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PLASTIC IN MEDICINE

A glance at medical plastic use and recycling

How plastic made its way into the medical industry

The first plastic materials were produced in the 19th century, but it was not until the middle of the 20th century that the advances in production technology helped plastic make its way into the healthcare industry. The use of plastic has revolutionised the field of medicine. Previously, medical devices were made of glass, metals or ceramics and had to be boiled, heated (autoclaved) or otherwise disinfected before every use. This was a long and painstaking process and its outcome was hard to control (today, surgical instruments are considered sterile for no more than six hours after disinfection provided they are kept in a sterile field). As a result, multi-use medical devices could be a source of transmitting infections.

As autoclave and then polymers made their way into hospitals, infection rates substantially declined.

Single-use plastic has eliminated almost all contamination risks and now plays a great role in keeping rates of nosocomial infections low. Its other advantages include price, plasticity (ability to be turned into any shape) and high chemical resistance. Present-day healthcare is the world of plastics.

IN CERTAIN CASES, THERE ARE SIMPLY NO ALTERNATIVES TO THIS MATERIAL. AN MRI MACHINE CONTAINS A GIANT MAGNET – MEANING NO METAL OBJECTS MAY BE PLACED IN THE ROOM WITH THE SCANNER

The many uses of plastic materials in medicine

Plastic applications in clinics and hospitals are numerous and include shoe covers, medical gloves, syringes, catheters, inhalers and face masks, bedpans, respiratory care consumables and spare parts of medical ventilators (used for COVID-19 patients in certain cases), protective goggles, containers, and boxes for first aid kits and medical devices. Different types of plastic can be used to manufacture almost anything, from sterile packaging to hand prostheses. Patients in critical condition awaiting heart transplantation are given artificial hearts made of plastic.

Artificial joint materials also include plastic. In certain cases, there are simply no alternatives to this material. An MRI machine contains a giant magnet – meaning no metal objects may be placed in the room with the scanner, and the easiest and cheapest option is to have an all-plastic MRI room. For some applications, plastic can be replaced with glass or ceramic, but these materials are fragile and cannot be so easily shaped. Plastic products may require less electricity and water to produce as compared to metal, paper or glass alternatives, according to some sources. On top of that, they are light-weight, which helps to reduce fuel consumption during their air and road transportation and manage their carbon footprint.

Plastic journey

Medical plastic is a convenient, reliable and relatively cheap material. However, in contrast to household plastics that are seeing a surge in recycling, it has certain processing issues. Some classes of medical plastic can be hazardous: if not disposed of properly, they may be a cause of disease spreading. The same applies to medical glass, metals and other materials that need to be collected, disinfected, sanitised and stored properly. Breach of rules for medical waste removal and disposal might lead to infectious disease transmission and outbreaks. For example, in 1999, as a result of improper medical waste disposal in South Africa, used hypodermic needles fell into the hands of children (who played with them) putting 54 of them in danger. Luckily, the kids were promptly examined and given preventive treatment and a hepatitis B vaccine.

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IN THE USA, HOSPITALS THROW AWAY 3,500 TONNES WORTH OF PLASTIC PACKAGING ALONE EVERY DAY

Medical waste falls into five hazard categories: category A includes items that were not in contact with bodily fluids from patients with infections (shoe covers, containers, packaging), categories B and C stand for medical waste that was either probably or definitely contaminated, category D comprises toxic and hazardous waste (thermometers and expired medicines), and category E is radioactive waste. Medical plastic usually falls within categories A, B or C. As it is prohibited to mix different waste categories, they are stored separately and put into containers of different colour (or with relevant labels).

Take a disposable syringe, for example. After a medical worker collects a blood sample, they use a clipper (disinfected separately) to snap off a needle from the syringe, which is then filled with disinfectant and put into a dedicated container and sometimes also sterilised in an autoclave. Once sanitised, syringes are placed in a yellow waste bag labelled as category B waste. In this way, they can be stored until the end of the working shift in a room with specially maintained temperature and air circulation conditions accessible only to authorised staff, as per sanitary regulations and standards. Then the syringes are sent for disposal. As category B waste, they are not recyclable and may be either properly burned or landfilled.

Why medical plastic is hard to recycle

In the USA, hospitals throw away 3,500 tonnes worth of plastic packaging alone (pills blister packs, packaging for surgical instruments and spare parts of devices, and medical polymer films) every day. There is no official data on annual plastic packaging consumption in Russia.

WHEN IT COMES TO HYGIENE, PLASTIC IS STILL IRREPLACEABLE IN SOME APPLICATIONS

Medical plastic cannot be landfilled without prior disinfection, and its disposal is a complex and multi-step process. Part of it can be recycled if hospitals arrange for separate waste collection, which would require additional staff training on how to accumulate and sort plastic waste by safety category and type. Medical plastic can also be sorted at dedicated disposal facilities, but it can only be done manually as the process has not yet been automated. Many companies find it unprofitable to buy, sort and process recyclables when they can manufacture new plastic at lower cost.

Nevertheless, there is certain progress in this field in some countries: category A waste is successfully recycled in the USA, Australia and New Zealand. The resulting output might be a mixture with a variable composition and, hence, no definite properties, which greatly hinders its application. But in some cases medical plastic can be recycled into homogeneous materials such as high-density polyethylene, polyvinyl chloride and polystyrene. They can be used to manufacture medical items that do not require sterilisation (packaging and containers) and household goods: bags, boxes, pipes, stationery, and construction materials.

With medical waste disposal standards in place, Russia still lacks the legislation to govern medical plastic recycling. Yet, some companies do focus on both disposal and recycling: for instance, Ekmus collects category A waste for partial recycling. According to some experts, certain disposable items – say, surgical trays – can be reused after proper disinfection. But, as these items are few, the effect will be rather negligible.

It would not be right to demonise plastic, because its properties make it a strong alternative to other materials. For example, plastic packaging extends the shelf life of food by at least 1.5 times compared to other or no packaging (and some studies suggest that the carbon footprint of food waste is higher than that of polymer packaging). When it comes to hygiene, plastic is still irreplaceable in some applications. In the end of the day, it all boils down to proper recycling to make sure that the negatives associated with plastic do not outweigh its positives.

Russia has no legislation to govern medical plastics recycling.

Alternative processing methods, such as chemical recycling or depolymerisation, and their further development may tip the scales in favour of plastic. Chemical recycling enables plastic decomposition into monomers convertible back into polymers with the same properties. Another solution would be to produce polymers from such resources as wood shavings or sugar industry waste. There renewable feedstocks can be used to produce bioplastics like polylactic acid or polyhydroxyalkanoate, which, in turn, decompose into more environmentally safe molecules. In Russia, this technology is being developed at NIOST, SIBUR's corporate R&D centre. The Company plans to use biodegradable polymers for part of its production should the solution prove viable.

Another potential response to the recycling problem is biological engineering. Scientists from the Toulouse Biotechnology Institute have recently synthesised an enzyme that can break down 90% of PET (one of the most widespread plastic materials). As bioengineering research continues, it is expected to bring about better ways of processing other kinds of plastic, including those that are actively used in medicine.

Source: *Meduza jointly with the All Chemistry magazine (https://meduza.io/feature/2020/04/28/maski-perchatki-rashodniki-dlya-ivl-eto-odnorazovyy-plastik)*