A simple solution to prevent the abdominal migration of temperature loggers, and to facilitate their smooth retrieval post-study in macaques

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Materials & Methods
Animals, housing, and care
This study included 12 adult healthy male cynomolgus monkeys (Macaca fascicularis) that were housed at the Biomedical Primate Research Centre (BPRC, Rijswijk, the Netherlands), aged 6-13 years, and weighing 5.6-11.3 kg. All macaques were pair-housed (same-sex couples) in the experimental facility. The monkeys had no history of abdominal surgery. The procedures performed in this study were in agreement with the regulations for animal handling as described in the EU Directive (2010/63/EU) and in accordance with the Weatherall report (2006). During the study, the monkeys were kept under close veterinary supervision. The animals were fed with commercial monkey pellets (Sniff, Soest, Germany) supplemented with fruit and vegetables, and drinking water was available ad libitum. Food was removed 16 hours before being infected with an Influenza virus, 12 cynomolgus monkeys (Macaca fascicularis) were implanted with temperature data loggers. These devices are small implantable recorders that measure temperature with a high degree of accuracy, and store the data in their internal memory. All measurements are in real time, and can be accessed after the logger has been retrieved at the end of the study. After retrieval of the data, the logger can be re-programmed and re-used for as long as the battery lasts. The transmitters' upper surface is very smooth, and has no ridge or other affixing possibility to attach the logger to the abdominal wall. In previous experiments, we experienced that such loggers migrated through the entire abdomen (Fig. 1), which made surgery to retrieve the loggers difficult, necessitating almost an explorative laparotomy. In order to refine this retrieval surgery, a simple home-made solution was devised: A bled knot of non-resorbable suture material with needle was created around the logger, and the needle was used to attach the logger to the abdominal wall during wound closure.

Surgery
Anesthesia was achieved by means of 10 mg/kg ketamine (Ketamine 10%; Artisan, Nederland Bv, Woerden, NL, 100 mg/ml) and medetomidine IM (Södastart; AST Farma B.V., Oudewater, NL, 1 mg/ml) As analgesia, 1 ml prior to surgery, 0.20 mg/kg meloxicam (Meloxicam, Boehringer Inhleheim, Alkmaar, The Netherlands) was administered together with 0.02 mg/kg buprenorphine (Buprecare®, AST Farma B.V., Oudewater The Netherlands). After surgery, animals received meloxicam (0.10 mg/kg PO) once daily for two days. Subsequently, the abdomen was shaved and prepared with chlorhexidine and povidone-iodine. The macaques were placed on a heated blanket in order to stabilise body temperature, and were breathing room air spontaneously throughout the surgery.

Results
The temperature loggers were removed smoothly from all 12 animals 5 months after insertion. All loggers were still fixed in the position where they had initially been stitched (Fig. 5). The retrieval surgery was scored as a minor discomfort. All measured data was uploaded successfully into a PC. The implanted loggers did not have an adverse affect on the animal's health, which was checked daily.

Conclusion
The bled knot around the smooth loggers to attach them to the abdominal wall was seen to be a simple solution to prevent abdominal migration of temperature loggers, and to facilitate their smooth retrieval post-study. The implanted loggers did not have an adverse affect on the animal's health.

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Fig. 1. Abdominal X-ray, lateral view: a non-attached logger that had migrated to the vertebral column is clearly visible. It is conceivable that surgery to retrieve the logger would be difficult, almost necessitating an explorative laparotomy.

Fig. 2. The pre-operative prepared logger, with suture material and bled knot around it.

Fig. 3. The pre-op prepared logger was inserted into the abdominal cavity, and the needle was then used to attach the logger to the abdominal wall during linea alba wound closure.

Fig. 4. Abdominal X-ray, lateral view: The logger was inserted into the abdominal cavity, and the needle was then used to attach the logger to the abdominal wall during linea alba wound closure.

Fig. 5. Minor surgery to retrieve the transmitter.

Fig. 6. An example of part of the temperature data collected from an animal during this study. A clear right-day pattern is visible.