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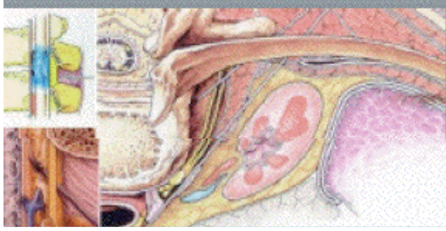
AnesthesiaDotCalm



News You Can Use

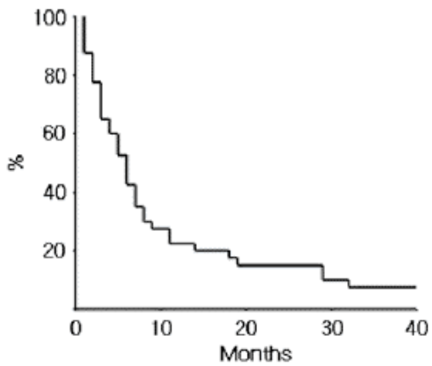
Insights Into Clinical Practice

Why is the Curve Have a Staircase Pattern

The Kaplan-Meier survival curve is often illustrated graphically. It looks like a poorly designed staircase, with vertical steps downward at the time an event we are observing occurs. For example, if we are interesetd in knowing how long teenagers can abstain from sexual intercourse, we would find that the act of sexual conjugation lowers our population an d leads to a vertical drop in the curve. Censoring on the other hand does not cause the curve to take a step down as it does when an event occurs. That's not to say that censoring doesn't influence the curve. Censoring the individual or entity reduces the number of items contributing to the curve, and each death or failure or complication after that point represents a higher proportion of the remaining population, and so every step down afterwards will be a little bit larger than it would have been. This effect on the shape of the curve isn't usually something which you can see just by looking at the curve.

Censoring, in effect, reduces the sample size of the individuals or things at risk after the time of censorship. And remember, reducing sample size always reduces reliability, so the more individuals or things censored and the earlier they are censored the more unreliable the curve is.

Surviving the Curve



Have you ever given much thought to the length of time it would take five guys sitting around watching a football game to devour a large deep dish pizza loaded with pepperoni, sausage anchovies green peppers and mushrooms. I have...about 15 minutes. Or have you ever wondered how many beers you would have to imbibe before you had to pee. Probably not, but I'm sure you can get a government grant to research this activity. After all, the government has a way of squandering our hard- earned money. But I digress. The point here is that some of us, namely researchers, often want to measure how long it takes for something to occur. Often researchers want to know how long it takes for someone to die. They do this because they tend to have a morbid outlook on life. Anyway, to do this, requires them to make an estimate of the fraction of patients who survive for a certain period of time. This estimate is known as a survival curve, although, I tend to think this is a misnomer of sorts because the term can easily be applied to other outcomes which have nothing to do, per se, with survival. For example, researchers may be interested in determining how long it takes for a

We can also look at this data another way. We may want to know how many catheters each day are subject to the risk of failure or censorship. Obviously at the beginning of day one every one of the 36 catheters is at risk for failure or censorship (see table below). Yet by the end of day one, 10 catheters were removed for various reasons and thus by the beginning of day two, 26 catheters remained at risk and by day three, 22 catheters were at risk and so on down the line.

Day	At risk		
1			36
2	36-(8+2)	=	26
3	26-(2+2)	=	22
4	22-(1+2)	=	19
5	19-(1+1)	=	17
6	17-(6+3)	=	8
7	8-(0+2)	=	6
10	6-(0+1)	=	5
12	5-(0+2)	=	3
13	3-(0+2)	=	1

Figure.2

To compute a Kaplan-Meier survival curve, you first need to compute the number of catheters at risk on each day.

This is just the number of catheters that were not previously censored or failures

Next you need to compute what is called in statistical parlance the ***conditional probability of survival***. Simply put, this is the probability that someone or something (in this case, a catheter)will survive at a specific point in time. These calculations appear in the table shown below. Okay, don't panic. This stuff is not so formidable as it appears. The number 1 in each line represents "unity", that is, the number of things, entities, people, or thig-a-ma-jigs at risk divided by the occurrence of a potential event. For example, suppose a room contained 36 couple to conceive or how long it takes for someone to be free of some disease. The statistic that is used to compute the survival curve is known as the Kaplan-Meier estimate. In calculating a person's life expectancy, for example, it would involve computing the number of people who died at a certain time point, divided by the number of people who were still in the study at that time.

Okay, let's see if I can make this concept a little clearer. Time for a little mathematics involving a research study published in a medical journal.

In a study involving 36 pediatric patients undergoing acute peritoneal dialysis through Cook Catheters researchers wanted to estimate how long these catheters would perform properly before any complication would develop (either occlusion, leakage, exit-site infection, or peritonitis). While they made note of the date of a complication, they also noted that a bunch of these patients had their catheters removed before any problems or complications set in. For example, they found that 18 catheters in this group of patients were removed because 4 of them recovered (patients do that sometimes, which it certainly screws up your study), 9 died and 5 were changed electively to a different type of catheter. Catheters removed prior to the development of any complication are considered (for lack of a better word)"censored" because the catheter stayed complication free at least until the time of removal and therefore cannot be figured into the longevity equation. In other words,when we censor a patient or entity , we are removing that person or thing from consideration because, for various reasons, it no longer possesses certain qualities, traits, behaviors, or attributes which had initially made it part of the population being evaluated. The table below lists the days at which failures and/or censored observations occurred.

healthy young women of the child-birthing age. And further suppose that each of these women have the potential to become pregnant at least once. Therefore, 36 women divided by 36 potential events equals 1. By the way, this is another way of saying 100% of these women have the potential to become pregnant. Likewise, in the study involving the Cook catheters, it can be said that all 36 catheters run the risk of failing in some manner. But in fact, as our study shows, they donÕt. What we see is that by the end of day one, 2 of the 36 catheters actually failed leaving 94% (0.94) of them viable and yet remaining at risk for failure by the end of day two. However, by the time the end of day 2 rolls around we have to make allowances for the 8 catheters that were censored the previous day. It is this "condition" that lowers the number of catheters at risk to 26. And because 2 more catheters fail by the end of day two, 92% have survived and yet remain at risk for failing by the end of day three. Likewise, by the end of day three we have to take into account that 2 catheters were censored by the end of day two and with 2 additional catheters failing 91% of the catheters survive and remain at risk as we enter day 4.

Day	1 - (Failures/At risk)
1	1 - (2/36) = 0.94
2	1 - (2/26) = 0.92
3	1 - (2/22) = 0.91
4	1 - (1/19) = 0.95
5	1 - (3/17) = 0.82
6	1 - (2/ 8) = 0.75
7	1 - (1/ 6) = 0.83
10	1 - (2/ 5) = 0.60
12	1 - (2/ 3) = 0.33
13	1 - (1/ 1) = 0.00

Figure 3

Computation of conditional probability of survival.

And now finally, if you don't have anything better to do with your life and you get your jollies by

Day	Censored	Failures
1	8	2
2	2	2
3	1	2
4	1	1
5	6	3
6	0	2
7	0	1
10	0	2
12	0	2
13	0	1

Figure 1: Failures and censored observations for catheter study.

Here we see that at the end of day one, 10 catheters were affected in some way; and by the end of day two another 4 catheters had gone to the wayside; and by the end of day three, 3 catheters fell out of the sample population. Anyway, you get the idea.

doing mental gymnastics, you ask yourself what is the percentage of catheters that survived at a particular point in time? And this is the crux of the survival estimate.

It'"s a no-brainer to see that at the end of day one, 94% of the catheters survived but at the end of day two, 92% of the 94% or 86% of the catheters survived; and at the end of day three, 91% of the 86% (or 82%) survived and so forth until the 13th day where you can calculate that none of the catheters survived (see table below). What we've done here is to compute what is called the cumulative product of probabilities, which is also known as the **Kaplan-Meier estimate of the survival probability.**.

Day	Catheters removed prior to failure	Catheters failed	Catheters at risk	Conditional probability	Cumulative product
1	8	2	34	32/34 =0.94	0.94
2	2	2	34-8-2=24	22/24 =0.92	0.94*0.92 =0.86
3	1	1	24-2-2=20	19/20 =0.95	0.86*0.95 =0.82
4	1	1	20-1-1=18	17/18 =0.94	0.82*0.94 =0.77
5	5	3	18-1-1=16	13/16 =0.81	0.77*0.81 =0.62
6		2	16-5-3=8	6/8 =0.75	0.62*0.75 =0.46
7		1	8-2=6	5/6 =0.83	0.46*0.83 =0.38
10		2	6-1=5	3/5 =0.60	0.38*0.60 =0.23
12		2	5-2=3	1/3 =0.33	0.23*0.33 =0.08
13		1	3-2=1	0/1 =0.00	0.08*0.00 =0.00

INSIGHTS INTO CLINICAL PRACTICE