SUMMARY

In 2017, 10.281 interventions of major surgery and 10.420 outpatient minor surgery interventions were performed at Josep Trueta's Hospital. Also, according to the medical sources consulted in the hospital itself, huge quantities of gauze are consumed in each of the operations. These data show the relevance of this consumable in the field of medicine, which end up becoming a waste in a short period of time. Taking into account the effect of sustainable development in today's industries and the difficulty in the management of medical waste, strategies must be undertaken to maximize their absorption capacity. Therefore, efficiency could be improved and consequently also the efficacy of the product, reducing the generation of waste significantly. However, it must be considered that the surgical gauzes contain a lead filament that allows their detection when exposed to X-rays. This insertion was made because if some gauze gets lost during the operation, surgeons can easily find it.

For these reasons, the main objective of this project was the production of high absorption surgical gases, through the use of cellulose nanofibres (CNF). At the same time, it was considered as a secondary objective to try to conserve radiopacity. Replacing the lead filament with another metallic material with similar characteristics, the titanium dioxide (TiO_2). Finally, the possibility of replacing this type of consumables for other materials manufactured as well with CNF, the aerogels, has also been evaluated.

Thus, the present research began with the production of cellulose nanofibres from bleached Kraft hardwood (*Eucalyptus globulus*) pulp fibres. Nanofibres were produced using two different reaction methods, in order to evaluate what type of nanofibres was better. On one hand, the enzymatic reaction method was used, and on the other, an oxidation reaction mediated by the TEMPO catalyst was applied. Once the different types of nanofibres were obtained, they were characterized correctly. The objective was to know which properties they had, and if they were the right ones to carry out the task.

Next, the infusion of all the necessary gauzes was carried out in order to obtain enough samples. The infusion method used was the same as for the infusion of epoxy resins, with the difference that it was adapted to the needs of this product. All gauzes were infused with TEMPO-CNF and the amount of nanofibres contained into the solution to infuse was 0,5%. In some cases, however, this solution also contained 0,3 g of glycerol and 10% TiO_2 for each dry gram of fibre. Glycerol was added in order to provide greater malleability to gauzes, while TiO_2 nanoparticles were added to provide the desired radiopacity properties. Once all the samples were infused, they were frozen properly due to their subsequent lyophilization.

Subsequently, it was proceeded to the production of aerogels 100% of nanofibres. Aerogels were created with the two types of nanofibres available: TEMPO-CNF and E-CNF. Of each type of aerogel, samples were produced at different concentrations (0,3% and 0,6% CNF), in order to observe the differences and determine the best option. Once prepared each solution, they were frozen just like gauzes.

At the end, in all the frozen samples, gauzes and aerogels, a lyophilization process was applied. This process allowed to extract the water of the samples without damaging the final structure of the product.

Finally, all the prepared samples were tested in the same way. Firstly, three different tests were performed in order to evaluate the properties of consumables with liquids: the water absorption test (WAV), the water holding time test (WHT) and the vertical wicking test (VWT). Next, the mechanical properties of some gauzes were evaluated by means of a stress-strain test. Even the antimicrobial properties of the final samples were evaluated, by means of an antimicrobial test. Finally, radiopacity was evaluated through X-rays, for samples containing titanium dioxide.

The results showed that gauzes absorption by adding nanofibres did not improve, but decreased on average by 27%. It was demonstrated by field emission of scanned electron microscopy (FE-SEM), that the CNF formed a three-dimensional structure between cotton filaments. This network reduced the porosity of the sample and made it difficult to absorb the liquid. On the other hand, it was discovered that the aerogels were able to improve the absorption of the reference gauzes (gauzes from the Josep Trueta Hospital) approximately 600%. This increase is due to the highly porous and lightweight structure that this type of consumable presented. Oppositely, the resistance of this last product greatly limited its applicability, since they barely could withstand their own weight when absorbing so much water.

With regard to evaporation capacity, its initial value was increased in the vast majority of samples. Since, it has been shown that the improvement of this property is due to the increase of their specific area. On capillarity, it was detected that by the addition of nanofibres to gauzes, it increased between 22% and 27%. It was concluded that this was due to the presence of a greater number of access points for the liquid. These entrances were formed between nanofibres and also between nanofibres and the cotton filaments. It was comprised that the smaller the diameter of these canals is, the better capillarity they will present.

When analysing the mechanical properties of some of the gauzes, the initial idea that they had to increase their resistance was rebutted. By adding nanofibres, these were slightly weaker and even neither elasticity was gained. Using the images captured with the FE-SEM, it was observed that this deterioration of the mechanical properties was due to an increase of their internal tensions when adding CNF. Regarding the results of the antimicrobial trials, no inhibitory rings were observed.

Finally, when the radiographies were performed on that theoretically radiopaque samples; it was not observed any radiopacity signal. It was concluded that this fact could be due to the nanometric size of the TiO_2 particle, because the presence of the TiO_2 nanoparticles was demonstrated but no X-ray device was able to detect its presence.