# PRECISION MEDICINE FOR ACHALASIA DIAGNOSIS: A MULTI-MODAL AND INTERDISCIPLINARY APPROACH FOR TRAINING DATA GENERATION

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Achalasia (AC) is a rare chronic esophageal motility disorder, characterized by impaired deglutitive lower esophageal sphincter (ES) relaxation and absent propulsive tubular peristalsis. Therapeutic management of AC patients targets relieving the obstruction at the esophagogastric junction. However, treatment response can vary depending on factors such as type of AC, degree of dilatation, kinking of the tubular esophagus and pressure at the lower ES. In line with precision medicine (PM) [1], the present work introduces an interdisciplinarily developed concept to combine valuable information from different diagnostic data sources into one coherent 3D-representation of the esophagus. In addition to improving diagnostic precision, the long-term objective is to train a machine learning (ML) model that predicts the success of individual treatment options. [1]

## 1. A NOVEL COMPREHENSIVE DATATYPE

Multiple data sources are consulted to diagnose the precise case of AC. These include endoscopy (ED), timed barium esophagogram (TBE), and esophageal manometry (MA). A first prototype that combines their information in a 3D-representation of the esophagus has already been developed. Interestingly, automated extraction of valuable information like the esophagus' form in a TBE or the automated generation of its 3D-representation proved to be unreliable due to a high variance in the data sources' quality. In order to address these challenges, the software was adapted in such a manner, that physicians can control and adjust the automated selection of relevant information before being utilized to generate the 3D-representation. Another positive effect of the presented human-in-the-loop approach is enhanced trust thanks to these plausibility checks. The process is as follows: First, a TBE and $N$ ED images are loaded to extract the esophagus' form, and diameter at previously defined positions along its course. The TBE supports mapping all sources to a shared scale. There, the user marks the point zero of the ED images and two widely spaced sensor points of the MA, i.e. the upper and lower ES. The resulting approximation of the patient's esophagus displays color-scaled pressure values whose movement can be tracked over the complete time span of the MA. All in all, there is still potential for improvement regarding the representation's accuracy. The course of the MA catheter, for instance, is only estimated. Furthermore, the approximation of the diameter could be more precise, and its implementation should be integrated within the ED technology, as in [2] for measuring polyp size during live colonoscopies. Also, the human-in-the-loop approach involves some risks, since inserting points of reference by hand is prone to some sort of variance. Thus, further automating the mapping of all data sources while still including the physician as reality check appears fitting. To enhance diagnostic precision, additional data sources (Endosonography or EndoFLIP) could be integrated to include information about the thickness of the esophageal wall or distensibility.

[1] Compliant with the Declaration of Helsinki. The study protocol was approved by the medical ethics committee of the Ludwig Maximilians University of Munich on June 27, 2022 (registration no. 22-0149).

## 2. OUTLOOK: MACHINE LEARNING

As of now, the prototype is tested in a clinical environment to assess therapeutic performance. An index consisting of volume and pressure values was added, to evaluate the therapy's success by comparing 3D-representations from before and after the procedure. The desired outcome is a decrease in size above the ES and a dilation within. Based on that data and index, the long-term objective is to enhance AC treatment with artificial intelligence, including domain experts from ML and medicine. Generally, disease data is rare and the presented multi-modal approach to develop a novel comprehensive data type for the diagnosis of AC is expected to capture information more precisely, in line with PM.

## 3. REFERENCES

[1] S. J. MacEachern et al., "Machine learning for precision medicine," *Genome*, vol. 64, no. 4, pp. 416–425, 2021.

[2] D. von Renteln et al., "Measuring size of smaller colorectal polyps using a virtual scale function during endoscopies," *Gut*, p. gutjnl—2022—328654, November 2022.