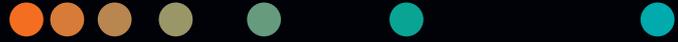


AI-Pathway Companion

Clinical decision support for prostate cancer care

Case study: University Hospital Basel

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Executive summary

Cancer care is becoming increasingly complex and personalized. More and more patient characteristics and disease specific data – clinical history, comorbidities, imaging, laboratory data, genomics/proteomics, lifestyle factors, pathology results – have to be factored in when deciding on diagnostic measures and care pathways. The most recent treatment recommendations can be found in international guidelines that, in the case of prostate cancer, are updated up to twice a year.

Together with Siemens Healthineers, University Hospital Basel (USB) has decided to collaborate on and implement AI-Pathway Companion Prostate Cancer, a next-generation clinical decision support software. AI-Pathway Companion is CE-certified¹ and uses AI-technologies to generate evidence-based recommendations for urologists who treat prostate cancer patients and have to decide on the optimal treatment approach.

The software presents a clinical navigation map that is both standardized² and highly personalized. It supports the physician by providing – at the point of care – a readily accessible overview of the patient’s clinical condition and diagnostic and therapeutic options at any given moment³. Furthermore, it helps the patient by illustrating the disease progression over time and possible disease trajectories based on therapy decision.

For Siemens Healthineers, advancing artificial intelligence and making it ready for clinical use is an important component of its strategy 2025, and AI-Pathway Companion is one of the solutions to drive new business beyond radiology and to fortify its position as a trail-blazer in digital healthcare. It builds on the company’s strong product portfolio, but even more so on the profound knowledge of clinical processes and evidence-based care along the care pathway that Siemens Healthineers has acquired in more than a century of being a healthcare innovation leader.

“It is always helpful to have knowledge available at the point of care, and it is very helpful for clinicians to see patient-specific decision trees unfold.”

Professor Philip Cornford⁴
Cancer Lead at Royal Liverpool University Hospitals Trust,
Vice Chair European Association of Urology (EAU)
Prostate Cancer Guideline Panel

At USB, AI-Pathway Companion was piloted successfully, and it is now being used in clinical routine to improve the efficiency of the multidisciplinary workflows of diagnosing and treating patients with adenocarcinoma, the most common form of prostate cancer. The vision is that of a digital, transparent, and highly personalized information-sharing and decision-making platform that draws both on published evidence and real-life patient data.

Guideline adherence and clinical decision support

In cancer care, treatment standards are usually summarized and referenced in national and international guidelines, notably the guidelines of the US National Comprehensive Cancer Network (NCCN) that radiate way beyond North America. In urological cancers like prostate cancer, they are referenced in the guidelines of the European Association of Urology (EAU) which, again, are adopted by many healthcare systems outside of Europe.

“Every patient with prostate cancer has the right to be treated according to the most recent evidence-based recommendations.”

Prof. Helge Seifert*
Head of the Department of Urology
at University Hospital Basel

It has repeatedly been demonstrated that guideline adherence in oncology translates into better outcomes. For example, a German breast cancer analysis showed that guideline adherence strongly predicted relapse-free survival and overall survival regardless of prognostic index. [1] A very recent breast cancer study from Asia clearly correlated survival with guideline adherence for different types of treatment, specifically surgery, chemotherapy, radiotherapy, and endocrine therapy. [2] And a further analysis based on a US national dataset showed that adherence to American College of Surgeons recommendations improved breast cancer survival. [3]

While most data on guideline adherence and patient outcomes refer to breast cancer, data also exist for other types of cancer that point in the same direction. In California, guideline adherence correlated with survival in pancreatic cancer. [4] And in an Italian multicenter study, adherence to EAU guidelines translated into better overall survival in penile cancer. [5]

Evidence-based care leads to better clinical outcomes, but how does it affect cost? A multi-year study performed in association with professionals from Abramson Cancer Center of the University of Pennsylvania and Johns Hopkins Carey Business School revealed that the cost of unwarranted components of oncology treatments averaged \$25,579 per patient. At current annual cancer incidence rates in the US, this translates to over \$10 billion per year in unnecessary costs that could be significantly reduced by eliminating unwarranted, non-evidence-based cancer treatment. [6]

A further study of women with early-stage breast cancer who received treatment for secondary metastases demonstrated both lower health care utilization and lower Medicare costs for patients receiving guideline-concordant care. The study of 5,651 patients conducted from 2006 to 2013 found that in comparison with concordant treatments, non-concordant treatments were associated with \$1,765 higher average Medicare costs per month. [7]

Thus, routine use of guidelines will benefit patients in multiple ways. But with an abundance of new research publications on personalized therapies and guideline updates becoming more and more frequent, acting according to guidelines is proving increasingly difficult for physicians, says Professor Philip Cornford, Vice Chair of the EAU Prostate Cancer Guideline Panel:

“The EAU Prostate Cancer Guideline is updated every spring, and often there is an additional update in autumn. Last year alone there were 4,500 new publications.”

Professor Philip Cornford*
Cancer Lead at Royal Liverpool University Hospitals Trust, Vice Chair European Association of Urology (EAU) Prostate Cancer Guideline Panel

The medical information tsunami that physicians are facing can be illustrated by numerous statistics. For example, the doubling time for medical data was 3.5 years in 2010. In 2020 it is estimated to be just 73 days. [8] As a result of information overload in an age of personalized precision medicine, guideline adoption by physicians providing cancer care is far from perfect, and there is considerable variability between institutions.

“What seems clear is that there are big gaps between what guideline committees say and what really happens when a doctor sits in front of a patient.”

Professor Philip Cornford*
Cancer Lead at Royal Liverpool University Hospitals Trust, Vice Chair European Association of Urology (EAU) Prostate Cancer Guideline Panel

This is where digital clinical decision support systems come into play. AI-Pathway Companion optimizes care pathways by creating a clinical navigation map that integrates patient-specific data from various sources. It also generates evidence-based treatment recommendations by matching individual patient data to guideline recommendations.

“A digital tool that provides evidence-based information in the context of individual patients will likely raise awareness for guideline recommendations.”

Professor Philip Cornford*
Cancer Lead at Royal Liverpool University Hospitals Trust, Vice Chair European Association of Urology (EAU) Prostate Cancer Guideline Panel

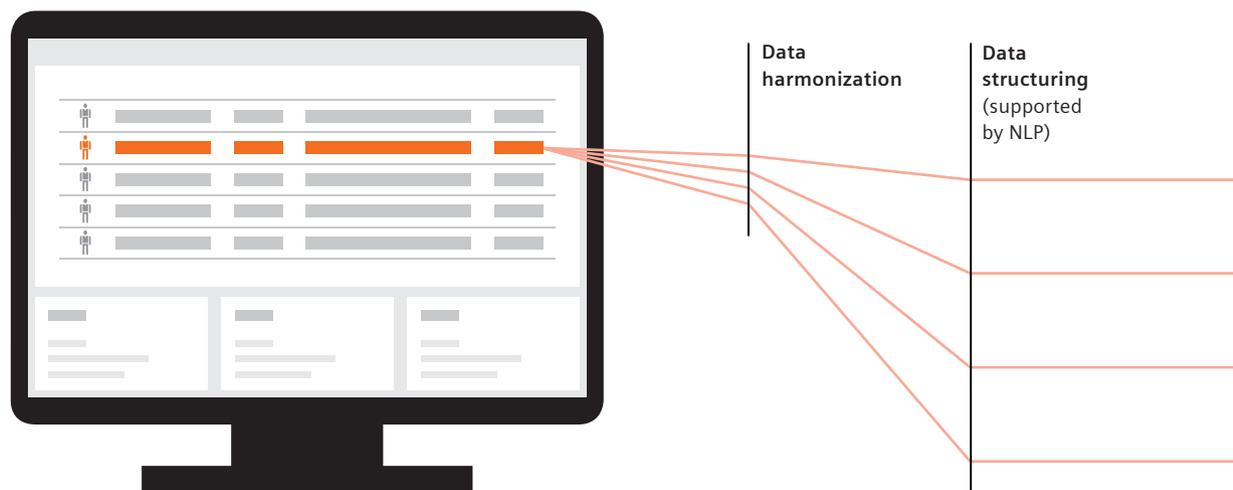
Personalization in detail

AI-Pathway Companion Prostate Cancer features various tools that provide personalized information or recommendations based on individual disease history, clinical data, personal preferences, and stage of disease. Here are just a few examples:

- Prostate cancer nomograms provide and visualize personalized predictions of disease courses and treatment outcomes. Patients will better understand the nature of their highly individual prostate cancer and the likely outcomes of different therapies.
- Nomograms can also be used to risk stratify patients, specifically in first-line treatment. This helps physicians to put patients on the best possible treatment pathway.

- Several visual dashboards and patient engagement functionalities boost shared decision-making during doctor-patient conversations. Thus equipped, the patient will better understand the different treatment options and the physician's recommendations and will be more capable of expressing informed preferences.

Personalized predictions of disease courses through automatically assembled prostate cancer nomograms help the patient to express informed preferences. Visualizations like these can be considered enablers for genuinely shared decision-making.



Standardization in detail

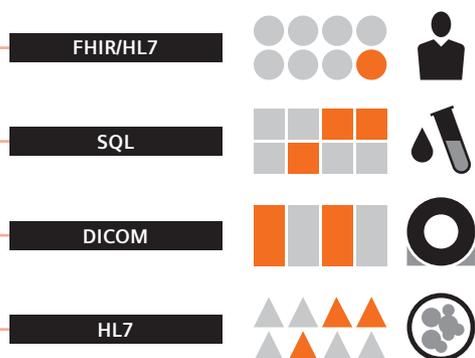
Cancer care varies greatly depending on the institution, indicating that adoption of evidence-based guidelines could be improved significantly. [9] This is especially true for prostate cancer: A Dutch analysis of 15 European treatment recommendations for different types of cancer showed that there was a particularly high inter-hospital variation in adherence to prostate cancer guidelines. [10]

Clinical decision support helps to reduce variations in care pathways – within an institution, but also across institutions. AI-Pathway Companion Prostate Cancer contributes to better standardization and reduced variation thanks to a number of technical and structural features and use of AI-technologies. These features help align individual patient data points with evidence-based knowledge and thus assist clinical decision-making:

- Aggregation of disease-specific and relevant information from reports that are stored in disparate IT systems like the electronic medical record (EMR) and the radiological, oncological and laboratory information systems (RIS, OIS, LIS).

AI-Pathway Companion is technically interoperable and vendor neutral. It utilizes common international standards to draw healthcare data from, and pass data between, systems. Specifically, the software is FHIR ready and can also exchange data through standards like HL7 and DICOM.

- Data is structured as necessary with the help of NLP and visualized along the individual clinical pathway to ensure informed decision-making. For example, radiology and pathology results are correlated and superimposed to provide tumor visualization.
- Customers retain a high flexibility regarding the source of evidence-based information. All diagnostic and therapeutic alternatives that exist in guidelines are featured in AI-Pathway Companion. Institution-specific standard-operating procedures (SOP)⁶ can be integrated and, with the help of AI-technologies, provided in a standardized fashion when necessary or desired.



An institution that intends to use AI-Pathway Companion should be able to provide as much structured clinical data as possible, since not all unstructured clinical data can be extracted with NLP. The ideal scenario is that clinical data is entered in a standardized way from the very outset.

What's in it for customers?

The USB experience

Urologists at University Hospital Basel (USB) have decided to take evidence-based prostate cancer treatment to a new level and rise to the challenge of multidisciplinary tumor care by accelerating medical progress. The Department of Urology is the global pilot site for AI-Pathway Companion Prostate Cancer and has recently implemented the new Siemens Healthineers software in routine care. By leveraging AI-technologies and smart data integration capabilities, Prof. Helge Seifert and his team are successfully reducing complexity and fighting data overload.

“Clinicians were involved in the development very early on. The software really mirrors the specific requirements of routine clinical users.”

Christian Wetterauer⁴
MD and AI-Pathway Companion Project Lead,
Department of Urology
at University Hospital Basel

The Basel urologists are focusing on two main use cases at the moment: patient consultations and multidisciplinary team meetings (MDT). The overall goal is to improve quality of care both in-house and across the regional prostate cancer care network that includes a number of smaller hospitals and urologists in private practice in Switzerland and Germany.

As a lower-hanging fruit, efficiency gains in daily routine will be measured. To this end, a number of key performance indicators (KPI) such as ‘time to find certain values’, ‘time to prepare an MDT’, and ‘overall length of time for presenting and discussing a patient during an MDT’ have been defined. These KPIs are currently being compared to the status quo ante, and more are under consideration, for example ‘time to prepare a consultation’ and ‘time to establish the International Prostate Symptom Score (IPSS)’. Another promising area for efficiency gains is the above-mentioned risk stratification through nomograms. Until now this has required an online tool; but with AI-Pathway Companion, nomograms are created automatically and made immediately available to the urologist.

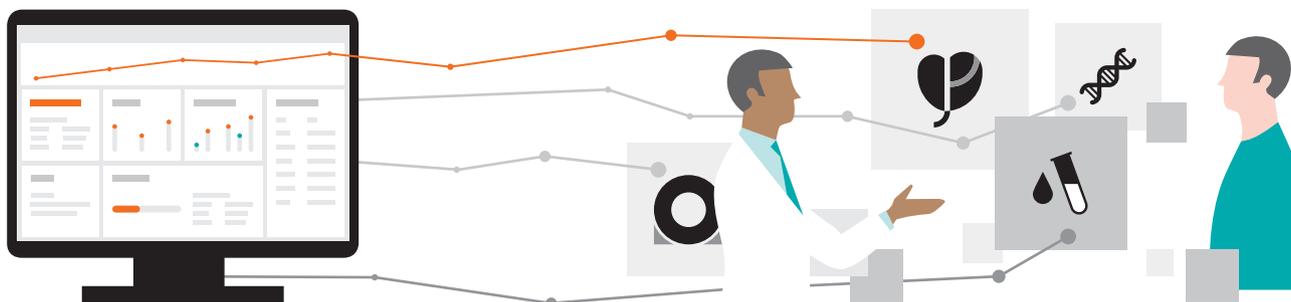
Use case patient consultations

AI-Pathway Companion Prostate Cancer provides evidence-based, patient-specific support at the point of care that can be very valuable during consultations between physicians and patients. Dr. Christian Wetterauer⁴, Project Lead at USB, aims to make AI-Pathway Companion the primary user interface for clinicians: "This software can be considered an educational tool. It is not a black box, but makes evidence transparent."

Using AI-Pathway Companion and its visualization features meets the two prime expectations of every cancer patient simultaneously: receiving best possible treatment in line with available standards and guidelines and talking face-to-face with their doctor.

"Software definitely won't replace the doctor. But it helps to make well-informed, evidence-based recommendations, and it can make different treatment options more transparent."

Prof. Helge Seifert⁴
Head of the Department of Urology
at University Hospital Basel





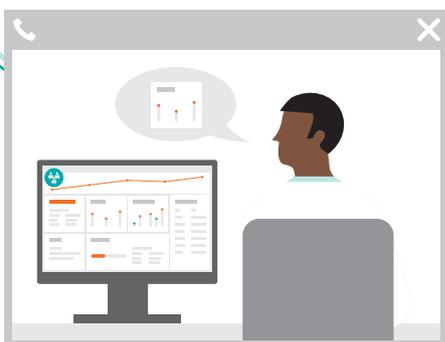
Use case multidisciplinary tumor board

The second important use case for AI-Pathway Companion Prostate Cancer at USB is the multidisciplinary tumor board (MDTB). The USB urologists treat about 200 patients with newly diagnosed prostate cancer per year. Hundreds more patients are presented during the weekly MDTB by colleagues from other hospitals in the vicinity and by ambulatory urologists. With 15 to 20 patients discussed weekly at USB, MDTB preparation is a time consuming task. Dr. Wetterauer states that preparing a patient for the MDTB takes between 5 and 12 minutes. Discussing the patient with colleagues takes another 5 minutes on average. Using AI-Pathway Companion for patient preparation saves considerable time, since it has all the necessary data already integrated, and the information is mapped conveniently along the patient journey in a way that makes it immediately usable for the MDTB.

During the MDTB, AI-Pathway Companion with its patient journey visualization and risk depiction aims to save time. It also leads to a much more holistic presentation and helps to make expert recommendations more transparent. Diagnostic and therapeutic options can be illustrated more clearly and clinical colleagues can join via teleconferencing.

“We don’t have to put together the information we need manually before an MDTB anymore, because data aggregation for each patient happens automatically. This should reduce preparation time considerably, ideally close to zero.”

Christian Wetterauer⁴
MD and AI-Pathway Companion Project Lead,
Department of Urology
at University Hospital Basel

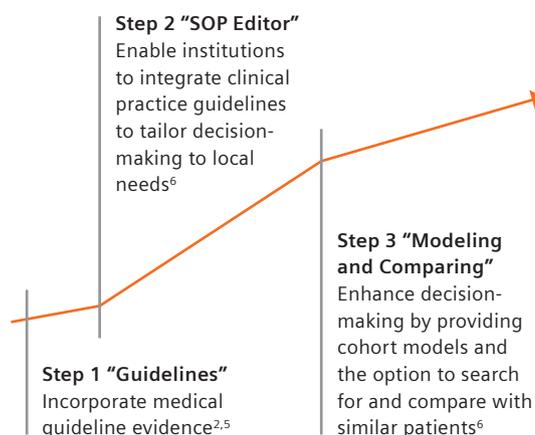


The vision to drive improved patient outcomes

AI-Pathway Companion’s ambitious goal is to improve patient outcomes. The vision is to:

- reach profound process improvements
- provide easy scalability thanks to a contemporary platform infrastructure
- propel disease-specific knowledge for elaborate and contextualized decision-making
- drive patient engagement and shared decisions
- generate insights

Improving clinical decision-making is a complex task, and AI-Pathway Companion is taking a stepwise approach to get there:



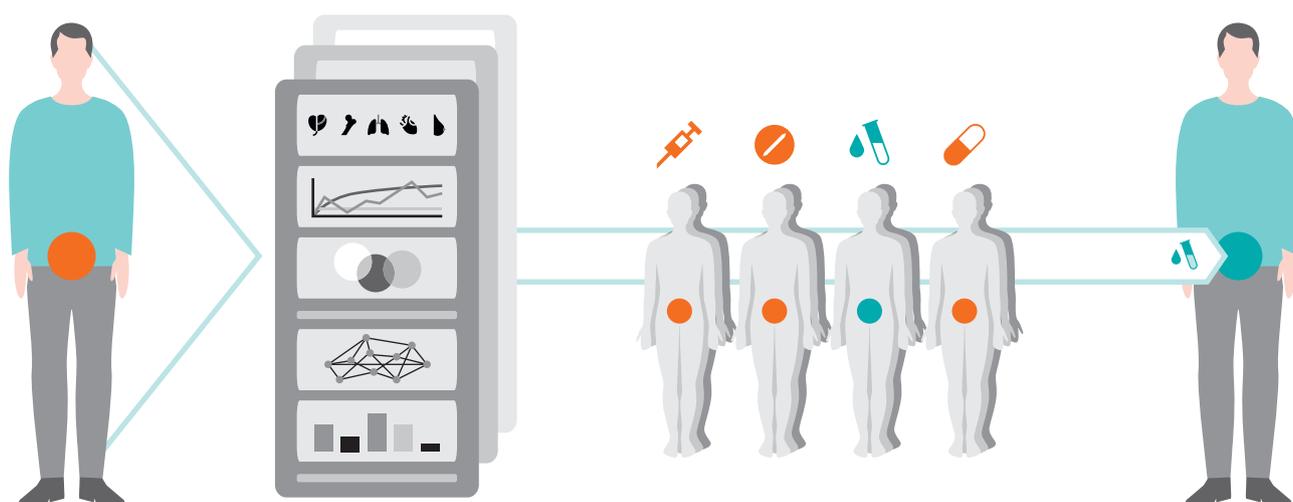
What’s next in AI-powered cancer care?

Here is our short-term working list:

- Deliver additional and valuable insights to drive informed decision-making
- Develop further pathways such as lung and breast cancer^{6,7}
- Strengthen clinical analytics capabilities: assure the physician that a decision is right
- Promote a consultative implementation approach to propel digital maturity at the customer site
- Accentuate patient centricity to promote patient engagement and patient knowledge and to foster shared decision-making
- Visualize Patient Reported Outcome Measures (PROMs)⁶ and integrate them in the individual patient pathway, indicating quality of care and effectiveness of therapeutic measures over the course of the disease and the different lines of treatment

And what about mid-term?⁶

- Increase personalization further by considering patient co-morbidities and taking into account the interaction of different care pathways in patients with more than one disease
- Establish digital twins by providing representation of organ functions and advance other types of patient-specific modeling
- Empower physicians to simulate outcome scenarios, for example how a patient will likely react to different chemotherapies
- Identify suitable clinical trials with a trial matching feature based on individual patient characteristics, and raise awareness of existing clinical research on the side of the patient and on that of the urologist
- Enable care givers to leverage self-generated evidence powered by cohort models and advanced prediction models
- Activate deep-learning AI-algorithms to leverage full potential of insights generation
- Use the Similar Patient Search to identify patients with a similar stage of disease or biological background to derive the best treatment option or diagnostic step



Summary

AI-Pathway Companion Prostate Cancer is a next generation, AI-powered data integration and clinical decision support software. Because data from various sources is mapped transparently and intuitively along the patient

journey, routine cancer care becomes far more efficient. By matching individual patient data with up-to-date recommendations and guidelines from NCCN and EAU and, if applicable, from local SOPs⁶, adherence to evidence-based standards in diagnosis and treatment is promoted and optimal guideline adherence facilitated. At University Hospital Basel, the global pilot site for AI-Pathway Companion Prostate Cancer, physicians benefit from more streamlined MDTBs and less time spent on tasks like assembling data and performing risk assessments⁴. Furthermore, available treatment options can be made transparent to patients so that shared, informed decision-making becomes a reality. Ultimately, better informed decision-making and higher guideline adherence should translate into improved medical outcomes for the prostate cancer patient. ●

“A software like this will lead to better quality of care. It will be especially valuable in peripheral hospitals and smaller medical institutions with a high caseload. We won’t be able to offer patient care in the future without integrating evidence-based knowledge and patient data.”

Prof. Helge Seifert*
Head of the Department of Urology
at University Hospital Basel

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The statements by Siemens Healthineers' customers described herein are based on results that were achieved in the customer's unique setting. Because there is no "typical" hospital or laboratory and many variables exist (e.g., hospital size, samples mix, case mix, level of IT and/or automation adoption) there can be no guarantee that other customers will achieve the same results.

¹ AI-Pathway Companion Prostate Cancer is CE-compliant in accordance with Directive 93/42/EEC.

² AI-Pathway Companion Prostate Cancer VA10A supports EAU and NCCN guidelines.

³ Prerequisite: All data is available as required per guideline. Feature dependent on quality of input data.

⁴ Employed by an institution that receives financial support from Siemens Healthineers for collaborations.

⁵ AI-Pathway Companion Prostate Cancer VA10A supports prostate cancer adenocarcinoma cases only.

⁶ The features mentioned herein are under development and not commercially available. Their future availability cannot be ensured.

⁷ This product is under development and not commercially available. Its future availability cannot be ensured.

Siemens Healthineers Headquarters

Siemens Healthcare GmbH
Henkestr. 127
91052 Erlangen, Germany
Phone: +49 9131 84-0
siemens-healthineers.com