Personalized vascular healthcare: insights from a large international survey

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Abstract

Fragmentation of healthcare systems through limited cross-speciality communication and intermittent, intervention-based care, without insight into follow-up and compliance, results in poor patient experiences and potentially contributes to suboptimal outcomes. Data-driven tools and novel technologies have the capability to address these shortcomings, but insights from all stakeholders in the care continuum remain lacking. A structured online questionnaire was given to respondents (n = 1432) in nine global geographies to investigate attitudes to the use of data and novel technologies in the management of vascular disease. Patients with coronary or peripheral artery disease (n = 961), physicians responsible for their care (n = 345), and administrators/healthcare leaders with responsibility for commissioning/procuring cardiovascular services (n = 126) were included. Narrative themes arising from the survey included patients’ desire for more personalized healthcare, shared decision-making, and improved communication. Patients, administrators, and physicians perceived and experienced deficiencies in continuity of care, and all acknowledged the potential for data-driven techniques and novel technologies to address some of these shortcomings. Further, physicians and administrators saw the ‘upstream’ segment of the care journey—before diagnosis, at point of diagnosis, and when determining treatment—as key to enabling tangible improvements in patient experience and outcomes. Finally, despite acceptance that data sharing is critical to the success of such interventions, there remains persistent issues related to trust and transparency. The current fragmented care continuum could be improved and streamlined through the adoption of advanced data analytics and novel technologies, including diagnostic and monitoring techniques. Such an approach could enable the refocusing of healthcare from intermittent contacts and intervention-only focus to a more holistic patient view.

Introduction

Cardiovascular diseases (CVDs) remain the leading cause of death worldwide, claiming around 18 million lives annually.1 This equates to over 300 million life-years lost and a further 35 million years lived with disability due to CVD.2,3 With a rapidly ageing global population (by 2050, one in six people worldwide will be 65 years or older4) and the explosion of CVD and its risk factors in low- and middle-income countries (where ~80% of global deaths occur),5 the burden of CVD will only continue to grow.
At the same time, today’s healthcare systems have never been more challenged: the fragmentation of teams and communications, economic challenges, and disjointed data streams across the care continuum have resulted in care providers who feel overwhelmed and patients who do not believe that their unique conditions are fully understood, nor their individual goals for treatment are being met.\textsuperscript{4,5} Further, healthcare systems tend to overemphasize ‘intervention’ and ‘fixing things’, rather than a holistic patient view that could be achieved by harnessing the power of data to optimize care across the entire patient journey\textsuperscript{7}—before, during, and after a given intervention. All of these factors may contribute to diminished patient experiences and potentially poorer outcomes—driving even greater costs for health systems and therefore ultimately for society.

The treatment of CVD worldwide has therefore reached an inflection point with the convergence of these macro trends, presenting an urgent need for innovative, integrated, and efficient solutions. Whilst data-driven solutions, the power of artificial intelligence techniques,\textsuperscript{8} and newer diagnostic and monitoring tools are being adopted by some physicians, healthcare systems, and patients, this remains piecemeal and limited by access, cost, and acceptability to all stakeholders, including regulators.\textsuperscript{9} We, therefore, aimed to gain insights into the state of vascular disease care today—and into how technology, data, and attitudes towards their use could help remove the barriers to the ultimate goal of optimal, tailored, patient-centric care.

Methods

To understand perceptions of how cardiovascular treatments could improve patient experience and outcomes through the employment of technological advancements and enhanced data visibility, we conducted a global survey of physicians, hospital administrators/healthcare leaders, and patients (n = 1432) in nine geographies (USA, UK, China, Japan, France, Germany, India, Italy, and Brazil), undertook a structured online questionnaire between December 2019 and January 2020.

Respondent characteristics

Patients surveyed (n = 961) were required by screening to be 35 years of age or older (the actual median age of respondents was 52 years); 70% of those surveyed had coronary artery disease or risk factors for CVD and the remaining 30% suffered from peripheral arterial disease. Participating physicians (n = 345) were defined as cardiologists or other specialists responsible for referral of patients to interventional cardiologists, vascular surgeons, or interventional radiologists. Hospital administrators (also including healthcare leaders, payers, providers; n = 126) had been responsible for the selection, purchase, or negotiation of cardiovascular devices, capital equipment, or relevant contracts in the preceding 12 months.

Survey results and analysis

Categorized responses from the survey questions (questions answered by patients n = 16; physicians, administrators n = 27) were collated and expressed as simple percentages to provide a narrative to address the expressed objectives of the survey and describe varying viewpoints. Although values are compared qualitatively, no formal statistical tests were applied to these data.

Results

Three key overarching themes were identified from the survey responses: patients wish to receive individualized, personalized care; there is a current inability and therefore pressing need to harness existing data sources adequately, to impact the quality of care delivery; and all parties align that diagnostic and data-driven technologies can assist the transition to the desired evidence-based and holistic ‘whole patient’ view, improving, and repairing a fragmented care continuum.

Personalized patient care

Findings arising from the patient questionnaires with regard to delivery of personalized care are summarized in Figure 1. In summary, patients desire (i) more face-to-face time and interaction with their supervising physician; (ii) a consultative and two-way relationship in which they can share a role in active decision-making; (iii) an individualized (‘for me’) treatment plan that draws on data and experiences from patients similar to them from their own physician’s experience, but also from others’ data, to supplement their own doctor’s knowledge; (iv) effective and seamless information-sharing between all stakeholders (primary care team, hospital specialist and healthcare systems), as well as with individual patients through the computer or smart applications; and (v) the ability for their physician to

Table 1 Respondent characteristics by geography

|                     | Patients | Physicians | Hospital administrators |
|---------------------|----------|------------|-------------------------|
| UK                  | 100      | 30         | 5                       |
| France              | 100      | 41         | 3                       |
| Germany             | 100      | 39         | 6                       |
| Italy               | 100      | 37         | 9                       |
| India               | 100      | 25         | 30                      |
| China               | 100      | 34         | 21                      |
| Japan               | 55       | 42         | 0                       |
| USA                 | 206      | 60         | 31                      |
| Brazil              | 100      | 37         | 21                      |
| Total               | 961      | 345        | 126                     |

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Patients have confidence in physicians’ decision-making, but they feel technology can help deliver more **personalized** care.

**Areas where patients believe technology could be leveraged to deliver better care:**

- **55%** of patients selected
  - Helping the doctor understand all the latest approaches to treatment to see exactly what is right for each patient

- **49%** of patients selected
  - Forming an understanding of a patient’s individual condition and measuring their unique risks

- **54%** of patients selected
  - Helping the doctor see where intervention is required

- **40%** of patients selected
  - Supplanting the doctor’s experience

**79%** of patients believe that their doctor knows the correct treatment plan for them.

**Doctors can take several steps to improve their patients’ confidence in their decision-making abilities:**

- **61%** of selected
  - Using new technologies that monitor patients’ progress and evaluate whether a treatment is working

- **55%** of selected
  - Keeping up to date on the latest research

- **54%** of selected
  - Having experience with similar situations

**Figure 1** Patient attitudes to delivery of personalized care. Infographic summarizes key themes around delivery of personalized care from patients surveyed (n = 961), encompassing the areas where patients believe technology could be better leveraged to deliver improved care and what steps physicians could take to improve patients’ confidence in their decision-making. Data are expressed as simple percentages of respondents indicating a preference.

Conduct remote monitoring to verify the treatment plan is working and to pick up early warning signs of relapse or deterioration (Supplementary material online, Tables S1-S3). Despite these unmet or undermet needs, the majority of patients surveyed (79%) agreed that their doctor knew/defined the correct treatment plan for them, although regardless of such confidence, the majority (58%) also expressed the desire to be involved actively in treatment decision-making and to understand options, as well as voice a preference in such choices.

Many of the patient concerns regarding barriers to optimum care were echoed by both physicians and hospital administrators/healthcare leaders (Figure 2): lack of time, lack of resources, staff, and tools to provide...
Where physicians and administrators see potential for technology to deliver better care:

**Barriers to better care**
- Scarcity of time available to spend with each patient (not allowing a more consultative approach) 55% (44%)
- Scarcity of resources for patients to make lifestyle changes that could improve outcomes 44% (33%)
- Lack of appropriate tools to aid with medication adherence and lifestyle changes 43% (47%)
- Lack of insight into aftercare and patient adherence with treatment 42% (45%)
- Lack of appropriate post-care facilities for recovery, such as cardiac rehab centers 41% (31%)
- Lack of staff resources to enable patients to be treated earlier 41% (34%)
- Misdiagnoses or inability to properly diagnose patients 31% (41%)

**How technology has improved care**
- Ability to provide more accurate diagnoses 63% (58%)
- Ability to treat the patient correctly from the start, reducing readmissions and costs 48% (48%)
- Pharmacological advancements that reduce intervention need 42% (33%)
- Earlier identification of co-morbidity risks 41% (38%)
- Better understanding of patient risk factors 39% (47%)
- Ability to personalize care based on data-driven insights 33% (42%)
- More patient involvement in their health through consumer digital health devices/wearables 33% (37%)

Figure 2  Barriers to optimal care that could be addressed by novel technology. Perceived barriers to better patient care (left side of infographic) and areas where technology has improved patient care (right side) from the viewpoint of both physicians and hospital administrators/healthcare leaders are illustrated. Data are expressed as simple percentages of respondents indicating a preference.

Insights into aftercare and post-care, as well as inability to correctly diagnose patients’ conditions were all noted by between a third and a half of all respondents (Supplementary material online, Tables S4 and S5). Nevertheless, a high degree of confidence in advances in diagnostic and treatment technologies related to CVD was expressed by both physicians and administrators (83 and 92%, respectively) and were felt to have translated into tangible improvements in patient care through more accurate diagnoses enabling early initiation of treatments to reduce readmission, need for intervention and costs, and a better understanding and earlier
identification of comorbidities and risk factors for CVD. Technological advancements also enabled personalized care (33 and 42%, respectively) and facilitated patient involvement through wearables and smart devices (33 and 37%, respectively) (Figure 2).

Harnessing data to improve patient care

Persistent data gaps across the care continuum were identified by patients from all geographies, particularly with reference to the lack of data on ‘patients like me’, compounded by a perception of healthcare systems failing to leverage rapidly evolving technologies that could enable data sharing and communication (Supplementary material online, Tables S2 and S3).

There was no clear consensus from physicians on which data gap was the most important (Supplementary material online, Tables S4 and S6), but treatment/outcome data tied to genetic markers or genetic mapping (43 and 38%, respectively), the impact of different treatment techniques on outcomes (42%), total costs of care including staff and follow-up costs (42%), and treatment plans based on lifestyle modification and/or medication adherence (41%). Administrators broadly agreed with this view but emphasized additionally the importance of data tied to the cost of care delivered (Supplementary material online, Table S7). In contrast, patients expressed more definitive views that the most valuable sources to help determine a personalized treatment plan included (Figure 3) data that would allow the physician to see the problem and act on it in a ‘tailored-for-me’ fashion (72%), data that relate to specific treatments being recommended (62%), data from clinical studies (51%), and data from patients like me that have got better (49%) (Supplementary material online, Table S3).

Data sharing and trust remain significant barriers to the development of personalized diagnostic and therapeutic approaches (Figure 3); despite near-universal agreement from surveyed patients that sharing personal information is important for future generations (92%) and that they themselves and others would benefit from such data sharing (90%), a significant minority still would definitely not wish to share personal data even if anonymized/private (23%), added to a further similar proportion (21%) neither agreeing nor disagreeing to share—resulting in persistent uncertainty over this issue in nearly half of patients (Supplementary material online, Figure S1).

Impact of novel technologies across the care continuum

Surveyed physicians and administrators reported the greatest potential for novel technology to improve decision-making prior to achieving a diagnosis (42 and 33%, respectively), at the point of diagnosis (54, 56%), and when determining treatment (both 52%) (Figure 4 and Supplementary material online, Tables S8 and S9). Such accurate decision-making was also seen to be most important in the early parts of the patient journey: prior to diagnosis (47, 37%), at the point of diagnosis (57, 62%) and when determining treatment (57, 54%). These areas were also reported by physicians as the points at which their care was felt to have the most impact on patient outcomes, but tellingly, where they also desired more control over patient care (Figure 4).

The impact of technologies and value of accurate decisions during intervention and in the period following surgery or intervention was seen as also having value, although reported less frequently: physicians reported technology and data inputs as important beyond 30 days after intervention (20%), also reporting this period as a time where they need further control/information (29%) but could still have a significant impact on overall patient outcomes (24%). Examples of the types of aftercare devices and how/where they might be best utilized are summarized in Figure 5.

The types of diagnostic and treatment technologies/tools cited by physicians and administrators (Supplementary material online, Table S10: administrators) to improve patient outcomes across the care continuum included the following: imaging tools to enable more accurate interventions (63, 55%, respectively), monitoring tools to assess treatment adherence (41, 44%), telemedicine tools (39, 34%), and data-driven artificial intelligence solutions to allow case comparisons against broader populations (21, 35%). All of these novel technological advances require adequate industry-sponsored support and training, endorsed by 39% of physicians and 37% of administrators, and were viewed as improving patient throughput and staff workflow.

Discussion

Our survey confirms that despite CVD remaining the premier cause of death worldwide, there exists a perception of a fragmented care continuum in all stakeholders in the vascular healthcare space and identifies important themes that could contribute to addressing the current situation, providing a more unified and holistic view of patient care. Further, the relationships between data, technology and potentially modifying patient outcomes were emphasized by all respondent groups.

In the survey, patients expressed a clear desire for personalized, tailored care, and two-way dialogue and decision-making with their physician. Achieving this could be enabled through greater data visibility—enhancing diagnosis, appropriate management plans to be formulated, and driving improved quality of life, if not future outcomes. Such a patient-centric view has become increasingly commonplace in many aspects of modern healthcare, including when considering patient safety, as endorsed by the World Health Organization by focusing on the whole patient, providers can see beyond the intervention alone. As a result, rather than appealing to medical devices/tools or individual treatments, the broader medtech industry could help to create an ecosystem that would benefit all stakeholders: better care for individuals, better efficiency for healthcare systems, and more optimal allocation of resources for governmental agencies. Such mutual benefits can be attained only by sharing and aligning the inherent
Patients are overwhelming supportive of sharing their data, especially for personal and societal benefits.

92% of patients think sharing their personal health information is important for future generations. Only 23% of patients would rather their information not be shared even if it’s private.

90% of patients think we can all benefit from shared patient data as science evolves.

What data would you want your doctor to use in determining a treatment plan for you?

- 72% of patients selected: Data that lets my doctor see my problem and act on it in a tailored-for-me manner
- 62% of patients selected: Data results from specific procedures or treatments my doctor is recommending
- 51% of patients selected: Data from clinical studies
- 49% of patients selected: Data that monitors how others like me have gotten well

Figure 3: Patient attitudes to data sharing and use of data in decision-making. Although patients are generally supportive of data sharing, some concerns remain regarding privacy (top panel). Of all use cases for data in determining treatment plan, data sources that enable personalized care ranked highest (bottom panel). Data are expressed as simple percentages of respondents indicating a preference.

Responsibilities: doctors providing the best care for their patients, including creating conditions that enable patients to adhere to prescribed treatments and lifestyle modifications; pharmaceutical industry, and demonstrated as feasible in a proof-of-concept study that reduced hospital re-admission after acute myocardial infarction through a patient-engaged digital health initiative. Relying on a device-, surgery- or intervention-based approach creates an enormously narrow view that cannot adequately
Across the **care continuum**, physicians and administrators see the most opportunity for technology and accurate decisions before intervention.

**Figure 4** Potential impact of novel technologies throughout the patient care continuum. Physicians and administrators/healthcare leaders expressed opinions indicating that the greatest impact of novel technology (and where accurate decisions had the most impact) was likely to be in the early stages of the patient care journey (left to right)—prior to diagnosis, at diagnosis or when considering treatment plans. Physicians also expressed that these parts of the care journey were also the points at which they could most influence patient outcomes, and additionally where they desired more control (bottom of infographic). Data are expressed as simple percentages of respondents indicating a preference.

Capture the diverse needs of individual patients, their families and carers, their treating physicians, and the healthcare systems that support them.

Although patients live in a qualitative world, physicians’ actions are guided by quantitative data and evidence that they have available to them at any given time. Although technological innovations can now enable anyone with a smart device or tracker to determine when to seek cardiac care (including for signs of ischaemia\(^\text{15}\) as well as arrhythmia\(^\text{16}\) ), the patient experience ultimately
Personalized vascular healthcare is defined by how providers are able to gather, integrate, and interpret varying and non-traditional data sources. Generating such signals is relatively easy; the challenging part is how providers will act upon these signals. According to patient respondents in our survey, gaps like this in the care continuum mean that their doctors possess ‘a lack of data on patients similar to themselves’. Implicit in narrative responses like this is a sense that patients felt there was a failure to leverage rapidly evolving technologies to communicate effectively and share data with other doctors and specialists as well as with the patients themselves; as a result, data-driven insights fail to deliver truly personalized care and opportunities to fine-tune patient experiences are missed. \(^7,^{17}\)

Lack of communication between care teams is not just a patient concern: one surveyed physician related that ‘the biggest barrier (to optimal patient care) is the complex environment that is healthcare’, encompassing concerns regarding both structural and communication issues within the overall ecosystem. However, to plug...
data gaps in the healthcare system that might address some of the siloed nuances of health delivery today, the key issue of data transparency and trust must be addressed; as highlighted in the survey, sharing of personal information is perceived to add value for individuals and the wider patient community/society, but a significant minority are still against sharing under any circumstances, including when data are anonymized—and nearly half of all patient respondents were either against sharing or offered no strong opinion on the subject. In contrast to other forms of data sharing from smart devices such as televisions and telephone sand watches, there appears to be added sensitivity when the data requested are personal and/or healthcare-related, itself perhaps surprising as patients may not be aware that health data can now be found in organizations outside of healthcare itself—whether it is patient-generated data from digital health sensors or even emerging real-world data sources such as social media posts or conversations with chatbots. Engendering trust that data sharing will not pose risk or harm to individuals after well-publicized data leaks\(^6\) is clearly critical to a data-driven future for a joined-up vision for vascular care.

To achieve a fully holistic and patient-centric view, healthcare systems should consider the emphasis on issues that may matter more to patients than hard endpoints, such as driving qualitative improvements in wellness.\(^7,11,13\) However, greater change may be required to effect such a change: financial healthcare incentives typically are based upon interventions and ‘fixing things’, whereas benefits dedicated to preventive measures and medical therapies are smaller in comparison. A greater focus on wellness and prevention has the potential to lighten the burden on providers, albeit in the longer term—and to deliver a higher quality of life for patients, also at a lower cost—and this is the essence of value-based healthcare.\(^19\)

Ensuring healthcare accessibility for all populations, including the poor, underserved, and elderly, is also a key component: not only should healthcare become more democratized, but technology companies must place greater emphasis on developing solutions optimized to reach these populations. For example, according to research conducted by the Pew Research Center\(^20\) and the Commonwealth Fund,\(^21\) mobile phone usage—with reliable Internet access—is high even among the poor and underserved and has been used to good effect in health interventions, including to reduce hospital readmissions after acute myocardial infarction,\(^14\) and to encourage attendance at follow-up appointments.\(^22\)

Improved data insights across a patient’s care journey could unlock data-enabled decision-making with the potential to allow providers to consider and treat the patient more effectively—from understanding risk factors and comorbidities, to providing precise diagnoses, from making the right treatment decisions to ensuring post-treatment plan adherence. There appears to be little doubt that technology can bring doctors closer to one another and closer to patients. By providing the right technological assistance, when and where needed, the medical technology industry can enable more precise diagnoses, correct treatment strategies, and sustainable patient outcomes that promote health.

### Supplementary material

**Supplementary material** is available at [European Heart Journal Supplements online](https://eurheartj.oxfordjournals.org/content/early/2021/09/02/eurhqq017).  

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### Data availability

The data underlying this article are available in the article and in its online supplementary material, and will be shared on reasonable request to the corresponding author.

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