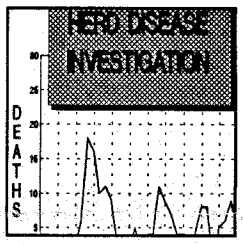
POPULATION MEDICINE NEWS

Epidemiology, Preventive Medicine, Public Health
Production Medicine, Computer Applications in Vet Med

November 9, 1992 5(23)

MAKING POPULATION STATISTICS REAL (AND USEFUL)

The trouble with terms like "mortality rate" is that, in their classroom forms, they have little utility for problem solving. Useful population statistics are dynamic and specific rather than historical and vague.



Part 7

Mike and Duke are discussing an outbreak of disease in a dairy heifer calf raising operation. As is true in most calf operations--and for that matter, most populations of any sort--the individuals in the population are always changing. A new group of neonates is brought in every week, and an equal-sized group of older calves is weaned and moved to a different facility. In such populations, off-the-cuff terms such as "mortality rate" are often difficult to interpret. Mike has just indicated that, according to the calf operation's owner, the mortality rate has increased from its usual 2% to 20%.

Duke: Do you feel this is accurate?

Mike: Henry's an honest guy; I believe what he tells me.

Duke: What did he mean when he said "the mortality rate is 20%."?

Mike: That 20% of his calves are dying.

Duke: They are gasping their last as we speak?

Mike: No, I mean 20% of the calves died recently.

Duke: Mmmm, 20% of them died on one day. This sounds like a poisoning.

Mike: No, no... not in one day; over the past couple of months or so.

Duke: Which calves died over the past 2 months?

Mike: Henry's calves! Whose do you think?

Duke: So, how many calves have been at risk during the past 2 months?

Mike: Well, about 30 per week arrive. So I guess it would be about 240.

Duke: So, Henry just started in business 2 months ago and did not receive any calves earlier than that?

Mike: No, he's been in business for years.

Duke: Then there have been considerably more than 240 calves at risk at some point during the past 2 months. Those that came in, say, 12 weeks months ago were still at risk as late as 1 month ago.

WEEK BEGINNING	NUMBER OF CALVES ENTERED	DIED*
06/07/88	20	1
06/14/88	27	0
06/21/88	20	0
06/28/88	32	0
07/05/88	41	1
07/12/88	40	1
07/19/88	27	0
07/26/88	17	1
08/02/88	36	0
08/09/88	19	0
08/16/88	36	3
08/23/88	40	1
08/30/88	35	2
09/06/88	32	1
09/13/88	33	0
09/20/88	24	4
09/27/88	39	1
10/04/88	33	1
10/11/88	0	2
10/18/88	55	7
10/25/88	36	8

* < 8 weeks of age

Screen 1

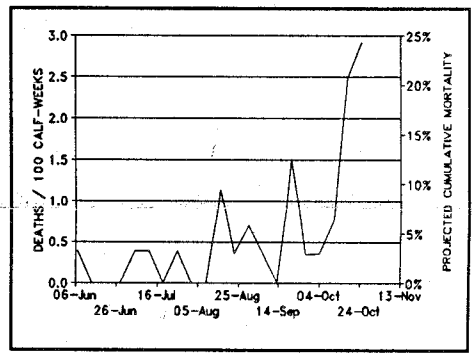


Figure 1. Dynamic measures of mortality tell us what is happening in a particular week rather than historically.

Mike: Well, I guess that's right. Henry must have meant that, of calves that have come in during the past 2 months, 20% have died.

Duke: Since most of these calves that have come in during the past 2 months have not yet completed their risk period, the true rate at which calves are dying over their pre-weaning period is much higher than 20%. Right?

Mike: Doesn't sound right. I'm not sure exactly what Henry did mean.

Duke: Here is several months worth of data from a similar operation (Screen 1). Now, look at this, Mike, and tell me how would you would compute mortality rate.

Mike: Well, I guess I'd divide the number that died in a particular week by the number that came in that week. That would be 5% for the week beginning June 8 and so on.

Duke: Do you think that the calf which died during the week of June 8 was one that arrived during that week?

Mike: Well, maybe not since it could have been any age up to weaning. Why couldn't we just keep track of how many of the calves that arrived on, say, June 8

	A	B	C	D	E
1				NUMBER OF CALVES	
2	WEEK	NUMBER OF CALVES		ENTERED	ESTIMATED
3	BEGINNING	ENTERED	DIED	LAST 8-WKS	AT RISK
4	06/07/88	20	1		
5	06/14/88	27	0		
6	06/21/88	20	0		
7	06/28/88	32	0		
8	07/05/88	41	1		
9	07/12/88	40	1		
10	07/19/88	27	0		
11	07/26/88	17	1		
12	08/02/88	36	0	260 *	258.0 **

* @SUM(B4..B12)
** +D12-0.5*@SUM(C4..C12)

Screen 2

eventually died?

Duke: You could. This is called cumulative mortality incidence rather than mortality rate. Unfortunately, it is a historical number. In knowing that 20% of calves which arrived during a particular period died *eventually* we would not know when they died. If we want a dynamic measure of mortality that reflects what is happening in a particular week, then cumulative incidence won't do.

Mike: What will, then?

Duke: We need to get an estimate of the number of calves at risk during each week. Though there are more complicated ways, here's an easy method (Screen 2). Note that in cell D12 the number of calves which entered in the current week plus the previous 7 has been summed. In cell E12, half the number of calves which died during the same interval have been subtracted. This is necessary because when calves die, they are no longer at risk of dying in a later week--the size of the population at risk is reduced. Since we do not know the ages of the dead calves from the data shown, it is possible, for example, that the calf which died during the week of July 12 might have been 7 weeks old at that time and would have no longer been at risk anyway by August 2. We subtract only one-half of the sum of the dead calves to reflect this uncertainty about the ages of particular calves. Though it is possible to compute the exact size of the population at risk, this is complicated and will have very little impact on the size of the at-risk group.

Now we copy our formula down. Since we do not have data for entry groups prior to June 7, we must extrapolate our data from the week of August 7 backwards (Screen 3). This will not be a problem if we can be confident that the population has been fairly stable in size (otherwise we will need to go back and find some earlier data). In disease investigations, we usually project our mortality rate computations back to a period of low rates when small assumptions about the size of the population at risk have minimal impact on the computed rates. Next, we divide the number of deaths by the number of calves at risk as in column F. Here we have an estimate of the instantaneous rate at which calves are changing from living to dead. We have chosen to express the rate in deaths per 100 calf-weeks but we could change it to any other convenient unit (e.g., deaths per 1000 calf-days).

A	B	C	D	E	F	G
WEEK BEGINNING	NUMBER ENTERED	NUMBER DIED	ENTERED LAST 8WK	ESTIMATED AT RISK	DEATHS/100 CALF-WEEKS	PROJECTED CUM. MORT.
06/07/88	20	1	260	258.0	0.4 *	3.1% **
06/14/88	27	0	260	258.0	0.0	0.0%
06/21/88	20	0	260	258.0	0.0	0.0%
06/28/88	32	0	260	258.0	0.0	0.0%
07/05/88	41	1	260	258.0	0.4	3.1%
07/12/88	40	1	260	258.0	0.4	3.1%
07/19/88	27	0	260	258.0	0.0	0.0%
07/26/88	17	1	260	258.0	0.4	3.1%
08/02/88	36	0	260	258.0	0.0	0.0%
08/09/88	19	0	259	257.5	0.0	0.0%
08/16/88	36	3	268	265.0	1.1	8.7%
08/23/88	40	1	288	284.5	0.4	2.8%
08/30/88	35	2	291	286.5	0.7	5.4%
09/06/88	32	1	282	277.5	0.4	2.8%
09/13/88	33	0	275	271.0	0.0	0.0%
09/20/88	24	4	272	266.0	1.5	11.3%
09/27/88	39	1	294	288.0	0.3	2.7%
10/04/88	33	1	291	284.5	0.4	2.8%
10/11/88	0	2	272	264.5	0.8	5.9%
10/18/88	55	7	291	281.5	2.5	18.0%
10/25/88	36	8	287	274.0	2.9	20.8%

* C4/E4*100 ** 1-@EXP(-F4/100*8)

Screen 3

Mike: Those numbers seem pretty low. The operation from which you obtained these data must have had exceptional management.

Duke: Not so. People are used to speaking of "mortality rate" when they really mean cumulative incidence. Cumulative incidence is like measuring the number a miles you've gone at the end of a day of travel rather than your speed at particular points in time. But, for problem solving we need instantaneous rates--what's happening now. Officer Smokey will not care about your average speed for the day if you were going 80 mph at that unfortunate instant in which he was "in the grass" with his "ears up." Yet, in knowing your instantaneous speed in mph or kph you can still compute the *expected* distance you will travel over any specified time period *assuming you continued at your present rate*. Similarly, by using the formula in Column G we can compute the *expected* cumulative incidence to weaning (8 weeks) *if the rate that is presently occurring were sustained over the 8 weeks to weaning.* Note that in the example data, the rate during the week of August 2 would result in a 20.8% cumulative mortality incidence if sustained for 7 more weeks. As shown in Figure 1, the transformation of rate to the more familiar cumulative mortality is cosmetic; effectively, we've only added a scale on the right. [small deviations exist]

Mike: It never was this complicated back in vet. school.

Duke: Computing mortality rate has always been the same for people who used data from real problems rather than make-believe ones.

POPULATION MEDICINE NEWS is produced by the Washington State University Field Disease Investigation Unit, Pullman, WA 99164-6610 (509-335-0711) and is supported in part by the WSU Cooperative Extension Service. Viewpoints expressed are not necessarily those of the University or its Administration. This newsletter may be copied by anyone. Editors: Dale Hancock and Susan Holler.