Editorial Commentary: Recovery After Anterior Cruciate Ligament Reconstruction Is Optimal About 85% of the Time

M. Allison Stegner, Ph.D., and Brian B. Gilmer, M.D., F.A.A.N.A., Editorial Board

Abstract: Recovery after anterior cruciate ligament reconstruction is optimal about 85% of the time. Revision surgery, psychiatric history, preoperative chronic knee pain, and subsequent knee injury are associated with suboptimal recovery patterns. Sophisticated growth models can analyze patient recovery trajectories. Growth mixture models (GMM) treat a whole cohort as a single group and characterize that group over time, for example, over the course of knee injury and subsequent recovery after surgical reconstruction. Latent class growth analysis is a subcategory of GMM that sorts the cohort into subgroups and allows analysis regarding groups having, for example, standard, delayed, and suboptimal recoveries. This theoretically allows a physician to anticipate which patients are likely to follow a suboptimal trajectory of recovery, to track that recovery based on the model, and to form a treatment plan accordingly.

See related article on page 2480

The most common procedures we perform as sports medicine surgeons will have a successful outcome in 85% of cases, and in 15% of cases, there will be some degree of clinical failure. Perhaps the rule is best proven by example. Eighty-three percent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction.[1] The rate of recurrent instability after arthroscopic Bankart repair is 15%.[2] The overall rate of successful healing of meniscal tears in anterior cruciate ligament (ACL) reconstructed knees is about 82%.[3] Although the precise numbers may vary on the basis of the study methodology, the numbers tend to hover consistently around the 85/15 rule.

The next logical question then, which the authors of the current study "Patients Follow Three Different Rates of Recovery Patterns Following Anterior Cruciate Ligament Reconstruction Based on IKDC Score" by Gursoy, Clapp, Perry, Hodakowski, Kerzner, Singh, Vadhera, Bach, Bush-Joseph, Forsythe, Yanke, Verma, Cole, and Chahla,[4] attempt to answer is: Who are the 15%? This information is important since it informs both clinical decision making for the surgeon and preoperative counseling for the patient.

In brief, the authors found that patients after ACL reconstruction tend to follow the 85/15 rule. If we combine the 77% of patients who have sustained improvement from preoperative to 1-year follow-up with the sustained improvement from 1-2 years (Class 1), with the 10% of patients who demonstrated functional improvement from 1-2 year follow-up (Class 2), we have a total of 87% of patients with acceptable functional outcomes at 2 years. The remainder (Class 3) demonstrated slight functional improvement at 1 year follow-up with a subsequent decline by year 2 follow-up. Furthermore, revision surgery, psychiatric history, preoperative chronic knee pain, and subsequent knee injury were associated with suboptimal recovery patterns.

The statistical methods to perform this type of analysis merit closer inspection. The authors use two special types of growth models—growth mixture models (GMM) and latent class growth analysis (LCGA)—to identify subgroups sharing similar characteristics from

Stanford University (M.A.S)

The authors report the following potential conflicts of interest or sources of funding: B.B.G. reports consulting fees from Arthrex; speaker fees from Arthrex and Doximity; travel support from Arthrex; board membership of a Clinical Advisory Board for Smart Medical Devices; committee or board member of Arthroscopy *and AANA; stock or stock options from ROM3 and Doximity; research support from Arthrex, outside the submitted work; financial support for research from Mammoth Orthopedic Institute; teaching fees from Reno Regenerative Medicine and Mammoth Sports Course. Full ICMJE author disclosure forms are available for this article online, as supplementary material.*

0749-8063/22598/$36.00
https://doi.org/10.1016/j.arthro.2022.05.001

within a larger more heterogenous whole. Traditional growth modeling methods treat the study cohort as a single, homogenous population and seek to summarize a single temporal trajectory (e.g., from pre- to post-operative recovery) within that population. GMM and LCGA are an extension of these methods, instead identifying previously unspecified and unrecognized subgroups within the larger study cohort based on similarities in their temporal trajectories.[5,6] Critically, these models are designed to detect subgroups when group membership is not known a priori. LCGA is a special case of GMM, which assumes that individual trajectories within a subgroup are the same, by setting the variance and covariance estimates within each group to zero.

Because the number of significant subgroups within the cohort is, by definition, unknown, the authors ran six GMMs and LCGAs, specifying between 1 and 6 subgroups in each case. Comparing among these models, the model with 3 groups was preferred because 1) the smallest subgroup was at least 5% of the total cohort, allowing for robust subsequent comparison among the subgroups, and 2) a Bayesian Information Criterion (BIC) model selection statistic indicated that 3 groups was better than either 1 or 2 groups, and adding groups achieved only marginal improvements in the model fit. BIC also indicated that the GMM models outperformed the LCGA models.

It is also possible to use these models to relate the different subgroup trajectories to individual covariates.[6] In the case of this study, the authors selected patient demographics, concomitant injuries, and other parameters, and chose to use post hoc tests to explore the influence of covariates on recovery trajectory. This theoretically allows a physician to anticipate which patients are likely to follow a suboptimal trajectory of recovery, to track that recovery based on the model, and to form a treatment plan accordingly.

If you did not catch all that, it's ok. I had to invite a biostatistician to coauthor this editorial. One might ask, "Why bother to learn about this methodology?" For one, since this methodology has been subjected to peer review and accepted, a regular *Arthroscopy* reader might expect to see articles using the same techniques applied to different clinical pathologies in the coming years, and it would be wise to familiarize yourself with the methods. Still, beyond the academic reasons, the clinical utility seems low. Particularly because the factors associated with poor outcome trajectories are not particularly modifiable, and because many of these factors have been identified previously by other research methods.

In fact, during editorial review, several reviewers and editorial staff specifically questioned the clinical relevance of this manuscript. They asked, in different ways, "So what? How does this information help us treat the patient in front of us in the exam room?" The potential use for this information is in counseling individual patients regarding their potential for outcomes after anterior cruciate ligament reconstruction (ACLR). I tend to use the 85/15 rule during the preoperative clinic visit with patients for a host of procedures, not just ACLR. It is simple, memorable, and patients seem to grasp a 15% chance of suboptimal recovery.

In summary, complex statistical methods aside, this article confirms that what we observe empirically in practice as true, is probably true. At its most basic form, science, particularly clinical science, is intended to confirm and demystify our observations about the natural world. The difference between superstition and science is that science will seek to explain why a phenomenon occurs, test and refine our understanding, to not act on information out of habit alone. A rule that holds up to different avenues of scientific inquiry is more robust and more likely to be true.

Although the statistical models used in this article may be in fashion now, they may not be in fashion tomorrow. As scientists, we should always seek new ways to test our observations. As clinicians, we must remember our own experience and the time-tested wisdom obtained from our mentors. This is the balance between the science and art of medicine, each ideally reaffirming the other.

References

1. Lai CC, Ardern CL, Feller JA, Webster KE. Eighty-three per cent of elite athletes return to preinjury sport after anterior cruciate ligament reconstruction: A systematic review with meta-analysis of return to sport rates, graft rupture rates and performance outcomes. *Brit J Sports Med* 2018;52:128-138.
2. Boileau P, Villalba M, Héry JY, Balg F, Ahrens P, Neyton L. Risk factors for recurrence of shoulder instability after arthroscopic Bankart repair. *J Bone Joint Surg AM* 2006;88:1755-1763.
3. Cannon JRWD, Vittori JM. The incidence of healing in arthroscopic meniscal repairs in anterior cruciate ligament-reconstructed knees versus stable knees. *Am J Sports Med* 1992;20:176-181.
4. Gursoy S, Clapp IM, Perry AK, et al. Patients follow three different rate of recovery patterns following anterior cruciate ligament reconstruction based on IKDC score. *Arthroscopy* 2022;38:2480-2490.
5. Nilam R, Grimm Kevin J. Methods and measures: Growth mixture modeling: A method for identifying differences in longitudinal change among unobserved groups. *Int J Behav Dev* 2009;33:565.
6. Jung T, Wickrama KA. An introduction to latent class growth analysis and growth mixture modeling. *Social and Personality Psychology Compass* 2008;2:302-317.