End-to-end multidisciplinary optimal design for improved personalized bioactive glass/ceramic bone substitute implants- ReBone: a Marie Skłodowska-Curie Doctoral Network

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INTRODUCTION: Common clinical problems frequently place a significant stress on the clinical system, and the musculoskeletal system is particularly susceptible to aging and traumatic occurrences. New solutions are required to address significant unmet needs for patients who require bone-substitute implants to treat critical-size bone defects, including personalized solutions for better clinical outcomes, material advancements to ensure higher mechanical reliability without sacrificing bioactive and bioresorbable properties, and optimized manufacturing techniques for materials and products of high reliability and quality. The four-year ReBone Doctoral Network, funded by the Europe Horizon Marie Sklodowska programme, aims to train a new generation of researchers in an innovative and multidisciplinary optimization process to provide technologies for customized bone-substitute implants based on bioactive ceramics and cutting-edge additive manufacturing techniques, to address the health and societal burdens of trauma and bone diseases.

MATERIALS and METHODS: A multidisciplinary network and training program have been planned in which ten doctoral candidates will jointly develop an innovative and integrated methodology to the design of personalized ceramic-based bone substitute implants. In order to achieve the purpose, a European network of partners and associated partners has been established encompassing diverse disciplines including biomechanics, clinics, materials engineering, mechano-biology, additive manufacturing technologies and mixed reality models for surgical planning simulations. Materials play a significant role in this project in terms of mechanical properties, bioactivity, biocompatibility, printing technology, and pertinent fidelity. Biologists, material engineers, bioengineers, and technology developers will collaborate to design and thoroughly characterize glass-ceramic based materials for the intended use. Four clinical cases of patients in the need of bone repair will be purposely selected with the aim to develop real-case scenarios of personalized design of bone-substitute implants. Clinical data will be used to create personalized multi-scale models of the implant at the organ level; concurrently, the design of device architecture, materials and parameters for manufacturing technology will be optimized to achieve improved implant outcome in terms of optimal mechanical performance in relationship to the shape and the anatomical location of the implant.

RESULTS AND DISCUSSION: As a primary result, a consortium of nine European countries has been constituted and an up-to-date multidisciplinary training program has been set. Furthermore, ten interdisciplinary doctoral research projects have been drawn; ten Doctoral Candidates will undertake the above-mentioned research program in a multidisciplinary environment.

Preliminary results achieved by the research institutes involved in the project in the area of ceramic materials development and characterization, additive manufacturing and biomechanics and a clinical research institute will constitute the solid background of the whole activity.

CONCLUSIONS: The Europe Horizon Marie Sklodowska program funds the ReBone Doctoral Network, which addresses issues with bone-substitute implants for critical-size bone lesions. A variety of research fields will be addressed by the multi-disccipliinary approach. Among these, technological and material development advancements are crucial and will serve as the foundation for the design of customized solutions.

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