Future Developments

Significant improvements in device performance have undoubtedly been realized with the advent of hydrogel coatings. Benefits include enhanced biocompatibility, lubricity, athrombogenicity and infection resistance, all of which should consequentially improve patient outcomes, decrease morbidity and prevent premature mortality. Hydrogel coatings are, however, typically characterized by poor abrasion resistance, thus limiting potential applications. Future research should focus on improving coating durability to withstand mechanical wear throughout the duration of implantation, in addition to the initial and often highly abrasive implantation process (Goodman et al. 2013). Furthermore, the development of durable, biocompatible and infection-resistant coatings is regarded as a matter of urgency to combat the increasing incidence of device-associated infections.

Hydrogel coatings have made the targeted site-specific delivery of bioactive agents a real possibility, with potential benefits including reduced systemic toxicity of therapeutic agents and antimicrobial resistance problems, improved compliance and, ultimately, enhanced therapeutic outcomes. An expanding range of incorporated bioactive agents, in combination with advances in nanotechnology, could enable the controlled delivery of chemotherapeutic agents from coated peripherally inserted central catheters (Mehta et al. 2010). In consideration of these potential capabilities, the ever-evolving nanotechnologies and implantable 'smart' devices will continue to be coated with hydrogels (Metha et al. 2015).

Future development of bioactive hydrogel coatings will be focussed on delivering agents in tune with *in vivo* requirements, with the aim of mimicking the natural biological milieu and initiating multiple cellular cascades in a controlled fashion. Bone healing, for example, requires the sequential delivery of multiple growth factors to stimulate angiogenesis and bone formation respectively (Goodman et al. 2013). Initial success has been achieved with the use of polyelectrolyte multilayer coatings. Recombinant human vascular endothelial growth factor (rhVEGF) and recombinant human bone morphogenetic proteins (rh-BMP) were incorporated into these multilayer coatings and eluted over eight days and two weeks respectively, demonstrating the potential to fine tune biological drug delivery *in vivo* (Shah et al. 2011). Sequential, tailored delivery of BMP-2 and BMP-7 has been achieved in another study where in growth factor-loaded nanocapsules of poly(lactic-*co*-glycolic acid) and poly(3-hydroxybutyrate-*co*-3-hydroxyvalerate) were incorporated into fiber scaffolds of chitosan and chitosan-polyethylene oxide (Yilgor et al. 2009).

With regards to blood-contacting devices, despite lifelong administration of complex anticoagulation therapy to patients, thrombosis remains the most common cause of device failure. For example, thromboembolic complications of mechanical heart valves are reported at a rate of up to 6.4% per patient year (Jaffer et al. 2015; Bluestein et al. 2013). Novel strategies to eliminate the risk of medical device-induced thrombosis are therefore urgently needed. This goal will only be realised through further understanding of the pathogenesis of thrombus formation at the interface between the blood-contacting device surface and the circulatory system, in combination with advancements in materials science (Jaffer et al. 2015). Hydrogel-coated surfaces which inhibit protein adhesion are promising, however human studies to test their