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The Outlier Who Wasn't

By Susan D'Agostino

Kyle was an uncommon student in my advanced statistics class. An Army veteran who had served in Iraq, he was not only older than the other students but was also studying business, while most of the others were math majors. And his grades were well above average. Most uncommon of all, Kyle died before the semester ended.

My ambitious students have the opportunity to make strides that position them for bright futures, and Kyle was definitely ambitious. As might be expected from a soldier, he did not flinch when he failed the first exam. Rather, he told me, "I was too confident pressing buttons on the statistical software. Now I understand you want me to explain what I'm doing." After he sought my help, his performance on the second exam drastically improved. So I offered him a deal: Continue on the upward trajectory, and his first exam grade would disappear. He responded by becoming the most active participant in class.

"Aren't you concerned about multicollinearity?" Kyle asked a classmate one day, undeterred by the prospect of looking foolish if he mispronounced "multicollinearity." When he did mispronounce it, he simply tried again, this time taking care with each syllable so that he got it right. Kyle was also the first student to utter "heteroscedasticity" aloud in class. He laughed at his first botched attempt but, as with "multicollinearity," succeeded the second time. No one would have accused him of showing off. Rather, the other students admired him, an ordinary guy who understood advanced statistics and was having fun to boot.

In short, Kyle was what is known in statistics as an outlier. Many statisticians disregard outliers, but I prefer to consider their impact. Occasionally they highlight a flaw in a statistical model. In

class, I might explain the ambiguity of so-called outliers using a scatterplot concerning student success on an exam.

With "number of hours studied" on the horizontal axis and "grade earned on the exam" on the vertical axis, each dot on my scatterplot would represent individual student metrics. Because students who study zero, one, or two hours are likely to earn poor grades on the exam, while students who study eight, nine, or 10 hours are likely to perform significantly better, one might hypothesize a straight-line model for student performance based on hours studied.

In this model, a student who studied 16 hours but does not see a proportional increase in his grade compared with the student who studied 10 hours would be considered an outlier. Of course, this student might not be an outlier; the law of diminishing returns is probably at work here. The flaw is in the straight-line model. That is, a curved-line model might be more appropriate. In superimposing a curved line over the dots on our scatterplot, we observe that the so-called outlier student may not, in fact, be an outlier after all.

So maybe Kyle *wasn't* an outlier. In many ways, he was exactly like my other students. Though 30 years old, he was still quite young. He was president of the campus chapter of the Student Veterans of America, loved the Boston Red Sox, was nurturing a relationship with a young woman, and eagerly anticipated his graduation. Maybe, as the government and universities work to ensure that veterans have access to emotional, practical, and financial support, individuals like Kyle eventually will fall in the center of our undergraduate student demographic. No doubt our classrooms, as well as our nation, would be better for it.

I was shocked when I learned that Kyle had died after a short illness. When we had exchanged emails the week before, he hadn't told me that his condition was life-threatening. Rather, he apologized for having missed class and told me he would present his end-of-semester project in our last class, just days away. In a subsequent email, he revealed that he had been hospitalized, but added, "They're saying I'm going to be out of here by Tuesday at

the latest." Our last class was scheduled for Thursday, two days after he died. Had Kyle been worried for his life as he wrote me those emails?

If he was willing himself back to health and normalcy, I understood the inclination. Oddly enough, six months earlier, I had faced my own serious illness. At the time, I continued email correspondence while hospitalized, without revealing my situation. There was some question about my chances of survival before an experimental treatment saved me.

Had Kyle's illness actually been as "short" as the university's email to the community had indicated? And why had I survived while Kyle had not?

Though Kyle and I had never discussed mortality directly, we came close twice. The first time was on Veterans Day, one month before he died. He invited me to hear him read out the names of soldiers who had died in Iraq and Afghanistan. He once confided to me that he felt that his responsibilities as campus president of the student-veterans group outweighed his responsibilities as a student. He had achieved near-perfect grades; I was moved to realize that his bar for honoring fallen soldiers was set even higher.

The second occasion took place shortly after Veterans Day. The illness I endured had brought on an autoimmune condition that put me at an unpredictable risk for anaphylactic shock. One night I woke at 4 a.m. to discover that my eyes, face, and throat were swelling. With some intervention, the crisis passed by 9 a.m. I headed to class, opting to wear sunglasses until the eye swelling and pain subsided.

"The sunglasses?" Kyle asked me discreetly just before class began. I offered him the brief explanation I planned to announce at the start of class: I was on the other side of a recent allergic-like reaction. Then I told Kyle something I did not plan to tell the class: There was an EpiPen in my purse, as my reaction could happen again. Kyle looked at me and nodded, an unspoken gesture indicating that he would help if I was unable to help myself.

When an invested teacher encounters a committed student, all concerns but the life of the mind become trivial. Kyle was grateful that I had not canceled class and was neither distracted by nor indifferent to the additional information I had provided. He was a man of action. In the event of an emergency, he would retrieve my EpiPen and stab me with it. In the meantime, we would engage in fostering a hard-core statistical discussion.

Thankfully, the EpiPen was not necessary, and we made progress that day in understanding residual plots for our multiple-regression models. Later my eyes returned to normal and I removed the sunglasses.

I did not sleep much the night before that last statistics class. My eyes were swollen, but not from the risk of anaphylactic shock. Students are creatures of habit who essentially assign themselves seats on the first day of class that they keep all semester. Kyle's seat was empty, of course.

What sense will I make of mortality when one of my perpetually young and intensely engaged students dies? I don't know. I do suspect, however, that I should consider the impact of this outlier —or was he not an outlier?—who was inclined to laugh, persevere, honor, study, and protect as he made his way through not just college but life.

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