



Together, we can

Fast-forwarding healthcare
through data collaboratives

Fast-forwarding healthcare through data collaboratives

Exponential proliferation in the number of connected health devices and consumer health and medical-grade digital apps is resulting in a torrent of healthcare data. Deep individual multi-omics profiling data and the move to cloud-storage technologies are adding to that flood. This data, generated by technical and scientific advances, holds great promise for accelerated healthcare progress and precision medicine. The question is: how best do health ecosystem players access data to fast-forward healthcare? Data Collaboratives (DCs) could be the answer.

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Executive summary



Life sciences companies increasingly use DCs to access high-quality data from ecosystem partners. The aim is to accelerate research and early development (R&D), clinical development, and post-launch insight generation.^{1 2}

To better understand the extent, implications, and potential benefits of DCs, we conducted a survey among 59 people who are heads of oncology and institutional review board (IRB) members. Of those surveyed, two-thirds already participate in DCs, and the remainder does not.

This quantitative research was supported with qualitative research among 18 cross-industry experts (pharma & MedTech, technology service providers, cancer registries, research institutions, patient communities). The research was conducted across the US and the top five EU countries.

We deliberately selected oncology for a close look into the therapeutic implications of DCs as it is one of the largest therapeutic areas (TAs)³ in terms of industry spending and new medications' launch pipelines. The outcomes of our findings could apply across TAs. First, we wanted to understand oncologists' key DC participation drivers—including their preferred ecosystem setups. Then we profiled the key challenges involved in establishing DCs. We assessed the challenges to success and looked at accelerators, success factors, and strategies vital to effective DC establishment.

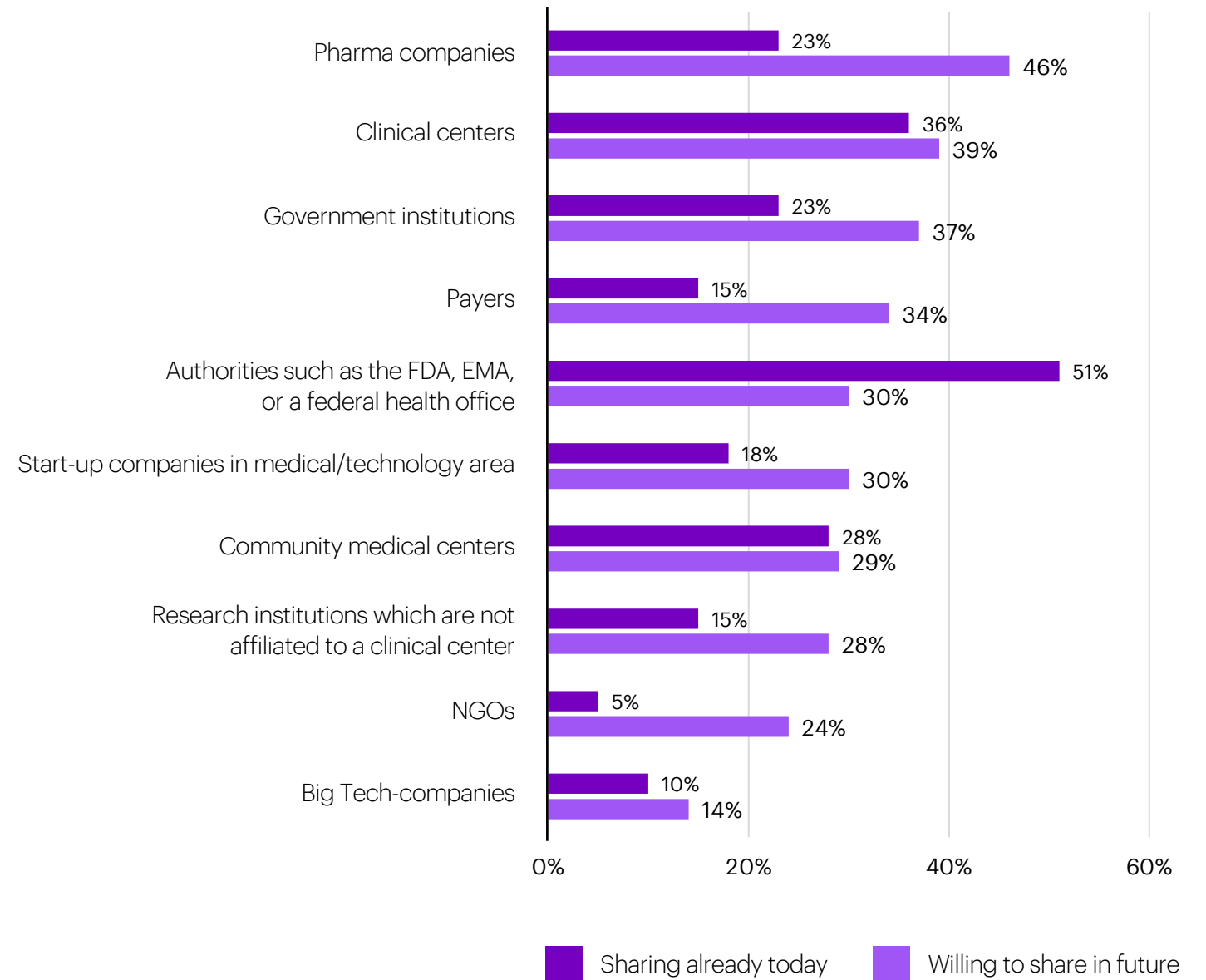
Oncologists believe that data collaboratives generate value

The overall trend was clear: respondents were unanimous in their view that DCs generate significant value for patient outcomes. Nearly two-thirds (64%) agree strongly and 36% agree somewhat. They also generally believe that DCs generate significant value for research outcomes, though the agreement is more muted on this point (38% strongly agree and 54% somewhat agree). Our survey indicates that DCs are more significant for patient outcomes than for research outcomes. Although we did not survey them, we would expect Pharma and MedTech companies to see significant DC value in the R&D space. While DC participants currently tend to share data more readily with regulatory authorities and clinical stakeholders, they are open to sharing more data with pharma companies in the future. (See figure 1.)



Key stat: Academic medical centers participating in data collaboratives are most willing to share data with pharma companies (46%), ahead of other clinical centers, governmental institutions, payers & health authorities – providing a strong opportunity for life sciences companies to engage.

Figure 1: Stakeholders with whom DC participants would share real-world data (RWD) now and, in the future.



Technical and human obstacles to data collaboratives

As far as obstacles go, technology and sponsorship seem to be common threads among all respondents. The top five challenges, in order, are:

- **Technical integration.**
- **Lack of sponsor commitment.**
- **Compliance with federal data protection regulations.**
- **Lack of trust among participants.**
- **Data harmonization.**



Key stat: Our research found that 92% of academic medical centers faced technical issues.

Life sciences companies can't wait to have an extensive data ecosystem at their fingertips. The implications for product development are immense, and DCs represent a particularly attractive opportunity to stimulate innovation and access large datasets from multiple parties. However, establishing a DC is not to be underestimated as a venture. Many of them fail for lack of a solid business case or because the needs and interests of participating parties are not well understood, preventing the realization of cross-organizational benefits. Some fail at the point of conception, while others are unsustainable in the longer term.

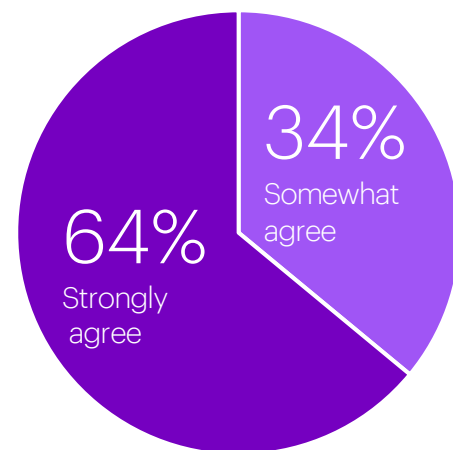
Yet, the faster and more effectively companies can implement DCs, the greater the competitive advantage they derive. Ultimately, the pioneering insights they obtain could drive improved healthcare—and make it more sustainable.

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Unpacking data collaborative value for patient outcomes

There seems to be no question about the value of data collaborative membership. All the oncologists who responded agreed that DCs generate significant patient outcome value—with nearly two-thirds (64%) agreeing strongly and 36% somewhat agree. Remarkably, not a single respondent said that DCs don't generate any value. All participants stated that real-world data (RWD) from data collaboratives generate significant value for patient outcomes.



64% strongly agree, and 36% somewhat agree that data collaboratives generate significant value for patient outcomes.

The two groups (those who anticipate patient benefits versus those who focus on research outcomes) correlate broadly with whether their academic medical centers already use DCs or not. Those already participating mostly use RWD from collaboratives to support their clinical decisions and improve care standards. Those not currently participating have a stronger interest in using RWD from DCs for translational research (new biomarkers, new treatment targets).

It seems (based on responses from oncologists) that data from a collaborative is more significant to patient outcomes than to research outcomes. However, without further research among pharma companies, we need to be conservative about drawing strong conclusions in this regard.



Pro tip: When approaching medical centers to help establish a data collaborative, identify their challenges and key priorities first. Tailor your messages and value proposition to the needs they have (patient outcomes or research progress).

Our research has identified more than 40 use cases for RWD from DCs. (See figure 2.) They fall into four categories: 1. Research and development, 2. Clinical care, 3. Understanding diseases and populations, and 4. Commercialization and regulatory. For oncologists, the **four most important use cases** are to:

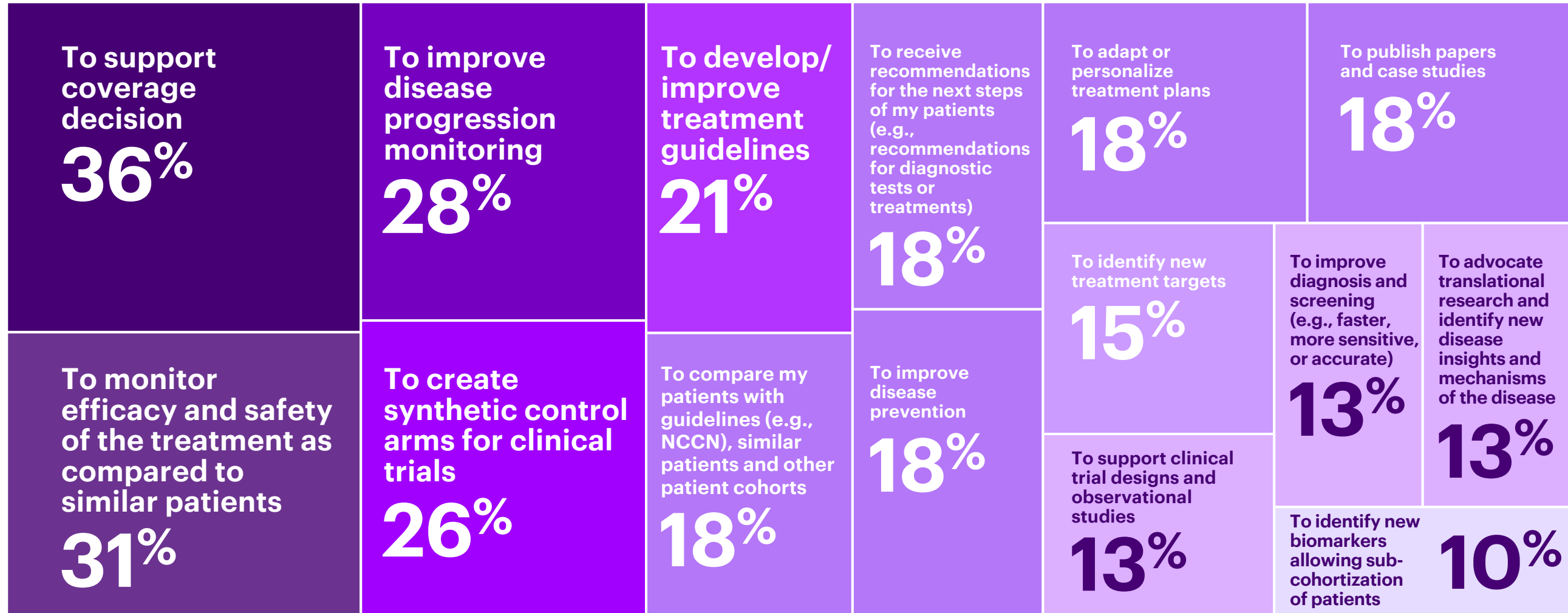
- **Support coverage decisions.**
- **Monitor efficacy and safety of the treatment as compared to similar patients.**
- **Improve disease progression monitoring.**
- **Create synthetic control arms for clinical trials.**



Pro tip: Our research showed that there is no holy grail of use cases. Rather, use cases differ from partner to partner—with some commonality.

Why use RWD from a data collaborative?

Figure 2: We asked survey participants why they use RWD from a DC—every participant was able to select multiple (N=39).



For DCs to work, they must satisfy all partners, so it's vital to build in enough flexibility to serve multiple use cases.

Give your data collaborative a head start

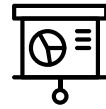
While a significant number of players are already engaged in data collaboratives, many still aren't. Even among players taking part in a DC, some report significant challenges. These challenges could limit performance, hinder the value proposition, or even cause a DC to fail if left unattended. First, technical integration and sponsor commitment are the two most important obstacles, while remaining compliant with federal data protection regulations. (See figure 3.) They apply across the board and healthcare organizations should address them if they're serious about DCs.

Figure 3: Key obstacles to data collaborative implementation reported by oncologists in our study.

- 01 Technical integration of my hospital's IT systems into the data collaborative
- 02 Lack of long-term commitment from the sponsor
- 03 Compliance with federal data protection regulations
- 04 Lack of trust amongst participating regulations
- 05 Technical implementation of data harmonization (the process of transforming the data from the hospital format to the format of the data collaborative)

To deal with obstacles to DC we used our research to help us group the most important challenges to effective DCs into the following six categories:

1 Business



2 Data



3 Technical



4 Data Privacy



5 Partner ecosystem



6 Governance and Legal



Pro tip: In the six sections below, we deal with the obstacles identified in the quantitative study, share insights from the expert interviews, and provide actionable recommendations.

1 Business challenges

Business challenges associated with DCs apply to both oncologists participating in DCs and those not doing so. **High participation costs are flagged by 40% of those surveyed.** Another key issue is that for **25% of the sample group, the benefit of participation is unclear** – and the absence of a business model to generate a return on investment makes sponsors reluctant to commit. Single-sponsor dependence is also very risky for a DC project. A sustainable business model will generate value and improve revenues, winning over more than one sponsor.

Our study reveals that prospective DC partners want to use RWD from the collaborative to identify new treatment targets and biomarkers. Oncologists already using data collaboratives find the greatest value in clinical care improvement and decision-making. This dichotomy of interests suggests that a clear understanding of prospective partner needs is essential to attracting the right DC partners.



Our recommendations:

- Identify key use cases and focus on them (instead of trying to solve every problem).
- Make sure that all stakeholders understand and can realize the benefits of DCs.
- Be sure to establish a sustainable business model—it’s one of the most important DC success factors. Here’s how we would implement their recommendations in detail:

Define a clear business strategy and compelling internal and external value propositions: Each TA comes with its own challenges and unmet needs along the patient journey (prevention, diagnosis, stratification, treatment, monitoring). To focus your DC investment, select a TA and define the key challenges you want to address. Perform your due diligence on existing collaboration initiatives and decide whether you want to build a DC or join an existing one that aligns with your ambitions. If it’s the former, you will need a compelling value proposition to get internal buy-in and attract the leading partners in the collaborative. As part of value proposition elaboration:

- Define a genuinely novel medical, scientific, or business focus for your DC.
 - Analyze the pros and cons of single vs collaborative approaches thoroughly and select areas of greatest impact and synergy.

Consider the entire value chain to identify relevant use cases that rely on data: Our interviews with industry leaders confirmed the importance of focusing on high value use cases. Don’t try to solve every problem. The use cases should consider everything from early research and development to launch, prevention, and ultimately long-term disease management. Key use cases will define what data is required so that the right partners can be recruited. According to our respondents, the four data uses most critical to DCs are to create synthetic control arms for clinical trials (70%), to support coverage decisions (57%), to improve disease prevention (43%), and to monitor efficacy and safety of treatment in comparison to other patients with similar conditions (25%).

Ensure long-term sustainable funding for the data collaborative: The fact that many collaboratives fail due to a lack of sustained senior sponsor commitment makes this recommendation vital. Remember to maintain a long-term payoff focus, as DCs take a while to establish, and benefits are only reaped after an intense setup phase. Steady institutional prioritization is important. Analyze ecosystem partner investment and revenue-sharing models to help ensure collective ongoing institutional commitment. “Non-monetary” contributions and capabilities of DCs partners such as tech platform hosting, running data science algorithms, or long-term retrospective data deserve a proper valuation in a co-funding setup. If time is of the essence, you are best off securing funds from your own organization to speed up DC implementation.

2

Data challenges

Among oncologists we spoke to, a hefty 64% of those who participate in data collaboratives have faced obstacles with the data (insufficient variety). Nearly half (44%) of the academic medical centers said that key required data sets weren't available from the partners in the collaborative (too much data heterogeneity). Nearly a third (31%) said the DC provided poor-quality data.

Other challenges included data heterogeneity (more than half (56%) of respondents said data harmonization is one of the biggest challenges). As a consequence, 21% of respondents highlighted the onerous process of agreeing on a common data model and terminology to reduce heterogeneity. Every potential DC partner follows its own standard or has simply adapted standards to some degree—a finding confirmed by our expert interviews. Disparate standards make it difficult to share data usefully between institutions—which applies mostly to unstructured data but not exclusively so. Overcoming these challenges is vital.





Our recommendations:

Holistically define your data needs:

Building on the business strategy created above, identify the required data and insights for your DC. Define required insights and algorithms to realize the use cases identified in the DC's business strategy (see the previous section). Then define the required data types to implement these insights and algorithms. Combine this process with the identification of data types as well as insights and algorithms that are more broadly relevant for the TA of focus. Doing so will serve use cases arising in the future. Remember to think beyond routine clinical data types—consideration of all related aspects is crucial if a DC is to meet TA needs holistically. Thinking should include nutrition, physical activity, biomechanics, mental health, social and other determinants of health, advanced genome, proteome, and microbiome profiling methods. Furthermore, key identified data types and insights, and algorithms must be prioritized. Their priority will be determined by the value they bring to the DC, and by how difficult it will be to access the data to develop relevant insights and algorithms. Prospective partners must be sourced and selected based on the data strategy and its prioritization plan. Ultimately, clear data strategy and execution address the missing key data set challenge.

Use industry-wide accepted data standards:

Agree on a common data model that follows industry-wide accepted ontology standards. In healthcare, the gold standard is the Unified Medical Language System (UMLS). It integrates most established medical coding systems such as ICD-10 (disease classification), SNOMED (health terms), and LOINC (laboratory results) under one meta-standard and provides cross-mappings between the coding systems. UMLS standards ensure semantic homogenization of healthcare data. That means partners can combine data from different sources later on to develop and train new insights and AI algorithms. For data sets not following any of the coding systems covered by UMLS, perform a one-off mapping exercise on them. The data format should follow industry standards, too, so that syntactical homogenization of the data is achieved. HL7 FHIR⁴ is commonly used for this purpose.

With AI assistance, you can significantly accelerate data transposition to the right standards. For example, several startups and tech companies recently released AI-based services that take unstructured doctors' notes as input. The services then convert them to UMLS standards as well FHIR resources. In our study, 38% of participants identified automation as one of the top solutions to streamline data capture and harmonization.

Establish minimal data quality requirements:

Define clear minimum data quality requirements for the DC and mobilize tools to automate data audits. Good quality data must be temporal, complete, accurate, integer/governed, with known provenance (as per the DMBOK⁵)—and relevant. These characteristics can be combined with data principles like the [FAIR principles](#). These frameworks can guide specific data quality requirements to be defined and implemented in data quality automation tools where possible. Assess data quality per the defined rules and communicate them to the data collaborative before data reaches a broader audience. The extent of AI algorithms' positive impact on healthcare is directly proportional to data quality (in the sense of *'garbage in, garbage out'*).

Business challenges

Data challenges

Technical challenges

Data privacy challenges

Partner ecosystem challenges

Governance and legal challenges

3

Technical challenges

Almost all (92%) of academic medical centers in data collaboratives have faced technical issues. The main technology challenges involve the technical integration of hospital systems with the collaborative. A third have faced technical difficulties with the DC platform itself or its associated services.

Our survey indicates that more than 90% of academic medical centers still use a purely centralized approach for data exchange with the DC. The centralized approach creates lengthy legal discussions on data transfer. When DCs generate copies of data, adherence to data privacy regulations becomes more complex. The approach inherently prevents expansion into certain countries due to local data privacy and security laws that prohibit data copying or transfer. Further drawbacks of the centralized approach include consent management difficulties, double-data entry, and large data transfer costs.



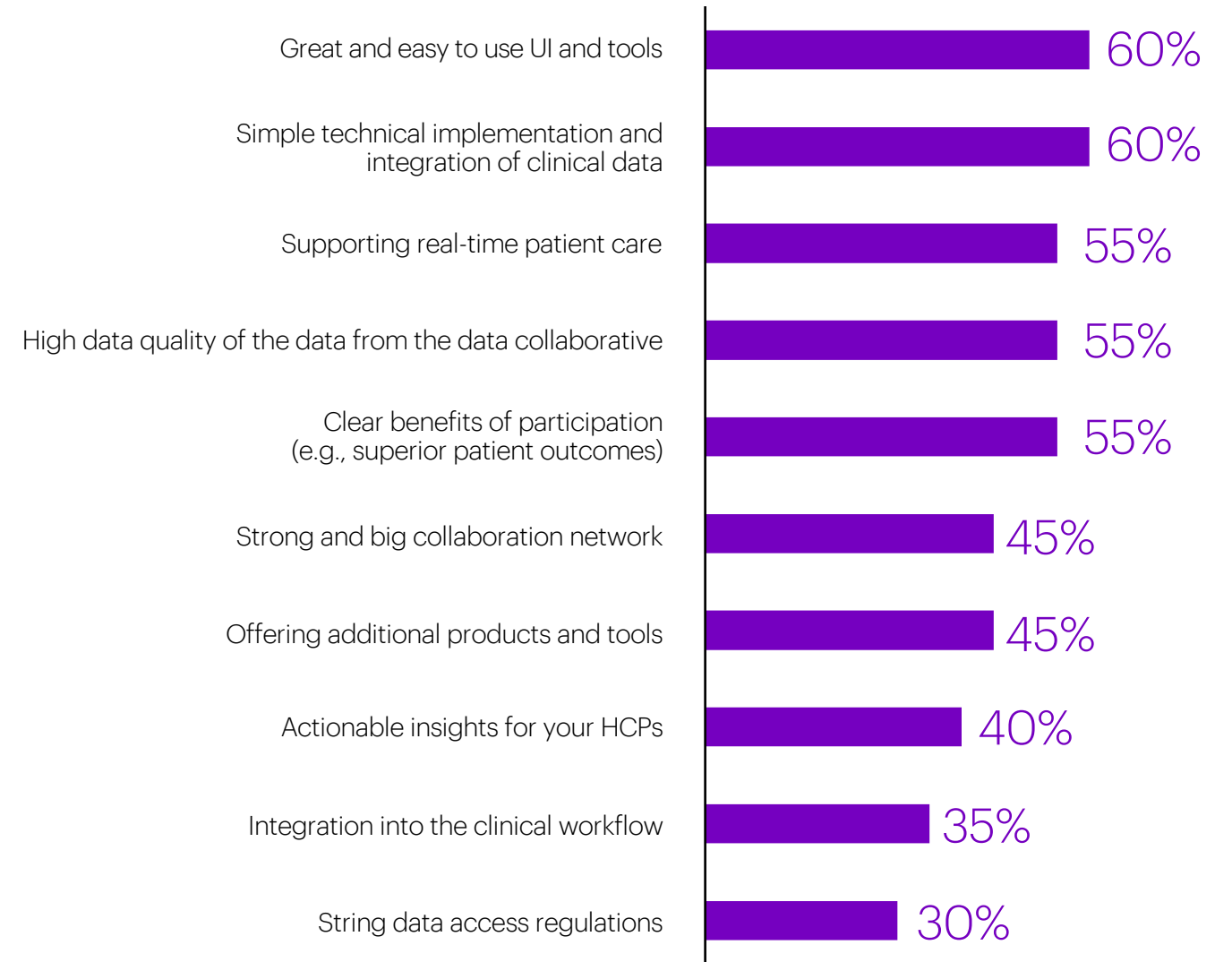
Addressing technical challenges

Of the various potential solutions to address infrastructure and technology challenges, the top three identified in our research are:

- **Customizable and ready-to-use modules allowing for data organization, data storage data analysis, and data governance (46%).**
- **Improved data analysis algorithms/tools (41%).**
- **Using a federated system approach instead of a purely centralized approach (33%).**

Ease of technical implementation and simplicity are key features that may encourage those not currently participating in a data collaborative to do so. (See figure 4.)

Figure 4: Key factors that would encourage data collaborative participation among those not currently engaged.



Our recommendations:

Build a flexible DC, tech platform and implementation team to allow for easy roll out of new use cases.

Remember—the real value is generated when we move beyond pure data exchange to actionable insights:

Easy exchange of data between participants is vital, but so is compliance with data privacy regulations and effective governance. Also, data only generates value if it supports decision-making. Consequently, it’s important to provide more than just data exchange capabilities. The DC’s technical platform should serve as a handy toolbox to create new models and insights that realize high-priority use cases. Collaborate with ecosystem partners to transform and prepare the data, develop and (re-)train AI algorithms. Then, present algorithm inference outputs to end-users in a data visualization dashboard.

Leverage true privacy-preserving technologies:

Privacy-preserving technologies must be at the core of the platform. Virtual data access (VDA) and federated learning (FL) enable DC participants to train algorithms that do not require a central data lake. Instead, the algorithm “travels” to the data in participants’ networks and is trained in situ. This approach can overcome data privacy regulations to a great extent. Participants retain full control over their data, and overall training costs are reduced. VDA and FL is a fundamental design decision that requires defining a fully decentralized platform architecture from the start. Decentralization is especially useful for simple platform deployment and usage to foster collaboration among participants.



Pro tip: Allowing data to remain with its owners while granting access to DC analytics and AI engines makes efficient use of computing power (through simultaneous training nodes) and addresses key data privacy and trust-related challenges.

Set up self-service DCs with data engineering and science support available as needed:

The DC’s founding partners must consider the need for on-demand data engineering and data science support. DC participants should first integrate data and develop and train new algorithms via a seamless, self-service front end. However, such skills and capacity can be scarce for some DC participants, depending on the complexity and condition of the data. Skilled resources should be offered on demand as second-level service support. The Custodian (see section Partner Ecosystem Challenges), being the neutral platform operator, is best positioned to offer such services.

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Data privacy challenges

Compliance with data sharing or data protection regulations is important. Data privacy issues are more common in Europe than in the U.S—on average, almost seven in 10 of those we surveyed have faced data privacy/legal obstacles. That number rises to nearly eight in Europe.

Our experience of setting up data collaboratives and enabling data-sharing initiatives across regions has shown that transferring health data across country borders is also an obstacle. For oncologists not currently participating in a DC, data security and privacy constraints represent the top barrier to participation in a DC. In fact, data privacy and security constraints are a hurdle for 60% of potential partners.

Addressing and implementing technical data security and privacy requirements was a challenge for 21% of our sample group. The challenge is underlined by the fact that 31% of medical centers want better data privacy and security approach.

Key stat: Our survey indicates that more than 90% of academic medical centers still leverage centralized approach to data sharing with data collaboratives which comes with significant privacy and protection challenges.





Our recommendations:

Address legal requirements first:

Especially for international DCs—local, regional and country-specific data privacy regulations vary. We, therefore, recommend that data privacy lawyers and IT security specialists contribute to DC design from the word go. Also, assess and discuss data privacy and security requirements with target institutions early. Our research shows that data privacy and security requirements from institutions can slow or prevent their participation in a DC. Even within a country, different institutions often have varying degrees of stringency. Championing solutions with a stringent institution may accelerate adoption among others.

Use anonymized and/or aggregated data where possible:

Check what kind of data is necessary to enable use cases and achieve objectives when the data strategy is first assessed and defined. Is RWD at the patient level really necessary, or is population-level aggregated data sufficient? Another solution is to use anonymized RWD or generate synthetic data based on the relevant real-world dataset—both alternatives would reduce data privacy constraints.

Enable lineage at the data level:

Data lineage creates transparency among partners, increases trust in data collaboration, and enables external data audits. Data lineage means recording and visualizing data journey information. That includes where data comes from, how it is transformed, what is changed, and why and who accessed the data. The custodian must be able to provide transparent reporting on data lineage. To achieve this, data lineage technologies should be a fundamental platform capability. Configure these technologies to meet governance regulations of the territories where the DC is rolled out.

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Partner ecosystem challenges

Appropriate partners are, per definition, indispensable to the success of a DC. Potential partners must be identified, approached, and evaluated against a set of criteria. Among our respondents, almost **nine out of ten have faced obstacles with the partner ecosystem.**

In terms of ecosystem partner challenges, **a lack of trust among participants was the fourth most mentioned challenge overall** among participating medical centers. It was also one of the challenges most often raised by industry experts. Political conflicts and partners' personal interests could be related to a lack of trust, and respondents mentioned them as important challenges.

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Our recommendations:

Rigorously evaluate and select the right partners:

The most important component of any data collaborative is its partners and potential partners, which should be thoroughly evaluated. Criteria should be:

- Scientific and medical excellence (publication and invention track record)
- 5Vs of the data they bring (volume, variety, veracity, velocity, value)
- Fitting in with the prioritized use cases and ability to effectively collaborate in a consortium (considering the track record of successful collaborations, and avoiding any competing interests and scientific “enemies”)
- Other value-adding in-kind contributions.

Establish trust:

Strong, trust-based ecosystem relationships are vital for the success and adoption of data collaboratives. Trust is a complex construct built over time. However, our experience and research found a set of success factors that will promote trust:

- Inclusivity (co-create vision and mission with the founding partners).
- Equality (ensure that all partners are equal and establish joint decision-making).
- Clear governance framework.
- Transparency (establish partner guidelines and policies, maintain strict security standards, and give stakeholders full control over their data).

Appoint a neutral custodian and chief partner officer (CPO):

To build trust (especially when some partners potentially compete) it is wise to appoint an ecosystem partner and chief partner officer as neutral custodians. The custodian operates and maintains the data platform, manages the data and analytics on the platform, onboards partners, and provides technical support. The custodian should not have any interest in the data and resulting analytics outputs and be able to scale resources as per current DC needs. The chief partner officer (CPO) should orchestrate progress toward the DC’s defined objectives and balance potentially competing (scientific, medical, or business-related) partner interests.

6 Governance and legal challenges

Our research found that 64% of academic medical centers have faced governance and legal challenges. Challenges include the creation of data transfer, usage, and governance agreements and agreeing on intellectual property (IP) and other contractual terms.

Industry experts we spoke to confirmed that contractual and governance agreements and signings are particularly onerous hurdles. Yet it is crucial to create an overarching (and binding) legal structure to achieve mutual trust and transparency. For example, who should sit on a DC governance committee and how will decisions be taken (e.g., equal votes, veto rights, etc.)? Also, how is data access granted, and for what purpose—will partners require data access requests? If so, is this the case for all partners or only competing ones? Many of the rules can be embedded in the technical infrastructure, but it's important to document the critical issues contractually.



Pro tip: While custodians need strong tech and operational capabilities, our survey indicated that HCPs are hesitant to share data with big tech. Ensure custodians do not have access to data—but rather provide the tech and operational engine.



Our recommendations:

Thoroughly define DC governance:

In our experience, data collaborative governance involves multiple aspects to be considered and addressed. We have grouped those aspects into the following categories:

- Define intended objectives and scope.
- Define partner roles and responsibilities.
- Define the DC's guiding principles (including trust, transparency, integrity and scientific excellence)
- Define data governance: establish processes, roles, and policies to help ensure high data quality and security.
- Define decision-making processes (how decisions are taken, do votes all carry equal value, do some partners have veto rights, etc.)?
- Define a financial sustainability strategy for your collaborative.
- Define the legal framework of the DC: This includes the clarification and definition of the legal setup, a framework for intellectual property (How will findings arising from shared data be regulated?), liability, and licensing.

Allow for flexible governance:

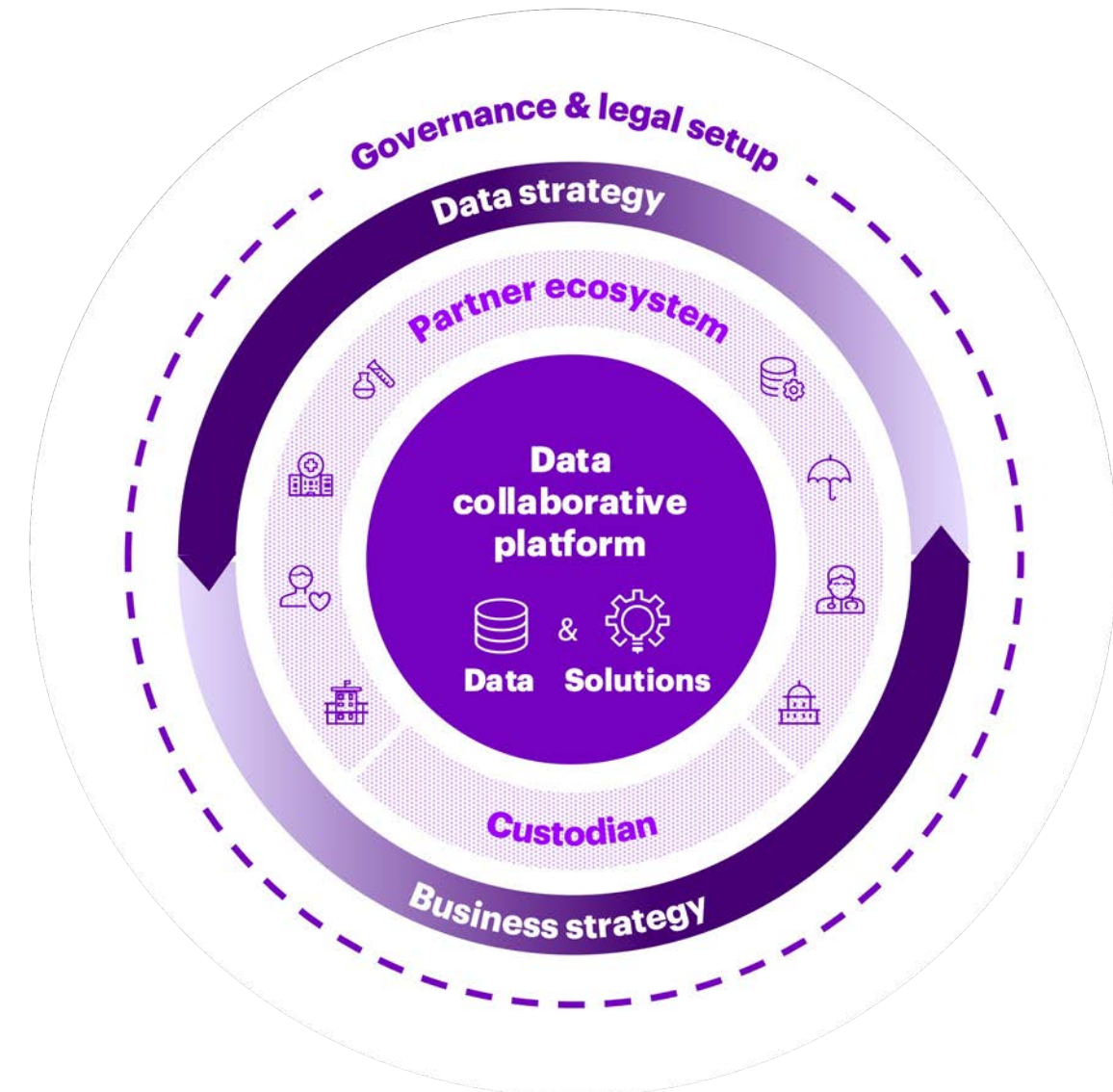
Instead of trying to codify every possible scenario, entrust a balanced, representative governance committee to handle borderline decisions. DCs evolve continuously, so embed flexibility into your DC's governance framework. Extendible framework agreements will allow you to capitalize on insights from existing partnerships. Though our survey shows that most DCs are still limited to specific studies, flexible programs limited to a period (as opposed to specific studies) are on the rise.

Kickstart your data collaborative journey

To keep pace with today's ever-changing world, setting up and working with the right partner ecosystem has become a new competitive advantage. Particularly in healthcare, cross-organizational and cross-industry partnerships are becoming the new norm for the industry to tackle the increasingly complex challenges of developing new, complex treatments, bringing them successfully to market, making them equitably affordable across high-, medium-, and low-income geographies, and making difficult decisions along the entire patient journey (right diagnosis, treatment decisions, etc.).

Appropriate data and information are key to meeting these complex challenges—especially when data is spread across various actors. As soon as data enters the partner ecosystem, its complexity increases exponentially. As such, effective data collaboratives require a multi-disciplinary approach, seamlessly orchestrating business, medical, legal, and technical angles. (See figure 5.)

Figure 5: The six major elements to be tackled when building a data collaborative.



Four key next steps to take

What's next? Life science companies can take the following steps to initiate their data collaboratives:



Decide on a niche where partners can unleash the benefits of collaboration to solve a particular TA challenge.



Define priority use cases with the entire life sciences and healthcare value chains in mind.



Establish a multi-disciplinary team consisting of business strategists, TA-focused medical, technical, and data professionals, as well as legal specialists covering data privacy and corporate law.



Analyze available external options to join a DC, ahead of starting your own. Starting your own entails significant effort. Key factors influencing this decision are alignment with your focus and objectives, and matching data needs.

If you decide to start your own DC...

As we have pointed out, this decision shouldn't be taken lightly. It makes more sense to find an existing DC that aligns with your objectives and needs if you can. Failing that, we have some important recommendations to share.

01 Choose between founding partner-centered or peer-to-peer collaboration setups. Founding-partner-centered collaboratives (every partner collaborates with the founding partner only) is easier to start with. Peer-to-peer collaboration (every partner can collaborate with every other partner in the data collaborative) is more complex but comes with greater inclusivity and thus a stronger value proposition for the partners. Make sure you articulate partner incentives up front.

02 Get senior financial leadership buy-in. Early value can often be generated by leveraging data from partners, but the truth is that building a data collaborative is a long-term endeavor. Financial benefits and economic sustainability may only be reached in the mid- to long-term. Hence, a suitable incubation period with substantial funding committed by the founding partners is essential for the DC to reach maturity and deliver ROI.

03 Define your data strategy—it will guide you in terms of which partners are most appropriate to onboard.

04 Identify suitable partners and establish the legal framework for the data collaborative early on with a core group of founders. Our experience shows that these are the two most time-consuming activities. They can seriously stall the launch of your data collaborative if not addressed early on.

Closing thoughts

The obstacles to DC establishment are not insignificant. But the rewards far outweigh the potential challenges, and a carefully conceived DC can use the data torrent being created in many demonstrable (and probably some as-yet unforeseen), value-creating and differentiated ways.

For future market leaders, DCs provide a clear pathway to strategic superiority and business success. They also hold the potential for far better service and health outcomes for patients on the ground. A cautious-but-decisive commitment is a key to a DC value proposition waiting to be unlocked.

References

¹ MELLODDY: “Multi-tasks ML across data types and partners boosts the predictive performance and chemical applicability domain of drug discovery-relevant models, without unacceptable leaks of private information”; <https://www.melloddy.eu/>

² Accelerating Medicines Partnership® (AMP®), a public-private partnership between the National Institutes of Health (NIH), the U.S. Food and Drug Administration (FDA), multiple biopharmaceutical and life science companies, non-profit and other organizations to transform the current model for developing new diagnostics and treatments.

³ Evaluate Pharma® World Preview 2021 – 14th Edition, July 2021

⁴ Fast Healthcare Interoperability Resources (FHIR)

⁵ Data Management Body of Knowledge (DMBOK)

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