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Gas Sensor Capsules: A New Paradigm in Gastroenterology for Assessing Functional Roles of the Gut Microbiota

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Background: Microorganisms of the gut contribute to our health, development and metabolic requirements. Many of these microorganisms satisfy their energy needs by the fermentation of food intake. This process produces certain gases. The production and relative concentration of these gases affect the functionality of the gut. The most prevalent gases in the metabolic activities include CH_4, CO_2, H_2, H_2S and NOx. As perturbations in environmental parameters, stress, diet and diseases affect the microorganisms of the gut, the activities of the microbiota are impacted and consequently the constituents of the gases are altered. We have recently introduced the concept and prototype of a swallowable, indigestible gas capsule (1,2) comprising a sensor based on thermal conductivity technologies, which could measure 'CO_2 - CH_4' and H_2 values in %. **Aims:** To test the operation of the human-sized gas-sensing capsules in pigs, where the effects of antibiotics was assessed on the luminal production of CH_4, CO_2 and H_2. **Methods:** Gas-sensing capsules (2.7 mm × 11.5 mm) containing a membrane that is highly permeable to diffusion of gas molecules, but not gut liquid, and whose electrical components sample and subsequently communicate the data to an external receiver every 5 minutes were evaluated. Capsules were administered via gavage to 2 pigs (~40 kg weight) receiving standard pig-growers diet alone (~7.5% fibre) or with co-administration of antibiotics (Lincopharm 800 - added to the pig's diet three days before the start of the trial) in a randomized study. Pigs were kept under the ambient condition and at constant temperature. Changes in gas constituents of 'CO_2 - CH_4' and H_2 were assessed until the capsules left the body of the pigs, and was compared between treatment conditions. **Results:** Gas profiles with and without administration of antibiotics are shown in Fig 2. Two main differences were noted: (a) in the fermentation region, H_2 concentration was less in association with antibiotics (2.6%) compared to without (4.1%), consistent with an overall reduction of the bacterial population; and (b) a stark difference in the production of CH_4 in the distal colon of pigs on antibiotics, with 'CO_2 - CH_4' being increased by 70%, consistent with reduction of activity and presumably number of methanogens in the colon. **Conclusions:** This capsule prototype has demonstrated *in vivo* the changes in colonic luminal gas production that might be anticipated in association with antibiotic therapy, indicating the validity of measurements obtained. Human testing of the gas-sensor capsule is warranted. **References:** 1. K. Kalantar-zadeh et al., Intestinal Gas Capsules: A Proof-of-Concept Demonstration. Gastroenterology doi:10.1053/j.gastro.2015.07.072. 2. J. Z. Ou et al., Human intestinal gas measurement systems: in vitro fermentation and gas capsules. Trends in Biotechnology 2015, 33, 208.

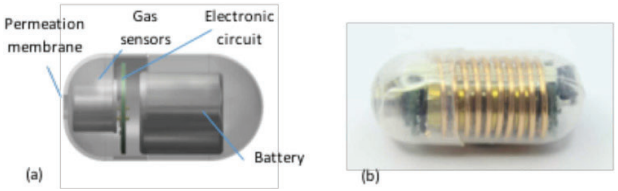

Fig 1 (a) Schematic of the internal components of the capsule and (b) the photo of the capsule with antennae included (not sealed).