

donation after cardiac death donors. This is based on a comprehensive national survey and United Network for Organ Sharing analysis of donation after cardiac death outcomes, which were completed at the direction of one of our own surgeons, Dr Linda Sher, as part of the American Society of Transplant Surgeons Scientific Studies Committee, with funding from our local organ procurement organization, One Legacy.³

REFERENCES

1. Luckett K, Kaiser TE, Bari K, et al. Use of hepatitis C virus antibody-positive donor livers in hepatitis C nonviremic liver transplant recipients. *J Am Coll Surg* 2019;228:560–567.
2. Kim WR, Lake JR, Smith JM, et al. OPTN/SRTR 2016 annual data report: liver. *Am J Transplant* 2018;18:172–253.
3. Sher L, Quintini C, Fayek SA, et al. Attitudes and barriers to the use of donation after cardiac death livers: comparison of a United States transplant center survey to the United Network for Organ Sharing data. *Liver Transplant* 2017;23:1372–1383. Available at: <http://doi.wiley.com/10.1002/lt.24855>. Accessed April 2, 2019.

Disclosure Information: Nothing to disclose.

Causation in Interventional Observational Studies



Thomas R McLean, MD, JD, FACS
Shawnee, KS

In a recent issue of the *Journal*, Turner and colleagues¹ described how, after their hospital was identified as an American College of Surgeons NSQIP outlier for *Clostridium difficile* (*C difficile*) infection, a series of interventions was associated with a substantial reduction in *C difficile* infection over the next year. The article is well written and there is no question that Dr Turner's hospital put a lot of time and effort into quality improvement. But because this article does not contemplate ergodicity (ie the dynamics of complex systems), whether the interventions caused the reduction in the rate of *C difficile* infection remains open.

Ergodicity concerns how much a system will fluctuate over time due to randomness alone.² If healthcare delivery occurred in a perfect ergodic system, then given an infinite amount of time, a provider's healthcare metrics (eg NSQIP) would spend time at every level of the quality of care spectrum. At the other end of the healthcare delivery's ergodic continuum is the absorption barrier, where once you are at a certain level of quality (good or bad),

then absent intervention, your quality of care will remain at that level indefinitely. An implied assumption of Turner and colleagues'¹ article (and for that matter almost all observational quality improvement articles) is that a provider's quality of care is fixed by an absorption barrier. This implied assumption allows the reader license to believe that the Dr Turner and colleagues' interventions caused the observed improvement in quality of care.

Although perfect ergodicity is not a hallmark of our healthcare system (as discussed later), it is very unlikely that the quality of care delivered by a provider is "fixed in stone" by an absorption barrier. Here it is not important to determine the exact level of ergodicity in our healthcare system, only that some degree of randomness is present. Once we allow that randomness plays a part in healthcare delivery, it becomes clear that the outcomes of interventional observational studies have a large component of regression to the mean. In the 2011 book, *Thinking, Fast and Slow*, Nobel Laureate Daniel Kahneman³ pointed out the fallacy that positive feedback improved a pilot's skills. A pilot's performance on a particular flight reflects the pilot's overall skill plus a certain degree of random fluctuation in that skill. Accordingly, improvement in a pilot's performance after receiving feedback (a form of intervention) was due to regression to the mean, not the feedback. Similarly, randomness in healthcare delivery means that observational studies demonstrating improved healthcare delivery post intervention have more to do with regression to the mean than evidence that the intervention cause improved quality of care.

I do not believe that healthcare delivery is perfectly ergodic. Providers who deliver suboptimal healthcare because of a lack of intelligence, laziness, substance abuse, or alcoholism will never deliver outstanding healthcare because of random fluctuations in that provider's abilities. But because our healthcare system exists somewhere on the continuum between perfect ergodicity and an absorption barrier, regression to the mean haunts every observational study to improve healthcare delivery.

REFERENCES

1. Turner MC, Behrens SL, Webster W, et al. Multidisciplinary approach to *Clostridium difficile* infection in adult surgical patients. *J Am Coll Surg* 2019;228:570–580.
2. Taleb NN. *Skin in the Game*. New York: Penguin Random House; 2017.
3. Kahneman D. *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux; 2011.

Disclosure Information: Nothing to disclose.