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**Vladimir Brusic, Dana-Farber CVC's Director of Bioinformatics**

## TIBCO Spotfire Provides Dana-Farber Cancer Institute with Unprecedented Insight into Cancer Vaccine Clinical Trials

Dana-Farber Cancer Institute is a principal teaching affiliate of the Harvard Medical School and is among the leading cancer research and care centers in the United States. It is a founding member of the Dana-Farber/Harvard Cancer Center (DF/HCC), designated a comprehensive cancer center by the National Cancer Institute.

When Karen Maloney, Business Development Manager of the Cancer Vaccine Center (CVC) at Dana-Farber Cancer Institute (Dana-Farber) in Boston decided to investigate the competitive landscape of the cancer vaccine field, she looked to a strategic planning and marketing MBA class at Babson College in Wellesley, MA for help with the research project. There she met Xiaohong Cao, whose bioinformatics background led to the decision to focus on clinical vaccine trials as representative of potential competition. This became Dana-Farber CVC's first organized attempt to assess in-depth the cancer vaccine market.

Cao focused on the analysis of 645 clinical trials related to cancer vaccines. The data was extracted in XML from the ClinicalTrials.gov website, and included categories such as 'Summary of Purpose', 'Trial Sponsor', 'Phase of the Trial', 'Recruiting Status', and 'Location'. Additional statistics on cancer types, including incidence and survival rates, were retrieved from the National Cancer Institute Surveillance data.

### Challenge

Although information from clinical vaccine trials is organized fairly well into categories and can be downloaded, there is great inconsistency and redundancy inherent in the data registry. To gain a good understanding of the landscape, both an overview and an in-depth analytic capability were required simultaneously. It would have been very difficult, not to mention incredibly time consuming, to analyze information from the multiple data sources separately, in order to understand the relationships underlying the data or identify trends and patterns using spreadsheets. And to attempt to use a traditional business intelligence tool would have required significant IT resources. Cao proposed using the TIBCO Spotfire DXP (Spotfire) computational and visual analysis tool for data exploration and discovery.

### Solution

Cao, a staff scientist on the science computing team at Genzyme Corporation, was experienced in using TIBCO Spotfire® software in her work. Scientists at Genzyme routinely incorporate Spotfire® enterprise

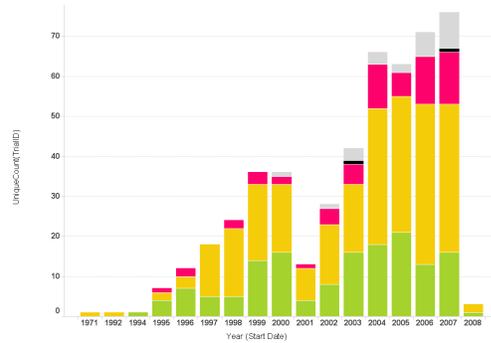


analytics into their analysis pipelines for genomics, drug screening data and other generic research data at the company. Cao knew that Spotfire® software's flexibility and visual environment would be well suited to rapidly summarize and visualize information about institutions, diseases, clinical approaches, clinical trials dates, predominant cancer types in the trials, clinical opportunities and pharmaceutical market coverage.

"Spotfire is ideal for summarization, visualization, and tabulation tasks," notes Cao. "It's easy to learn and use because the graphical user interface facilitates graphing and tabulation by using drag-and-drop actions." Cao also cited the ability to instantly generate queries and refine several rounds of analysis quickly in Spotfire: "Spotfire enterprise analytics provides us with a dynamic view with which to look at analyses at a high level and drill down quickly to dig deeper into patterns and outliers."

At the project's outset, Cao imported the data sets into Spotfire software and configured the application to assess the cancer vaccine clinical trials market. She presented the preliminary findings to Maloney and Vladimir Brusic, Dana-Farber CVC's Director of Bioinformatics, using the Spotfire interface to demonstrate. Brusic was immediately taken with the presentation and he joined the project, adding his expertise to shape the analysis approach. Within three months the project was completed; with the bulk of that time spent correcting database inconsistencies and properly annotating data – the step prior to importing the information into Spotfire. "While the quality and format of the data slowed us down," comments Brusic, "we were impressed with how quickly Spotfire facilitated different iterations as we worked to refine the data formats and classifications."

A key characteristic of Spotfire software is its versatility; questions can be formulated and re-formulated rapidly as users learn new

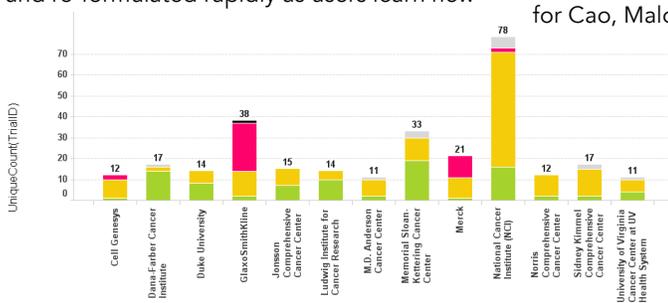


Cancer vaccine trials started per year.

things about their data and instantly ask follow-up questions. A complex, composite question also can be defined directly from the interface using several mouse clicks. Spotfire stands out for its ability to glean knowledge discovery from databases, applying techniques from databases, statistics and artificial intelligence to extract high-level information from a large volume of low-level data.

Would the CVC at Dana-Farber have tackled this project without a tool such as Spotfire? "It would have been very difficult to go through all the data separately and then compare lists and we certainly couldn't have done it as thoroughly or interactively," observes Maloney. "Spotfire made it easy to get multiple views of the data, and quickly drill down to extract subgroups instantaneously with just a point and click of the mouse."

Maloney and Brusic had been aware, in a general way, which cancers were being addressed by vaccine research, and they also knew that it takes time and effort to extract specific details and summarize key information. The versatility of Spotfire software enabled the analysis of various dimensions of the clinical trials landscape, including clinical trials by timeline, type of cancer, lead institution, patient population, and/or specific vaccine technology. Spotfire enterprise analytics made it possible for Cao, Maloney and Brusic to perform



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complex queries of cancer vaccine trials data, exposing hidden patterns, trends and biases in the data.

For example, it revealed the number of clinical vaccine trials per cancer type, over time, by phase, by lead sponsors, as well as trial activity relative to cancer type and survival data. It also identified cancers that are neglected in the cancer vaccine field: bladder, liver, pancreatic, stomach, esophageal, and all of the low-incidence cancers. "Spotfire quickly gave us a visual analysis of major trends and main clusters of activity, highlighting neglected areas and graphically pointing out the glaring need of many of these cancers for additional vaccine development," said Brusic.

At the completion of the project, Cao demonstrated Spotfire enterprise analytics to Dana-Farber's CVC clinicians who perform clinical trials. They posed queries about ongoing cancer vaccine clinical trials that Cao answered following a few mouse clicks. The reaction was uniformly positive as they saw immediate utility for Spotfire software in the larger field of medical/clinical intelligence gathering.

## Results

With the help of Cao and Spotfire software, Dana-Farber's CVC developed a first-of-its-kind analysis approach to rapidly extract complex data specifically for cancer vaccines from the major clinical trial repository. Summarization and visualization of these data represents a cost-effective means of making informed decisions about future cancer vaccine clinical trials. The findings are helping the CVC at Dana-Farber understand its competition and the diseases they are working on to help shape its strategy in the marketplace.

Spotfire software's visual and computational analysis approach provides the CVC at Dana-Farber and the research community at large with

a better understanding of the cancer vaccine clinical trials landscape, and enables rapid insight into the hotspots of cancer vaccine activity, as well as into the identification of neglected cancers.

As a result of a paper published in the journal *Immunome Research*, co-authored by Cao, Maloney and Brusic, the Spotfire application has received much interest from universities and government institutions, which are intrigued by the marriage of analysis principles and computer science. The Spotfire solution was very effective in pointing out the gap between having available data on clinical vaccine trials and having the ability to perform effective analysis of that data. "We knew the gap existed, but we needed to have specific numbers and facts to demonstrate it," notes Maloney. "Spotfire was very effective in doing this and it's important that we share this information with colleagues."

This knowledge is useful for various professionals, including research directors and planners in companies, hospital administrators, researchers and scientists, physicians conducting clinical trials, policy makers, grant officers at funding bodies, and government regulators. By combining public databases of clinical trials, data formatting by XML, and computational analysis and visualization, Dana Farber's CVC has shown that specific knowledge can be extracted, summarized, and presented to the user.

"The whole field of medical research is going through an enormous transformation, in part driven by information technology," adds Brusic. "Using a tool like Spotfire for analysis is a promising area in this field because it helps integrate information from multiple sources, ask specific questions and rapidly extract new knowledge from the data that was previously not easily attainable."

*Cao, Maloney and Brusic are grateful to Genzyme Corporation for the use of the Spotfire software.*



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