A Bayesian Gompertz approach to evaluate the optimal surgical space for laparoscopic surgery

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Laparoscopy is a surgical procedure performed using small incisions and a camera to visualise organs or conduct minor surgeries in the abdomen or pelvis. To create enough space for the surgical instruments, carbon dioxide (CO2) is insufflated into the abdomen. It is crucial to identify the critical point at which insufflation should be limited to maximise surgical space and minimise harmful effects.

To evaluate the relationship between insufflation pressure and intra-abdominal volume generated and make inferences for some interesting outcomes of the procedure, a Bayesian logistic growth curve was used in previous studies. In this work, a Bayesian Gompertz growth mixed-effects model is proposed. The asymptotic deceleration point of the Gompertz curve, calculated from the fourth derivative of the function, can be considered as the critical point beyond which it is expected that the increase of the surgical space is not of practical interest. The main goal of this study is to compare the two-modelling approaches and select the option that best suits the relationship between insufflation pressure and intra-abdominal volume generated in a laparoscopy.

The data upon which our model has been applied were obtained from 49 patients who underwent laparoscopy at the Hospital Universitario y Politécnico La Fe (València) between March 2021 and January 2023. For each patient, the intra-abdominal volume was recorded based on the insufflated intra-abdominal pressure at the start of surgery. Furthermore, variables including age, sex, weight, height, number of previous pregnancies, and several anthropometric measures, such as sagittal abdominal diameter, body mass index, and conicity index, were also recorded.

Keywords: Critical growth points; Non-linear mixed models; Repeated measures.