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Visualizing Oncology Data Through Interactive Dashboards

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ABSTRACT

The conventional way of generating visuals in Oncology trials is to use statistical and graphical procedures within SAS®. It is well known that generating visuals using SAS/Graph is time consuming and presents a lot of challenges for the programmers. In addition, the reviewers would now also like to see their visuals more interactively rather than using a static output. In this paper, we will present how one can make use of SAS statistical procedures along with data visualization tools such as TIBCO Spotfire® to overcome those challenges and have interactive clinical trial graphs that are widely used in Oncology trials (e.g. Waterfall, Swimmer, and Kaplan-Meier plots). We will also provide details on how this approach is helping the end users not only review the results at a high-level but also drill-down to a subject level patient profile.

INTRODUCTION

In the Clinical industry, the data is presented in the form of tables, listings and figures/graphs (TLF or TLG) which are typically generated by SAS. However, the output that is generated from SAS is static and does not help the reviewer drill down the data further. Moreover, in the Oncology trials, the reviewer may want to see their data more interactively by drilling down the data further to get a complete big picture. Visualizing the data using Spotfire is one of the techniques that can be used to address these issues.

Visualizing the data is a crucial part in Oncology Trials, helping the investigators understand difficult concepts more easily. It is more beneficial when we can enable the visualization to be interactive. So, this paper will present how one can make use of SAS statistical procedures along with data visualization tools such as TIBCO Spotfire® and create interactive clinical trial graphs that are widely used in Oncology trials (e.g. Waterfall, Swimmer, and Kaplan-Meier plots).

WATERFALL PLOT

Drug responses in the oncology trials are categorized into different categories (e.g. Complete Response, Partial Response, Minimal Response, Stable Disease, Progressive Disease etc.) based on the Response Evaluation Criteria in Solid Tumors (RECIST). By depicting the information in these categories, it makes the reviewer's job to interpret results easier. Waterfall plot is one of the techniques to interpret these results. In this paper, by making use of SAS and Spotfire, waterfall plot is presented with the maximum percentage change of Tumor diameter for each unique subject identified by the type of tumor response.

Waterfall plot is a new way of presenting information in the Oncology trials, which is essentially a bar graph. For example, in oncology trials, the waterfall plot is used to present the subjects response to the study drug based on certain parameters like Tumor Diameter. The horizontal (x) axis in the waterfall plot may represent the unique subjects participated in the trial and the vertical (y) axis may represent the percentage change (growth or reduction) in the tumor diameter. In general, the waterfall plot may vary from poor value i.e. tumor growth on the left side of the plot to the best value i.e. tumor reduction on the right side of the plot.

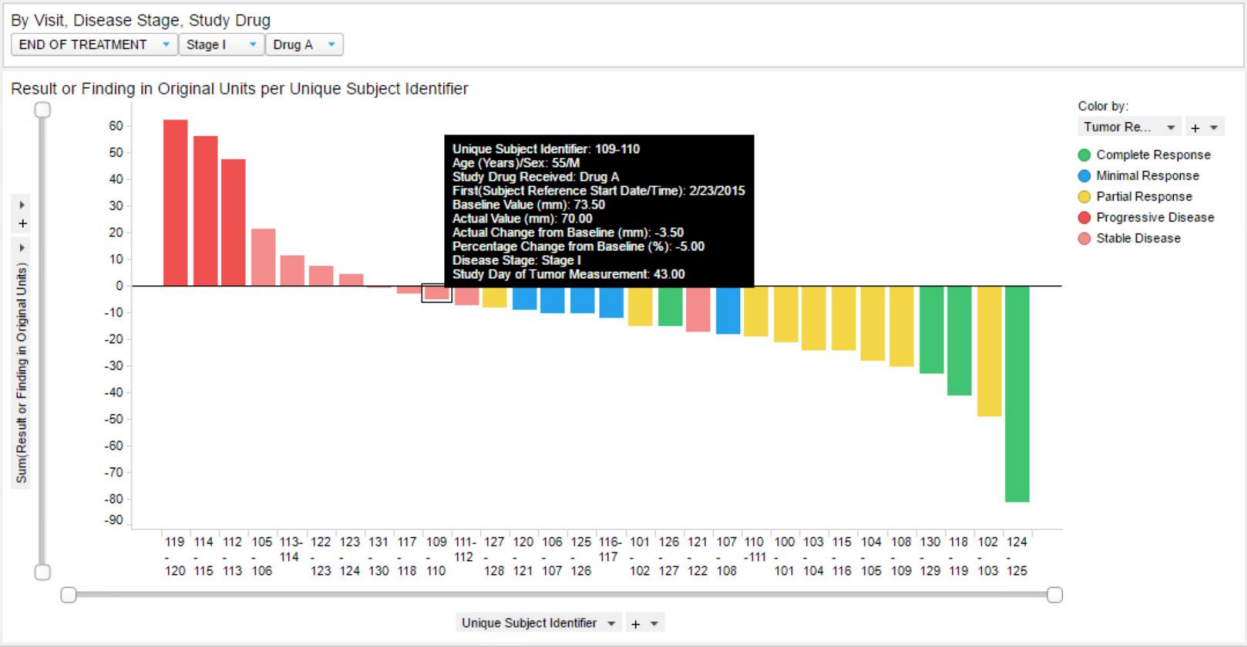

Figure 1 Waterfall Plot

Fig. 1 shows the Waterfall plot created in Spotfire. Percentage change from baseline of the tumor to each visit is calculated in SAS. The above waterfall plot gives us a great picture about the performance of the study drug by showing the percentage change of the tumor diameter from baseline for each subject and differentiating the bars by color based on the subject's response to the drug. When the curser is pointed at any of the subject, a tool tip is displayed which gives the user a brief information about the subject such as Age, Sex, Subject Reference Start Date, Baseline Value of the tumor diameter, Actual Value of the tumor diameter for a visit, Actual and Percentage Change from Baseline, Disease Stage of the subject, and Study Day of Tumor Measurement as shown in the figure. In the figure above, '109-110' subject's information is shown in the tool tip when the curser is pointed to that subject's data point. The tool tip is not limited to the information shown in the figure. The reviewer can add any information about the subject he is interested in. For example, a reviewer may want to know about the subject's Smoking Status.

Alsoby using the visit and disease stage filters as shown in the above figure, the graph can be updated to any visit or to any disease stage of the subject. For example, the reviewer may want to look at the plot for tumor change from baseline at the end of Cycle 1 or may want to see the results by disease stage of the subject. The above figure is generated based on 'END OF TREATMENT' visit and 'Stage 1' of the disease.

SWIMMER PLOT

Time-to-Event analysis is a very important part in Oncology trials and the best way to summarize the study drug performance is through Kaplan Meier curve. However, the reviewer or the sponsors will be very interested to know how each individual subject is reacting to the study drug. This issue can be resolved by creating Swimmer plot, which is a graphical way of telling disease response 'story' of a subject over time. This plot distinctly provides the fluctuating relationship between the subject's tumor response (e.g. RECIST measurements) and the patient survival.

One traditional way of generating swimmer plot is by using SAS statistical procedures such as SGPLOT. But the output that is generated by SAS is static and does not provide the investigators the ability to dig into the data. Also, modifying and customizing these kinds of outputs is still a complicated process. To avoid these limitations, one can use Spotfire to generate the swimmer plot. With its ease of access, this helps the end user to view their data more interactively and helps in data exploration.

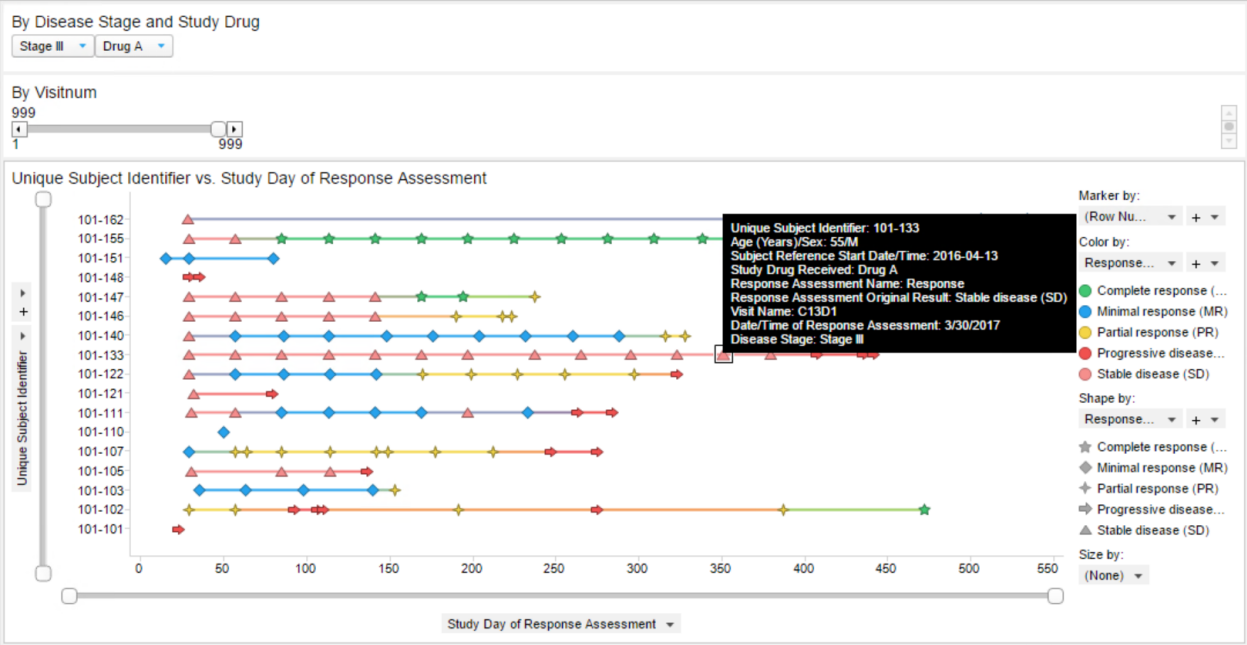

Figure 2 Swimmer Plot

Fig. 2 shows the swimmer plot generated by the Spotfire. The input to the Spotfire is the Disease Response data created in SAS using Study Data Tabulation Model (SDTM) guidelines. The above plot in Spotfire is created by plotting unique subject identifier against study day of the subject differentiated by disease response. The subject's response to the study drug is differentiated by different color and shape. The plot in the above example, shows us different bits of information such as the duration of the disease response, what type of response and when did it start and end, how good the response was to the study drug etc., A tool tip for a subject 101-133 is presented in the figure, which gives us the brief introduction of the subject and this includes Age and Sex of a subject, Subject's Reference Start Date, Type of Drug received by the subject, Visit, Response Date and Study Day of the subject's response assessment, Disease Stage at the baseline and the type of response to the study drug. As said earlier, the information that is included in the tool tip is not limited to what has been shown in the example. The reviewer or the sponsor may add any information that is important for the study.

Spotfire allows the user to add filters on the visualization as shown in Fig. 2. Visit Number slider, Disease stage and Study drug received filters has been added on top of the visual. These filters allow the user to see the plot based on the Disease stage and the Study drug received by the subject. But again, the user can add any number of filters that are needed for the analysis.

KAPLAN-MEIER CURVE

The comprehensive way of representing oncology trial data is through Kaplan-Meier survival estimates plot. This estimate is one of the best possibilities to calculate the probability of subjects surviving for a certain amount of time after the treatment. The main objective of a Kaplan-Meier estimate is to show when a specific event (time-to-event) has occurred for a subject that received the study drug. Overall survival is the event that has been considered in this paper. The event in the estimate can happen at any time during the trial. For example, it may start when the subject received the study drug and end when the clinical end point is reached. The horizontal X-axis in the Kaplan Meier plot represents the time of survival in the trial and the vertical Y-axis represents the event probability.

Kaplan Meier curve is created using 'Line Plot' option in Spotfire. The sponsor or the investigator can choose any end point by creating a filter and selecting a parameter. Here Overall Survival is selected as an end point.

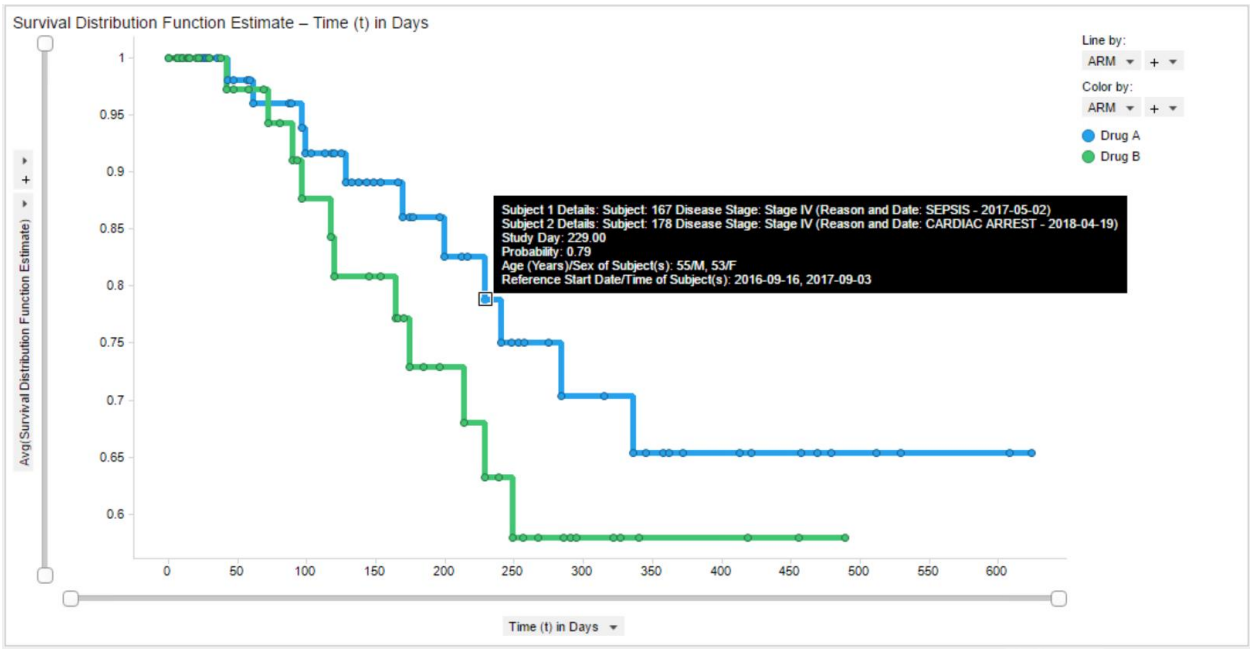

Figure 3. Kaplan Meier curve

Fig. 3 shows an example of the Kaplan-Meier Curve created in Spotfire. A sample clinical trial data is considered, and the event probability is calculated by using PROC LIFETEST in SAS. Due to the static nature of the output created by SAS, it is very difficult for a reviewer to explore and drill down the data further. The reviewer may want to see exactly what was happened and when the event has occurred. For example, the reviewer may want to know the subject information, type of an event, Disease stage of the subject, and when the event has occurred.

The above figure implies that the graph is a step function and dips down when an event has occurred. In the example shown above, two drugs (Drug A and Drug B) are compared based on the survival estimates. A tool tip has been created to help the reviewer to know the information such as Subject ID, Age, Sex, Disease stage, Study Day, Subject's Reference Start Date, Reason and Date of death. The tooltip in the above figure shows that, 2 deaths have occurred on the same study day and the age and reference start dates of those subjects are also shown. When the study has a greater number of subjects, the curve produced by SAS will be clumsy and it will be very difficult for an investigator to interpret the graph on an event level. But in Spotfire, we can interpret the curve very clearly by zooming in to the graph by adjusting the zoom slider available below the x-axis.

CONCLUSION

This paper discussed about how the end user can make use of SAS statistical procedures and Spotfire to create interactive visualizations that can be used to interpret results in Oncology trials effectively. Regardless of the complexity in the oncology data, these visuals (Waterfall, Swimmer, Kaplan-Meier) provides the end users a complete big picture of the data. Adding interactive feature to these visuals gives us the ability to drill down the data further to a granular level, which makes the data review process faster and more effective. By using SAS and Spotfire, reviewers can now review the results of their oncology trials from Day 1 and eliminates the need to wait until the study TLFs are programmed.

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