

Dörte Wichmann, Benedikt Duckworth-Mothes, Bernhard Hirt, Dirk Wilhelm, Jana Steger, Martin Zweimüller, Armin Küllmer, Martin Raithel, Jürgen Maiss, Peter Pott, Thomas Wittenberg

Training and education of young physicians and engineers in the field of endoscopy and laparoscopy – a review of Germany-wide joint cooperation and training possibilities

<https://doi.org/10.1515/cdbme-2023-1136>

Abstract: **Introduction:** Application-related (hands-on) training and instruction is an essential component in the advanced education of physicians in residency. To teach and train required endoscopic examinations and interventions in a standardized manner, courses are offered by various societies. Within these courses the assistant endoscopists learn and train how to use the technical equipment and how to perform the examinations and related interventions. Similarly, for graduate biomedical engineering students with a job- or research-related interest in the field of endo- and laparoscopy, an early involvement and practical introduction to the instrumentation and techniques – if possible already during their studies – can generate a fundamental understanding of the technical requirements as well needs of the physicians. **Objective:** As various such (hands-on) training-courses for flexible and rigid endoscopy specifically addressing young physicians, surgeons as well as engineers are offered by numerous institutes, this contribution tries to provide a structured overview on/over these possibilities. **Material:** Known cross-institutional courses in the field of endo- and laparoscopy currently offered in

Germany in cooperation of physicians *and* engineers are listed and briefly described. **Results:** A total of $n = 4$ cross-institutional courses for the introduction and training in flexible and rigid endoscopy have been identified. **Discussion:** The cross-institutional courses for physicians and technicians in the field of endo- and laparoscopy presented serve to provide a better understanding of the subject matter and the field of either discipline. Questions that arise in the field of endoscopy from physicians can be addressed at an early stage and, if necessary, worked on with little effort. Ideas for new instruments and even new interventions can arise and be pursued through an intensive exchange between technicians and physicians. Collaborations are established on a local basis which will foster national activities in this field and which allow to develop competencies relevant for the industrial sector of medical engineering.

Keywords: Endoscopy, laparoscopy, education, hands-on training, interdisciplinary cooperation.

1 Introduction

Informed innovation in *biomedical engineering* relies on an understanding of real clinical problems, the context within such problems arise, and the stakeholders affected by potential engineering solutions [1-3]. To meet the demands of an evolving technical industry and lead the way in engineering education, innovative curricula are essential. Such understanding is most often gained – if it is gained at all – via meaningful engagement in clinical environments and regular interactions with clinical experts. On the other hand the same understanding and interaction is needed from the side of the clinicians. A combination of training courses for resident trainees *and* biomedical engineering students and staff could solve the understanding problem [3]. Especially

***Corresponding author: Dörte Wichmann**, University Hospital of Tübingen, Working Group Experimental Endoscopy, Development and Training, Waldhörnlestrasse 22, 72072 Tübingen, Germany, email: doerte.wichmann@med.uni-tuebingen.de

Benedikt Duckworth-Mothes, Bernhard Hirt: University Hospital of Tübingen, Germany, **Dirk Wilhelm, Jana Steger:** Technical University of Munich, Germany, **Martin Zweimüller:** Vivantes Hospital Friedrichshain, Berlin, Germany; **Armin Küllmer:** University Hospital of Freiburg, Germany, **Martin Raithel:** Malteser Waldkrankenhaus **and** University Erlangen, Germany; **Jürgen Maiss:** Forchheim, Germany; **Peter Pott:** University of Stuttgart, Germany; **Thomas Wittenberg:** Fraunhofer Institute for integrated Circuits IIS; Erlangen, Germany

the value of hands-on, experiential learning, and motivated by the desire to bring engineering students to a more profound understanding of clinical problems, are the fundamental idea behind *joint* training courses. The outreaching effect of joint research and development in this field is well known and has led to a new principle of interaction, so called “Surgineering” or “Endoscopineering” [1].

2 Collection of cross-institutional courses

In the following some known cross-institutional courses in cooperation of physicians *and* engineers in the field of endo- and laparoscopy and currently offered in Germany are listed and briefly described.

2.1 DGE-BV course for young endoscopist

The working group “young endoscopists” of the German Society of Endoscopy and Imaging (DGE-BV) performed one combined workshop day for gastroenterological residents and biomedical engineering students in 2022. A complete day, which was filled with lectures and hands-on training on simulators based on dry-models as well as the *Erlangen Active Simulator for Interventional Endoscopy* (EASIE) for flexible endoscopy was offered to the participants. Within the workshop, the participants of the training developed joint projects, which are continued until now. Further cooperation is planned.

Such endoscopy courses have a long tradition at the annual congress of the DGE-BV. Since 1998, the EASIE-simulator training courses for physicians and assistant have been established by the inventors of the EASIE-simulator. They founded a non-profit organization, the “Endo-Verein” (Association for the Quality-Oriented Practical Training in Endoscopy). The aim is the improvement of medical education for physician and nurses (and recently also engineers) in the field of flexible endoscopy. The group has developed so-called “organ-packages” using organs from slaughtered pigs as a byproduct of meat production. These specimens allow realistic training of nearly all interventional endoscopic procedures. This year we celebrated the 25th anniversary of these courses at the DGE-BV. Furthermore, the EASIE-simulator had been used to evaluate new instruments and techniques [4,5,6].

2.2 Incisions – Insights: Medical technicians and physicians

At the University Hospital of Tübingen two events are scheduled (and moderated by Prof. Dr. Hirt, head of the Department of Clinical Anatomy) each year under the title “Incisions – Insights”. These workshops are organized by the Inter-University Center for Medical Technologies Stuttgart - Tübingen (IZST), the BioRegio STERN Management GmbH and the Association for the Promotion of Biotechnology and Medical Technology e.V.. The workshops take place on different medical topics with live transmissions of surgical interventions as well as practical exercises in the operating room of the Department of Anatomy. It allows different disciplines to come together for joint activities and provides an opportunity to identify unmet challenges and to develop new ideas for technical solutions by an interdisciplinary dialog. Three of these workshops with focus on endo- and laparoscopic techniques have taken place so far. It has to be mentioned here, that these events are held for medical engineering companies and not for training of students and medical residents. One specialty of this course is the use of self-designed and -built silicon anatomical phantoms [7,8].

2.3 MITI-Course: Surgical interventions for engineers

At the University hospital “Klinikum rechts der Isar”, the “Hands-on Intensive Training for Engineers” takes place twice a year which is organized by the MITI research group. These courses are under the auspices of the surgical working group of “Computer and Robot Assisted Surgery – CTAC” and supported by the “German Society for Biomedical Engineering” – DGBMT. Under the guiding theme “Surgery in praxis”, the program provides profound insights into clinical daily life and the challenges encountered in surgery. Key note lectures on open, laparoscopic, endoscopic and robotic surgery, as well as hospitalizations in real life interventions provide participants with a comprehensive understanding for the discipline. These thus pave the way into laparo- and endoscopic hands-on experience in simulators and trainers. Standard procedures such as an appendectomy, gallbladder removal or endoscopic polyp resections are performed by the participants themselves on models, to get acquainted with the deficiencies of minimally-invasive surgery. By this means, the course creates a platform for an interdisciplinary exchange and aims to improve mutual understanding for the challenges of

each discipline. The course has been established more than ten years ago and was held the 22nd time this year. The course is offered in German and English language.

2.4 Erlangen seminary for diagnostic and interventional endoscopy

For the past ten years a seminary “diagnostic and interventional endoscopy” has been offered twice a year for biomedical engineering students at the Friedrich-Alexander-University (FAU) of Erlangen-Nuremberg. On one hand this course is a regular seminary, where the students (usually +/- 12) have to research and present topics in this field, such as e.g. the technical details, advantages and application possibilities of wireless capsule endoscopes, stereo endoscopes, tele-manipulators, surgical robots, endoscopic ultrasound (EUS), virtual reality (VR) and artificial reality (AR) in endoscopy, Natural Orifice Transluminal Endoscopic Surgery (NOTES) or disposable endoscopes. On the other hand, together with the Malteser Waldkrankenhaus Gastroenterology department in Erlangen and the EASIE-Verein, within an additional seminary session (usually 3-4 hours) various endoscopic hands-on training opportunities are offered. These include the use and practice of laparoscopy training systems based on the “Lübecker toolbox” [9], cystoscopy, colonoscopy and gastroscopy training units, as well as polypectomy and endoscopic retrograde cholangio-pancreaticography (ERCP) demonstration using bio-phantoms. Especially this hands-on part is usually shared with the young endoscopy-students and medical assistants in the Malteser Waldkrankenhaus, who can use the laparoscopic training systems and the swine bio-model for advanced training. Based on this seminary, in the past years also two additional interdisciplinary two-day courses “endoscopy for engineers” have been offered and organized together with the DGBMT.

Table 1 summarizes the key parameters (of the identified) interdisciplinary courses. Table 2 indicates different types of training phantoms used in the courses, ranging from commercial available phantoms, via self-designed built and digital phantoms to bio-preparation (swine). Even though various virtual reality (VR) training systems have been available in the past [10,11,12], the courses investigated still use classical (silicon or bio) phantoms as well as commercially available training systems.

Table 1: Comparison of the presented courses

Course	DGE-BV	Incisions/ Insights	MITI	Erlangen seminary
Number of participants	N=28-60	N = 50	N = 20	N=12-14
Lectures	Yes	Yes	Yes	Yes
Hands-on	Yes	(Yes)	Yes	Yes
Visitations	No	No	Yes	(Yes)
Time	8 h	4 h	20 h	12x 1,5h

DGE-BV = Deutsche Gesellschaft für Endoskopie und Bildgebende Verfahren; MITI = Institute for minimal-invasive, interdisciplinary therapeutic interventions; N = number; h = hours;

Table 2: Comparison of phantoms and training systems used

Course	DGE-BV	Incisions /Insights	MITI	Erlangen seminary
Bio-preparations	X	--	X	--
Commercial	X	X	X	X
Self-built	--	X		X
VR	--	--	--	--

3 Discussion

There is a strong need for combined training for biomedical engineering students and medical residents. These courses are essential to identify problems as well as jointly discuss and develop adequate solutions for current endo- and laparoscopy-based diagnosis and treatment procedures. To this end, different cross-institutional courses have been implemented by various institutions in past years. What all courses have in common, is the high level of enthusiasm of the participants, as well as the interdisciplinary interest to initiate and address new ways solving challenges. Whether there exists a possibly increased participant adherence to the disciplines taught by the courses afterward would need to be evaluated in a follow-up survey. Also, a website listing and describing all courses throughout Germany that can be attended jointly by medical professionals and biomedical engineering students or professionals would be desirable and shall be addressed shortly, as not all such courses are known to the authors as well as the interested participants. There also exist some related training courses, which teach endo- and laparoscopy techniques within in

broader scheme, such as e.g. the ICCAS “Digital Operating Room Summer School (DORS) in Leipzig [13].

Based on the endo- and laparoscopic phantoms and training systems, as indicated in Table 2, mainly commercially available, self-built and bio-phantoms are used so far, as mainly anatomical knowledge and manual skills are thought and trained. Also, such phantoms and training systems can be transported and set up quite easily. Furthermore, they support group experiences. Nevertheless, with the availability of VR systems it can be expected to be used more often in the future as part of such interdisciplinary hands-on courses.

Author Statement

Research funding: no funding involved. To realize the workshops organisations received material funding from medical engineering companies. Conflict of interest: no conflict of interest. Ethical approval: The research related to human use complies with all the relevant national regulations, institutional policies and was performed in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors’ institutional review board or equivalent committee.

References

- [1] Siewerdsen, JH, et al., Surgineering: curriculum concept for experiential learning in upper-level biomedical engineering. *Int J Comput Assist Radiol Surg*, 2020. 15(1): p. 1-14.
- [2] Lozano-Duran, A, et al., Training Scientific Communication Skills on Medical Imaging within the Virtual World Second Life: Perception of Biomedical Engineering Students. *Int J Environ Res Public Health*, 2023. 20(3).
- [3] Brenner, DJ, et al., Integrated interdisciplinary training in the radiological sciences. *Br J Radiol*, 2014. 87(1034): p. 20130779.
- [4] Maiss J, Naegel A, Hochberger J. The European experience - current use of simulator training in Europe. *Techniques in Gastrointestinal Endoscopy* 2011; 13(2): 126-131
- [5] Wedi E, Koehler P, Hochberger J, Maiss J, Milenovic S, Gromski M, Ho N, Gabor C, Baulain U, Ellenrieder V, Jung C. Endoscopic submucosal dissection with a novel high viscosity injection solution (LiftUp) in an ex vivo model: a prospective randomized study *Endoscopy International Open* 2019; 7(5): E641-E646.
- [6] Wittenberg T, Prinzen M, Nowack N, Maiss J, Hagel A, Münzenmayer C, Raithel M (2017): Bildbasierte automatische und echtzeitfähige Polypenerkennung: Erste Ergebnisse am Tiermodell. In: T Rösch, S Groth (Eds.): *Endoscopy campus, DGE-BV, 6.-8.4.2017 in Berlin*, pp. 98-99, <https://www.endoscopy-campus.com/wp-content/uploads/ec-magazin-2017-01.pdf>
- [7] Koch, K, Schweizer, U, Mothes, B, Wichmann, D, Grund, KE, 2020. Interventional training model for flexible endoscopy in postoperative altered anatomy of the upper GI tract. *Endoscopy* 52, eP13.
- [8] Tell V, Duckworth-Mothes B; Schweizer U; Königsrainer A; Wichmann D., Wichmann, D. 2023. Entwicklung eines interventionierbaren Bronchialtrainers für das Training in der flexiblen Bronchoskopie. *Pneumologie* 77, Po 446. <https://doi.org/10.1055/s-0043-1761136>
- [9] Laubert T, Tomaschewski, M; Auerswald, P; Zimmermann, M; Brüheim, L; Keck, Tobias; Benecke, C, 2018. Implementierung eines laparoskopischen Simulationstrainings in der studentischen Lehre – das Lübecker Toolbox-Curriculum. *Zentralbl Chir* 143, 412–418. <https://doi.org/10.1055/s-0043-106851>
- [10] Huber, T, Wunderling, T, Paschold, M, Lang, H, Kneist, W, & Hansen, C (2018). Highly immersive virtual reality laparoscopy simulation: development and future aspects. *Int. CARS*, 13, 281-290.
- [11] Huber, T., Paschold, M, Hansen, C, Wunderling, T, Lang, H, & Kneist, W (2017). New dimensions in surgical training: immersive virtual reality laparoscopic simulation exhilarates surgical staff. *Surgical endoscopy*, 31, 4472-4477.
- [12] McIntosh, KS, Gregor, JC, & Khanna, NV. (2014). Computer-based virtual reality colonoscopy simulation improves patient-based colonoscopy performance. *Canadian J. of Gastroenterology & Hepatology*, 28(4), 203-206.
- [13] <https://www.iccas.de/en/dors/>