

## Chapter 2

# The Need for Invasive Sensing

The fast progress in medicinal therapies, clinical instrumentation and drugs development have contributed paradoxically to higher demand for patient monitoring in healthcare systems. The higher increase in chronic patients and an aging population has led to the use of intensive and invasive methods in general wards areas, which otherwise were reserved for patients in high level of care environments, such as intensive care units. Invasive monitoring of physiological parameters, such as blood pressure, heart rate and body temperature among others, is certainly an extensive practice in clinical settings. It is, however, the monitoring of biochemical parameters by means of biosensors that we are interested in for the scope of this volume.

Continuous monitoring of metabolites (glucose, lactate, pyruvate, urea, glutamate), proteins and nucleic acids (DNA, RNA) can potentially provide a rapid detection of life-threatening events. A slight change in the mix of proteins can predict a possible heart failure (Braunwald 2008). Glucose, pyruvate and lactate are tightly correlated with ischemia; hence an early detection provides a faster and more accurate therapeutic intervention. Elevated levels of uric acid are associated with leukaemia, pneumonia and kidney damage. Meanwhile DNA measurements provide diagnosis for inherited diseases and pathogenic infections (Malhotra and Chaubey 2003). Other variables such as changes in ions ( $H^+$ ,  $K^+$ ,  $Ca^{2+}$ ,  $Na^+$ ), which are associated with fluxes across membrane, play an important role in biological processes. Gases ( $O_2$ ,  $CO_2$ ) and other species ( $H_2O_2$ ,  $NO$ ) generated or consumed during the biochemical reactions can also be of great importance to improve health care, reduce hospital stay of critically ill patients and provide a better control of chronic illness such as diabetes and kidney failure (Wilson and Johnson 2008).

Hospitals and clinical settings around the world still rely on frequent in vitro measurements to monitor patients' biochemical parameters. This system provides only a series of discrete measurements, which are not representative of the overall patient's physiology and can miss rapid biochemical changes. Furthermore, it is labour intensive for the nurses and inconvenient for patients, besides having

associated human errors. Ideally, continuous in vivo measurements are required in order to predict, diagnose and respond earlier to an adverse event. Non-invasive monitoring is preferable to invasive monitoring for patient healthcare both at home and in clinical settings. However, in the case of biochemical monitoring, non-invasive procedures are limited to urine, stool and saliva samples. Considering that most of the current biochemical parameters measured in vitro in clinical practice are invasive (blood or tissue samples) and that this trauma is minimal compared with the surgery itself, implantation of sensing devices in the human body allows not only a close monitoring of patient biochemical levels but also the possibility of “closed feedback loop” systems for drug delivery (Steil et al. 2004; Kato et al. 2010). Nevertheless, implantation of any device into the human body has an associated risk. Hence, the implantation of biosensors and probes must guarantee the safety of the patient and must have very strict requirements to avoid any risk of infections.

## References

- Braunwald E (2008) Medical progress: biomarkers in heart failure. *New Engl J Med* 358:2148–2159+2094
- Kato R, Munkhjargal M, Takahashi D, Arakawa T, Kudo H, Mitsubayashi K (2010) An autonomous drug release system based on chemo-mechanical energy conversion “Organic Engine” for feedback control of blood glucose. *Biosens Bioelectron* 26:1455–1459
- Malhotra BD, Chaubey A (2003) Biosensors for clinical diagnostics industry. *Sens Actuators, B* 91:117–127
- Steil GM, Panteleon AE, Rebrin K (2004) Closed-loop insulin delivery—the path to physiological glucose control. *Adv Drug Deliv Rev* 56:125–144
- Wilson GS, Johnson MA (2008) In-vivo electrochemistry: What can we learn about living systems? *Chem Rev* 108:2462–2481

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