Biomaterials in infection treatment

Valorisation

Since the development of the “science of medicine”, one of the main focus areas has always been the conquest against infection. Major breakthroughs in this battle have been the development of aseptic techniques, antibiotics and vaccines. All these measures have saved millions of lives over time. Regrettably, these improvements are threatened to fail because of their own success (e.g. overuse of antibiotics in livestock and commonplace viral infections), and as a consequence infection prevention and eradication are becoming an ever more challenging problem, mainly due to the concept of antimicrobial resistance (AMR). Micro-organisms have developed very strong survival skills over the many millions of years that they have been around, that render them resistant against more and more antibiotic, antivirals and anti-parasitic drugs (e.g. antimalarials). More and more frequently, media report on patients dying from “incurable” infections and “superbugs”. The World Health Organisation (WHO) has effectively defined this issue as one of the biggest future threats mankind will encounter in the next decades to come (Global action plan on antimicrobial resistance, 2015). Several initiatives have been implemented (e.g. antibiotic stewardship, tracking, development of new drugs and diagnostics and preventative measures for infection), but the question remains if this will be enough to conquer AMR. On the other hand, usage of biomaterials and implants is increasing exponentially, and as a consequence also the incidence of biomaterial/ implant related infections. Unfortunately, the level of evidence and the amount of literature on biomaterials in relation to infection is still very low, as showed in this thesis.

One of the ways to conquer antimicrobial resistance is to develop other mechanisms of action than those that are used in “classical” antibiotics or antivirals. Bioactive glass S53P4 has shown to have that potential. It’s working mechanism is twofold : the local rise in pH is a physiological phenomenon, mainly having effect on bacterial enzymes and the local rise in osmotic pressure is a mechanical effect, disturbing the bacterial cell-wall. One of the reasons that no development of resistance against bioactive glass S54P4 has been observed to date, may well be this double mechanism of action : micro-organism potentially find it difficult to develop mechanisms against different threats at the same time. Therefore, bioactive glasses are truly one of the biomaterials that will continue to be used in the post-antibiotic era. As the main use is now the filling of bony defects in osteomyelitis, there is still a lot of potential in expanding the scope of this biomaterial : the use in infected non-unions or even soft tissues and perhaps it could be applied as a coating on implants (either nano coating or by aerosol deposition). S53P4 bioglas has been shown not only to kill planktonic bacteria, but also bacteria in biofilms.[1,2] Obviously, issues like the threat of third-body wear will have to be addressed when using bioactive glass in combination with joint replacements.

In this age of rising health care spending and ever more expensive treatment strategies; cost-effectiveness is becoming an increasingly important issue for decision makers and health professionals. S53P4 bioglas has been proven to be cost-effective in the treatment of chronic osteomyelitis and can therefore not be ignored in future decision-making regarding this pathology.

This thesis also showed that the issue of (musculoskeletal) infections is even more important in low- and middle income countries as it affects more and younger (economically active) people and healthcare resources are a fraction of those in developed countries. Therefore, there is a need to improve on treatment, preferentially making it a one-stop-shop procedure. If costs of state-of-the-art biomaterials like bioactive glass could be significantly reduced, their applicability would significantly increase and potentially address millions of individuals.

1. Drago L, Vassena C, Fenu S, Vecchi ED, Signori V, Francesco RD, et al. In vitro antibiofilm activity of bioactive glass S53P4. Future Microbiology. 2014 2017/04/11;9(5):593-601.
2. Coraça-Huber DC, Fille M, Hausdorfer J, Putzer D, Nogler M. Efficacy of antibacterial bioactive glass S53P4 against S. aureus biofilms grown on titanium discs in vitro. J Orthop Res. 2014;32(1):175-7.