Why intraperitoneal glucose sensing is sometimes surprisingly rapid and sometimes slow: A hypothesis

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Introduction

- Fast glucose sensing dynamics is crucial for a fully automated and well-functioning artificial pancreas.
- Animal trials have shown fast, but varying intraperitoneal glucose dynamics [1].
- Diffusion of glucose in water is slow, with a diffusion coefficient of:

$$D = 6.7 \times 10^{-6}\ cm^2 s^{-1}$$ in water at 25°C [2]

- By combining Fick's first and second law, it is possible to calculate the diffusion time of glucose over a specified distance:

$$t \approx x^2/2D$$

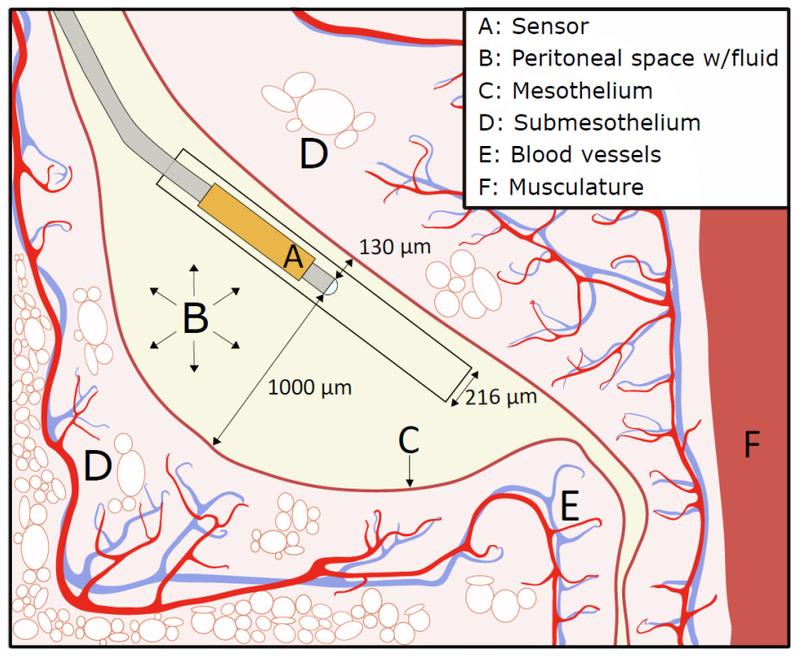
where t=time, x= distance, D=diffusion coefficient

- The diffusion coefficient of glucose in IP fluid is unknown, but faster diffusion at higher temperatures and slower diffusion at higher viscosities, are arguments that water at 25°C could be an estimate of peritoneal fluid at 37°C.

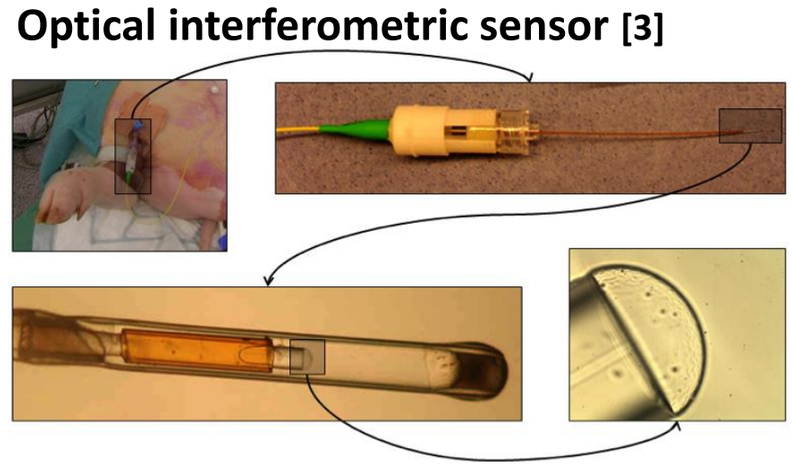
Glucose diffusion times in water at 25°C:

For x = 1 mm;	=>	$t_{25°C,\ 1\ mm} \approx 750$ s
For x = 100 µm;	=>	$t_{25°C,\ 100\ \mu m} \approx 7.5$ s
For x = 10 µm;	=>	$t_{25°C,\ 10\ \mu m} \approx 0.075$ s

Sensor in the peritoneal space



Optical interferometric sensor [3]



The Hypothesis

We hypothesize that glucose changes can be detected as quickly in the abdominal cavity as in arterial blood only by locating the glucose sensor at the surface of, and in direct contact with, the peritoneal lining.

Evaluation

- Glucose was in some cases detected as fast in the intraperitoneal space as in the femoral artery. This may imply that the sensor was measuring glucose directly against the peritoneal lining.
- In other cases, longer time delays may imply that the intraperitoneal sensor was located in a lumen filled with peritoneal fluid.

Implications and Conclusion

- Glucose sensors in an intraperitoneal artificial pancreas should measure glucose directly on the surface of or in the peritoneal lining.
- This approach could provide the near real-time glucose measurements necessary for a well functioning artificial pancreas.

References

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