Die Kardiologie
vormals Der Kardiologe

Positionspapiere

Kardiologie
https://doi.org/10.1007/s12181-022-00592-y
Accepted: 21 December 2022

eCardiology: a structured approach to foster the digital transformation of cardiovascular medicine

Position statement of the German Society of Cardiology

Benjamin Meder[1,2] · David Duncker[3] · Thomas M. Helms[4] · David M. Leistner[5,6,7] · Franz Goss[8] · Christian Perings[9,10] · Victoria Johnson[11] · Anne Freund[12] · Christoph Reich[1,2] · Jakob Ledwoch[13] · Ann-Kathrin Rahm[1,2] · Barbara Ruth Milles[1] · Stefan Perings[14] · Janine Pöss[12] · Christoph Dieterich[1,2,15] · Eckart Fleck[16] · Philipp Breitbart[17] · Jochen Dutzmann[18] · Gerhard Diller[19] · Holger Thiele[12] · Norbert Frey[1] · Hugo A. Katus[1,2] · Peter Radke[20]

[1] Department of Cardiology, Angiology and Pulmology, University Hospital Heidelberg, Heidelberg, Germany; [2] Informatics for Life, Heidelberg, Germany; [3] Department of Cardiology and Angiology, Hannover Medical School, Hannover Heart Rhythm Center, Hannover, Germany; [4] Peri Cor Arbeitsgruppe Kardiologie/Ass. UCSF Office, Hamburg, Germany; [5] Department of Cardiology, University Heart Center, Charite University Medicine Berlin, Berlin, Germany; [6] DZHK (German Center for Cardiovascular Research) partner Site Berlin, Berlin, Germany; [7] Berlin Institute of Health (BIH), Berlin, Germany; [8] MVZ Med 360° München – Alter Hof, Munich, Germany; [9] Department of Cardiology, Pneumology and Intensive Care Medicine, Katholisches Klinikum Luenen-Werne, Luenen, Germany; [10] Westdeutsches Zentrum für angewandte Telemedizin, Düsseldorf, Germany; [11] Department of Cardiology, University Hospital Gießen, Gießen, Germany; [12] Department of Internal Medicine/Cardiology, Heart Center Leipzig at University of Leipzig, Leipzig, Germany; [13] Isarherzzentrum, Isarklinik, Munich, Germany; [14] CardioCentrum Düsseldorf, Düsseldorf, Germany; [15] Klaus Tschira Institute for Integrative Computational Cardiology, Heidelberg, Germany; [16] Klinik für Innere Medizin – Kardiologie, Deutsches Herzzentrum Berlin, Berlin, Germany; [17] Department of Cardiology and Angiology, University Heart Center Freiburg-Bad Krozingen, University Medical Center Freiburg, University of Freiburg, Bad Krozingen, Germany; [18] Department of Cardiology, Angiology, and Intensive Care Medicine, University Hospital Halle (Saale), Halle (Saale), Germany; [19] Klinik für Kardiologie III: Angeborene Herzfehler (EMAH) und Klappenerkrankungen, Universitätsklinikum Münster, Münster, Germany; [20] Department of Internal Medicine-Cardiology, Schoen Klinik Neustadt, Neustadt in Holstein, Germany

The German version of this article can be found under: https://doi.org/10.1007/s12181-022-00584-y.

Scan QR code & read article online

Introduction

Cardiovascular (CV) medicine was historically connected to general technological advancements and progress in the computer and information technology (IT) industry whether it be cardiac phenotyping with computer tomography or magnetic resonance imaging requiring processing of high dimensional datasets, coronary interventions supported by digital image processing in picture archiving and communication systems (PACS), or implantation of highly integrated devices with wireless nearfield communication-enabling modern pacemakers, loop recorders, pulmonary pressure sensors and implantable defibrillators. Molecular phenotyping and genomic investigations have become standard of care for a broader range of CV diseases, such as cardiomyopathies. Together, firm technological integration has resulted in improved outcome for many cardiovascular conditions.

More recently, cardiovascular medicine shifted from its foundation of trial designs based on evidence-based medicine towards newer concepts following the approach of precision medicine including umbrella and basket trials, considering the individual (genetic) background and environmental exposures. Accordingly,

Published online: 17 February 2023

Abstract

The use of digital technologies in medicine is developing largely in parallel with the IT industry. Today, every cardiologist in Germany uses IT systems to make appointments, store patient data and write doctor's letters. So why is it necessary to introduce a dedicated eCardiology program within the German Society of Cardiology (DGK)? So far, digitalization has failed in many respects to fulfill its promise of making the daily lives of physicians and patients easier. Clinical EDP solutions derive mainly from accounting systems and lead only to a limited extent to an improvement in patient care. Negative effects on burnout rates and job satisfaction of medical staff could even be observed. Additionally, since May 2018 the introduction of the European General Data Protection Regulation with its principles of purpose limitation and data minimization has made the storage and use of medical data more difficult. This also has fundamental implications for developments in artificial intelligence (AI), which are based on the availability and quality of big data (= large, complex data sets) and could permanently change the healthcare system. The technology-driven progress of medicine does not end at the doorstep of a hospital but causes a significant cultural change in our society. The use of so-called wearables, search engines on the Internet and social media is increasingly enabling e-patients to make their own diagnoses and independent decisions regarding their health. As a result, physicians often see well-informed, but also misinformed patients who have been advised on health-related data by their own smart devices. The DGK recognizes the enormous challenges and potential of digital medicine to improve the prognosis of cardiovascular diseases. As part of the eCardiology program, the Society has established five committees to promote and communicate important aspects of digital health: transsectoral collaboration, mobile health, precision digital health, society and policy, and education and media. We report here on the elements of each committee and its working groups.

Keywords

Digital health · Artificial intelligence · Wearables · Health apps · Decision support

deep and precise phenotyping of individual patients by a multimodal approach and development of targeted treatments for smaller groups (*one treatment for many*) or even for single patients (*one treatment for some*) is being pursued in a nearly exponentially rising number of phase I–III trials [1]. Importantly, the idea of individualized treatment concepts does not necessarily require development of new pharmaceuticals; repurposing of existing drugs or the selection of the best existing therapy at the right dosage and timing for an individual can be sufficient to increase effectiveness and efficiency and thereby improve overall outcome. This concept also has to take preventive, socioeconomic and environmental measures into account, since the overall health of a population not only depends on medical care (**Fig. 1a**).

The human brain can process and integrate only 5–8 data sources in a real-time clinical setting (**Fig. 1b**). The overwhelming information generated by laboratory results, imaging and vital sign monitoring to name only few, can hardly be integrated by a treating cardiologist in the setting of an overcrowded chest pain unit. Already today, many more complex datasets from genomics, transcriptomics, functional measurements and wearables need to be seamlessly integrated to fully use their health information. It is evident that only IT solutions will be able to achieve the goal of highly parallel information processing. The potential of such big data in combination with major advancements in machine learning (ML) and artificial intelligence (AI) can already be judged from existing research results [4]. By using big data, very large data sets from routine diagnostics and study registries with over 1.7 million images from EyePACS and the UK Biobank, a team from Google was able to evaluate images of the retina via AI and assess the presence of cardiovascular risk factors [5]. Astonishingly, the AI even managed to accurately predict the age and sex of the person in question from the fundus, which physicians are unable to do and which indicates that further "hidden" information from routine diagnostic data can be identified by AI in the future. Such impressive early demonstrations of performance could now be achieved in many succeeding studies, as recent examples highlighted the use of AI for X-ray imaging, the prediction of fractional flow reserve (FFR) from reconstructed and computer-modeled coronary artery tomography scans or the prediction of incident atrial fibrillation in ECGs showing sinus rhythm at the time of the prediction [6–9].

Leading companies, but also startups from the technology and computer sector, have engaged in the healthcare market. However, most of them do not follow the strategy of established medical technology companies, but try to target their innovation towards consumers rather than doctors. This is best exemplified by their developments for cardiovascular health. Smartphones were originally developed for the purpose of communication, but with their versatile function due to integrated sensors and installable apps they soon became intricate part of the modern lifestyle. Smartphone's smaller siblings, the wearables, soon added to the equipment of the digital native. Building on the high penetration of the market, functional flexibility via apps and incorporation of cheap but precise sensors, companies such as Apple were able to deliver large numbers of class IIa medical devices to the customer that incorporate features such as atrial fibrillation detection and showed their capability to perform cardiovascular trials in the scale of population studies [10, 11]. Recently, the German Cardiac Society published its position on the use and caveats of wearables, providing professionals important insights into this fast-evolving technology [12]. With the global coronavirus disease (COVID) pandemic starting in 2020, wearables have finally proven to be reliable components of integrated care, with the advantage of high scalability [13]. Technologies such as telemedicine care, chatbots, or AI-assisted diagnostic tools are suddenly widespread.

The potential of digitization of health care can be compared to the introduction of antibiotics or other revolutionary treatment options. In cross-sectoral care, not only the patient is addressed, but also providers and effects on the society need to be mentioned (**Fig. 2a**, from [14]). Health care digitalization, however, has in

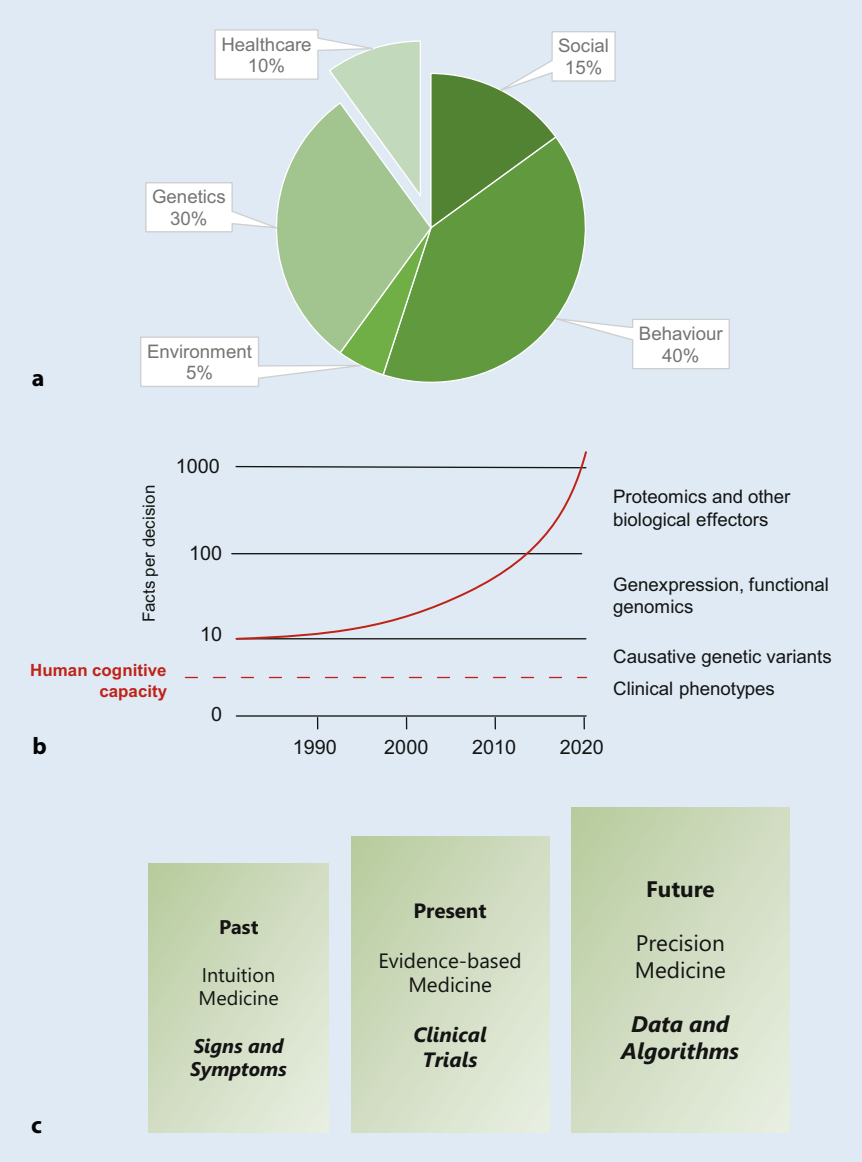


Fig. 1 ▲ **a** Contribution of different factors on population health. As shown, health care is responsible for approximately 10% of population health, which means that health engagement especially by digital technologies should cover all other areas, too (modified from [2]). **b** Ability to process facts in real-time clinical decision making in comparison to the scale of data sources that are nowadays available in a routine setting (modified from [3]). **c** The development of medicine will strongly depend on information and information processing by algorithms, incorporating the clinical judgement of the physician and the principles of evidence-based medicine

many aspects been especially problematic in Germany. Missing cross-sectoral exchange of information, analog medical prescriptions, and lack of risk factor and disease surveillance by national registries are only few of many factors that underline weaknesses of federal and multipayer systems. Additionally, the late introduction of some kind of reimbursement for digital health services in combination with restrained investments in hospital IT have put many innovative ideas from startups and industry on hold. By establishing the German Digital Healthcare Act ("Digitale-Versorgung-Gesetz"), it will be possible to address some of these issues; however, compared to other European countries such as Estonia or Austria, Germany is still years behind regarding infrastructural and telematic developments for digital health [15]. The German insurance card ("Gesundheitskarte"), for instance, was presented to the public by chancellor Merkel as a worldwide leading endeavor in 2005, but the initial version included only some demographic data and was never augmented by the planned capabilities of cross-sectoral, paper-free data exchange or advanced patient participation and is still nothing more than an "ID-card"-like relict of the analog world. Even rudimentary digital functions turned out to be problematic. In 2020, it took 52 days to manually reestablish the connection of more than 50,000 resident doctors' offices after a change of electronic certificates went wrong. In 2021, the whole concept was buried and the "Telematics Infrastructure 2.0" concept was proposed. The new system will be cloud and open source based, and first use-cases like the e-prescriptions are finally on their way to broader rollout (◘ **Fig. 2b**, modified from [16].

Mission statement

Cardiovascular medicine seems a pristine discipline for the digital transformation and it may look like digitalization will perpetuate itself. There are, however, several caveats and dead ends that need to be considered and many aspects clearly will benefit from a strong, user-driven participation in digitalization. DGK ("Deutsche Gesellschaft für Kardiologie – Herz- und Kreislaufforschung") eCardiology aims to proactively engage in user and patient-centric digital health developments by supporting cross-sectoral strategies, mobile solutions, precision digital health and will bring together peer groups from cardiology, industry, society and politics. By a joint strategy with DGK Academy/eAcademy, the topics and key developments of eCardiology will be fast and transparently communicated and introduced in a structured educational program. Participation of Young DGK is key to implement knowhow of the 'digital natives' and will aim to actively bridge gaps between generations of cardiologists. Contents of eCardiology will be hosted on the dedicated website http://www.dgk.org/ecardiology, which in the future will provide an interactive way of communication.

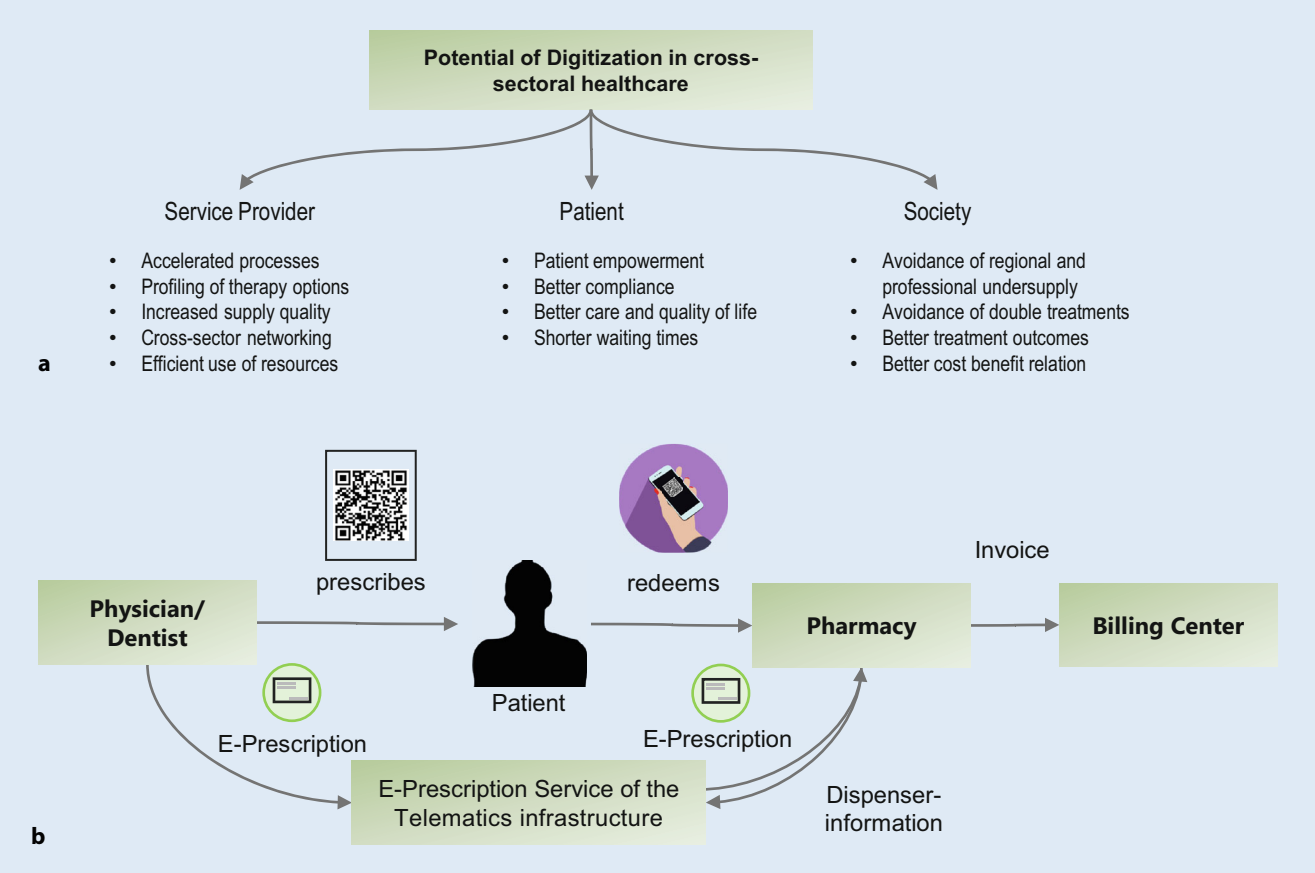


Fig. 2 ▲ **a** Potential of digitization in cross-sectoral healthcare. Digitization can address and improve aspects of individuals but will also have an effect on the whole society. **b** Example from the Telematics Infrastructure. The electronic prescription is one component of cross-sectoral communication. For backward compatibility, it uses 2D barcodes to allow classical printing of prescriptions, in case a person does not possess a smartphone. (Courtesy of © Pixay GmbH [2022]. All rights reserved)

Aims and structure

By evaluating digital health solutions and the establishment of standards and quality measures, e.g. for artificial intelligence-based tools, the eCardiology program will proactively take part in a safe, user- and patient-centric digital transformation. Accordingly, we have designed the structure of eCardiology to best anticipate the needs of our cardiac society and the patients. Importantly, the different committees and experts will be closely linked to the existing structures (working groups, clusters, project groups, standing committees and sections) within the DGK and are not thought to be mutually exclusive. As such, the exchange between the committees and existing working groups of the DGK will be essential to benefit from and amplify the broad expertise and innovative work of all its experts.

Figure 3 shows the basic structure as of the date of this article. It is anticipated that new and equally important topics will come up rapidly. The anticipated speed of developments, hence must be reflected by the use of digital and social media and web technologies to disseminate and communicate the eCardiology program. Close collaboration with other national ("Deutsche Gesellschaft für Innere Medizin" [DGIM]), European (ESC Digital Health) and international programs that aim to foster digital health will also be key to achieve sufficient impact on society, politics and industry. The eCardiology program also will critically evaluate boundary conditions of digital health in Germany, such as the General Data Protection Regulation (GDPR), which on the one hand introduced the right of data privacy for each individual in the European Union, but on the other hand, often hinders or complicates solutions for data exchange, aggregation and usage for healthcare and research.

Cross-sectoral strategy committee

Financing of medicine in Germany is divided in the outpatient and inpatient sectors. This means that diagnostic or therapeutic measures are only reimbursed within the provider's own sector. This has several advantages, e.g. that expensive high-end medicine is restricted to hospital stays covered by diagnosis-related groups (DRG). One considerable disadvantage is a barrier function between both sectors, not only for certain diagnostic tests (e.g. genotyping) but also for data exchange. Up till now, there is no standardized and seamless way to exchange digital data between general practitioners, resident specialists and hospitals.

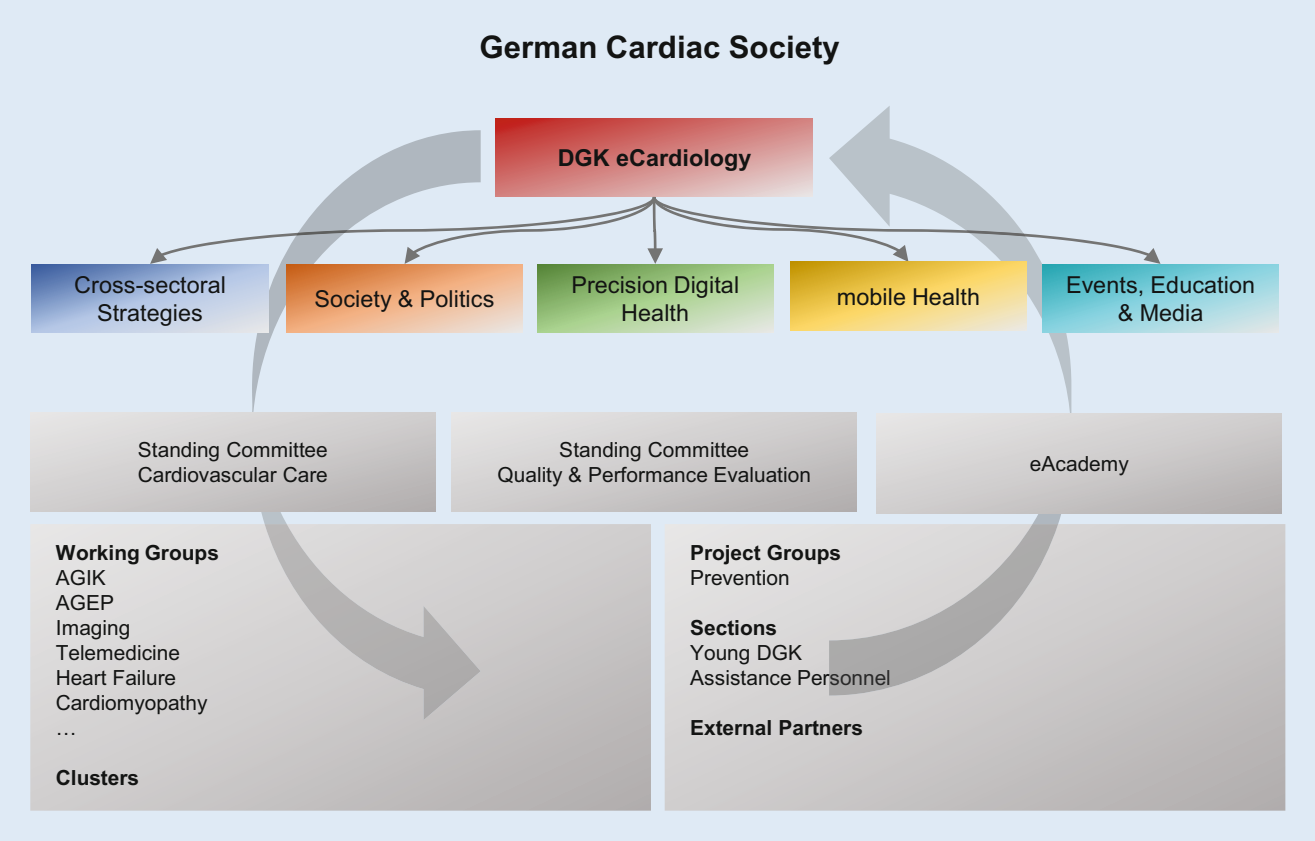


Fig. 3 ▲ Structure of the DGK eCardiology and the individual eCardiology committees. The different committees are tightly connected to the standing committees on cardiovascular care and quality and performance evaluation as well as with the existing working groups and clusters of the DGK. Information exchange will be facilitated to best address the multiple facets of digitization in the setting of cardiovascular medicine. *DGK* "Deutsche Gesellschaft für Kardiologie – Herz- und Kreislaufforschung", *AGIK* "Arbeitsgruppe Interventionelle Kardiologie der DGK", *AGEP* "Arbeitsgruppe Elektrophysiologie und Rhythmologie der DGK"

Aims

Health care in Germany suffers from inadequate coordination and cooperation at the sectoral interfaces. There is kind of an "invisible wall" between prevention, outpatient and inpatient treatment, as well as rehabilitation and care [17]. The insufficient permeability and flexibility at the interface between the outpatient and inpatient sectors particularly hinder the exploitation of the current and future potential of outpatient care [18]. What is taken for granted in other industries has not yet been implemented in the German healthcare system: the routine exchange of information between the individual IT systems that complies with data protection requirements and focuses on the patient [17]. Hence, the introduction of a cross-institutional electronic patient record (ePA) would be a sensible measure to strengthen cross-sectoral and interprofessional cooperation [19], which has direct impact on the personalization of treatment pathways.

Structure and definitions

The committee for cross-sectoral strategies defined the following priorities:

Portals and interfaces. Digital transformation of the medical sector does not only include the introduction of new digital diagnostic and therapeutic tools such as wearables, smart devices, telemedicine or artificial intelligence (AI) but also the cross-linkage of information. However, medical information is stored in different IT systems of the respective institutions (hospital, rehabilitation center, resident specialists, general practitioner) and up till now, there is no overarching infrastructure in our health care system that enables central storage and transfer of medical information between these individual stakeholders. This leads to a loss of information, slow processes and repeated procedures; ultimately causing inefficiency, increasing costs and insufficient quality of the system. Therefore, the national ePA project has been proposed and developed in order to overcome these intersectoral barriers. However, uncertainty exists, which functions will be implemented in this system and how and by whom data will be handled in the future. Beside this national platform, other systems and mobile applications built by independent (insurance) companies will penetrate into the market. Such intersectoral data platforms need to fulfill many different requirements to operate effectively and to be accepted and used by patients and physicians. Some of the main requirements include the following:

- Point of care is shifting
  The development of systems should be user-centered. Technical or legal realization of such systems should be adjusted to user requirements instead of user adaptation to technical or legal feasibility. Only such an approach will provide a patient and physician friendly, easy-to-use platform that improves the increasingly necessary data exchange mechanisms.
- Real-world data recorded by the patient
  The platform needs to be actively managed by patients and should not be operated solely by physicians. Without the possibility of direct access by and participation of patients (patient empowerment) who are increasingly medically educated and demand self-management, acceptance of these systems will come up short [20].
- Improvement of treatment quality by AI or big data analysis
  Data must not only be digitally stored. Semantic structures allow for processing of the information beyond interpretation of the treating physicians. Such central processing by automated clinical decision support systems, AI or big data analysis may further improve treatment quality [21].

An example for a digital platform meeting with respect to the aforementioned criteria is CardioCoach ("Bundesverband Niedergelassener Kardiologen"). It is an application that can be run on computers and mobile devices. Both physicians (from outpatient, inpatient and the rehabilitation sector) and patients can store and actively manage medical data (e.g. medical history, diagnostic reports, vital signs, training plans, patient reported outcomes). Tools like this allow shifting data collection to the point of care by completely adhering to data privacy regulations [22].

e-Prescriptions. The e-prescription (**Fig. 2b**) will be situated in the area of statutory health insurance in the telematics infrastructure (TI) of the health care system. Doctor's practice and pharmacy must be connected to this via a virtual private network (VPN), which will use a certified connector. As of January 1, 2022, this will also include hospitals. Once a doctor has issued the e-prescription and signed it with a qualified electronic signature, it is transferred to a prescription server within the TI. At the same time, the patient receives a prescription token within a smartphone app; alternatively, one receives a hard copy with a QR code. With this information, the patient can visit a local or online pharmacy and redeem the prescription, just as they did with a paper prescription. The pharmacy will scan the QR code and obtain the prescription from the server. Smartphone owners can also present the QR code on site for scanning or preselect a pharmacy in advance in the app and submit the prescription token [23].

EHR. Patients should be able to play a more active role in their own healthcare. This should be achieved with the electronic patient record (ePA), since the ePA will be available to all citizens "free of charge". This should gradually contribute to connecting the health sectors—both between different specialists or pharmacies as well as between doctors, pharmacies and patients [24]. Since the ePA represents a considerable additional administrative effort for the doctors to maintain its content it needs financial compensation.

Telecardiology. Digital applications for telemonitoring start at the interface between patient and doctor or members of other health professions. These applications can improve the exchange of information, captured by internal or external sensors or devices, through the direct transmission of data and facilitate patient self-management. As a result, patients no longer have to constantly visit the doctor's office for follow-ups, but can be called in as needed. However, telecardiology has to follow clearly structured treatment processes to achieve the outcome improvement reported in scientific literature. Following this, telecardiology centers need to be certified according to requirements of the medical societies [25]. The DGK has long-term experience in telecardiology by its dedicated working group, which is a pioneering structure in Germany and which will be integral in future strategies.

Action plan

Overcoming organizational boundaries (hospital, cardiologists in private practice, general practitioners) leads to increased value creation of treatment pathways. In the future, healthcare will also take place on smartphones and not only in the doctor's office [26]. Digital information on smartphone platforms should therefore not be restricted by boundaries of sectoral care and reimbursement. This changes the approach to patient care completely: data are where the patient is. The physical dependency of many service processes on the patient's presence can be removed under the conditions of digital infrastructure and networking. Sensor technology and smart diagnostic devices at the point-of-care provide comprehensive diagnostics, regardless of the respective provider and are ideally compatible with the relevant systems. Telemedical services were carried out, the value chains in the form of treatment paths are extended and continued, so that previously incapable or unrealizable methods and new business models are possible. This means that significantly more options are available to provide health services across all three sectors (outpatient, inpatient, at home) in a consistent end-to-end treatment path and treat them individually.

The development of the e-health landscape is currently clearly driven by demand. Acceptance on the part of consumers is crucial for the success of digital offers. Important conclusions can be drawn from this for the primary healthcare market. In particular, the realization that the specific requirements of patients are decisive for the progressive digitization of health offers that should be incorporated into the design of new services in the future. A large number of patients now not only accept digital solutions, they are even actively demanding them. Concerns about data protection and security still play a role, but obviously take a back seat when users see clear added-value in the networked services. After all, the internet, smartphones and apps are already part of everyday life for the majority of Germans. The implementation of e-health offers, therefore also reflects the increasing digitalization of society. Hence, digitization is a high priority on the political agenda. In terms

of health policy, digitization is not only specified top down through large projects such as the telematics infrastructure, but are often driven by bottom-up strategies from smaller initiatives and startups. In cooperation with DGK working group of cardiovascular outcome research and this eCardiology committee, "KardioNet digital" is a typical bottom-up project. The design is based on real demand and daily life of patient care: managed care supported by a digital tool for information management and coordination of patients across the clinical and ambulant sectors of cardiologists and general practitioners. Personal coaching by an experienced heart failure nurse is a pillar of this concept. Digital information flow in this project means smart acquisition of data by smartphone cameras, easy access on web-frontends for all healthcare sectors and security comparable to that in banking software.

The potential of digital technologies for use in health services and the potential benefit of mutual added value for patients and providers are far from exhausted. With Health Services 4.0—the interlinking of standard health services with digital technologies and the combination of the two—it is possible to both increase the outcome of the individual service and comply with the regulatory changes and requirements in a more targeted way. This requires an extension of the entire value chain treatment pathway across all three sectors (inpatient, outpatient, home care) and also the skills and resources of the provider for the dynamic balancing of exploitation and exploration. This committee will follow the evolving developments and set recommendations on best-practices, participate in real-world projects and link the DGK to stakeholders and patient groups active in cross-sectoral strategies.

Society and politics committee

Stakeholders in the transformation of health care into a digital health need to be tightly informed and proactively incorporated in any of the major strategies of the eCardiology topic of the DGK. Hence, this committee is composed of and sides with experts from politics, patient interest groups, foundations, insurance companies and industry.

Aims

The society and politics committee supports the implementation of digital cardiovascular diagnostic and monitoring technologies as well as digital therapeutics through direct interaction with policy makers at national and European levels. This is warranted by connecting interdisciplinary cardiovascular medicine with scientific institutions, patient representatives and the digital health industry. The main and overarching objective is to create an appropriate policy framework and to adapt subordinate provisions in order to facilitate translation of digital and telecardiology applications and their reimbursement. This also requires coordination with the bodies of self-government and the public in Germany.

Decision-making processes in politics and self-management shall be accelerated by the early involvement of this committee. Due to the high medical and health-economic challenge of cardiovascular diseases in Europe, decision-makers are mostly aware of the topicality and socioeconomic significance of cardiovascular diseases. However, the high potential of digitalization to improve, personalize and standardize diagnostics and treatment of cardiovascular disease remains often unknown and needs stimulation as given by the society and politics committee. Finally, the committee promotes digital cardiovascular research and development programs with public funding as well as connecting digital cardiovascular companies to the clinical cardiovascular medicine for early clinical studies in the field of eCardiology in Europe. Integral is cooperation with the standing committees of the DGK as highlighted in the structure diagram. It is important to highlight our patient-centered approach, enforcing their digital integrity and rights.

Structure and definitions

Within the society and politics committee following working teams are focusing on subtopics and cooperate among each other:

Politics. The politics working group comprises representatives of health insurance companies, association of health insurance doctors and health policy at German and European level. Via this expert panel, the DGK has successfully contributed to hearings and written opinions and thus influences political decision-making. As an example, a process for a structured evaluation of cardiovascular telemedicine usage could be initiated and propelled to legislation. Currently, the input of cardiological expertise in the design of the German "Digital Care Law" is of particular importance.

Industry. Representatives of the pharmaceutical industry, the cardiovascular device industry as well as companies producing digital cardiovascular solutions have the opportunity to work close with cardiologists and therefore to reconcile the orientation of cardiovascular medicine with the further development of digital solutions. Certainly, the exchange in the course of personalized cardiovascular medicine is part of the translation of the "eHeart" and "eVessel" industry into cardiovascular medicine and its way back is at the center of the exchange.

Ethics. Innovation and value creation through digital technologies is not possible without building trust ("digital integrity"). This includes respecting personal rights in cyberspace and is closely linked to ethical aspects and data protection in digitalization in the healthcare sector. The working group, which consists of patient representatives, doctors, politicians, lawyers, sociologists and theologians, is to contribute the topic of "digital integrity" to cardiovascular digitization.

Representation of patients. Members of patient support groups and patient foundations—representing patients' interests—are in close cooperation with representatives of industry and cardiovascular physicians and scientists. Driven by the COVID-19 pandemic, patients' awareness for digital solutions was significantly raised through remote monitoring, online consultation and health-screening tools based on routine data and boosted digital cardiovascular medicine and participation of patients in Germany.

Legal conditions. Suitable legal framework conditions are certainly the basis for the extensive use and use of data and

digitized health solutions. At the national level, data protection requirements and regulations governing sector separation in the healthcare system are often not yet in line with the fast-track progress in digitalization. It is therefore a concern of the "legal condition" working group to obtain suitable conditions through statements on easily implementable but also legally secure framework conditions. This is done with a special focus on globalization and opening of the German healthcare system to a European level.

Action plan

Having succeeded in appointing experts for the working groups within the society and politics committee, topics of transsectoral-digital networking, telemedicine, electronic patient record (ePA) as well as the question of ethical and structural preconditions for AI-based health decision-support systems are being developed and communicated. The standardization of data sets in the context of electronic patient records, which will allow "big data analyses" from routine care data, is another example that is currently in progressed state.

These initiatives are accompanied and supplemented by highlighting existing examples and development of guidelines for optimal integration of eHealth solutions in Germany. As such, the committee identifies solutions such as the EU-funded EU Interreg project "PASSION HF" (PAtient Self-care uSIng eHealth in chrONic Heart Failure) and others to inform the DGK members, who are invited to also share their projects and pilot studies. A whitepaper on the digital eHealth development and strategy in the coming years addressed to the political parties in the German houses of parliament will be prepared, to start a dialog on optimal patient- and physician-centered digital transformation.

Mobile health committee

Most of health care-related work happens in dedicated environments, such as hospitals or physican's offices. However, limited availability of doctors especially in rural areas, the overcrowding of hospitals and exploding costs increasingly limit the access of patients for high-quality treatment. The shift towards mobile, patient-centric diagnostic, monitoring and therapeutic tools such as smartphone apps will be a big opportunity to circumvent bottlenecks, save costs and provide uniform quality levels across the country. Also, doctors rely more and more on decision support tools integrated in the hospital information system or as mobile app, which allows decision making and interaction with colleagues across disciplines, e.g. in emergency care.

Aims

One primary aim of the mobile health committee is to improve guideline adherence by mobile health technologies using smartphones, tablets and also stationary computers. The digital transformation of guidelines can be accomplished by a range of applications ("apps") providing full text guidelines text (i.e. pdf format), specific calculations tools (i.e. providing risk-score calculations) and clinical decision support (CDS) tools. By integration of CDS tools into electronic health records using patient data, physicians will soon be enabled to find guideline-based decision support in complex clinical scenarios in real-time and without manual data input at the bedside. Another way of improving guideline adherence will be accomplished by co-operation with already existing expert systems through deep integration of the latest guidelines. Finally, the mobile health committee will develop rating systems for mobile cardiology applications including communication technologies and will highlight those on the eCardiology internet portal and in other media.

Structure and definitions

At present, the mobile health committee oversees four major topics that are interconnected. A close cooperation between other eCardiology committees, existing DGK working groups and Young Cardiology representatives is essential.

The process of digital guideline transformation is well defined. After publication of new or revised ESC guidelines, the committee of clinical cardiology ("Komitee der Klinischen Kardiologie", KKK) designates experts in the respective cardiology field. These experts are authoring the development of condensed "pocket guidelines". In addition, the experts will get in contact with representatives of the committee for mobile health with experience in the field of digital guideline transformation. After creation and programming of a specific application, calculations and/or CDS tools, authors will check the applications in a standardized manner. The app will then be sent back to the KKK for final approval. Existing DGK CDS apps have undergone successful TÜV Süd approval including quality management systems (DIN 13485). Finally, clinical trials using CDS tools and measure process and outcome indicators will be initiated or supported.

For integration of existing guidelines into medical expert platforms, co-operations will be set-up and the integration process will be closely supported and approved by the committee. The process and results will also undergo review and approval by the KKK.

Finally, different rating system will be evaluated in order to provide orientation for physicians and/or patients using medical apps in the field of cardiology.

Action plan

- Improve guideline adherence by digital transformation
  - Develop guideline apps, calculation and clinical decision support tools
  - Enable CDS tools to be integrated into electronic health records
  - Perform or support clinical studies using CDS tools
- Build co-operations with industry providing medical expert platforms
  - Integrate current guidelines into these systems
  - Aim for clinical studies in co-operation with industry partners
- Evaluate a rating system for cardiology apps to be used by physicians and/or patients

Precision digital health committee

The paradigm of evidence-based medicine and the reliance on large-scale randomized clinical trials led to the improvement of prognosis for many cardiovascular diseases, especially the most prevalent ones such as coronary artery disease, acute coronary syndromes, hypertension or heart failure. However, other disease entities that

are also frequent, but more heterogeneous are less likely to benefit from this concept.

There have been remarkable developments of individualizations in many aspects of cardiovascular medicine, made possible by genomics, high-resolution imaging, longitudinal follow-up and longitudinal phenotyping with digital biomarkers. Processing and integrating this multimodal information in actionable and patient-safe readouts needs several techniques going beyond classical statistics, requiring big data storage and processing, bioinformatics and advanced machine learning.

Aims

The precision digital health committee aims to develop and propel important key elements for precision medicine strategies with special emphasize on digitalization of processes and usage of digital information for clinical decision making. The approach will be tuned towards the requirements of cardiovascular diseases, which are different from precision medicine strategies, e.g. for cancer. Differences are, for instance, the larger availability of cardiovascular longitudinal digital biomarkers from wearables, but also the current lack of cardiovascular "tumor boards" for integration of multimodal, multidisciplinary information in clinical decision making, the differing requirements for genomics (germline rather than somatic information, less access to tissue) and the short timeframe for many decision-making processes (emergency cardiac care). Hence, this committee is devoted to propel use cases and pilot implementations that serve as examples for the broader community. Additionally, interaction with research-intensive industry is envisaged. For outreach and communication, we established a web platform, presenting the society with latest developments and resources on digital health (https://www.dgk.org/eCardiology).

Structure and definitions

The structure of this committee includes six task forces that will establish essential components for precision health developments. Importantly, there is a tight interplay with existing DGK work groups and eCardiology committees.

We foresee a high potential in genome medicine for several cardiovascular diseases and proof-of-concept studies have provided preclinical evidence of successfully cardiovascular gene repair [15]. However, Germany is especially underdeveloped in clinical genetics partly due to insufficient reimbursement of genetic investigations. The *Genomics Task Force* will bundle expertise from the cardiovascular genomics community, ranging from genotyping technologies, their application in research but also for diagnosis, predictive medicine, family medicine and pharmacogenomics. Gene therapies and gene repair will be another focus that we follow and communicate. Action items also include the development and implementation of standards for interpretation of genetic results using advanced methods, electronic genome data storage and safe exchange in the clinical environment or in precision medicine trials.

The *big data* group goes beyond genomic data and aims at methods for integrating cardiovascular and other medical data from EHR (Electronic Health Record) and molecular phenotyping. There are several research networks aiming at national data integration across all academic university hospitals, such as the HIGHmed, DIFUTURE, MIRACUM, SMITH, ADMIRE, HD4CR, or share-it! consortia. We aim to propel cardiac use cases that are important for development of methods and definitions of data integration, (fair) data usage concepts and ethical considerations.

The *PATIENTome* group is a unique concept aiming at fingerprinting the precise cardiovascular situation of individuals. While established methods already harvest data from cardiovascular imaging, integrating data from all biological sources in a cross-sectional and longitudinal manner is key to understand disease processes and their future relevance for decision making. The added value will be the more precise understanding of the etiologies of conditions, individual risk factors and the identification of suitable "cases like me" that inform the physician about similar, previously treated patient cases and their outcomes to select the best strategy in the current individual.

The three above mentioned task forces rely on strong methodological expertise including bioinformatics, artificial intelligence and mobile/advanced technologies. *Bioinformatics* has made systems biology possible by understanding the individual data sources generated from human or other biomaterials, catching the interplay between different molecular, subcellular and cellular layers and provides a glimpse on the relevant nodal players in disease processes and therapy development or selection. The methods are mostly based on linear regression statistics, but nowadays also include Bayesian statistics, machine learning and deep learning. The later methods are of tremendous potential not only for molecular data, but also for the integration of clinical data.

The *Artificial Intelligence* working group will foster the development, certification and implementation of AI in the sense of IA (intelligent augmentation, Peter Fitzgerald). For a successful use of AI, it will be necessary to also inform stakeholders, physicians and members of the general society about the capabilities but also caveats of AI tools in diagnostics and decision making. Ethical and philosophical consideration regarding the impact on our current understanding of medicine also need to be incorporated. The development of methods to compare the applicability of AI software from different autonomy levels and measure their robustness based on differing environment and data sources are also of considerable importance.

The *Mobile Technologies* working group will survey developments in novel digital technologies that can provide useful digital biomarkers for precision medicine strategies. Prominent examples are wearables with single lead ECG, which additionally incorporate sensors for activity, noise, pulse rate and are sold millions of times. Other upcoming technologies include implantable devices for measurement of physical and molecular markers, patches for detection of metabolites from sweat or medical devices that will replace the stethoscope by handheld multimodal sensors (including sonography) with AI algorithms to guide bedside data acquisition and interpretation.

Action plan

To achieve the goal of individualized cardiovascular medicine, it is necessary to gather reliable information on the fast-developing field, which is largely driven by non-academic technology companies outside of Germany. The position of this committee is that it is essential to actively redirect and funnel developments that happen outside our cardiovascular society but largely impact their professional members. Providing information to DGK members is thought to be pivotal to allow a constructive and internationally competitive strategy in digitalization of cardiovascular medicine in Germany.

As such it is necessary to:

- Collect, curate and publish data on key developments in the field of precision digital health
- Use methods for fast, but credible dissemination of information, e.g. with the recently launched eCardiology web-portal
- Clearly differentiate between data, opinion and vision
- Engage with industry (solution provider), insurance companies (payer) and patients
- Establish a DGK position paper for implementing precision digital health technologies in a safe and efficient way
- Set benchmarks for quality standards for relevant technologies being presented by peer-reviewed dissemination
- Develop modern curricula together with DGK eAcademy and take active part in DGK events, representing latest developments in the field, overcoming existing hurdles and fears over digitalization
- Start of DGK pilot studies incorporating the concepts of Precision Digital Health

eAcademy: Education, events and media committee

The DGK has founded its own Academy in 2001 to advance high-quality education for physicians, nurses and technicians. Since then, it has grown remarkably and represents now the main provider of educational courses and training in cardiology in Germany. Moreover, several structured curricula have been initiated that certify advanced training in cardiology subspecialties such as interventional cardiology, electrophysiology or heart failure. Currently, due to rapidly evolving technology and changing expectations of trainees, there is an urgent need for more extensive application of web-based formats using digital communication in the eAcademy. Moreover, eCardiology topics are still sparse in the educational program, but of great interest especially for younger clinicians. Thus, we propose here to increasingly "digitalize" current education offers by the DGK academy as well as to establish specific education tracks in digital health technologies, including at the two yearly DGK conferences.

Aims

The aims of the eAcademy are to provide high-quality educational and scientific content and to ensure elaborated digital education both for cardiologists-in-training and young academics. Considering the current rules for certification and accreditation, which are based on physical presence, new qualification and training in the future has to be based on digital formats including appropriate accreditation.

Structure and definitions

The eAcademy with the eCardiology group is responsible for the 3 pillars in education: 1) (digital) conferences, 2) eMedia and 3) eLearning.

Conferences. The DGK organizes two major cardiovascular conferences per year. In the last few years, numerous lectures at both congresses have already been offered as online streams, representing the growing effort in medialization. In the course of the contact restrictions during the COVID pandemic, both conferences in 2020 were held completely virtually. A continuous offer of virtual sessions, which can be streamed or followed on-demand over the whole year, was established (online congress). The congress in fall 2020 was again held completely virtually over three days with several conference rooms in parallel. The educational content generated by the DGK academy was integral part of these efforts. The experience from these events will flow into the planning of future congresses.

eMedia. The DGK in cooperation with the BNK (Bundesverband Niedergelassener Kardiologen e.V.) operates a platform for digital content, the www.kardiologie.org website. Conference contributions, comments from key opinion leaders and other cardiology content are its core competence. It is planned to expand educational trainings with focus in cardiovascular medicine. The DGK has concentrated their online academic activities in large parts on the kardiologie.org platform and the eAcademy hosted on the same site. It launched in April 2020 and offers more and more certification relevant on-demand webinars. Specifically, kardiologie.org has onboarded 8 rubric editors in 2019 from renowned German centers, who actively update the users in the four most relevant cardiological subdisciplines. Their contributions span from video interviews on new technological and society-relevant developments such as smartwatches and their use in cardiology, to webinars about new guidelines, as well as updates from international congresses as video talk discussions and interviews with experts and international guideline authors. Recently, kardiologie.org entered thy field of interactive live webinars with high customer participation and enthusiasm.

Finally, DGK congresses had to fundamentally adapt the format due to COVID-19. In May 2020, the DGK launched the weekly live webinar congress format "DGK Online 2020" with three live webinars per week. In October 2020 the "Jahrestagung and DGK Herztage" were held as a virtual congress with enormous success. This congress format will be continued in 2021, with regular live webinars 3 times per week, whereby several are relevant for certifications.

Education. The DGK Academy has already developed and established a wide range of advanced and sophisticated training courses covering all areas of cardiology. Various subspecialties within cardiology are represented here, but also the various levels of training of cardiologists and assistant personnel are taken into account. Thereby, the Academy offers the whole spectrum from introductory courses for young cardiologists, as well as special and

focused courses for experienced cardiologists. Digital content should not only represent a substitute for existing content, but rather expand and supplement the existing content. The younger generation of cardiologists in particular is increasingly familiar with the use of digital content and therefore generally more affine towards digital offers. Therefore, special attention is paid to the dedication towards eCardiology training for next generation cardiologists.

The eAcademy is thus also committed to focus on teaching general "digital competence" of the cardiologist by educating appropriate skills and critical handling of digital medicine. In recent years, cardiology has been characterized by continuous advances in knowledge and technology and a large number of practical and algorithm-based guidelines. The abundance of this scientific information and the speed of implementation of guideline-relevant studies require a high level of competence in dealing with traditional and modern media, from classic publications to open access articles to online databases and so-called "social media". Here, cardiologists have to acquire digital research skills that enable them to quickly identify practice-relevant content and innovations while at the same time making a critical selection of the content and rejecting any incorrect or questionable representations. The advantages of digital medicine are speed, availability and the possibility of new didactic tools. There is an increasing tendency towards digital training offers in the form of interactive online training courses and webinars, which means that these offers can be widely used and, if necessary, at any time.

Various e-health domains related to cardiology require an interdisciplinary training, e.g. to telemedical offers, hospital information systems, digital networks, mobile health or big data. Another task here is also to take up and convey the knowledge and initiatives of the other eCardiology committees. The number of virtual training courses and webinars has increased significantly.

The training within the different curricula for certifications of subspecialties of the DGK represents another central component here. The DGK Academy guarantees high-quality content and education. Particularly advanced training-intensive certifications can be resource-limited, like certification for cardiac magnetic resonance imaging (MRI). New digital formats have been developed by the DGK Academy for this purpose. For example, a digital case-based training concept was developed for advanced MRI training, in which a case-based concept enables high-quality case-based learning including approved examination for certification. This new way in communication-based live education is already established in courses by the CMR Academy executing live CMR diagnostic studies and assessment as well as remote examination based on a case database. A new format of accreditation in cooperation with "Ärztekammer" (German Medical Association), SCMR (Society for Cardiovascular Magnetic Resonance) and EUCMR (European Cardiovascular Magnetic Resonance) is partly already in place.

Action plan

- Convert existing high-quality face-to-face content to digital offers and expand and enrich them with digital tools and content.
- Provision of a platform for e-learning; structuring and offering of new training content (virtual reality, digital cardiology, big data, simulation training for interventional procedures, database for image interpretation including AI assistance)
- Provide appropriate resources for "digital competence"

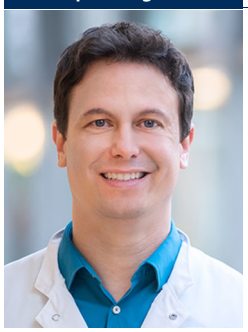
Timeline

The decision to form a digital health agenda within the DGK originates from 2018. Since then, multiple meetings and teleconferences have resulted in the formation of a task force for digital health and later in 2019 the eCardiology program. In 2020, eCardiology presented during the COVID pandemic at the DGK Online 2020 and DGK Herztage, which was also an online-only event. The short-paced dissemination of information will use established DGK media such as CardioNews, but also a dedicated internet platform, which started in 2021 (www.dgk.org/ecardiology). Collaborative work and participation by all DGK members is envisaged by this evolving platform to use the strengths of both digital technologies and the broad expertise within our society.

Practical conclusion

The eCardiology program of the German Society of Cardiology aims to improve the transformation of medicine towards digital health. To fundamentally change integral aspects of medicine, a user-centric approach with incorporation of the broad expertise of this society is essential. Flexible and rapidly adapting mechanisms in the operation of DGK eCardiology will be key to success in the fast-moving field of digitalization. We hence advocate for combining openness and visionary thinking with the tradition of evidence- and data-driven scientific approach of cardiovascular medicine. Since many topics are addressed in existing DGK work groups, eCardiology does not aim to double structures, but integrate and enable communication in a most efficient way.

Corresponding address



Prof. Benjamin Meder
Department of Cardiology, Angiology and Pulmology, University Hospital Heidelberg
Im Neuenheimer Feld 410, 69120 Heidelberg, Germany
Benjamin.Meder@med.uni-heidelberg.de

Declarations

Conflict of interest. The authors' conflict of interest can be found online at the DGK homepage at http://leitlinien.dgk.org/ for the corresponding publication.

For this article no studies with human participants or animals were performed by any of the authors. All studies mentioned were in accordance with the ethical standards indicated in each case.

References

1. Sedaghat-Hamedani F, Katus HA, Meder B (2018) Precision medicine for cardiovascular disease: Learning lessons from cardiomyopathies. Herz 43(2):123–130. https://doi.org/10.1007/s00059-017-4667-x
2. Matheny ME, Whicher D, Thadaney Israni S (2020) Artificial intelligence in health care: a report from the national academy of medicine. JAMA 323(6):509–510
3. Miller BM et al (2010) Beyond Flexner: a new model for continuous learning in the health professions. Acad Med 85(2):266–272. https://doi.org/10.1097/acm.0b013e3181c859fb
4. Meder B, Radke P (2019) Digital cardiology. Dtsch Med Wochenschr 144(7):447–451. https://doi.org/10.1055/a-0740-8631
5. Poplin R et al (2018) Prediction of cardiovascular risk factors from retinal fundus photographs via deep learning. Nat Biomed Eng 2(3):158–164
6. Rajpurkar P, Irvin J, Zhu K, Yang B, Mehta H, Duan T, Ding D, Bagul A, Langlotz C, Shpanskaya K, Lungren MP, Ng AY (2018) CheXnet: radiologist-level pneumonia detection on chest X-rays with deep learning. arXiv. https://doi.org/10.48550/arXiv.1711.05225
7. Tesche C et al (2018) Current and future applications of CT coronary calcium assessment. Expert Rev Cardiovasc Ther 16(6):441–453
8. Attia ZI et al (2019) An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction. Lancet 394(10201):861–867
9. Wegner FK et al (2022) Machine learning in the detection and management of atrial fibrillation. Clin Res Cardiol 111(9):1010–1017. https://doi.org/10.1007/s00392-022-02012-3
10. Perez MV (2019) Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation. N Engl J Med 381(20):1909–1917. https://doi.org/10.1056/NEJMoa1901183
11. Lubitz SA et al (2021) Rationale and design of a large population study to validate software for the assessment of atrial fibrillation from data acquired by a consumer tracker or smartwatch: The Fitbit heart study. American Heart Journal 238:16–26. https://doi.org/10.1016/j.ahj.2021.04.003
12. Veltmann C et al (2021) Wearable-basierte Detektion von Arrhythmien. Kardiologe 15:341–353. https://doi.org/10.1007/s12181-021-00488-3
13. Ates HC, Yetisen AK, Güder F et al (2021) Wearable devices for the detection of COVID-19. Nat. Electron 4:13–14. https://doi.org/10.1038/s41928-020-00533-1
14. Dörries M, Gensorowsky D, Greiner W (2017) Digitalisierung im Gesundheitswesen – hochwertige und effizientere Versorgung. Wirtschaftdienst 97(10):687–703. https://doi.org/10.1007/s10273-017-2200-8
15. Amoasii L et al (2018) Gene editing restores dystrophin expression in a canine model of Duchenne muscular dystrophy. Science 362(6410):86–91
16. Borchers D (2021) Rezept: digital – Medikamente per Smartphone – demnächst auch in Deutschland. c't (3):114
17. Amelung et al., A.e., Europäische Kommission. 2017.
18. Projektbericht Stiftung Münch 2016. https://www.stiftung-muench.org/wp-content/uploads/2016/09/G-BA-web.pdf
19. Gutachten des Sachverständigenrat 2018, S 429–431. https://www.sachverstaendigenrat-wirtschaft.de/fileadmin/dateiablage/gutachten/jg201819/jg2018_08_gesundheit.pdf
20. Stanhope V, Matthews EB (2019) Delivering person-centered care with an electronic health record. BMC Med Inform Decis Mak 19(1):168
21. Thun S, Lehne M (2019) Interoperabilität – Voraussetzung für Künstliche Intelligenz und Big Data in der Medizin. eHealthcom
22. Gottlieb S (2018) Statement from FDA Commissioner Scott Gottlieb, M.D., on FDA's new strategic framework to advance use of real-world evidence to support development of drugs and biologics. U.S. Food & Drug Administration, Silver Spring
23. Borchers D (2021) Diagnose: digital, Start für die elektronische Patientenakte. c't (1):116
24. in Deutsches Ärzteblatt.
25. Helms TM et al (2019) Grundlegende Strukturmerkmale eines kardiologischen Telemedizinzentrums für Patienten mit Herzinsuffizienz und implantierten Devices, Herzrhythmusstörungen und erhöhtem Risiko für den plötzlichen Herztod. Herzschr Elektrophys 30(1):136–142
26. Rytina S (2018) Hauptstadt-Kongress erörtert Künstliche Intelligenz: „Das Gesundheitssystem der Zukunft findet auf dem Smartphone statt". https://deutsch.medscape.com/artikelansicht/4907041?nlid=123280_3142&src=WNL_bom_180613MSCPEDIT_DE&uac=240735HJ&faf=1 (Erstellt: 13. Juni 2018). Zugegriffen: 21. März 2019

Zusammenfassung

eCardiology: ein strukturierter Ansatz zur Förderung der digitalen Transformation in der Kardiologie. Positionspapier der Deutschen Gesellschaft für Kardiologie

Der Einsatz von digitalen Technologien in der Medizin entwickelt sich weitgehend parallel zur IT-Branche. Heute nutzt jeder Kardiologe/in in Deutschland IT-Systeme, um Termine zu vereinbaren, Patientendaten zu speichern und Arztbriefe zu verfassen. Warum ist es also notwendig, innerhalb der Deutschen Gesellschaft für Kardiologie (DGK) ein eigenes eCardiology-Programm einzuführen? Bisher hat die Digitalisierung ihr Versprechen, den Alltag von Ärzten und Patienten zu erleichtern, in vielerlei Hinsicht nicht erfüllt. Klinische EDV-Lösungen stammen vorwiegend von buchhalterischen Systemen ab und führen nur begrenzt zur Verbesserung der Patientenversorgung. Es konnten sogar negative Auswirkungen auf die Burn-out-Raten und die Arbeitszufriedenheit von medizinischem Personal beobachtet werden. Zusätzlich hat seit Mai 2018 die Einführung der europäischen Datenschutz-Grundverordnung mit ihren Grundsätzen der Zweckbindung und Datenminimierung die Speicherung und Nutzung medizinischer Daten erschwert. Dies hat auch grundlegende Implikationen für die Entwicklungen der künstlichen Intelligenz (KI), die auf der Verfügbarkeit und Qualität von Big Data (= große, komplexe Datenbestände) beruhen und das Gesundheitssystem nachhaltig verändern könnten. Der technologiegetriebene Fortschritt der Medizin endet dabei nicht an der Türschwelle eines Krankenhauses, sondern bewirkt einen maßgeblichen kulturellen Wandel in unserer Gesellschaft. Der Einsatz von sog. „Wearables", Suchmaschinen im Internet und „Social Media" ermöglicht den „e-Patienten" immer öfter, selbst Diagnosen zu stellen und eigenständige Entscheidungen in Bezug auf ihre Gesundheit zu treffen. Ärzte sehen dadurch oftmals gut, aber auch falsch informierte Patienten, die von ihren eigenen Smart Devices zu gesundheitsrelevanten Daten beraten wurden. Die DGK erkennt die enormen Herausforderungen und das Potenzial der digitalen Medizin, die Prognose kardiovaskulärer Erkrankungen zu verbessern. Im Rahmen des eCardiology-Programms hat die Gesellschaft 5 Ausschüsse gegründet, die wichtige Aspekte von Digital Health fördern und vermitteln: transsektorale Zusammenarbeit, Mobile Health, Precision Digital Health, Gesellschaft und Politik sowie Ausbildung und Medien. Wir berichten hier über die Elemente jedes Ausschusses und seiner Arbeitsgruppen.

Schlüsselwörter
Digital Health · Künstliche Intelligenz · Wearables · Gesundheits-Apps · Entscheidungsunterstützung