

Tempus Connectivity

Harnessing discrete molecular data in the EHR to support precision oncology programs

Key takeaways

- ✓ Integrating discrete molecular data into EHRs facilitates clinical decision support for clinicians and powers clinical trial opportunities.
- ✓ Tempus is a leader in both next-generation sequencing (NGS) and discrete molecular data integrations with EHRs.
- ✓ Tempus has integrated somatic, germline, and pharmacogenomic discrete results with the Epic Genomics Module.
- ✓ Tempus has performed over 24 discrete Epic (including Aura) EHR integrations with health systems, with the integrations expected to double in 2024.
- ✓ From an integration standpoint, over 2,000 healthcare institutions have direct data connections with Tempus.
- ✓ Tempus can deploy an integration to transmit discrete molecular testing results into Epic EHRs in as little as 3-6 weeks.
- ✓ Tempus can support discrete and/or PDF result delivery integrations with any EHR.

The promise of precision medicine

Next-generation sequencing (NGS) has changed the landscape of clinical oncology over the past decade, essentially becoming the standard of care in cancer diagnosis and treatment.¹ Indeed, **over 66% of all new cancer medications are now “targeted therapies,”** which require a biomarker to help define the right medication for the right patient at the right time.² Tempus, which was founded in 2015, has become a leader in using NGS to broadly assess the genomic composition of individual patient diseases and comparing resultant findings to the Tempus multimodal database³, providing results that empower clinical providers to personalize management approaches to each patient. Practically speaking, to aid precision medicine efforts for clinical care providers, Tempus smart reports provide NGS test results with associated patient-informed therapies and clinical trial matches.⁴

Historical challenges with delivering NGS results

Expediting and facilitating the ability of clinical providers to recognize actionable genomic alterations is crucial to improving the lives of all cancer patients. Although EHRs serve as the primary interface for clinicians and laboratories to order tests and receive results, molecular profiling information has historically existed outside of the EHR, buried and locked in PDF reports. Clinical providers have needed to fill out paper requisitions and fax or email them to NGS laboratories for processing. Similarly, NGS results have typically been delivered as a fax or an encrypted email. This extremely manual workflow is time-consuming, cumbersome, and adds additional complexities for clinicians in finding, accessing, and acting on those results, which are not associated with the patient chart; in a multidisciplinary care setting these issues are multiplied.

Through connectivity between Tempus and EHR systems, clinicians can not only receive test results discretely, but also order molecular testing directly through the EHR system, ultimately saving time and streamlining the clinical workflow. Originally starting with somatic variant data from NGS, Tempus’ discrete data delivery and ordering offering now encompasses its full suite of molecular offerings, including but not limited to: (1) DNA sequencing of solid tumor and hematologic malignancies, (2) full germline DNA sequencing panels for hereditary cancers and pharmacogenomics, (3) RNA profiling, including fusion analysis, (4) immunohistochemistry for key biomarkers, like PD-L1, and (5) algorithmic tests that further analyze lab data, such as the PurISTSM subtyping algorithm in pancreatic cancer and the Tumor Origin Test.^{5,6,7}

Advantages of connecting discrete molecular data to EHRs

Over the past few years, further developments in data interoperability standards, such as Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR)^{8,9}, and improvements in EHRs, have allowed the transmission of discrete molecular data elements into the EHR. As opposed to free-text data, discrete data is recorded in structured, computer-readable formats. Figure 1 demonstrates the difference between the PDF and discrete versions of data that can be used for downstream precision medicine purposes.

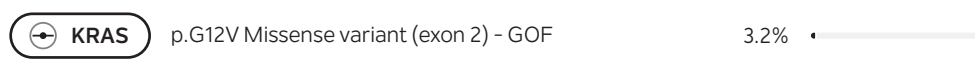
Figure 1. Comparison of PDF to Tempus discrete format (JSON - Report Object).

A. Standard display from a PDF for the KRAS alteration which is not computer readable.

GENOMIC VARIANTS

Somatic - Biologically Relevant

Variant Allele Fraction



B. Discrete genomic data using the HL7 transmission format which allows the EHR to be able to display NGS data in the same location as simple blood tests and trigger clinical actions as appropriate [e.g., matched FDA-approved therapies based on alteration as in this KRAS G12V example].

```
"variantDetails": [  
  {  
    "gene": "KRAS",  
    "geneDescription": "KRAS is a GDP/GTP binding protein that acts as an intracellular signal transducer. KRAS is involved in several pathways involved in cellular proliferation and survival, including the PI3K-AKT-mTOR pathway and the Ras-Raf-MEK-ERK pathway. Activating mutations, copy number gains, and overexpression of KRAS are associated with cancer progression.",  
    "display": "KRAS",  
    "hgncId": "6407",  
    "entrezId": "3845",  
    "gene3": null,  
    "gene3Display": null,  
    "gene3Hgncl": null,  
    "gene3EntrezId": null,  
    "gene5": null,  
    "gene5Display": null,  
    "gene5Hgncl": null,  
    "gene5EntrezId": null,  
    "variantDescription": "Missense variant (exon 2) - GOF",  
    "pVar": "p.G12V",  
    "cVar": "c.35G>T",  
    "transcriptId": "NM_033360",  
    "allelicFraction": "3.2",  
    "genomicSourceClass": "somatic",  
    "fusedGene": null  
  }  
]
```

Importantly, the use of discrete fields in EHRs enables clinical providers to activate powerful precision medicine features such as:

- 1. Finding molecular results quickly and easily** in the same area as hemoglobin or white blood cell count results.
- 2. Enabling clinical decision support (CDS).** CDS tools “include computerized alerts and reminders to care providers and patients; clinical guidelines; condition-specific order sets; focused patient data reports and summaries; documentation templates; diagnostic support, and contextually relevant reference information, among other tools.”¹⁰ A concrete example of CDS is a recommended dose reduction in a potentially toxic medication due to a patient’s genotype.¹¹ In Epic, Best Practice Advisories (BPAs) and Genomic Indicators are two types of CDS that can be facilitated through discrete data EHR integration.
- 3. Facilitating clinical trial enrollment.** Discrete molecular data elements are easily parsed by computer systems and expedite clinical trial matching. The Tempus TIME program uses EHR integration to rapidly identify patients based on key clinical and molecular enrollment criteria. If a patient meets eligibility criteria, sites are able to open a clinical trial in an average of 10 days.¹²

Since beginning to integrate discrete NGS data into EHRs, Tempus has been a part of multiple successful partnerships that have leveraged the benefits of integration to improve patient care. Over the past 8 years, greater than 50% of academic medical centers in the U.S have worked with Tempus. From an integration standpoint, **over 2,000 healthcare institutions** have direct data connections with Tempus. This growth is spurred not only by the promise of precision medicine noted above, but also by use cases that truly showcase how discrete reporting of molecular data supports clinical decisions at the point of care.

Importance of clinical partnerships

TriHealth provides an excellent case study demonstrating how successful use of Tempus' discrete NGS data for clinical trial matching and clinical decision support can advance patient care.¹³ Tempus worked alongside TriHealth to build an infrastructure for discrete molecular data resulting in their EHR system by establishing direct connections between Tempus and TriHealth's instance of Epic.¹⁴ Similarly, Vanderbilt University Medical Center has used EHR integration and Tempus data to expedite patient matching for clinical trials.¹⁵

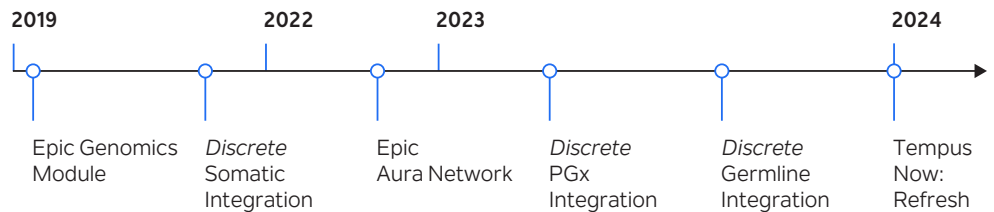
Tempus is a leader in discrete molecular data integration with Epic

Seamless ordering and delivery of molecular testing data is a foundational aspect of NGS-powered personalized medicine that has been optimized through the Tempus pipeline. However, discrete molecular data opens opportunities for more than organized data transfer. Tempus' EHR integrations are focused on providing decision support for clinicians.

Epic is the most frequently used EHR software in the United States.¹⁶ The Epic Genomics Module allows health systems to use their NGS data to trigger "genomic indicators" that **activate patient management recommendations**.¹⁷ These recommendations are carefully selected, clearly presented, and easily customizable directly within the EHR. For example, if a patient has a hereditary cancer causing mutation in a gene like BRCA, a genomic indicator, depending on its settings, can flag or provide a referral to a genetic counselor. Clinicians can decide which recommendations they want to see depending on their needs, and the system even automatically prepares orders based on standards of care.

Tempus was the first NGS laboratory to deliver discrete somatic genomic data directly into the Epic Genomics Module in 2019 with clinical partner Rush University^{17,18}, and has since been involved with a series of additional firsts (Figure 2). **Recently, Tempus was the first NGS company to leverage Epic's order and results anywhere (Aura) platform for somatic discrete data with clinical partner Ochsner.**¹⁹ This data was presented in abstract form at ASCO (e13568). Aura has been a game changer in allowing Tempus to expedite the integration of molecular data into the EHR.

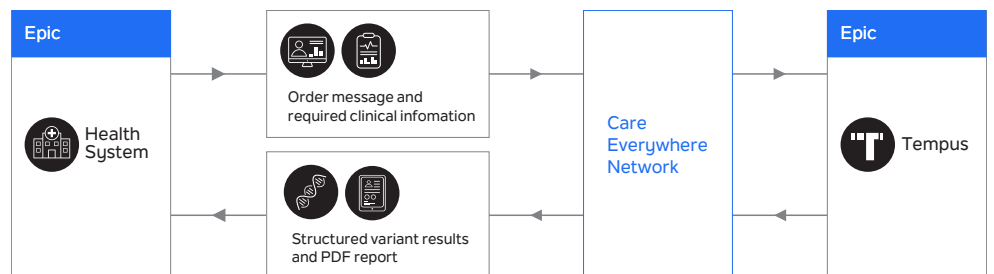
Figure 2. Tempus/Epic genomic data integration milestones.



Tempus' Aura integration improves time to integration of discrete molecular data

Epic's Aura network circumvents traditional 'point to point' molecular data integration by using Epic's pre-existing interoperability network, Care Everywhere. This new bi-directional orders and results exchange architecture reduces Epic integration builds from months to weeks (Figure 3).

Figure 3. Schematic of the Aura network.



Since connecting with the Aura network, Tempus has decreased integration time by 78%, moving from a mean time of 6.7 months to 1.5 months with deployment times as low as **3-6 weeks**²⁰ Across all EHR systems, the time to integrate discrete molecular data in EHRs has been steadily decreasing since Tempus initiated its program, and the team is constantly working to improve integration speed so clinicians are provided with up-to-date results.

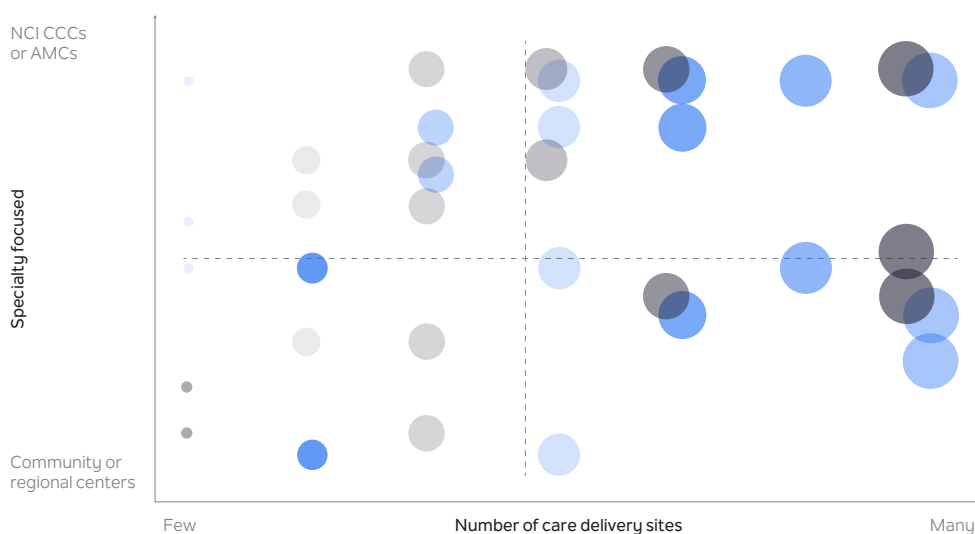
Expanding discrete molecular data to all EHRs

While EHRs have been widely adopted in health systems across the United States, EHR software differences continue to lead to interoperability challenges. Although Tempus NGS test results are easily ordered from and incorporated into the Epic EHR, many clinical facilities outside of large health systems use other EHR systems. Utilizing interoperability standards required under the Office of the National Coordinator for Health IT's certification program, Tempus has developed an integration pipeline compatible with any EHR system, including Epic, Cerner, Flatiron's OncoEMR, Meditech, iKnowMed, and Veradigm (formally Allscripts), culminating in **350+ direct data connections across over 2,000 healthcare institutions**. Due to the broad compatibility of the Tempus integration pipeline, these connections range from National Cancer Institute Comprehensive Cancer Centers (NCI CCCs) and Academic Medical Centers (AMCs) to community and regional hospitals (Figure 4).

Figure 4. Tempus has integrated with a multitude of practices, both large and small – academic and community based.

Delivering discrete genomic results – supporting all care delivery models

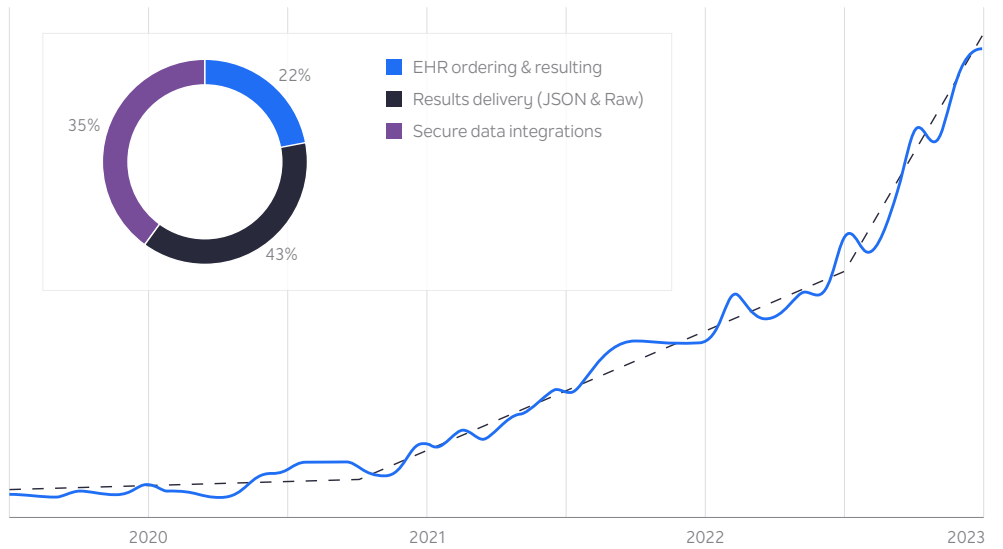
■ Live accounts ■ Sites in-progress



To continuously improve and expand the integration of discrete molecular data into a multitude of EHRs across the United States, a multidisciplinary team has been assembled at Tempus. This team includes Epic EHR-certified engineers, medical informatics specialists who previously worked for industry leaders such as IBM, board-certified pathologists, and practicing clinicians from a variety of backgrounds. Through their collaboration, the number of connections to EHR systems continues to grow (Figure 5).

Figure 5. The number of Tempus connections continues to grow.

EHR initiated order volume



Looking forward

As Tempus strengthens and expands its connectivity capabilities with EHR systems, new features are simultaneously being developed to enhance the clinical provider experience. In addition to distilled and organized testing results, for instance, broader NGS data can now be supplied through Epic's cloud-based server for large sequencing files to support research. Another ongoing effort is Tempus Refresh, which will allow clinicians to receive updated recommendations based on new clinical trial information and/or treatment options that became available after the report was initially provided. These features will increase the depth and utility of molecular data available in EHRs, aiming not only to *provide information but strengthen the insights that follow*. Building upon the existing framework for EHR integration and moving ahead to these novel developments in the field, Tempus will continue to lead in the NGS integration space.

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