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DYNAMIC CONSENT IN CLINICAL GENETICS

Implementation barriers

SAFER, SMARTER, GREENER

Author
DNV GL, Group Research and Development, Precision Medicine Program

Contact
Sharmini Alagaratnam,
Bioinformatics Scientist, Principal Researcher,
Precision Medicine Program
Group Research and Development
E-mail: Sharmini.Alagaratnam@dnvgl.com
Mobile: +47 993 71 772

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Adrian Thorogood, Research and Development Specialist (Law and Ethics), University of Luxembourg, Luxembourg

Anton Hasselgren, Researcher in Medical Technology, Department of Neuromedicine and Movement Science, Faculty of Medicine and Health Science, NTNU Norwegian University of Science and Technology, Norway

Daniel B. Thiel, Researcher and Ph.D. candidate, Department of Health Management and Policy, School of Public Health, University of Michigan, USA

Prof. Edwin Morley-Fletcher, President of Lynkeus, Rome, Italy

Gillian Martin, Ph.D., Department of Sociology, Faculty of Arts; and Centre for Molecular Medicine and Biobanking, University of Malta, Malta

Harriet Teare, Ph.D., Research Leader at RAND Europe, UK

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Yngve Sejersted, MD, Ph.D., Medical Geneticist, Oslo University Hospital, Norway

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EXECUTIVE SUMMARY

The reach and relevance of clinical genetics to compliment the increased prevalence of personalised diagnostic and therapeutic decision making is growing, with accompanying demands for technologies and processes that support informed patient decision making. Dynamic consent is an approach that can facilitate two-way communication, setting and modifying of consent preferences by patients over time. It also supports informed patient autonomy and the needs of clinical genetics environments. Despite these benefits, implementation to date is limited.

Driven by our purpose to safeguard life, property, and the environment, DNV GL's research and innovation in healthcare activities focus on identifying roles to address data sharing and infrastructure, legal and regulatory challenges, and gaps in trust that prevent the implementation of precision medicine in routine clinical care. In order to identify barriers to implementation of dynamic consent for clinical genetics, we have performed a literature review and conducted semi-structured qualitative expert interviews, including with pioneering groups in dynamic consent, supported by a survey of clinical genetics professionals on consent practices. These activities with ethical, legal, clinical, laboratory, IT and industry representatives focused on the practical and ethical issues related to dynamic consent, to understand the barriers that have prevented its more wide-spread implementation.

The findings revealed six categories of barriers: ethical, legal and regulatory, knowledge and competence, financial, cultural and organisational, and technological. During this work some examples of approaches for addressing these barriers were encountered and are detailed alongside.

In order to deliver on the value of dynamic consent in clinical genetics for all stakeholders, trust, transparency and interoperability are integral considerations when developing and implementing solutions, with relevance for the use of dynamic consent in other clinical specialities.


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INTRODUCTION

The reach and relevance of clinical genetics, where genetic information from an individual is used as part of the basis for diagnostic or therapeutic decision-making, is rapidly increasing across many specialist medical areas. Applications range from the identification of genetic predispositions for familial hypercholesterolemia or breast cancer, to precision medicine applications such as the diagnosis of rare diseases and tailoring of cancer treatment according to tumour genetic profiles.

The increasing demand for and access to clinical genetics have been driven by dropping costs of high-throughput sequencing technologies, where by one estimate, 60 million patients are expected to have had their genomes sequenced in a clinical context by 2025 [1]. New knowledge is also accumulating rapidly, supported by analysis algorithms and decision trees.

These approaches are continuously expanding and redefining the clinical insights that can be gained from data originating in a genetic test, with many implications for healthcare professionals, patients and society at large. Reanalysis of an individual's sample or data at a future date may reveal new insights impacting their health and clinical management that are not known today, with the potential to transform genetic clinical care from a disconnected series of single interaction points to a more continuous care model. Similarly, in the precision medicine paradigm, knowledge gained from the diagnosis and treatment of a single patient has the potential to inform the care of other similar patients – but only if their personal health and genetic data can be safely, legally and effectively shared. Genetic tests can also potentially give rise to additional findings outside the original scope of testing that are of relevance to the individual undergoing testing. The many ethical challenges arising from clinical genetics to deliver informed consent and preserve patient preferences around family implications, recontact and data sharing are challenging today's static, paper-based consent and data access management systems (Figure 1).

To have a biological sample submitted for sequencing i.e. to undergo genetic testing.

To be informed about secondary and/or clinically actionable findings not related to the primary purpose of the test, in coordination with international guidelines e.g. ACMG59.

To agree to share genetic and health related data for diagnostic purposes for own or other patient diagnosis, in accordance with relevant regulations such as the General Data Protection Regulation (GDPR).

To agree to be contacted about (or participate in) future research opportunities (or even determine which research opportunities to include ones' data in).

Figure 1. Examples of statements presented for consent in clinical genetics today

"People who work in clinical genomics have to have two minds. Now they can't just have the mind of the medical professional, they have to have the mind of a digital researcher."

Prof. Peter Chow-White, Ph.D., the School of Communication and the GeNA Lab at Simon Fraser University, Canada

Clinical genetics is additionally subject to blurred boundaries between research and clinical practice due to the rapid pace of innovation in genetic sequencing technologies and our ever-increasing understanding of genetics in human health and disease [2, 3] (Figure 2). Continuous transfer of methods and knowledge from research environments to clinical setting puts additional and potentially differing requirements on how to best communicate implications and set mutual expectations and preferences through an ongoing clinician-patient relationship.

Recent research has suggested dynamic consent as an approach to meet the challenges described above for researchers, clinicians and healthcare organisations [4–9].

There are different interpretations of the concept of dynamic consent. After reviewing the literature, we observed three emerging hallmarks:

1. Options for consent can be presented and set through sustainable two-way communication between patients, healthcare professionals and researchers,
2. Patients have the option to modify their preferences over time if desired and when relevant, and
3. The preferences set the basis for dynamic downstream clinical and data management actions.

Figure 2. Examples of convergence and divergence of clinical and research genetics

"People just want to be asked. They see it as a sign of respect that you would ask them first."

Daniel B. Thiel, Researcher and Ph.D. candidate, Department of Health Management and Policy, School of Public Health, University of Michigan, USA.

While digital means of collecting and managing consent are not strictly required, the move away from paper-based consent helps enable the full potential of dynamic consent, where both the level of dynamism and digitalisation can be viewed as a continuum on a scale (Figure 3). The potential of dynamic consent can further be boosted by additional features such as integration into the patient pathway, usability, traceability, interoperability, auditability and platform delivery, all of which can support (cross-border) data sharing where relevant. However, the relevance of these additional features needs to be considered for the specific use case where dynamic consent is to be applied.

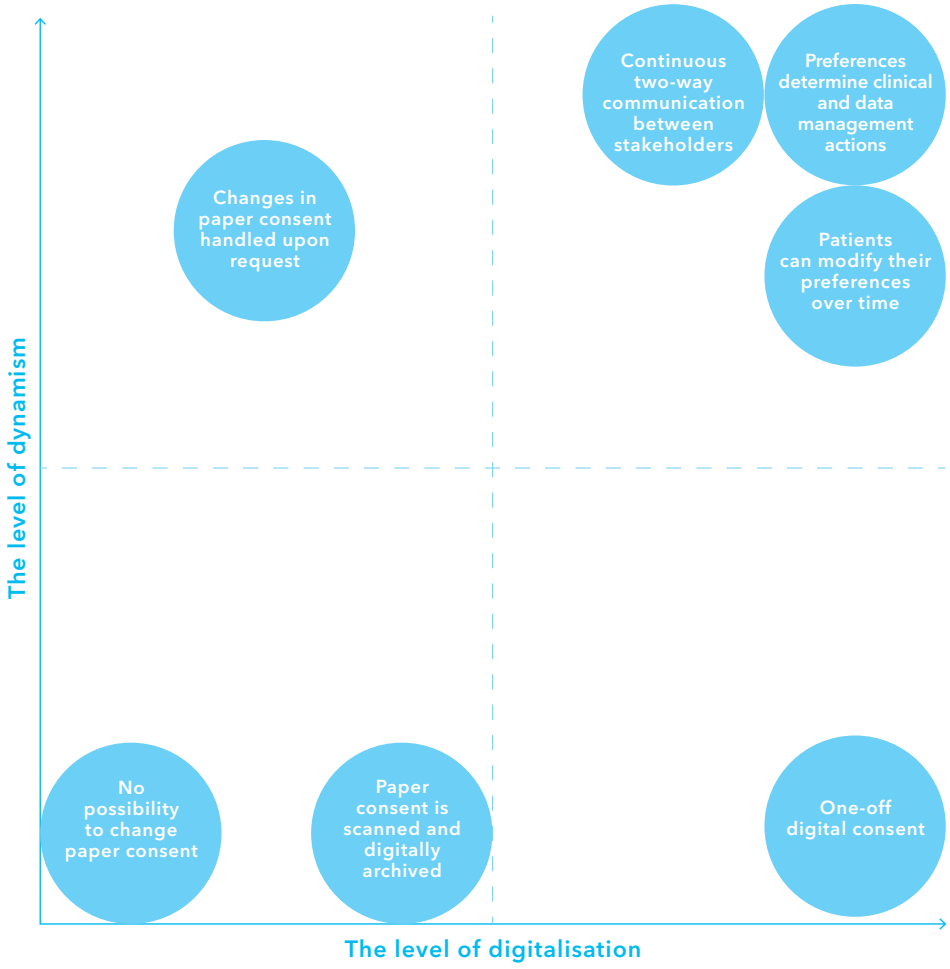


Figure 3. The dynamic versus digital scale for delivering consent

"Dynamic consent can be an electronic platform that allows patients to ask questions and raise concerns to their healthcare professionals between appointments. So that when patients and healthcare professionals meet again the next time, there is already a structure to that conversation because they already know what needs to be covered in the meeting - dynamic consent has already provided an overview."

Harriet Teare, Ph.D., Research Leader at RAND Europe, UK

Since the concept of dynamic consent in genetics was first raised in 2001 [10, 11] and the term coined in 2008 [12, 13], a number of initiatives have focused on transforming this concept into solutions and applications, such as the RUDY study platform [6], CTRL from Australian Genomics [9], and those built into commercial genetic testing services such as Blueprint Genetics [14], and direct-to-consumer genetic profiling tests such as those from 23andMe [15]. Some of these applications are in use today and to different degrees include some or many of the hallmarks described previously. However, implementations of dynamic consent solutions remain few and largely local, both geographically and institutionally, with limited interoperability and connectivity between instances. This last in turn can limit the utility of these solutions for effective data sharing.

At DNV GL, our purpose is to safeguard life, property and the environment. Our research and innovation activities span many sectors, but in healthcare we specifically aim to develop assurance roles to overcome the challenges related to data-sharing and infrastructure needs, legal and regulatory challenges, and gaps in trust that prevent the clinical implementation of precision medicine in routine clinical care. In 2019, we worked with the largest national initiative in Norway for precision medicine with experts from healthcare organisations, legal, and academia towards (1) developing practical strategies for managing challenges around harmonised delivery of informed consent in the Norwegian clinical genetics environments [16] and (2) assessing digitalisation needs to support germline genomic medicine [17]. Dynamic consent was identified as an enabler of dynamic healthcare service as an important technology to aid communication between patients and healthcare professionals in clinical genetics [18]. In 2020, through our cooperation with the Nordic Alliance for Clinical Genomics (NACG) [19], we led an inclusive, multi-disciplinary co-development process to create a clinical consent framework for genetic testing for adoption by the Nordic countries [20]. These efforts have highlighted that management and decision-making surrounding the knowledge generated from patient data are becoming more frequently shared with patients. Dynamic consent offers one approach to facilitate patient autonomy and preference setting and changing, with an opportunity to engender trust across the ecosystem.

In this paper, we attempt to answer the question of why implementation of dynamic consent in clinical genetics remains as limited as it does, despite its value for patients, healthcare organisations and others. Through a review of the literature, NACG workshop discussions including a survey, and a series of expert interviews, we identify and present six categories of barriers that have prevented more wide-spread implementation of dynamic consent, and discuss examples of approaches for overcoming these we encountered during this work.

VALUE OF DYNAMIC CONSENT

"Dynamic consent will make it a lot easier for us to provide more continuous care. For example, if patients have consented for recontact or relevant reanalysis, we can run improved analyses to ensure that we do not miss a diagnosis."

Yngve Sejersted, MD, Ph.D., Medical Geneticist, Oslo University Hospital, Norway

The high cost and labour-intensive nature of static paper consent approaches in healthcare settings have previously been described [21, 22], for example, paper-based consent is likely to require rework due to lost consent forms, illegible handwriting, and incorrect information, as well as significant healthcare administrative time [22]. Additionally, more continuous communication in clinical genetics introduces new needs on consent processes in this context, precipitated, for example, by patient address changes, non-responsiveness, and potentially necessitates additional face-to-face interaction between patients and their healthcare professionals [23].

These challenges and their associated needs were validated through a workshop on consent held by NACG in November 2020 attended by 79 professionals currently working in clinical genomics from 5 Nordic countries and beyond [24]. A survey conducted during this workshop identified ethical considerations (55%, or 17/31 respondents) and legal clarifications (52%, or 16/31 respondents) as being most challenging during the development of consent processes (see Appendix 1 for more details). The majority of respondents felt healthcare organisations should inform patients about reanalysis procedures (90%, or 27/30 respondents), where 96% were of the opinion that patients should have the option whether or not to consent to reanalysis (96%, or 23/24 respondents).

The findings of this survey and the resulting discussions at the workshop around them underline the potential value afforded by dynamic consent (Figure 4). While interconnected, these benefits are distinct for individuals, groups or organisations in the clinical genetics sphere. In this section, we tease apart and delineate the value for the following specific groups: patients, healthcare professionals and healthcare organisations, and consider its broader value for society in general.

Value to patients

An easy-to-access and use dynamic consent solution allows patients to securely access and manage their preferences related to whether, what and when clinical genetics results are reported back to them. It can also provide a point-of-control to manage sharing of their data, where data sharing in clinical genetics increases the likelihood of obtaining a diagnosis in the absence of evidence within a single hospital. Accompanied by appropriate two-way communication, dynamic consent offers continuous opportunities for the balanced delivery of tailored information [25, 26], in turn facilitating informed and updated understanding about genetic testing procedures and advances in the field related to their diagnosis and clinical management [27]. Consequently, dynamic consent offers patient empowerment through the ability to control their preferences and readily facilitates changes as relevant and desired, including review of consent choices as younger patients come of age [28].

Value to healthcare professionals collecting consent

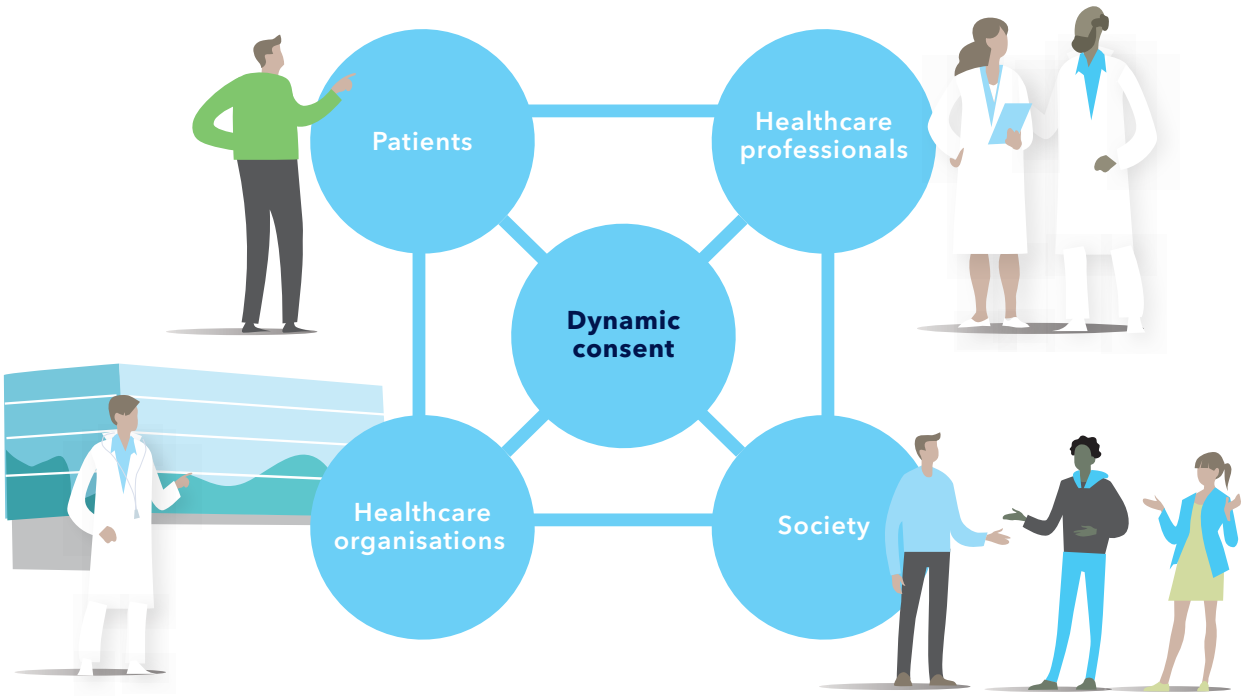
Dynamic consent offers value to clinical genetics professionals responsible for collecting and managing patient consent, through a reduction in paperwork, data entry and the administrative burden that negatively impacts clinical time [27, 29]. Updated

Value to patients

- Easy to access and use consent management
- Facilitates transparent informed consent through continuous communication about genetic testing procedures and advances in knowledge
- Enables tailoring of information to different demographics and needs
- Supports preferences on granularity, frequency and type of communication
- Supports consent review from younger patients that come of age

Value to healthcare professionals collecting consent

- Simple system for collecting and managing consent
- Easy process to interpret permissible consents in real time
- New consents easily acquired as unforeseen permissions are identified
- Efficient recontact methods



Value to healthcare organisations

- Standardised collection and management of consent
- Better scalability and interoperability across medical disciplines and external organisations
- Improved organisational productivity through more complete information collection
- Documents consent in compliance with laws and regulations

Value to society

- Instills and perpetuates trust in sharing of health data
- Supports transition to a digital health ecosystem
- Enables development of knowledge, medicines and services

Figure 4. Value of dynamic consent in clinical genetics and beyond

"Preparing the consent forms for our clinical genomic flagship projects was challenging, where the forms were incredibly long and complex, not tailored to individual participant needs, and conveying information contained was labour intensive."

Matilda Haas, Ph.D., Project Manager for CTRL, the Australian Genomics consent platform, Australia

consent preferences can be accessed and complied with, including for return of results and data sharing. Changes to consent can be achieved without direct interaction and/or involvement of these professionals, reducing the overall time required for the whole consent process.

As new as-yet-unforeseen permissions are required, and knowledge is gained, potentially including current and future identified clinically actionable medical outcomes, a systematic dynamic consent approach ensures that recontact and reconsent of patients can be achieved in a more timely and economical manner than traditional paper-based consent methodologies.

Value to healthcare organisations

Here, healthcare organisations are meant as a collective term for the clinicians, researchers and clinical units responsible for delivering patient care in the field of clinical genetics. For these organisations, there is a need for a more systematic approach to generating, curating and applying existing and new knowledge, through, for example, patient data sharing and the development of new guidelines or evolving lists of clinically actionable genes [30, 31]. In this context, a dynamic consent management system has the potential to collect and make up-dated consents actionable both for the patient and the data originating from their genetic testing.

Implementing a standardised dynamic consent methodology can reduce the variability in how consent is collected and managed across a healthcare organisation. As consistency of consent management and monitoring increases, dynamic consent has better potential to scale, as well as making permissible access to consents available across an organisation. It can also improve organisational productivity [22, 23], easing the workload of auditing incorrect or missing information [32].

Finally, dynamic consent can serve to document consent in the instances where it is legally required [32], also to avoid downstream liability actions in case of non-compliance [2]. Development of a dynamic solution can be iterative, guided by needs of the particular organisation, in response to changing audit and regulatory requirements [31, 33].

Value to society

De-identified genetic data is less frequently considered anonymous due to an increasing risk of reidentification as different data sources are combined [3, 7]. As such it is increasingly difficult to share under the pretext of anonymous data sharing (supported by GDPR [34]) and is instead reliant on patient consent [8]. Dynamic consent presents opportunities to extend the sharing of patient data outside the institution they have been generated in and with other medical and health-related disciplines, where standardising engagement with patients and capturing their preferences could prove valuable and motivating for patients [13]. Integration of dynamic consent into current healthcare practices can support the digital health transition, and, if delivered in a way that offers assurance to users, help instil and perpetuate trust in the digital health ecosystem [3, 31, 35]. Looking more broadly, dynamic consent can contribute to the basis for a living ecosystem where new knowledge, medicines, technologies and services can be sustainably developed by both academic and industry partners for the benefit of healthcare and society at large.

BARRIERS TO IMPLEMENTATION OF DYNAMIC CONSENT IN CLINICAL GENETICS

Despite the value of dynamic consent to individuals and organisations in the clinical genetics sphere, and the development of solutions that deliver dynamic consent, instances of implementation remain few and limited in scope, both geographically and organisationally.

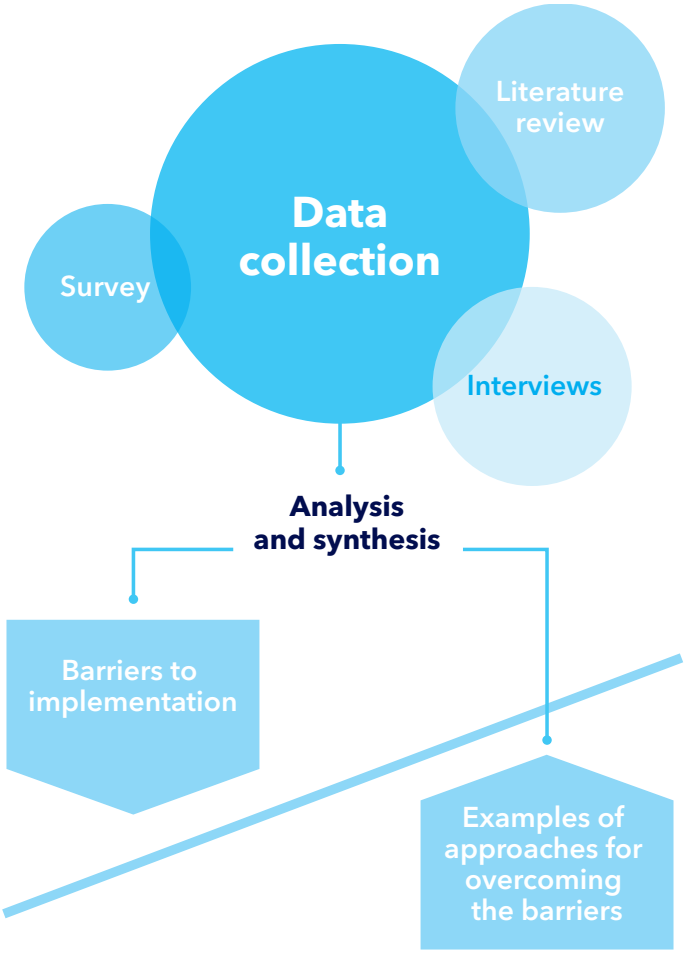
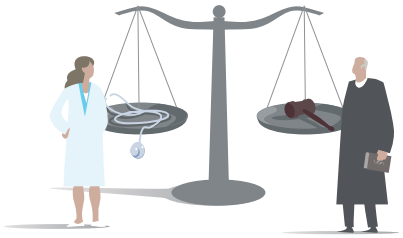


Figure 5. Methodology

For this paper, we applied a methodology combining a literature review and semi-structured qualitative expert interviews, supported by a survey of clinical genetics professionals, to map the barriers to implementation of dynamic consent in clinical genetics (see Figure 5 and Appendix 1 for methodology). Analysis and subsequent synthesis of the findings revealed six categories of barriers, summarised with their subcategories in Figure 6.

This section will review each of the barrier categories in turn, listing the factors and aspects that play into each, before briefly describing examples of approaches for overcoming these barriers that we encountered during this work.

ETHICAL BARRIERS:
- Ensuring trust
- Autonomy versus information overload
- Sharing data
- Revoking previously consented data



LEGAL AND REGULATORY BARRIERS:
- Regulation
- Use of data
- The GDPR

KNOWLEDGE AND COMPETENCE BARRIERS:
- Consent comprehension
- Variable user backgrounds

FINANCIAL BARRIERS:
- Investment versus gain

CULTURAL AND ORGANISATIONAL BARRIERS:
- Stakeholder engagement and collaboration
- Cultural shift

TECHNOLOGICAL BARRIERS:
- Security
- Traceability and transparency
- Interoperability

Figure 6. Six identified barriers to implementation of dynamic consent

3.1 ETHICAL BARRIERS

Ensuring trust: How can trust in dynamic consent approaches be developed and maintained?

Genetic testing gives rise to information about the individual being tested, but also their family members, including siblings and offspring [7], which needs to be managed. The lack of patient trust in this management may suggest a barrier to their engagement with dynamic consent tools [7, 36]. The measures to assure confidentiality and prevent privacy breaches and data misuse need to be in place for the benefit of both the patient and healthcare organisations who administer and manage consent [5, 36].

"Trust issues are really important. It needs to be built at the beginning as a central concern and recognised that it has to be woven into the fabric of the implementation of dynamic consent."

Daniel B. Thiel, Researcher and Ph.D. candidate, Department of Health Management and Policy, School of Public Health, University of Michigan, USA. "Weaving the trust fabric" is credited to Assistant Professor Jodyn Platt, Department of Learning Health Sciences, Medical School, University of Michigan, USA

To overcome this barrier, in-person interactions or other direct forms of communications with healthcare professionals and researchers remain integral to ensure patients' understanding of consent information and to foster trust [5, 36]. An introduction to the dynamic consent tool initiated by the healthcare professional could instil the basic trust necessary for initial and continued use, nurtured through ongoing communication. Methods employing qualitative engagement at local levels to explore target users' degree of comfort and discomfort in using a dynamic consent tool could be used [29]. Polling specific target user groups about their concerns and needs can provide valuable information and clear criteria for how dynamic consent provides value to them. Finally, independent assurance of technologies and their integration in production processes, particularly focusing on security, privacy and logging of data use, through the verification of security and confidentiality aspects of dynamic consent tools could provide an additional dimension of trust for implementers and empower the decisions and actions of users.

Autonomy versus information overload: How can patient education efforts and autonomy be balanced for effective patient empowerment?

To obtain consent based on free will, a patient's understanding to the nature of treatment is necessary. This is recognised as the ethical obligation and it is a requirement to inform patients prior to them giving their consent. The continuous engagement required of patients to comprehend the scope and benefits of primary and secondary use of their data, and to consent for each change, study or organisation as data recipient may represent a barrier to the utilisation of dynamic consent [8, 37]. Options for patient autonomy over their own data may lead to information overload, withdrawal, and excessive self-protective behaviour [7, 25, 29].

A balance should be struck that facilitates both a strong sense of participant autonomy and minimised patient effort. Providing patients too frequently with too many consenting options accompanied by supporting information around these, can be overwhelming and lead to consent fatigue [29].

"From a clinician's perspective, that inherent trust that patients place in us, when they come to seek care, is sacrosanct. Patients cannot think that I am treating them as an asset to the institution as opposed to a patient. That's where respect for patient autonomy is so important."

Prof. Fei-Fei Liu, MD, FRCPC, FASTRO, Chief of the Radiation Medicine Program, and Head of the Department of Radiation Oncology at the Princess Margaret Cancer Center, and Professor and Chair of the Department of Radiation Oncology at the University of Toronto, Canada.

To mitigate the risk of excessive protective behaviour, a consent needs analysis could be performed through dialogue with patients and experts in genetics, education and psychology, to ensure that an engaging education and assessment program is created [7]. Options for tailoring frequency of contact would respond to varying levels of engagement for different individuals. Establishing and maintaining a strong sense of patient autonomy develops feelings of empowerment, forming the basis of trust and approval required for systematic use of dynamic consent approaches [7].

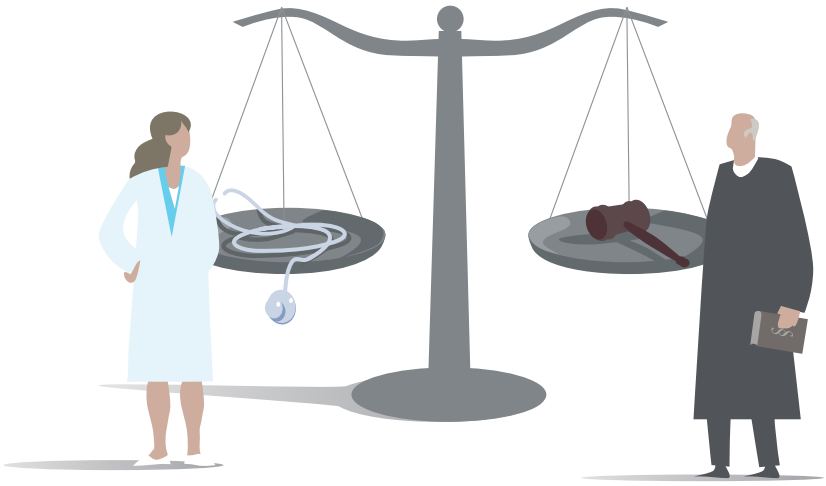
Sharing data: How can consent form the basis of external data sharing for patient benefit?

The likelihood of finding a patient diagnosis for the rare diseases in particular relies upon data sharing outside of the organisation of origin. Uncertainty and confusion relating to the legality of cross-border data sharing regulations presents a barrier to healthcare professionals about whether and how to share consented data securely [2].

To address this, standard organisational procedures that instruct healthcare professionals about the use of consent as the basis for secure patient data sharing, both internally and externally to an organisation, with considerations relating to privacy breaches, data misuse and confidentiality issues should be established [8, 38, 39]. This supports patients' motivation to obtain diagnosis for their disease, where this agreement to share data can be captured through informed consent. A process supporting legal, organisational and regulatory compliance can address the need for clarity around consent as the legal basis for data sharing as required [8].

Revoking previous consents: How can expectations and limitations of revoking consent be managed?

Data previously consented for analysis and/or research contributing to combined results from analysis or publications cannot necessarily be revoked and paradoxically may even identify the patient if done so [2, 7]. As such, management of patient expectations relating to complete data deletion if they withdraw their consent has been identified as an issue for the implementation of dynamic consent [7]. One way to approach this is to systematically convey to the patient limitations and time points where revocation is possible [7].



3.2 LEGAL AND REGULATORY BARRIERS

Regulation: How can fit-for-purpose regulations for dynamic consent be developed, standardised and translated into a clinical genetics' environment?

A lack of fit-for-purpose regulations and standardisation of approaches presents a barrier to implementation [31, 32]. Some institutional review boards that regulate if research methods used are ethical, are reportedly uncertain about whether electronic signatures are valid [40], which laws would apply, and how the electronic signatures would be stored [5]. Similarly, a failure to understand legal precedents, for example, those relating to data security and privacy, prevents uptake of dynamic consent, due to variable and unclear requirements at organisational, national and international levels [25].

To overcome this, efforts should involve coordinating, identifying and complying with the relevant regulatory requirements for implementing dynamic consent in clinical genetics. For healthcare professionals wishing to standardise procedures for dynamic consent implementation, local authorities should be engaged to develop best practices [23].

Use of data: How can restrictions be balanced to ensure the patient benefits?

Although restrictions on use of data, including potential future and third-party use, are regulated to protect patients' rights and interests, they represent a barrier to diagnostic and research opportunities that could benefit the same and future patients [41]. Healthcare organisations are often reluctant to release their patient data and host data other than their own, due to legal and capacity restrictions. They frequently operate with unclear procedures relating to the length of time patient data are stored and what processes are allowed, on both organisational and national levels [25]. Centralisation of data is often avoided, thus it is a challenge to track availability, use and missed opportunities for patient diagnosis and benefit as clinical genetics knowledge changes. Dynamic consent can support use of consented data, with the potential to act as a checkpoint that healthcare organisations and researchers can consult to ensure regulatory compliance and appropriate use of patients' data.

The GDPR: How can patients' privacy be balanced with their right to healthcare and other rights?

Healthcare organisations are tasked with the challenge of ensuring traceability in patients' data in case of changes in consent and other findings, whilst maintaining privacy when sharing outside of their unit or organisation. Knowledge around GDPR requirements for consent, for example, inclusion of patients' right to know versus their right not to know in terms of the return of results and incidental findings, should be considered, and researchers or healthcare professionals should be aware of their obligations relating to incidental findings and more [37]. While new technologies can be positively leveraged in this context, they may also result in other complications. Blockchain technology, for example, facilitates transparency through the creation of immutable records of consent. Although this may appear to conflict with the GDPR as users are unable to fully erase records pertaining to them thus negating the right to be forgotten, circumvention of this limitation and therefore compliance with GDPR is possible with the use of pseudonymisation and off-chain links [8].

"The most important thing about dynamic consent is that it comes hand-in-hand with informational health literacy and patient engagement, where challenging and complex elements can be explained and made accessible to patients who can then make an informed decision. Dynamic consent allows you to actually provide information over time and update people as things change, and continue that conversation."

Harriet Teare, Ph.D., Research Leader at RAND Europe, UK

3.3 KNOWLEDGE AND COMPETENCE BARRIERS

Consent comprehension: How can different consent preferences be tailored to ensure that patients are fully informed about the genetic testing procedure and its risks and benefits, as well as their rights?

Genetic literacy is challenging to impart, newer sequencing technologies have implications that are difficult to fully understand and predict [7, 31], and the availability of counsellors and clinicians with specific expertise in genetics is limited [31]. Empowering patients with the ability to indicate their preferences around return of results and data sharing necessitates that patients understand what they consent to, their rights, and the associated data security and privacy risks, or so-called informed consent. Delivery of dynamic consent through an electronic dialogue interface reduces the need for face-to-face interaction, however, this interaction is traditionally seen as an important opportunity to allow participants to raise questions, particularly for more complex and riskier situations, where the comparative utility of an electronic platform for this purpose remains to be proven [6]. Acute situations, such as for genome sequencing for infants in neonatal intensive care with suspected genetic conditions, combined with psychological stress, may compromise the ability of patients to give consent.

To counter this, conversations with a clinical genetics specialist can be complemented with an engaging and effective educational and assessment program with interactive multimedia components [8], quizzes and tailored information that support the patients education needs [5, 36]. Additional education programs can be developed according to new information that arises, to help the patient make new decisions aligned with their preferences. Educational materials and assessments can be completed at a patient's own pace and convenience, allowing them to comprehend what they are consenting to in a comfortable fashion [7]. These can act as checkpoints to potentially indicate where additional support is required by clinical geneticists on a case-by-case basis. Education programs in the dynamic consent process can be modified and extended to clinicians that lack experience in genetics but still play a role in the care of patients undergoing genetics testing [31]. Providing education about clinical genetics to both general public and healthcare professionals is perceived to improve the process of obtaining consent.

Variable user backgrounds: How can variable patient digital literacy, aptitude and willingness be catered for?

Patients and other stakeholders in the clinical genetics sphere have variable digital literacy, aptitude and willingness to engage [5, 7, 23, 42]. This raises the challenge of ensuring that dynamic consent does not exclude certain users such as those belonging to particular age, cultural, socio-economic or linguistic demographic groups. Until recently dynamic consent approaches have been pioneered by research organisations with data collection as the primary motivation. As a result, patients and users had a limited role in the development and delivery process, however, as a requirement for patient knowledge and decision making becomes more prevalent, consent solutions must be developed to address their needs. One approach to this is to incorporate user-centred design methods to create tailored dynamic consent approaches for use by variable user backgrounds. These should address the whole user experience, with a focus on lay people readability and through incorporation of multiple translations and culturally-tailored explanations [42].

"Greater coordination is thus required between public authorities, academic players, and private actors in order to set up converging oversight practices able to adapt rapidly to evolving technological conditions."

Effy Vayena, Ph.D. and **Alessandro Blasimme**, Ph.D. in Health Research with Big Data: Time for Systemic Oversight [26]

3.4 FINANCIAL BARRIERS

Investment versus gain: How can ongoing resources be aligned for continued use and return on investment?

Dynamic consent is perceived as disruptive, and raises the question of whether the implementation investment and the gain are worth the efforts required [33]. While widespread use of dynamic consent solutions remains limited, organisations may choose to develop a solution tailored to its needs. However, implementation and integration of either of these options has its costs, and resources will need to be assigned specifically to this end, encompassing IT support and infrastructure, equipment, training of personnel and multidisciplinary expertise [23, 32]. Anecdotal evidence from our interviewees indicate that only a very small proportion of patients (and sometimes none) have requested changes to their consent preferences, however, awareness of the possibility and the ease of changing consent may be underlying factors here [43]. The prioritisation of dynamic consent, with or without associated benefits, will have to be considered in the wider context for each organisation intending to implement.

It has been reported, however, that the total cost of implementation and operation of a dynamic consent solution is not significantly higher than paper-based consent [22]. The use of pre-existing resources, such as national platforms, patient contact infrastructures and open source applications/libraries, can reduce initial costs. In addition, the establishment of initial investment and effective reimbursement models, can facilitate implementation of dynamic consent [44]. Identification of key individuals or organisations to foster collaborations in developing or using a dynamic consent solution, and sharing a platform, could also be used to decrease costs [7].

Software from relevant genomics research projects, for example, the prototypes CTRL (Australian Genomics) [9] or the open-source Dwarna (Malta biobank) [8], attempts to address the needs of this new field and could also reduce the initial investment required. It is important, however, to note that despite the fact that development costs can come from research sources and are, therefore, not borne by the healthcare institution, implementation and sustaining IT investment for long-term use can be high, with the additional risk of abandonment, and should be balanced against existing commercial solutions that may be relevant and adapted.

"The technology is already here to implement Dynamic Consent. That is not the issue. The real issue is how to get it adopted in existing healthcare systems, which requires a change in culture, behaviour and procedures. The wide-scale adoption of Dynamic Consent requires a deep understanding and analysis of the human factors that might be the barriers or drivers of implementation in existing systems. People need to be able to see the benefits it can bring to them and their practice, and how it could transform their interactions and relationships with patients, leading to better research and health outcomes. This requires good case studies as well as a critical analysis of what works and what does not in different contexts."

Prof. Jane Kaye, Ph.D., Director of the Centre for Law, Health and Emerging Technologies (HeLEX), the University of Oxford, UK, and Director of the Centre for Health, Law and Emerging Technologies, University of Melbourne, Australia

3.5 CULTURAL AND ORGANISATIONAL BARRIERS

Stakeholder engagement and collaboration: How can key stakeholders be engaged?

Healthcare organisations are notoriously complex organisations, where the implementation of dynamic consent requires the involvement of and impinges on at times unclear domains of expertise, responsibility and governance of multiple clinical, regulatory, technical and administrative units, all within the same healthcare organisation. Systematic engagement with key stakeholders in an organisation around the benefits, concerns, alignment on incentives and ultimately decision making around implementation is both a challenge, and critical to success [21]. There should be broad agreement on in which clinical settings dynamic consent can improve the patient experience or standard of care delivered, and how these should be engineered and implemented to support the patient-clinician relationship [5].

Cultural shift: How can organisations effectively change existing practices?

Consent management is already an integrated part of many clinical care pathways, and the introduction of dynamic consent tools would likely impact these pathways in different ways. In addition to engagement and agreement at all levels of the organisation, a shift in culture required for successful adoption is not easy to achieve. Clinics must balance resources for improvements with requirements for service delivery, while the implementation of a dynamic consent solution requires staff at all levels to drive change. Non-alignment between the disparate priorities of different units and roles, such as a focus on patient centricity, needs of genetics laboratories, requirements for reimbursement and competing demands on clinical time, can negatively impact the potential of dynamic consent.

Shifting of priorities will require dynamic consent solutions to satisfy regulatory, IT and clinical requirements prior to implementation, among others by engaging institutional review boards, independent ethics committees and hospital authorities. Ideally, this will foster cultural change for all end users (including patients, clinicians, leadership) and secure time, resource, expertise, commitment and coordination investments [29].

The convergence between research and clinic in genetics as shown in Figure 2 offers opportunities for testing and learning about the implementation of dynamic consent, among others through engagement with external research and clinical stakeholders with experience in this field for the transfer of valuable knowledge. Despite differences in mandates and motivation, the mutual benefits can support a cultural drive for change in environments where research and clinical considerations overlap, which are relevant for the wider clinical genetics' community. One approach to this could be the creation of a network of dynamic consent pioneers, producing best practices and recommendations to champion its wider implementation outside of isolated pockets of innovation.

"Ethics means Information Technology (IT). Whatever you offer to people has to be recorded, tracked and kept secure."

Adrian Thorogood, Research and Development Specialist (Law and Ethics), University of Luxembourg, Luxembourg

3.6 TECHNOLOGICAL BARRIERS

Security: How can security practices be addressed to ensure patient privacy?

The use of dynamic consent for the management of access to clinical genetics data is subject to the same data security and privacy considerations as other software used in this field, specifically confidentiality, integrity and availability of the (personal) information associated with consent. However, the broad range of stakeholders involved poses a unique risk. While individual organisations may manage their data security risks through tools such as ISO 27001 [45], and software manufacturers are bound by both voluntary and mandatory security requirements, mapping these risks and implementing appropriate mitigations is difficult when these span multiple organisations with different goals and incentives [5, 31].

In cases where data may be produced in a clinical context but stored in or transferred to research infrastructure, different security regimes may introduce risks. These institutions may have different technical measures in place, such as more or less stringent firewalls, physical access controls, and authentication protocols, but may also have fundamentally different practices and security cultures that could contribute to data security risks [37, 46, 47]. These issues are, however, not unique to dynamic consent: while the transfer of clinical data to high-performance computing clusters outside of the hospital network is commonplace today, the increased mobility and volumes of data access in a setting with dynamic consent highlight the importance of addressing security issues in a responsible way [3, 39]. Cross-institution, off-site or cloud and/or cross-border networks of data access may challenge pre-existing security roles and raise questions regarding the authority and responsibility of stakeholders and the jurisdiction they belong to. To safeguard patient privacy and confidentiality, dynamic consent solutions must also provide a trusted identity management process, including identity proofing, credentialing, authentication and authorisation [37, 48]. A robust infrastructure to authenticate each subject's identity as pinpointed by some studies, is key to identity management, for example, using two-factor authentication and the use of an audit trail to reliably track consent status and records of each consent transaction over time [37, 48]. Incentivisation of such infrastructures as well as user friendliness through target user involvement in development and piloting authentication procedures can support successful implementation [4, 29, 37]. Finally, the use of independent parties to verify security and confidentiality aspects of dynamic consent tools could provide an additional dimension of trust for implementers and users, help organisations manage liability of managing consent and potentially downstream data access.

Traceability and transparency: How can patient preferences be tracked across complex landscapes?

The use of genetics data in clinical and research contexts involves a wide array of stakeholders. In addition to the patient, their family, doctor, clinical and laboratory specialists, and research scientists in private, public, and increasingly hybrid roles all have interests in this ecosystem. Furthermore, a complex environment of institutional review boards, ethics and data access, and local, regional, and national ethics committees contributes to decisions regarding data use and data access, in some cases bypassing direct consultation with the patient.

In this complex environment, the organisations and stakeholders that process personal data, along with the decisions underlying who has access to

"We have to develop governance systems which allow data to move across different contexts in a way that respects the interests and rights of individuals, while allowing research to proceed."

Prof. Jane Kaye, Ph.D., Director of the Centre for Law, Health and Emerging Technologies (HeLEX), the University of Oxford, UK, and Director of the Centre for Health, Law and Emerging Technologies, University of Melbourne, Australia

this data in situations where these decisions have been delegated (for example, to a biobank data access review board) is not always apparent. In certain cases, research participants may find that organisations may hold and process their health data without their knowledge or consent, for example if samples were taken and explicitly consented for publicly-funded research and later analysed by researchers with commercial interests (see [51] for one such example). Ultimately, trust in this complex web of agreements, access permissions, and samples can be built when these systems are based on the principles of traceability and transparency [8, 21, 49, 50].

One of the challenges for dynamic consent solutions is to provide mechanisms to ensure traceability and transparency across this complex landscape. Current paper-based approaches to dynamic consent operate largely as black boxes, although these can potentially be integrated with electronic systems that track and trace who has accessed which data and when. While the technical solutions to provide these are regularly implemented in medical, legal, and financial software, the large number of stakeholders in a clinical genetics' environment, each with proprietary computing infrastructures, poses a unique challenge.

Interoperability: How can a dynamic consent solution be integrated effectively into clinical genetics environments?

The implementation of dynamic consent for accessing clinical genetics data faces the same interoperability and standardisation challenges seen elsewhere in health IT. Organisations often rely on a complex patchwork of proprietary databases and custom-built tools, and integration between these various IT systems is often under-resourced. While there are standardised data ontologies such as HL7 [52], SNOMED CT [53], and HPO [54], the use of these resources is not ubiquitous, and in many cases even standard formats that are in broad use are often adapted subtly or used in ways that support local clinical use cases, and may not be strictly interoperable without additional data management or intermediate processing steps. Furthermore, standardised ontologies are not available for many critical aspects of genetics data, such as metadata describing laboratory and bio-informatics pipelines.

Initiatives that move towards standardising the representation of genomic data and its metadata, ontologies structuring data use such as DUO for research purposes [55], APIs used to exchange these data [56, 57], and necessary supporting infrastructure such as common authentication [58, 59], data use and identity tokens are key to achieving dynamic consent, where larger (research) data repositories have limited support for dynamic consent. Hospitals may also face significant implementation barriers due to under-resourcing and the accumulation of legacy technologies debt, and as such tools for dynamic consent should be relatively easy to implement and maintain [23], relying on already existing common packages and environments [44], and preferably packaged in easily deployed modalities [5, 31].

Ideally, an IT system for providing and administering dynamic consent would incorporate a standardised data structure and API, allowing easier integration with EHRs and clinical genetics analysis packages. For example, integrating patient consent to research and healthcare, supporting the integration of information derived from patient care and research, enhancing evidence generation to efficiently integrate improved prevention, treatment, and care-delivery methods.

ELEMENTS OF DYNAMIC CONSENT IN CLINICAL GENETICS

Implementation of dynamic consent requires consideration of its essential elements to highlight possible pitfalls and to ensure a smooth implementation process.

Through literature review and expert interviews, seven major elements of dynamic consent were identified. These are: registration, login, giving and review of consent, return of results, reanalysis, data sharing and revision. In an attempt to convey these, we depict in Figure 7 an overview of these major elements which a dynamic consent process may include, while Figure 8 shows the sub-elements associated with each of the major elements.

The elements described illustrate how complex dynamic consent processes are, and give an indication that maturity time is still likely to be required before more widespread use in clinical genetics. Nevertheless, it is hoped that this description can represent a starting point from which to generate useful discussions on the implementation of dynamic consent in clinical genetics and beyond.

Method, limitations and considerations

To understand the needs of dynamic consent in clinical genetics, we mapped out elements of a dynamic consent process, addressing current and future anticipated processes of dynamic consent in clinical genetics through the following:

- **Input:** The literature review, interviews and the team's knowledge (human genetics, biomedical research, UX, bioinformatics, human factors and cognitive psychology).
- **Process:** A series of workshop meetings with the team members over a couple of months.
- **Output:** A simplified process of a dynamic consent process in clinical genetics, reviewed by a genetic counsellor.

This simplified description of elements may be incomplete, vary in different contexts, environments or countries, and may become outdated in the future. Therefore, some considerations should be made when analysing the process. For example, the illustrated dynamic consent process does not reflect the occasional necessity to handle a patient's preferences on a case-by-case basis, such as rechecking legacy consent preferences for reanalysis, or the potential of changing a preference to receive secondary findings at the time of delivery of primary results. It does not adequately illustrate the breadth of educational materials available, the utility of self-assessments, and the potential for two-way communication to enable and ensure patients are adequately informed prior to consenting.

During the development of this model, some questions relating to whether patient data would be kept in a shared, separate database, and if additional consents would be required for this, were not adequately answered. Additionally, the process in dynamic consent for transfer of responsibility from the parent to a minor, following them reaching the age of self-determination, is still not considered, and this would potentially vary in countries, as this age varies.

"The pandemic has accelerated the electronic world. We use electronic systems everywhere, for example, in banking. We should be able to have dynamic consent too for clinical genetics."

Vigdís Stefánsdóttir, Ph.D., Certified Genetic Counsellor, Department of Genetics and Molecular Medicine, Landspitali National University Hospital, Clinical Associate Professor, Faculty of Medicine, University of Iceland, Iceland

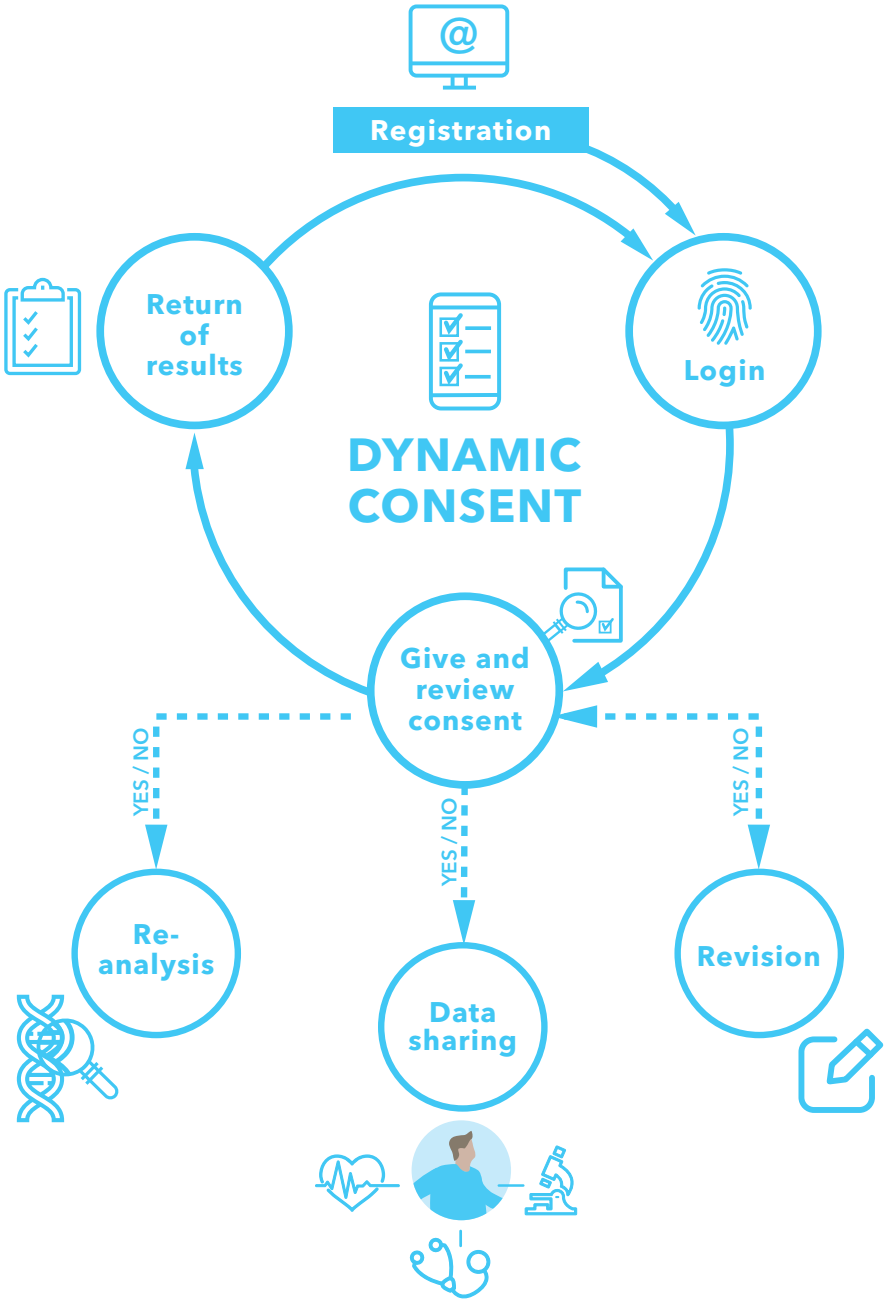
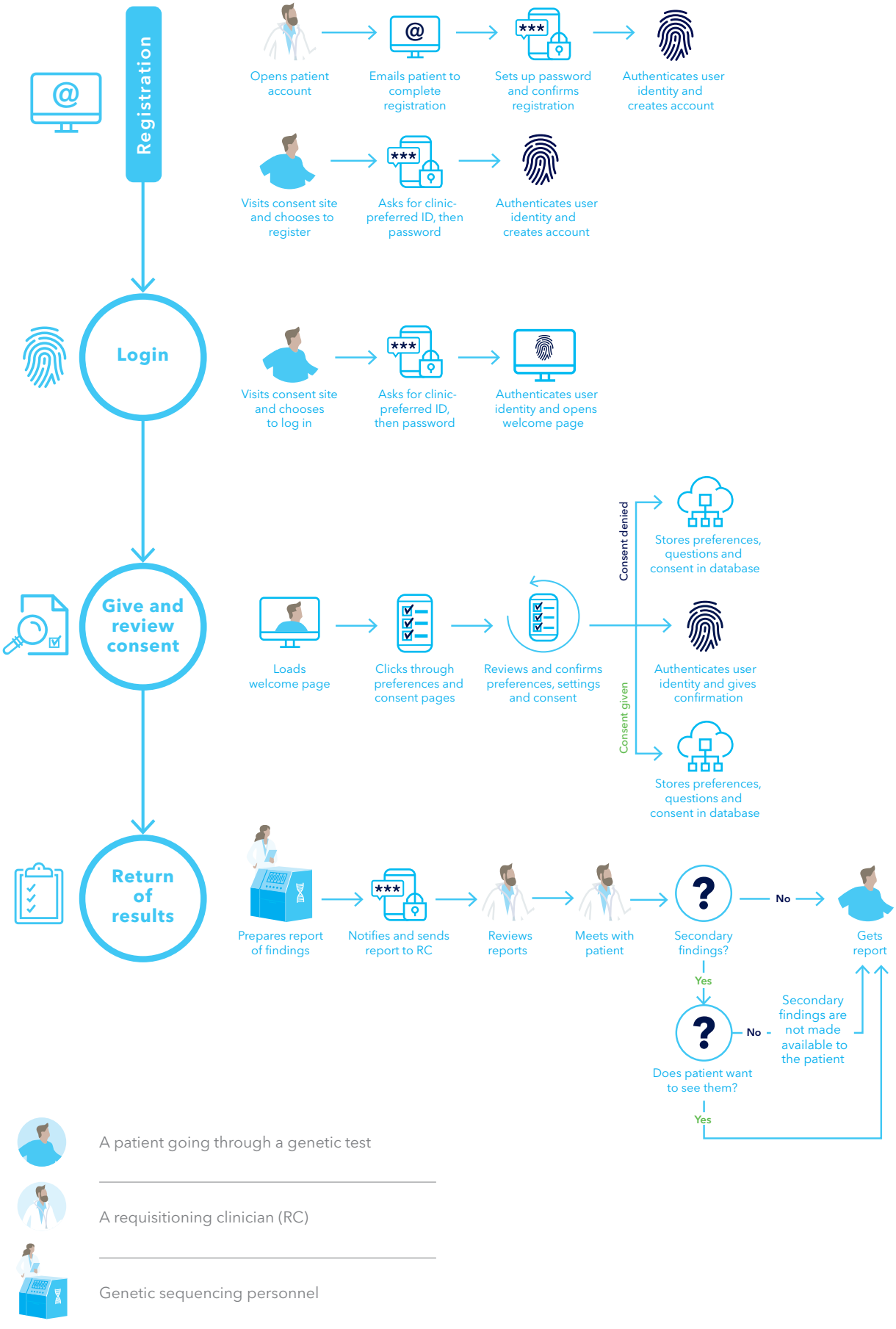


Figure 7. Major elements of a dynamic consent process


Registration
Opens patient account
Emails patient to complete registration
Sets up password and confirms registration
Authenticates user identity and creates account
Visits consent site and chooses to register
Asks for clinic-preferred ID, then password
Authenticates user identity and creates account
Login
Visits consent site and chooses to log in
Asks for clinic-preferred ID, then password
Authenticates user identity and opens welcome page
Give and review consent
Loads welcome page
Clicks through preferences and consent pages
Reviews and confirms preferences, settings and consent
Consent denied
Stores preferences, questions and consent in database
Authenticates user identity and gives confirmation
Consent given
Stores preferences, questions and consent in database
Return of results
Prepares report of findings
Notifies and sends report to RC
Reviews reports
Meets with patient
Secondary findings?
No
Gets report
Yes
Does patient want to see them?
No
Secondary findings are not made available to the patient
Yes
A patient going through a genetic test
A requisitioning clinician (RC)
Genetic sequencing personnel

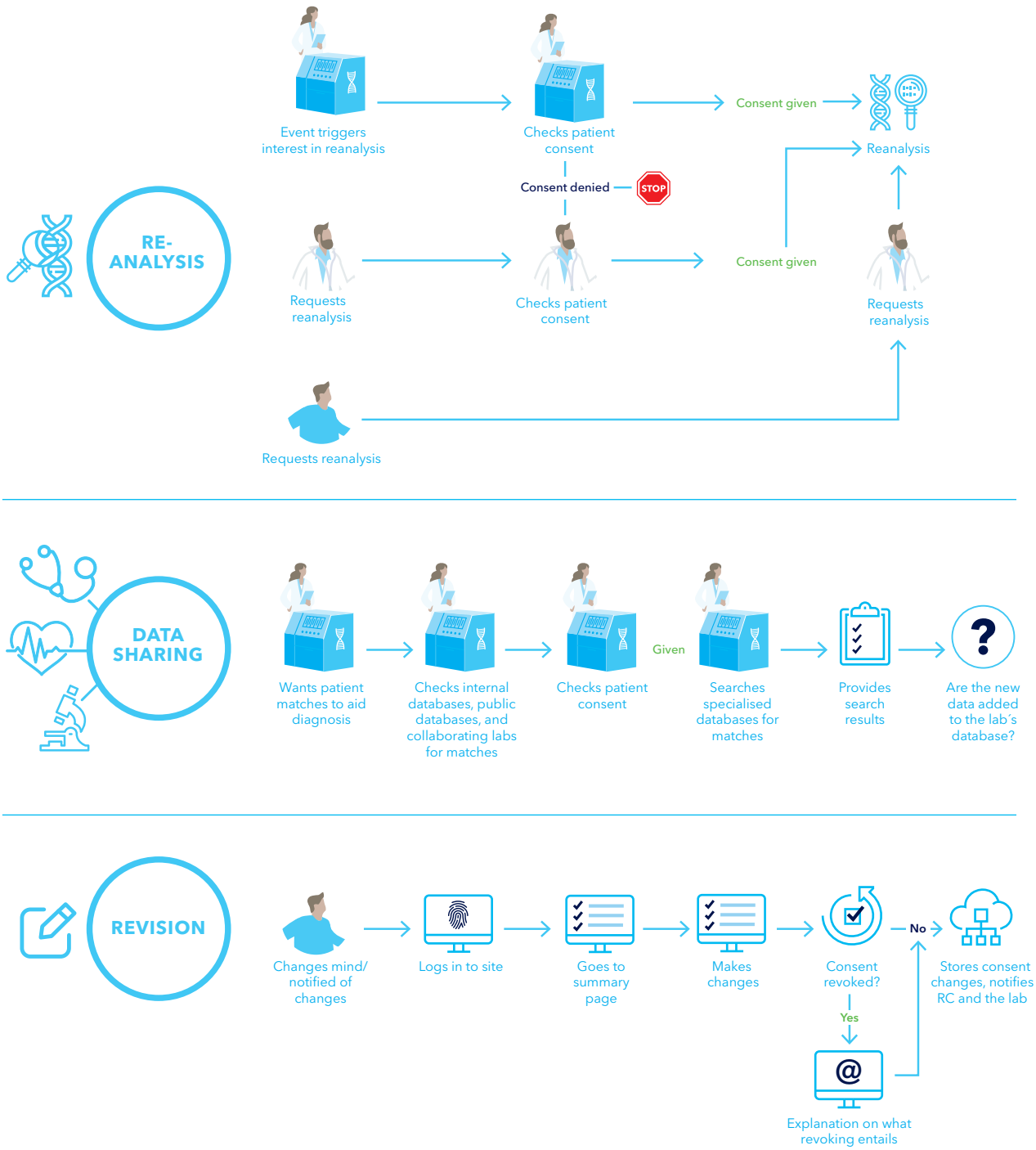


Figure 8. Sub-elements of dynamic consent in clinical genetics.

Registration to access a dynamic consent portal can be initiated by a requisitioning clinician (RC) or a patient. Once registered, the patient can log into the consent portal to give, review, revise or revoke consent anytime. Once completed, test results and reports from the lab are returned to the RC who reviews and adjusts reports according to the consent. The RC meets with the patient to discuss reports.

Reanalysis may be triggered by an event, such as new scientific knowledge regarding a variant, or a request by the RC or patient. If reanalysis is triggered by an event or a request by the RC, the RC checks patient's consent and requests reanalysis if consented.

For diagnostic purposes, the patient's data may be matched with other cases by checking internal, public and collaborating labs' databases. If a match is still not found and the patient gives consent, the next step is to check alternative specialised databases outside the hospital and across borders.

CONCLUSIONS

The quantity and quality of genetic information sequenced from individuals, as part of the basis for their diagnostic or therapeutic decision-making, is rapidly increasing across many specialist medical areas. At the same time, the decisions made by a patient regarding their preference for return of results, reanalysis and primary and secondary use of their genetics data in clinical and research contexts must be traceable by a wide array of stakeholders across a diverse ecosystem. The value from this clinically generated data may benefit both current and future patients. How this value is harnessed relies upon initiatives that are operationalised through standard organisational procedures that guide healthcare professionals about the use of consent as the ethical and legal basis for secure patient data sharing. This can inform how the sharing of patient data both internally and externally to an organisation can be achieved whilst ensuring robust considerations relating to privacy, transparency and confidentiality.

The three hallmarks of dynamic consent, defined here to be that: (1) options for consent are presented and set through sustainable two-way communication between stakeholders, (2) patients can modify their preferences over time, and (3) the preferences set the basis for dynamic downstream clinical and data management actions, together ensure that both informed patient decision making and the needs of clinical genetics ecosystems can be supported and met.

Dynamic consent has the potential to transform the processes supporting a patient's clinical genetics journey, and can consequently contribute towards exploiting the full potential of precision medicine through broader patient-controlled data sharing for clinical and research purposes. However, to fulfil its potential in this ecosystem it must overcome interoperability and standardisation challenges, seen elsewhere in health IT, foster culture change through systematic engagement and alignment of priorities with key stakeholders, and build on convergence values between research and clinic genetics for transfer of knowledge and resources. One approach to this could be the creation of a network of dynamic consent pioneers, producing best practices and recommendations to champion its wider implementation outside of current isolated pockets of innovation.

As an independent assurance and risk management company, DNV GL aims to create value both directly and indirectly from assurance services provided. By analysing data sharing and infrastructural needs, legal and regulatory challenges and gaps in trust across the stakeholder ecosystem that prevent the clinical implementation of precision medicine in routine clinical care, we work towards practical assurance strategies that address these. From this work, dynamic consent has been identified as one such technology where barriers to implementation exist, and where assurance of technologies and systems could provide trust across the ecosystem.

Through a literature review and a series of semi-structured qualitative expert interviews, supported by a survey of clinical genetics professionals, we mapped the barriers to implementation of dynamic consent in clinical genetics, to collate understanding about why only a limited number of geographically and institutionally isolated instances are currently in use. Analysis and subsequent synthesis of the findings revealed six categories of barriers, summarised with their subcategories in Figure 6. These barriers are: ethical; legal and regulatory; knowledge and competence; financial; cultural and organisational; and technological.

The ethical barriers represent the challenges associated with ensuring trust, addressing secure sharing of data for the patients benefit, and establishing understanding around revoking of preferences; to ensure empowerment of patients. The cultural and organisational barriers recognise the challenges of operating across complex ecosystems with engagement required at varying expertise, domains and governance levels, and the necessity for alignment between the disparate priorities of different units and roles to drive culture change. The technological barriers identified highlight the challenges associated with safeguarding patient privacy and confidentiality and the need for traceability and transparency of agreements across complex landscapes, where each partner may operate with non-standard proprietary computing infrastructures that challenge interoperability. Finally, due to the limited number of implemented dynamic consent solutions to reference, there are likely more challenges outside of what has been captured and presented in this paper that may require consideration, especially when developing solutions that are meant to be interoperable and extend beyond local organisations.

The results of this work echoed and validated the perceived value that dynamic consent approaches may offer to patients, healthcare professionals, healthcare organisations and wider contexts. Even in cases where ongoing communication with patients is not required, future value may arise as new insight impacting care management is discovered, and as unforeseen factors support the transformation of genetic clinical care from a disconnected series of single interaction points to a more continuous care model.

In addition to the disruptive innovation that dynamic consent may bring to clinical genetics environments, it also has the potential to support paradigm shifts for medicine in other specialties. As more use cases develop where dynamic consent approaches can be applied, the barriers and challenges identified in this paper pinpoint several topics that should be considered prior to and as developments are underway. As a result, it is our hope that the findings in this paper can additionally be used to strengthen the discussions around dynamic consent applications in other settings.

APPENDICES

APPENDIX 1 METHODOLOGY

The findings presented in this white paper draw upon (1) a literature review, (2) a series of semi-structured virtual interviews, and (3) a survey. Qualitative methods were applied to analyse and synthesise collected data into summarised findings. Although efforts to identify and include all relevant work and contacts were made, omissions could have occurred. This highlights the need for more widespread and connected networks in the field to share learnings, instead of relying solely on individual pioneering projects.

Literature review

A literature review was conducted to identify scientific articles published in English that discussed barriers in implementing dynamic consent in the field of genetics both in research and clinical work. A snow-balling method was utilised to identify relevant articles, and was halted upon saturation of barriers identified. Content analysis was conducted to identify and categorise barriers of implementation of dynamic consent relevant for clinical genetics (Table 1). Because the literature review included publications relating to implementation of dynamic consent in research in genetics, considerations specific to research may have been captured. These were included because of the limited availability of articles documenting specific implementation in clinical genetics, and their apparent relevance.

The 29 articles included were predominantly perspective/conceptual (48.3%) and original research (41.4%) in nature. Almost 70% were published in the past three years, and most of the included articles focused on implementation within research in genetics (65.5%).

Interviews

Fourteen semi-structured virtual interviews, ranging from 30-60 minutes, were conducted to capture first-hand experiences with obtaining and implementing consent and/or dynamic consent with experts in ethics, legal, genetic counselling, clinical, biomedical research, bioinformatics and product development located globally (specifically Australia, Canada, Iceland, Luxembourg, Malta, Norway, the UK, USA). The interviews focused on the barriers of implementation of dynamic consent for clinical genetics, capturing any possible or suggested solutions to overcome the barriers mentioned. Interviewees were selected following identification of authors from relevant papers, from applicable contacts from the DNV GL healthcare network, and referrals from these, which may have introduced sampling bias. Some interviews were conducted with more than one expert from the same project, whereas other interviews were conducted with a single expert per project. Content analysis was conducted to cluster interview responses. Interviewees provided written consent to participate and the data from the interviews were managed in compliance with the GDPR.

Survey

The 9th NACG virtual workshop included a session on consent facilitated by DNV GL, where a Nordic consent framework and toolkit was presented and discussed with 113 participants with clinical, academic, legal and industry expertise in clinical genetics [24]. A survey was conducted during the workshop focusing on consent content in clinical genetics. The predominance of Nordic participants may have introduced some bias.

Selected results are shared here to provide additional information relevant for dynamic consent in clinical genetics, including (Figure 9):

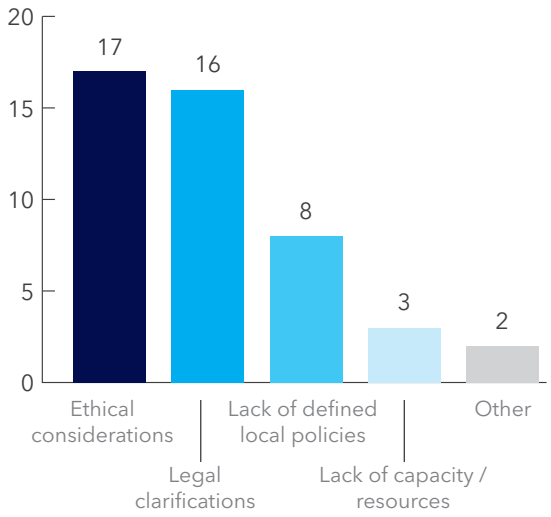
- Survey participants perceived that one way to improve the process of obtaining consent is the use of dynamic consent.
- Ethical considerations and legal clarifications were perceived as the greatest challenges in developing consent processes.
- There were mixed responses to decide whether consent alone is appropriate to determine whether to share patient data for diagnostic purposes.
- The majority of responses showed that patients do not have the option to choose what results are returned to them, because this is decided by the healthcare professionals. However, participants felt that patients should be asked and notified if reanalysis is to be conducted.

INCLUDED SCIENTIFIC ARTICLES		BARRIERS DISCUSSED					
Titles of the included articles (alphabetically)	Year of publication	Ethical	Legal and regulatory	Technological	Knowledge and competence	Cultural and organisational	Financial
"Just tell me what's going on": the views of parents of children with genetic conditions regarding the research use of their child's electronic health record [49]	2019	Yes					
Addressing benefits, risks and consent in next generation sequencing studies [47]	2015	Yes					
Authentication of patients and participants in health information exchange and consent for medical research: a key step for privacy protection, respect for autonomy, and trustworthiness [48]	2018	Yes		Yes			
Building the Partners HealthCare Biobank at Partners Personalized Medicine: informed consent, return of research results, recruitment lessons and operational considerations [36]	2016	Yes	Yes	Yes	Yes	Yes	Yes
Consent codes: upholding standard data use conditions [39]	2016		Yes	Yes			
Delivering genomic medicine in the United Kingdom National Health Service: a systematic review and narrative synthesis [31]	2019		Yes	Yes	Yes	Yes	Yes
Desiderata for digital consent in genomic research [37]	2018	Yes	Yes	Yes	Yes	Yes	
Design issues in e-consent [60]	2018						Yes
Dwarna: a blockchain solution for dynamic consent in biobanking [8]	2019	Yes	Yes	Yes	Yes		
Dynamic consent management for clinical trials via private blockchain technology [33]	2020	Yes		Yes			Yes
Dynamic consent: a patient interface for twenty-first century research networks [21]	2015		Yes	Yes		Yes	
Dynamic Consent: a potential solution to some of the challenges of modern biomedical research [44]	2017						Yes
Dynamic consent: an evaluation and reporting framework [4]	2019			Yes		Yes	
Dynamic-informed consent: a potential solution for ethical dilemmas in population sequencing initiatives [7]	2020	Yes	Yes		Yes		Yes

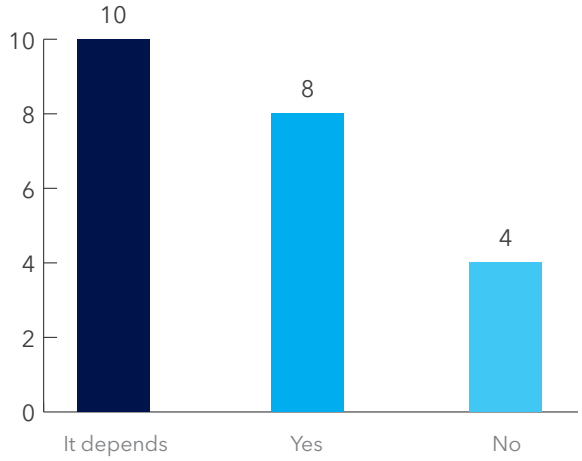
Table 1. The list of included articles and their identified barriers

INCLUDED SCIENTIFIC ARTICLES		BARRIERS DISCUSSED					
Titles of the included articles (alphabetically)	Year of publication	Ethical	Legal and regulatory	Technological	Knowledge and competence	Cultural and organisational	Financial
Equitable participation in biobanks: the risks and benefits of a 'dynamic consent' approach [42]	2018				Yes		
From the bench to the bedside in the big data age: ethics and practices of consent and privacy for clinical genomics and personalized medicine [3]	2015		Yes	Yes			
Genomic big data and privacy: challenges and opportunities for precision medicine [2]	2016	Yes	Yes		Yes		
Health research with big data: time for systemic oversight [25]	2018	Yes	Yes	Yes			
Implementation of electronic consent at a biobank: an opportunity for precision medicine research [23]	2016		Yes	Yes	Yes	Yes	Yes
Legal regulation in digital medicine [61]	2020		Yes				
Leveraging mobile technology to improve efficiency of the consent-to-treatment process [22]	2017			Yes			Yes
Patient assessment of chatbots for the scalable delivery of genetic counselling [62]	2019				Yes		
Public and biobank participant attitudes toward genetic research participation and data sharing [38]	2010	Yes					
Registered access: authorizing data access [41]	2018		Yes				
Replacing paper informed consent with electronic informed consent for research in academic medical centers: a scoping review [5]	2020	Yes	Yes	Yes	Yes	Yes	
Testing an online, dynamic consent portal for large population biobank research [29]	2015	Yes		Yes		Yes	
The RUDY study: using digital technologies to enable a research partnership [6]	2017				Yes	Yes	
Transcelerate biopharma: eConsent implementation guidance [32]	2017		Yes	Yes	Yes	Yes	Yes
User-focused data sharing agreements: a foundation for the genomic future [63]	2019			Yes			

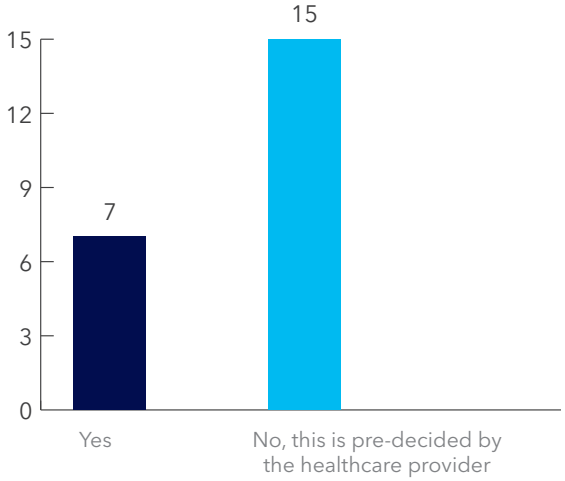
In your opinion, what is the greatest challenge in developing consent processes? (multiple responses possible) (N=31)



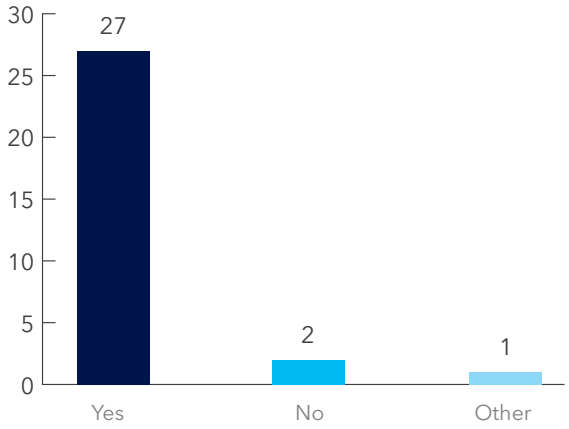
In your opinion, is it appropriate that patient consent should determine if their personal data is shared for diagnostic purposes? (N=22)



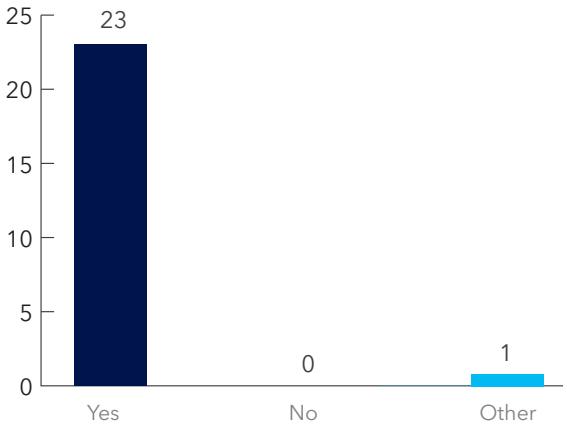
Do patients have the option to choose what they would like returned? (N=22)



In your opinion, should the healthcare institution inform patients about reanalysis procedures? (N=30)



In your opinion, should patients have the option to consent (or not) for reanalysis? (N=24)



The participants were asked "How can the process of obtaining consent be improved?", and the free text responses were categorised into:

- The need for an electronic consent, ideally dynamic consent, for patients to have an overview and ability to change their preferences.
- The need to provide additional education about genetic analysis and consent processes to general public and healthcare professionals.
- Needs analysis in terms of what kind of consent needed (e.g. sharing information with relatives versus different types of genetic data).
- Patient engagement in developing consent forms.
- The need for more relevant resources e.g. genetic counsellors.

Figure 9. Survey findings from the 9th NACG workshop November 2020

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DNV GL AS
NO-1322 Høvik, Norway
Tel: +47 67 57 99 00
www.dnvgl.com

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