An Osmotic Pressure-based Implantable Glucose Sensor: Preclinical Results

Andreas Pfützner, Sanja Ramljak, Bernd Lecher, Anja Meier, Eugene Van Wyk, Rune Frisvold,
Lifecare AS, Bergen, Norway; Pfützner Science & Health Institute, Mainz, Germany; Sciema UG, Mainz, Germany; MfD GmbH, Wendelsheim, Germany; Cambridge Consultants, Cambridge, UK

Background

The technology of the Sencell glucose sensor (Lifecare, Bergen, Norway) uses the competitive and reversible binding of glucose vs dextrane to the lectin concavalin A (ConA) to measure an osmotic pressure difference arising between a reagent chamber (containing ConA and dextrane) and a diffusion chamber, which is in direct contact with interstitial fluid to determine interstitial glucose concentrations. Both compartments are separated by a nanoporous membrane permeable to glucose and water, but not to ConA or dextrane. A first study in pigs has initially demonstrated the capability of the technology to track interstitial glucose. It has also led to specific sensor modifications for signal noise reduction, e.g. the introduction of a second measurement chamber to measure mechanical pressure “noise” signals and deduct them from the signals. This device iteration was now evaluated in another animal experiment.

Methods

Three pigs (1 female, 2 male) were subjected to i.v. glucose loads (100 mg glucose/kg body weight) after two day of signal equilibration and documentation. Into each animal, three working and one reference Sencell device were implanted into the s.c. space at the neck and by wire connected to a wearable data logger with wireless data transmission to the analysis computer. The Sencell signals were collected every 5 min and evaluated in comparison to two reference assessments (Dexcom G4 interstitial glucose (every 5 min) and YSI 2300 STAT Plus with capillary glucose from the ear veins (every 15 min)) for 5 h.

Results

The Sencell sensor units obtained raw signals, which in many case already paralleled the interstitial glucose results of the Dexcom Sensor over extended time periods after an initial one-point calibration. Deduction of movement artefacts by substracting the signals of the reference pressure chambers from the active sensors substantially reduced the noise level of the signals (Fig. 2). The magnitude of the signals was in a predicted range. There was no loss or drift in sensor signals over the three experimental days (see Fig. 3) and no external signs of inflammation were observed in the histology examinations.

Fig.1.: Osmotic pressure cell principle and experimental setup

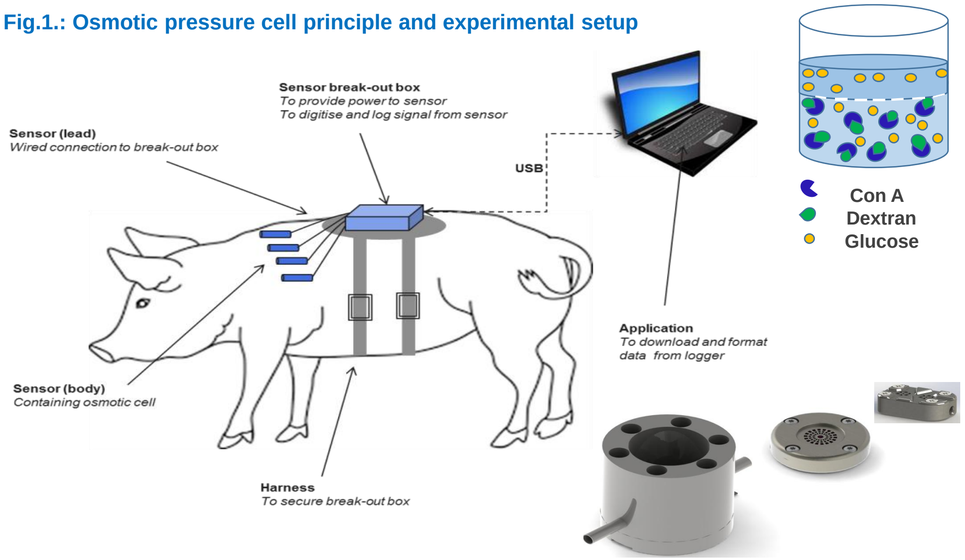


Fig.2.: Normalized raw data signal of the Sencell device and the glucose signal of the Dexcom G4 sensor

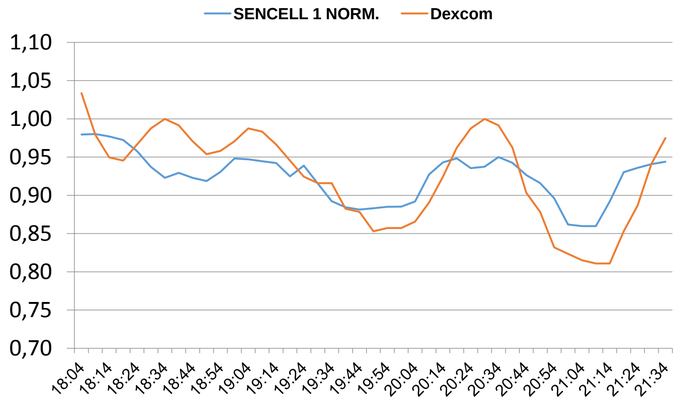
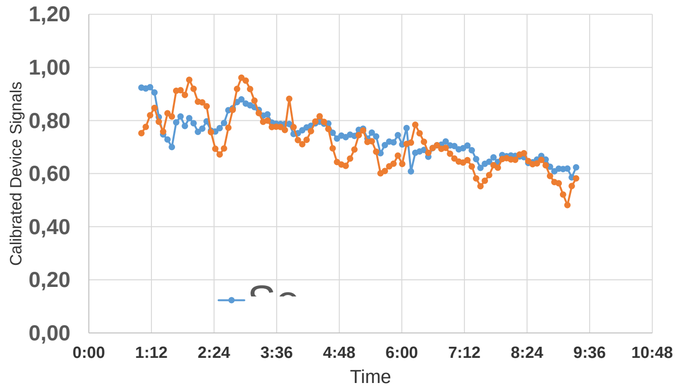


Fig.3.: Raw data signal of the Sencell device after retrospective one-point calibration with the Dexcom G4 sensor



Conclusions

In comparison to prior experiments, the introduced device changes resulted in improved signal to noise ratio and stable sensor signals over the entire observation period. Methods of nano-biosensing and microfluidity technologies are currently employed to achieve further miniaturization prior to entering into the clinical development phase.

LifeCare AS, Bergen, Norway: Contact Information: Rune Frisvold, CEO: +4790136063, Rune.frisvold@lifecare.no