Regulatory science for biomaterials: are we doing right things right?

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INTRODUCTION: The aim of this work is to highlight gaps and drawbacks in modern development of biomaterials which are intended themselves alone or in combination to be deployed in medical devices, especially for Class III under the EU MDR 2017/745. More tight requirements for biomaterials safety and efficacy demand proper testing and assessment which might be not always aligned with the R&D process [1].

MATERIALS AND METHODS: We analyse here several examples related to the assessment of properties several biomaterials (silicone, PLA, titanium, zirconia) and align these with the objectives of the regulations, which in general do not state specific methods or outcomes to be reached for orthopaedic and dental applications. We show in particular how biomechanical and physical-chemical properties should be evaluated in the *in vitro* conditions to mimic as close as possible their intended purpose [1,2].

RESULTS AND DISCUSSION: Results of the testing show that the same biomaterial exhibit functionalities which are different for varied applications, and hence known standard methods are lagging in providing information relevant to the clinical purposes. In particular, known ISO 10993 for biocompatibility assessment in lacking essential stimuli needed for orthopaedic and dental uses, and is insufficient for the regulatory authorities to prove biomaterials usability. This requires a deeper knowledge of the target tissues and locations where these biomaterials are intended to be applied, considering i.a. biomechanical compliance, proper hemodynamic and neurologic stress windows, foreign body response, inflammatory corrosion resistance under physiological loads, *etc*.

CONCLUSIONS: Most of existing standard testing protocols require a substantial update and detailing for biomaterials to take into account those biomaterials specific purpose, and not in general. We suggest that biomaterials tuning should always include a specific purpose which will be complemented with a tailored test protocol. This would allow early detection of unsuitable solutions before seeing failures in clinical trials or on the market [1,3].

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REFERENCES

[1] Gasik M. Understanding biomaterial-tissue interface quality: combined in vitro evaluation. *Sci. Techn. Adv. Mater.* (2017), 18:550-562. https://doi.org/10.1080%2F14686996.2017.1348872

[2] Zuhlke A. Dynamic mechanical characterization of biomaterials for medical devices. *Aalto University Doctoral Theses* (2023), 148 p. https://urn.fi/URN:ISBN:978-952-64-1255-9

[3] Gasik M. Biomechanical characterization of engineered tissues and implants for tissue/organ replacement applications. In: *Biomaterials for Organ and Tissue Regeneration*, Eds. E.N. Vrana, H. Knopf-Marques, J. Barthes, Woodhead Publ. (2020), 599-627. https://shop.elsevier.com/books/biomaterials-for-organ-and-tissue-regeneration/vrana/978-0-08-102906-0

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