrium of the heart and pumps it past an oxygenator worn outside the body. The blood then returns under pressure to the aorta to be pumped out to the body. This method helps support the amount of blood that is pumped by the heart (cardiac output).

4.3.2. Venovenous (VV) method

Venovenous ECMO takes deoxygenated blood from a large vein, passes it through the oxygenation process and returns it to the body through another large vein. This form does not support cardiac output of the heart but it allows for the removal of carbon dioxide through the oxygenator unit and doesn't just add oxygenated blood alone. Patients receiving ECMO will have a large catheters (tubes) placed in the body to remove and replace the blood volume after gas exchange. Because of the risk of blood clots, patients on ECMO are given anticoagulant drugs (blood thinners) to reduce the risk of clot formation and complications. Fig 2. shows the working principles of artificial lungd. ECMO has been used for decades in newborns and children with lung failure, pneumonia, meconium aspiration syndrome and other conditions. More recently, it has proven to provide beneficial support for adult patients with severe respiratory and/or cardiac failure, allowing for recovery of the heart or lungs or acting as a bridge to transplantation or ventricular assist devices.

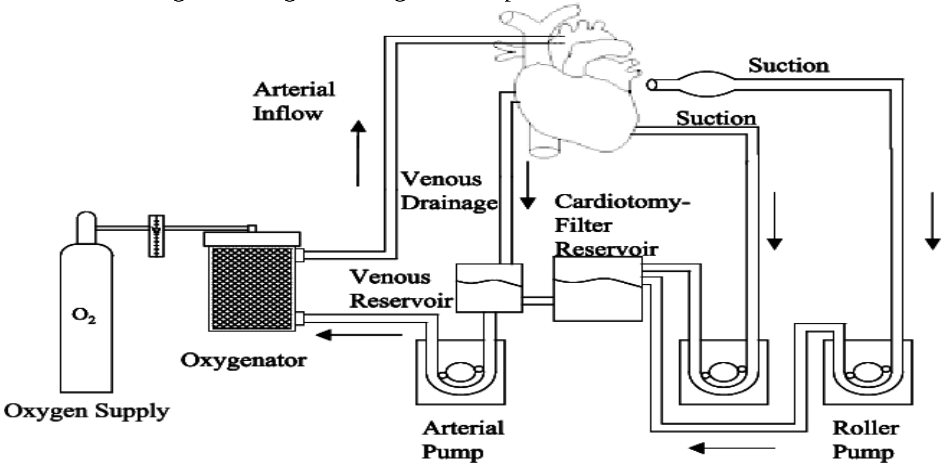

Fig 2. Artificial lung working Principe **(Chaves, Filho et al. 2019)**

4.4 Successful Medical Trial

Use in COVID-19 patients Beginning in early February 2020, doctors in China have increasingly been using ECMO as an adjunct support for patients presenting with acute viral pneumonia associated with SARS-CoV-2 infection (COVID-19) when, with ventilation alone, the blood oxygenation levels still remain too low to sustain the patient. The initial reports indicate that it is assisting in restoring patients' blood oxygen saturation and reducing fatalities among the approximately 3% of severe cases where it has been utilized. For critically ill patients, the mortality rate reduces from around 59–71% with conventional therapy to approximately 46% with extracorporeal membrane oxygenation. A March 2021 Los Angeles Times cover story illustrated the efficacy of ECMO in an extremely challenging COVID patient. In February 2021, three pregnant Israeli women who had "very serious" cases of COVID-19 were given ECMO treatment and it seemed this treatment option would continue.

A portable, external oxygenation device developed by a physician-scientist and a biomedical engineer from the University of Maryland offers the benefits of extracorporeal mechanical oxygenation (ECMO) and frees up patients to ambulate. Moreover, in December 2020, doctors at the University of Maryland Medical Center were the first in the world to use the device, the Abiomed Breethe OXY-1 SystemTM, in a human.

4.5 Current Use of Breethe at University of Maryland Medical Center

Dr. Griffith says the hospital, which has offered Breethe to at least eight patients in the first two months alone, is currently using the device for patients with acute respiratory distress syndrome (ARDS), including patients with COVID-19 and trauma-related conditions who would ordinarily require mechanical ventilation or ECMO. Fig 3. shows the extracorporeal membrane oxygenation

While the FDA issued a 510(k) clearance of the device in October 2020 for usage of up to six hours, previous guidance issued in April 2020 permits use of the device for longer periods during the COVID-19 public health emergency.

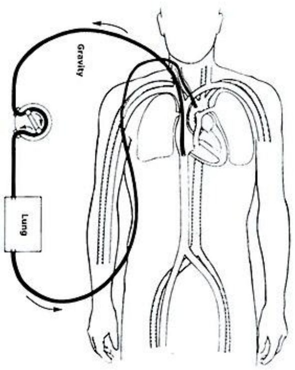

Fig 3. Extracorporeal Membrane Oxygenation (Chaves, Filho et al. 2019)

4.6 Advanced Features of Mechanical lung

The major features of the lungs include the bronchi, the bronchioles and the alveoli. The alveoli are the microscopic blood vessel-lined sacks in which oxygen and carbon dioxide gas are exchanged.

4.7 Limitations of Mechanical Lung

Sometimes the fragile alveoli (small air sacs in the lungs) rupture, allowing air to accumulate around the lung and collapse it, a condition called pneumothorax. To avoid these problems, doctors try to limit the volume and pressure of air delivered by the ventilator.

5.1 Artificial Liver

The article represents the necessity of artificial liver made by textile material. We can't avoid the importance of artificial liver as it helps the metabolism system of carbohydrate, protein as well as digestion and filtration. The article will provide us clear idea about the textile fiber used in artificial liver like Poly ethylene terephthalate, Poly [D-L-lactic-co-glycolic acid], Poly [N-p-vinyl benzyl-D-lacto amide]. Then we highlighted the possibility of this device instead of complex operation for liver tissue and the clinical trials of this device which shows a hope for the medical treatment system. At last we discovered the working principle of artificial liver in brief with the action of mechanism of hepacure BAL system.

Artificial livers are kind of liver made from hollow viscose, to filter patients' blood and to help remove the waste products. Liver basically used to help the process of digestion and also metabolize carbohydrate, lipid and proteins. Liver also helps the body to get rid of waste products. Waste products that are difficult to excreted by the kidneys are removed from the blood by the liver. The artificial liver will be able to act as an 'auxiliary engine' for a patient, during periods when the patient's own liver cannot manage to function adequately. Blood is recirculated from the patient through the artificial liver – a process that takes several hours. In order to avoid the problem of rejected cells, every single patient needs a bio-reactor.

5.2 Textile fiber used for Artificial Liver

The artificial liver is usually made of hollow membrane fibers like PVA, hollow viscose & triacetate to separate and dispose of patient's plasmas and supply fresh plasma.

- **Poly ethylene terephthalate (PET)** Polyethylene terephthalate (PET) is one of the most used polymeric materials in the health care sector mainly due to its advantages that include biocompatibility, high uniformity, mechanical strength and resistance against chemicals and/or abrasion. However, avoiding bacterial contamination on PET is still an unsolved challenge and two main strategies are being explored to overcome this drawback: the anti-adhesive and biocidal modification of PET surface.
- **Poly [D-L-lactic-co-glycolic acid](PLGA)** In past two decades poly lactic-co-glycolic acid (PLGA) has been among the most attractive polymeric candidates used to fabricate devices for drug delivery and tissue engineering applications. PLGA is biocompatible and biodegradable, exhibits a wide range of erosion times, has tunable mechanical properties and most importantly, is a FDA approved polymer. In particular, PLGA has been extensively studied for the development of devices for controlled delivery of small molecule drugs, proteins and other macromolecules in commercial use and in research. This manuscript describes the various fabrication techniques for these devices and the factors affecting their degradation and drug release.
- **Poly[N-p-vinyl benzyl-D-lacto amide], PVLA** For hepatocyte culturing studies, the scaffolds were additionally coated with an artificial glycopolymer (poly[N-p-vinylbenzyl-D-lactoamide], PVLA) in order to improve cell attachment

5.3 Working Principle of Artificial Liver

A composite scaffold combining textile superstructures and biomimetic glycopolymers is introduced, which may allow engineering of organotypic liver tissue in vitro. Woven poly(ethylene terephthalate) (PET) fabrics were coated on one side with a thin biodegradable polymer film (poly[D-L-lactic-co-glycolic acid] PLGA), in order to obtain a polar structure. The composite structure ensured the stability of the membrane during in vitro degradation, independently of mesh size. Matrix porosity increased when a polymer blend matrix was used. For hepatocyte culturing studies, the scaffolds were additionally coated with an artificial glycopolymer (poly [N-p-vinyl benzyl-D-lactoamide], PVLA) in order to improve cell attachment. It was observed that formation of aggregates depends on the scaffold geometry as well as on the pretreatment and medium conditions. After 4 days in culture, the pores of the fabric were filled with aggregates illustrating the possibility of immobilizing hepatocyte aggregates in well-defined spatial configurations on textile structure(Karamuk, Mayer J Fau - Wintermantel et al.). Fig 4. demonstrates the mechanism of action of HepaCure-BAL. HiHeps, functional hepatocyte.

HexaellHepaCure-BAL with hiHeps as working cells is a liver support system which could partially replace liver functions . Its main mechanisms include removal of toxic substances in patient plasma; secretion of liver-specific proteins such as ALB, AAT and TRF; reduction of inflammatory responses and promotion of liver regeneration.

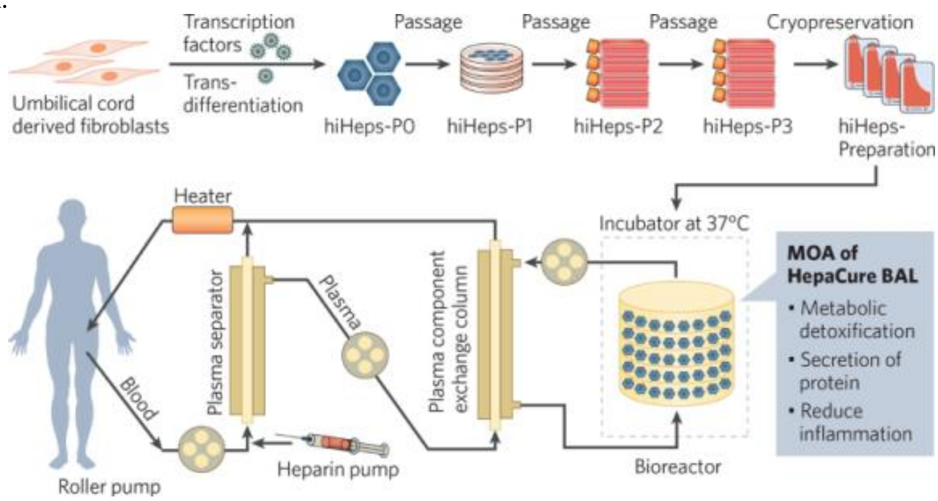

Fig 4. The mechanism of action of HepaCure-BAL. HiHeps, functional hepatocytes (Wang, Zheng et al. 2023)

5.4 Possibility of Bio-artificial Liver

Mayo Clinic researchers are planning clinical trials of a bio artificial liver that might eventually provide an alternative to transplantation for patients with liver failure. "Our ability to successfully perform liver transplant surgery has led to our biggest problem in this field: the shortage of donor organs," Dr. Nyberg says. "If we can devise new technologies to avoid liver transplant, we've achieved a major accomplishment." Dr. Nyberg, who leads Mayo Clinic's Artificial Liver and Liver Transplantation laboratory, has devoted more than 25 years to developing the bio artificial liver. About 38,000 people in the United States die each year from liver disease, according to the Centers for Disease Control and Prevention. "Acute liver failure claims the lives of over 30 percent of people who are diagnosed with it. Liver transplantation has been the go-to option for treatment, but it comes with many risks and isn't always an option, due to compatibility and availability of donor livers," Dr. Nyberg says. " Fig 5. shows the support sytem for bio artificial liver. A bio artificial liver device could allow physicians to treat and extend the lives of more patients, safely and cost-effectively, with fewer risks.

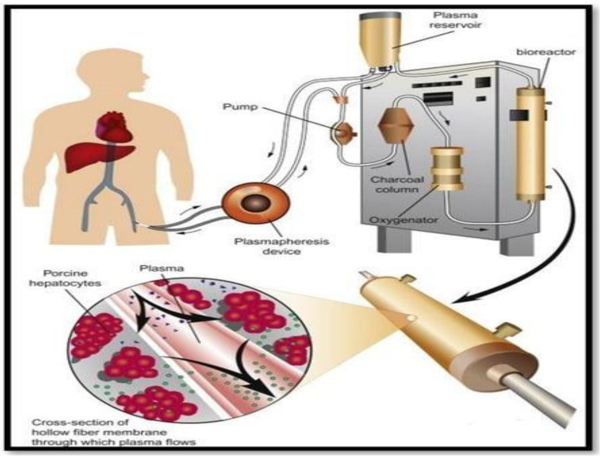

Fig 5. Bio artificial liver support system **(Ali, Haque et al. 2021)**

5.5 Successful clinical trials

The first clinical study of HepaCure-BAL was conducted in 2016. A single patient was successfully treated, before undergoing liver transplantation three weeks later.

Ten patients with acute-on-chronic liver failure were then enrolled for an Investigator Initiated Trial (IIT). Treatment was given once or twice, with an interval of 7 to 10 days. The primary outcome was safety, and a change of IgA, IgG and IgM. The secondary outcome was a survival rate of 28/90 days.

The primary safety endpoint was achieved, with 90 per cent of patients surviving 28 days, and 80 per cent surviving 90 days. Two years later, seven patients are still alive without liver transplantation.

Based on the results of the IIT study, Hexaell submitted its Investigational New Drug (IND) application to the Chinese drug regulator (NMPA) in Q1 2021. It will also submit its application to the US Food and Drug Administration, where Hexaell hopes to out-license its technology to other companies.

Hexaell is seeking international partners and further funding to facilitate further trials with HepaCure-BAL

5.6 Who may require one?

People with ALF or ACLF most often require artificial liver treatment before undergoing a liver transplant or to improve liver function.

Liver failure often results in cirrhosis, most often due to long-term problematic alcohol use or chronic hepatitis C. Other less common causes of cirrhosis include:

- Autoimmune diseases
- Diseases of the bile duct such as primary biliary cirrhosis, Alagille syndrome, and biliary atresia
- Wilson’s disease
- Nonalcoholic steatohepatitis, also known as fatty liver disease

People with acute liver diseases leading to cirrhosis and people with liver cancer might also require artificial liver treatment.

6. Advanced Technologies and Future Prospects

The field of medical textiles continues to evolve with advancements in nanotechnology, bio materials, and additive manufacturing. Emerging technologies offer opportunities to enhance the performance and functionality of extra corporeal devices further. For example, nanofiber-based membranes improve filtration efficiency and reduce membrane fouling in artificial kidneys, while 3D printing enables the customization of implantable scaffolds for tissue regeneration.Furthermore, the integration of smart textiles with sensing capabilities enables real-time monitoring of physiological parameters, enhancing the precision and efficacy of extra corporeal therapies. These innovations not only expand the therapeutic capabilities of medical textiles but also pave the way for personalized medicine approaches tailored to individual patient needs

7. Conclusion:

A brief overview of the application of extra corporeal devices in various areas of medical sectors for the healthier life and betterment of human being. The development of new item will help the patients to overcome their suffering in previous days. This study provided an overview of the innovative, intelligent and smart textile products related to medical textiles, particularly extracorporeal devices as medical textile products such as artificial kidney, artificial skin, mechanical lung, Artificial Liver. The critical function that medical textiles play in extracorporeal devices which are essential to contemporary medical interventions like hemodialysis and cardiopulmonary bypass has been emphasized in this paper's conclusion. The provision of vital services, including biocompatibility, durability, and performance optimization, in medical textiles has a substantial impact on treatment results and patient care. Continuous improvements in textile materials and manufacturing processes continue to improve device efficacy and safety, even in the face of obstacles like infection control and biocompatibility problems. Future developments in medical textiles promise to increase the functionality and applicability of extracorporeal devices, which might completely change how different medical specialties treat patients. These technologies are becoming increasingly important to modern healthcare, as seen by their development, which is improving patient outcomes and advancing medical practice worldwide.

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