TITLE: Preparing Manuscripts for Publication: Advice from a Journal Editor - Titles, Abstracts, and Figures

PRESENTER: Dr. Thomas Annesley

Slide 1:

Hi. My name is Thomas Annesley. I am deputy editor of the journal *Clinical Chemistry*. On today's webcast I want to talk to you about preparing manuscripts for publication, advice from a journal editor, titles, abstracts, and figures.

Slide 2:

The objectives of this presentation are threefold. First, I want to emphasize three important items in a manuscript that create a first impression for an editor, peer reviewer, and reader.

I want to illustrate the importance of clarity in your message and use a number of examples to help drive that home. I'll also give you some additional examples of how to give your manuscript more appeal and punch for the reader.

Slide 3:

While publishing is an important aspect for advancement in many careers, it's important to remember that your published work makes little contribution if no one reads it.

Therefore, it is vital that you make your paper clear, concise, and accurate. If a reader cannot understand what you did, then they will move on to another paper and read it, and possibly cite that one over your paper.

Slide 4:

A scientific paper has many components, shown here: the title, the abstract, the introduction, methods, the results, discussion, a summary or conclusion, references, figures and tables. Now time precludes me covering all of these today, so what I want to do on the next slide is to discuss the three components that have a great impact on a first impression that somebody might have of your paper.

Slide 5:

These three components include the title, the abstract, and your figures. And this is what we will cover today.

Slide 6:

Take a look at this billboard. Pretend you're driving down the road and read this as rapidly as you can.

Slide 7:

Clearly you didn't have time to read this. It was too complex, too much information for the time you had while driving down the road.

So what was the real topic and message of this billboard?

Slide 8:

This was the real message of the billboard. If you were driving down the road and were taking time to read this, you'd have no problem reading it and understanding what its message was.

That same complicated message on the previous billboard, which you can go back and see at your convenience, is the same as the message presented here. It's about the most fuel-efficient hybrid vehicle in its class. Clearly this billboard was much more important and much more informative in presenting its important information to you.

So think of the title of your article as the billboard. It's your advertisement. It's your first opportunity to deliver your message to readers.

Slide 9:

The title is the first thing that readers see. So it's important that you draw readers to your article by putting important key words and terms in the title. It's important to be brief while still adequately describing the content of the paper.

You want to avoid catchiness, unless it's a special article. A scientific paper should have a scientific title. A review article, an opinion piece, an editorial might be occasions where you can use a catchy title, but only in those circumstances.

And most importantly the title should stand on its own without a need to read the paper. Certainly the title cannot be comprehensive enough to put all the information about your methods and results. But the title should make it clear to any individual who sees it and reads it what the paper was about, what you studied, and potentially what you're going to show in the paper.

Slide 10:

I'm often asked, "How long should a title be?" Well, being a good politician I try to avoid a straightforward answer. And I always tell people the length of a title should be just right. Now that may seem like a simple answer, but in reality, you'll know when a title is just right.

Shorter is better. Longer is often more confusing. You should try and shoot for 15 words or less. Some journals even have word limits and may limit you to 10 words or 15 or 20 words. So it's important for you to read the instructions from the journal that you have an interest in submitting to, to find out what types of titles they use, what types of titles have been published in previous articles in that journal, and if there are any word limits.

One way to help keep your title shorter is to avoid using phrases such as, "a study of," "investigations on," or "a novel study of." Why would you want to publish something that you didn't do a study on? Why would you want to publish something that wasn't novel? Clearly these are identifiers that don't add much to a title and can be removed without hurting the message.

Slide 11:

In a title it's important to use common abbreviations only, those that your scientific audience and readers will clearly understand and those abbreviations that are relevant to the topic that you are discussing.

So for example, in the U.S. I might use the term CDC instead of the Centers for Disease Control, FDA instead of Food and Drug Administration, IRS instead of the Internal Revenue Service, and of course in your country you may have national offices and national institutes for which there are abbreviations or acronyms. Everybody would know what DNA is or PCR or HPLC so it is OK to use those sorts of abbreviations.

It's important that you include key words in the title that you want indexing services to use. And, unless it's a study that involves human subjects, it's important to state the species and be specific as you can about stating the species. Instead of just saying that you did a study in rodents, make sure that you said that your study was in rats, or mice, for example.

Slide 12:

Word use and order are important in a title, as illustrated in the two examples shown here.

"H1N1 virus testing on mice using polymerase chain reaction," those must be pretty smart mice if they've learned how to use PCR. My boss has always told me he could replace me with a monkey, but if he could replace me with mice to perform PCR, I'm really in trouble.

Look at the second one, "Blood from organ donors stored on ice yields higher crossmatch percentages." I'm not going to volunteer for that study if as an organ donor they're going to store me on ice before they draw blood. You as the researcher would probably have trouble getting this through your ethics committee too.

But again, these are just two examples of the importance of word use and the order in which they are presented can impact the message that somebody takes from your title.

Slide 13:

Look at these two titles, "Treatment of Pediatric Melanoma Patients with Lasers." If I was a physician, I'd hate to walk in the waiting room in my clinic and have all these pediatric patients running around

with lasers, playing "Star Wars." The second title states the same thing, but in fewer words, much more succinctly, "Laser Treatment for Pediatric Melanoma," concise, clear, only one message.

Slide 14:

Now we're going to look at a series of original and revised titles on the next few slides, again, giving you examples of ways you can improve the presentation of your titles and make them more concise, clear, specific, and accurate as far as exactly what you did in your study.

In this slide the original title describes the development and evaluation of a new ELISA for the sensitive detection of lupus-specific antinuclear antibodies. There's a couple of problems with this title.

The first is, as mentioned in another slide earlier, why would you not want to present something that wasn't developed and evaluated? Stating that you developed and evaluated something in a title really just includes useless words.

Secondly, it says that the evaluation was for a new ELISA for a sensitive detection for a lupus-specific ANAs. The term "sensitive" can be arbitrary, and it's really in the eye of the beholder. So using these fairly arbitrary terms doesn't help in most titles.

So, when I looked at a title such as this, the revised title as I had suggested it was as shown below it, "New ELISA for detecting Lupus-specific anti-nuclear antibodies." The title is concise, uses far fewer words, and is very specific about what's being reported, a new ELISA for detecting lupus-specific antinuclear antibodies.

Slide 15:

Let's look at the original title here, "A validated method for simultaneous screening and quantification of multiple opiates by solid phase extraction and UPLC-MS/MS." This title also has a number of problems.

First, as mentioned on the previous slide, why would you want to submit a non-validated method for publication? Stating that you have a validated method really adds very little. You would be proving that in your methods, your results, and your discussion.

Secondly, if you look at the first seven or eight words of this title, it takes a long time just to get to the point of what was the topic of the study. It was the screening and quantification of opiates by solid-phase extraction in UPLC-MS/MS.

If you were to do a Google search and put in a term, "opiates" or "UPLC" and this title was to come up, it's possible that the search engine that you're using might cut the title off after five or six or seven words.

In the case of the original title shown here, what you would see would be "A validated method for simultaneous screening and quantification of" and then the rest would be missing, and you'd have to click on that to see what the actual title was. That may be bothersome to some readers who may just decide to go to the next article in that search engine list of results for which the title might be more clear.

Also in that original title it says that the study was for multiple opiates. Well, what is multiple? That is another subjective term. Was it 3 opiates, was it 10 opiates, was it 15 opiates? And although not fully required in a title, the specimen that was used for the analysis of the multiple opiates is also not included in this title.

So let's look at the revised title, "Simultaneous screening and quantification of 14 opiates in whole blood by solid phase extraction and UPLC-MS/MS." We've now stated that it was simultaneous screening and quantification. We listed the number of opiates, 14. And we included the specimen, which was whole blood, including the technique which was solid-phase extraction and UPLC-MS/MS, basically the same number of words, but a much more informative title.

Slide 16:

Here's another example, "Evaluation of siRNA molecules as sensitive and specific biomarkers of hepatic injury." That reads as an OK title at first look, but it still has some drawbacks.

"Sensitive and specific biomarkers"—well, how are they sensitive and specific? That may be a rather arbitrary and subjective definition in your case. How many siRNA molecules were studied? Was it all of them, was it two?

So let's look at the revised title now, "Plasma siRNA 114β, 146-CE, and 166-α are biomarkers of hepatic injury," much clearer, concise, more straightforward and accurate title. You studied three RNA molecules and found that they were biomarkers of hepatic injury. The second title tells the reader specifically what the article is about and what the final message is.

Slide 17:

Let's look at these two, "Pilot and early proficiency testing results from newborn screening tests for Cystic Fibrosis: Measurements of trypsin in dried-blood spots." A fairly lengthy title, and I would question whether you really need to state whether they were pilot and early proficiency testing results. That could be mentioned in the paper.

My suggestion for a revised title, when a paper similar to this was submitted, was as shown in the second example, "Proficiency testing results for dried-blood spot trypsin for newborn screening for Cystic Fibrosis." Contains about 30 percent fewer words, much more concise, still conveys the same message.

Slide 18:

Let's look at the original title here, "Value of amniotic fluid sphingomyelin quantification in fetuses with G1-α gene mutations of unclear significance." Well what's of "unclear significance" here? Is it the value of the amniotic fluid sphingomyelin has unclear significance? Is it the G1-α gene mutations that are of unclear significance? I don't know. Basically this entire title has unclear significance to me.

The revised title makes it much clearer exactly what was studied. "Amniotic fluid sphingomyelin quantification is useful for identifying G1-α gene mutations of unclear significance." You now realize that it's the gene mutations that are of unclear clinical significance, not the amniotic fluid quantification.

Slide 19:

So in addition to word choice and order, it's also important for you to consider who is your audience, and what do you want Google or other search engine software programs to display?

Let's look at these two titles. The first states that amniotic fluid sphingomyelin quantification is useful for identifying gene mutations of unclear significance. It starts off with "amniotic fluid sphingomyelin quantification." Those are the catch words that are going to draw somebody's attention.

Perhaps you want to emphasize the G1-α gene mutations rather than the amniotic fluid sphingomyelin quantification. In this case you could change the order of the wording in the title to emphasize the gene mutations and that they were identified by amniotic fluid sphingomyelin quantification. In each of these titles it's the same information, but it's emphasizing one aspect of the study versus another.

Slide 20:

Look at these two titles, "Blood stored on ice yields higher crossmatch percentages for organ donors." That title emphasizes that blood was stored on ice and then was studied for its crossmatch percentages.

The wording can be reversed in the title so that now it states, "Higher organ donor crossmatch percentages for blood stored on ice." In this case, the title might draw HLA laboratorians, transplant surgeons, and other people interested in organ donors and crossmatches, rather than the importance of storing blood on ice.

Slide 21:

Again, these two titles describe the same study, but emphasize two different aspects of the study. The first title emphasizes the proficiency testing results for dried blood spot trypsin for newborn screening. The second title talks about Newborn Screening for Cystic Fibrosis: Proficiency Testing Results for Dried-Blood Spot Trypsin.

The first title might draw the interest of clinical chemists, medical technologists, and those individuals who are interested in proficiency testing for the performance of a test, in this case dried blood spot trypsin. The second title, which emphasizes the newborn screening for cystic fibrosis using dried blood spot trypsin, might draw clinicians, internists and other individuals who treat patients with cystic fibrosis. Same study, two different emphases in the title.

Slide 22:

So, again, sometimes it helps to begin the title as soon as you can, if not immediately, with an important word. So let's look at these two examples here. What group of readers would be interested in the content of the papers in these two titles?

Example one, "Halothane-Anesthesia Impairs Pulmonary Function in Newborn Lambs." So the emphasis here in the first words are "halothane anesthesia," which certainly might be of interest to anesthetists and anesthesiologists.

The second title changes the wording a little bit and now states that the paper is about impaired pulmonary function in newborn lambs anesthetized with halothane. Same topic, same paper, but the

title now emphasizes the impaired pulmonary function in these lambs, not the halothane anesthesia. In this case the three starting words, "impaired pulmonary function" might draw the attention of another type of reader, in this case pulmonologists rather than anesthesiologists.

Slide 23:

Again, who's your audience? What do you want to emphasize? And what do you want search engines to display? Here's the same study for which a title is presented in two different manners.

In the first study, the three primary words are "plasma methotrexate quantification," is useful for identifying potentially fatal drug dosages. A clinical chemist, a laboratory, and a medical technologist, or someone who performs methotrexate assays in the laboratory might immediately be drawn to this.

Changing the wording of the title, now the emphasis on the second one is on potentially fatal drug overdoses can be identified by plasma methotrexate concentration quantification. In this case individuals who deal with patients who might have potentially fatal drug overdoses, such as an ER physician, might be more readily drawn to this title.

So again, who is your audience, what do you want to emphasize, what do you want the search engines to display, drug overdoses or methotrexate quantification?

Slide 24:

So here is a summary about the important aspects of titles. First, in every title you want to be brief, yet clear. Clarity is important in all aspects of writing a paper. Word use and word order are important, as I've shown a number of examples.

If possible, try to begin the title with an important word. Something that will catch a reader's attention. You want to use key words or terms that you want identified with your paper, those that will draw reader interest, and those that might be used by indexing services. You want to avoid abbreviations, unless they're common terms. And for studies that don't involve humans, you want to state the species to be most clear to the reader.

Slide 25:

Let's move on to this abstract. I like to think of the abstract as an elevator talk. How many of you know what an elevator talk is? For those people who are involved in sales, the elevator talk represents their 60-second opportunity to describe their product, its importance, and what you want a customer to know about your product in as short a time as possible.

So pretend you're on the 30th floor of a hotel building and the doors open, an important customer of yours walks in and says, "Hey, I wanted to talk to you. Tell me a little about your company and your product." The doors close and you've got 30 to 60 seconds to describe your product, its importance, and why it should be important to your customer before the elevator reaches the first floor.

Well that's basically what your abstract represents to the reader. It's a 60-second opportunity for you to describe to the reader what you did, why it's important, what you found, and what it means for others.

Slide 26:

The abstract is a make or break decision point for editors. Editors don't have time to read full papers, so they look at titles and abstracts first. The content of the abstract is often the only information that an editor will use in making a decision as to whether to review a paper or decline it. Similarly for peer reviewers, the information in the abstract is what creates the first impression for that peer reviewer.

Abstracts also affect the citation rate for a paper. If an abstract is unclear, does not fully describe what was involved in the study, doesn't clearly describe the results and what they mean, an individual may decide to bypass on your paper and go look at another paper to use to reference in their own publications.

Every abstract should include at least these four things. It should include the rationale for the study, what was studied and why. It should include at least some basic description of the study design and the methods used. Clearly you can't include all method details, but you can give a brief description about what type of study it was and basically what methods were used. The abstract must include results. And lastly, the abstract must include conclusions that are supported by the data.

Slide 27:

Creating an abstract is like telling a story by answering questions. In the reintroduction, you might want to describe what problem, question or hypothesis is being studied. Why would it be of interest to the reader? Describe the methods. How did you perform the study? Answer the question or test the hypothesis.

In the results, you want to answer the questions, what did you find? Did you solve the problem through the hypothesis or answer the question? And lastly, in your discussion or your conclusions, you want to state, what do the results mean, and what value do they add to the scientific literature.

Slide 28:

You always want to write or rewrite the abstract after completing the main text. Some people like to jot down an outline for what they would like to have in an abstract, but it's important to rewrite the abstract again after completing the main text. If you think about it, how can you summarize something that hasn't been written yet? If you haven't written the paper, how can you create the summary for it?

Slide 29:

The background is usually presented in the present or past tense. An example of a present tense would be, heart disease is the number one killer of men in the United States. Or you might want to use the past tense and say that CK-MB has previously been shown to be an excellent diagnostic marker of myocardial infarction.

Methods are always presented in the past tense. You did them in the past. You performed them in the past and they should be described in the past tense. We performed the following. We analyzed. Things like that. The results are also presented in the past tense. You obtained the results in the past tense, and they really aren't considered valid until they are accepted for publication.

So in your study you found the following, you observed the following, the results showed something. Your conclusions can be written in the present tense. You are now writing the paper. And you are making present time conclusions about what your data shows. Our study shows that this marker is useful in this disease.

So again, background, present or past tense; methods, past tense; results, past tense; and conclusions in the present tense.

Slide 30:

As editors we see a number of common problems with abstracts. First, the background section of the abstract often fails the logic test. A writer might describe what they did, but not why they did it and why it's important.

The methods section often times lacks sufficient detail. Third, the results section is often too generic. And fourth, the conclusion section essentially restates the results. It does not state conclusions, it basically restates the data.

Now in the next few slides I'm going to give you an example of an abstract for the scientific paper that was written in two different ways, and I want you to read these next slides as we go through them and determine which text is more important.

Slide 31:

So I want you to stop here and read these two different versions of the background section of an abstract for a paper. And when you're done you can start the presentation again. Let's look at the first background description.

Atherosclerotic disease is a major cause of death in the United States. That's OK, it states a topic and it states a fact. The authors then go on to say, "we investigated which analyte, IL-6 or β-selectin, would be a better prognostic marker for atherosclerotic disease." Why did they do the study? What are IL-6 and β-selectin? Why do they choose to investigate those over other markers?

The rationale and the logic for the study just are not clear in this first background.

Let's look at the second background text now. Serum concentrations of the vascular inflammation marker β-selectin correlate with atherosclerotic disease severity.

That's a fact. It's good background. There is an inflammation marker, β-selectin, for which serum concentrations correlate with atherosclerotic disease severity. But β-selectin has a large intraindividual variation. There's the problem. We have a useful marker, but it shows large intraindividual variation that limits its utility. Reading further, we investigated whether IL-6, another marker of vascular inflammation, could predict disease severity and mortality risk.

So now we know the background, the problem, and the purpose of the study. A current marker, β-selectin, correlates with disease but is limited by a large intraindividual variation. So the author shows another marker of vascular inflammation, IL-6, and studied its utility in predicting disease severity and mortality risk, two different backgrounds, the second one much more informative.

Slide 32:

Now stop at this slide, and read the two different versions of the method, and continue on when you have decided which version is more informative.

Let's compare the two. Looking at the first one, the text states that the investigators divided the patients into four groups. OK. What were the four groups? Specimens from each patient were tested for IL-6 and β-selectin and matched against the patient's disease group. That's OK, that's informative.

During the study period, these analytes were measured again to determine whether concentrations changed with disease severity. That's mildly informative, but it doesn't tell you how often the measurements were made or exactly at what time points they were made again during the study.

The text then states mortality was also monitored for each group to investigate any relationship between IL-6 or β-selectin and the risk for death. That's an informative statement.

Let's compare this methods description with the text for the second one. Consecutive outpatients undergoing evaluation for peripheral vascular disease were divided into four categories ranging from no functional impairment, group one, to severe functional impairment, group four. We now know what the four groups were and that they were ranked from no functional impairment in the first group, to severe functional impairment in the fourth.

Blood was collected at baseline and quarterly over three years. And now it describes when blood was collected and at what time points it was measured.

Serum IL-6 and β-selectin were quantified to calculate intraindividual variation and to assess the relationships of these markers to disease severity and mortality. Much more informative. It describes the four groups, describes when blood was collected, and when it was analyzed during the study.

Slide 33:

Take a look at these two texts for the results portion of the abstract, and when you are done reading these, start the presentation again.

Let's look at the first example. IL-6 concentrations were different between groups, with the IL-6 concentration significantly different between groups one and three and one and four. That's somewhat informative, but all it states is the values were different between the two groups. Were they 5 percent different, 500 percent different?

The IL-6 concentrations were significantly different between the groups. Well, were they mildly significant, or highly significant? Was the P less than 0.05 or was the P less than 0.0001?

Go down to the second text. This now states that baseline median IL concentrations were 12, 26, 96, and 144 in micrograms per liter for categories one to four respectively. And it gives you a highly significant B value for categories three and four versus one.

You now have the exact numbers, so you can calculate the exact change across the four categories. And you now know the level of statistical significance. Again, the second example appears to be much more informative.

Slide 34:

Lastly, look at these two conclusions for the study, read them, and when you're done deciding which one is more informative, start the lecture again.

Now let's compare the two. The conclusions in the first are that IL-6 and β-selectin concentrations change with a change in heart disease severity. Intraindividual variation of IL-6 was much lower than β-selectin, further validating the use of IL-6 over β-selectin. Further work is needed to confirm this observation. There are two drawbacks to this conclusion.

The first is that the first couple of sentences basically just restate the results, they don't state conclusions they restate results. IL-6 and β-selectin concentrations changed with a change in heart disease, that's a result. Intraindividual variation of IL-6 was lower than β-selectin. That's a result, not a conclusion.

The only conclusion here is that work is needed to confirm this observation. If you ever want to kill an abstract and kill your chances of having a paper reviewed, end with a weak conclusion that further work is needed. Try to avoid using such final sentences in your papers.

The text for the second conclusion paragraph states that IL-6 appears to be a better marker of disease severity and mortality than β-selectin in patients with peripheral vascular disease exhibiting lower intraindividual variation and significant concentrations with disease severity. Again, it does restate some of the results, but your conclusions are that IL-6 appears to be a better marker than β-selectin.

Slide 35:

Interestingly, both abstracts contain 207 words, but one of the abstracts was clearly more informative than the other.

Slide 36:

You also, in an abstract, want to emphasize and reuse those key words and terms that you want the reader to associate with your paper and indexing services to use. I call this "subliminal advertising."

Slide 37:

Now you don't need to reread this abstract, but this is a rewrite of the second abstract that we saw in the earlier example that I thought was a better abstract than the first. Again, without reading it, I have underlined key words and terms that I use consistently throughout the abstract.

You'll see the terms "vascular inflammation," "β-selectin," "atherosclerotic disease," "β-selectin," "vascular inflammation," "disease severity" and "mortality." In the methods, "functional impairment," "functional impairment" again, "interleukin 6," "β-selectin", "disease severity" and "mortality."

Slide 38:

Continuing on with the results and conclusions from this abstract, you'll see the same terms consistently used again. "IL-6," "β-selectin", "disease severity" and "mortality," "interleukin 6," "β-selectin," and in

the conclusion, "interleukin 6," "disease severity" and "mortality," "β-selectin," and "disease severity" once again.

Whether or not you realized it when you were reading this abstract, I was continually hammering home some key words and terms that you will subliminally now remember for this paper.

Slide 39:

So let's summarize the aspects of a well-written abstract. A well-written abstract should stand on its own without the need to read the paper. It should tell as complete a story as possible. What did you study, why did you study it, how did you study it, what did you find, what does it mean? The reader can find extensive details within the paper, but you should at least be able to answer those questions for the reader.

A well-written abstract states the hypothesis, the question, or objective of the study. It also completes the study by answering that question or answering whether the hypothesis was proven or not. The abstract contains key words and terms that you have in the title and will also extend into the introduction.

You always want to stay within the allotted word count. And the abstract does not contain information that is absent in the paper. This is something that often slips by writers, especially when they're doing a revision or update to a paper.

You may have a peer reviewer that asks for something to be added to a paper or says that some control experiment could just be stated in the text, and really you can take away information, methods, descriptions, figures and tables related to that experiment.

So if you add something to a paper, always remember to see whether that information should be included in the abstract or if you are asked by someone to remove information and text from a paper, make sure that it doesn't remain in the abstract.

Slide 40:

A well-written abstract also doesn't make conclusions that are unsupported by the data. Oftentimes we see conclusions where the authors will state, “this method could be applied to these other tumor markers.” You don't know that. You haven't shown that.

You might predict that because these tumor markers have similar characteristics, the method should be applicable to things like that. But don't make a conclusion for which you don't have supporting data or have not performed the experiments.

Limit the use of abbreviations. Follow the order of the main text. Many journals use what's called the IMRAD format. I-M-R-A-D, which stands for introduction, method, results, and discussion. If that's the order of the sections of a paper, make sure that your abstract parallels in the presentation of information the introduction, then the methods, then the results, then your discussions or conclusions.

Abstracts should not contain references, nor should they contain any reference to tables or figures within the paper, so don't cite tables and figures in the abstract. And again, you want to use the same topic words repeatedly to drive home your message.

Slide 41:

Let's talk a little bit about graphs now. A good graph or a good figure has several attributes. First, it draws attention to the data and not to the graph itself. Some graphs become so fancy and sophisticated that you see the entire image, and you really don't focus in on the data itself. You want your graph to draw attention to the data and not necessarily the axes and the numbers and things like that.

Secondly, the data points, which are usually symbols, and connecting lines should be easy to read and distinguish. Choose symbols that are easy for the reader to see, large enough for them to see, and easy enough for them to distinguish from one another.

As an example, a closed black circle and a closed black rectangle may look very similar when reduced to page print size. You might find it's better to use an open square and a filled square, or an open circle and a closed circle, or an open or a closed diamond to help the reader distinguish the data points and the symbols.

Third, you want to make sure that the numbers and the labels for each of the axes are readable and their meaning is clear.

Fourth, you want the two axes if it's an XY plot to be visually balanced. That generally means that the ratio of the X-axis to the Y-axis is around 1.0 to 1.3. So either the X-axis is slightly longer but not obviously longer than the Y-axis, or the two axes have a similar length to them, more visually balanced, much more pleasing, usually easy for the reader to distinguish and understand.

Slide 42:

There are other attributes that a good graph or figure has. The scales used on each axis must match the range of data. Oftentimes we'll see graphs where the data may only go halfway up on a Y-axis or halfway down an X-axis, and therefore the upper half or the right half of a figure looks completely blank. Use as much of the figure as you can.

Second, tick marks should be used appropriately. The error in this case is to use too many tick marks and then to make them too large.

Third, the legend should be clear and concise. The reader should be able to rapidly determine what the figure is about by a short description in the legend.

The message from the legend and the figure should be understood without the need to refer back and forth to the main text. If a person has to look at a figure, go back a page, look at text to describe it, determine what was done, going back and forth just confuses the reader and minimizes the impact of the figure and the presentation of the data.

And lastly, a good graph deserves to be a graph. All of us in our studies perform many experiments that are control experiments that either prove a simple concept, show something happened, or just validate

that something did not happen. Just because we performed experiments doesn't mean we have to graph them all and include them all in a paper. So consider whether the data truly deserves to be graphed.

Slide 43:

This is an example of what I would consider to be a good figure. This is from a hypothetical study of patients with HIV where they were studying the effect of a new drug, albenovir, in changing the blood viral load after daily oral treatment.

So let's look first at the legend and see if it is informative. The legend states that the figure shows the change in blood viral load during daily oral treatment with albenovir. So it states that you're monitoring a change, it states that the therapy was daily, and it states that the treatment was with albenovir.

The symbols shown in the figure legend corresponding to lines in the actual figure are distinct from one another, closed square, open triangle, inverted closed diamond, open diamond, and closed diamond. Easy to distinguish from one another. In the actual figure, the Y-axis shows the viral particles per mill, and the X-axis shows the time after initiation of treatment in months.

So by looking at the figure and looking at the legend, hopefully it's clear that this is a figure about change in viral load after daily treatment with a drug, in this case albenovir. There were five different treatments, and you're showing the change in the viral load at months one, three, and six. You shouldn't have to go back and forth to the main text to figure out what this figure was about.

Slide 44:

There is more than one way to present data. This is just an alternative approach to presenting the same information and data as in the previous figure, but now placing the symbols and their legend in the figure itself if it helps the reader make more sense of the figure.

So now the figure legend simply states that it's the change in blood viral load during daily oral treatment with albenovir, but now the reader can associate each of the five dosages and their five symbols with the five lines shown in the figure.

You may find that this is an easier way to present your data than the previous example. The point again is to decide on what design of a figure best presents the data and the message that you want to convey to the reader.

Slide 45:

Another example of the same sort of data is shown here. This might be a better slide for a PowerPoint presentation because it makes it very clear to people that the top line represents 0 milligram dose; the second, 2 milligram; 5; 10; and the bottom line 20 milligrams per kilogram.

Again, the figure legend is very simple, just stating that the figure shows the change in blood viral load during daily oral treatment with albenovir. Concise, clear, the figure is designed so that it draws attention to the data itself, not the axes, not the numbers on the axes, but the actual center or data itself within the figure.

Slide 46:

This is an example of the same data presented in two different formats. The left figure shows a comparison of serum and plasma sodium, prepared specimens from 150 patients. Physiologic sodium concentrations generally run from 125 to 160. Because of this, by using two axes, a Y and an X axis, that were drawn to intercept at zero, all of the data points were compressed to the upper right hand portion of the left figure.

It's very difficult to determine if there were any outlier points and how much scatter there really was. By plotting the same data on expanded scales, as shown to the right, where instead of starting at zero, the Y and the X axes started at 120 millimoles per liter, the data is much easier to look at and evaluate for outliers and any problem data points. The right figure makes use of the complete figure and is much more visually a better representation of the data.

Slide 47:

These two figures also show the same data plotted in two different ways. In this case, the investigators were interested in determining, after they drew blood specimens from some rats, how quickly did the plasma alanine concentrations change during storage before they were able to get to the initial analyses of the specimens.

So basically they were looking for a percent change of baseline concentrations versus how long the blood samples were stored at room temperature before they were processed and then frozen for analysis. If you look at the left figure, you can see that most of the data points take up the upper half of the figure and that much of the lower half of the figure is wasted space.

What appears to be happening in the left figure is that oxalate, EDTA and citrate showed no change in baseline concentrations, whereas specimens that were drawn in heparin anticoagulant containing tubes showed a drop of approximately 20 percent within 18 hours. Alternatively, the same data can be shown by expanding the Y-axis, as shown in the right hand figure.

In this case, the Y-axis starts at 70 percent of baseline and goes to 110, while the Y-axis still remains on a linear scale from zero to 18 hours. You can notice two things here. As was shown in the left slide, indeed the specimens drawn with heparin anticoagulant did decrease by about 25 percent at 18 hours.

But by expanding the scale, it now becomes clear that in specimens that were drawn in oxalate anticoagulant containing tubes, the alanine concentrations actually increased by about 8 percent over 18 hours. Expanding the representation of the data can be more clear to the reader and sometimes help you see differences that you might not have normally seen.

Now if you do change the scaling on a figure, as was done in the right figure and the Y-axis, it's very important to note in the figure legend that you did so. And in fact the figure legend shown below states that it’s the percent change in plasma alanine concentrations after storage of whole blood at room temperature. (Note expanded y-axis scale).

Slide 48:

This is data that we generated in our laboratory when we were doing experiments on patient specimens for monitoring tacrolimus concentration. We did two things in this experiment.

We evaluated whether blood drawn in different anticoagulants would be acceptable and showed stability. And we also wanted to make sure specimens were stable over time, so that they could be collected at an offsite location and either delivered the same or next day, or potentially even mailed in to the laboratory.

In this case, the Y-axis is expanded again from 70 to 110. And it becomes very clear that with the four different anticoagulants, that after 72 hours of storage, there was really no change in tacrolimus concentrations when stored at room temperature. This is an informative figure. The problem with this figure is that it presents data that really does not need to be presented as a figure.

This is a good example of generating data and then thinking that you must include a figure showing the experiments in your paper. The information shown in this figure could easily be described in two or three sentences within the main text, that when tacrolimus samples drawn with these four anticoagulants were stored for up to 72 hours before processing, there was no change in tacrolimus concentrations.

Slide 49:

Let's summarize what we've talked about as far as graphs and figures. First, figures should be self-explanatory. You shouldn't need to go back and forth to the main text to figure out what's being presented in the figure. Between the legend, the axes, the symbols, the lines, and any other descriptors, the information in the figure should be self-contained, self-explanatory, and without need to go back and forth to the main text.

Second, within a figure you want to emphasize the data, not the overall graph. You want the reader to focus in on the data. Third, and something that people will often forget, is you need to consider how a graph will look when it finally appears in page print. Like you, I often create figures with software programs like Excel, Stat Graph, SYSTAT, other software packages that will create figures that look very large on the computer screen.

However, when these figures are compressed to a two inch by two inch or five centimeter by five centimeter square image on a printed page, things that appeared clear in the initial figure oftentimes are not readable in the final reduced version. So it's always important to think about how that graph will look when it's in very, very small print in the journal.

Don't include a figure if it wastes space. That last example that I showed you was the inclusion of a figure that really didn't need to be included in the figure. And lastly, sometimes a table or just statements within a text can serve the same purpose as a figure, so think about tables or text as alternatives to always using figures.

Slide 50:

So let's summarize our take home lessons from this lecture. First, titles are your billboard. They're your first advertisement, your first visual advertisement of your paper, the first thing that readers will see. Therefore titles must be as concise as possible, as informative as possible, and really contain the key words and terms that you want the reader to see and associate with your study.

Think of the abstract as your elevator talk. It's your 60-second or 250-word opportunity to describe to somebody what you did, why you did it, what you found, why it's important, and maybe future directions that might be undertaken. You've got 60 seconds, 250 words to get your message across. Therefore make that abstract count.

Lastly, quality and clarity in your graphs and figures is important. Graphs and figures must be understood without the need to go back and forth through the text. Symbols must be clear, legends must be clear, axes must be clear, the message must be clear from a figure. Also make sure that the clarity of your figure is the same when it is reduced to the size of page print, to five centimeter by five centimeter size.

So I want to thank you for participating in this *Clinical Chemistry* Trainee Council webcast. If you want to find more information about upcoming webcasts and other information, you can reach that at the Trainee Council, and I thank you very much for your attention.

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