Requirements of Minimum Statistical Knowledge for Academic Surgeons

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In a comprehensive review of the primary research regarding general surgery published in core clinical journals, Dr Williams and colleagues[1] found that 93.5% of the reports were observational, and the chi-square test was most frequently used, followed by logistic regression and Student's *t*-test to analyze them. Dr Williams and colleagues suggest that the priority to bridge the gap in statistical literacy is learning these statistical procedures. In the era of big data, however, understanding the concept of statistical models may be required for surgeons.

Surgical and statistical training may share the process in which the principle based on scientific evidence endorses the justification of practice. In the first issue of the *Lancet* (October 1, 1823), the outline of a surgical lecture at St Thomas's Hospital in Central London was published; in this outline, the lecturer said that operations cannot be safely undertaken by any surgeon without possessing a thorough knowledge of anatomy and physiology.[2] Even now, this is true. Likewise, acquisition of the practical skill for statistical tests alone is not enough to correctly interpret the results of observational studies.

In order to minimize the bias inevitably associated with data obtained from observational studies, several statistical models can be considered. For each model, multiple statistical procedures are commonly performed, as mentioned in the review.[1] Basic statistical tests can be quickly performed using a calculator on free web sites, such as chi-square test,[3] Student's *t*-test,[4] and Mann-Whitney U test.[5] More complex tests, including multiple logistic regression and discriminant analysis, can be performed using a computer-aided statistical package, even without having a specific knowledge of statistics. However, choosing an optimal statistical approach to big data is challenging for surgeons. Performance of logistic and Cox models decreases as the number of variables per outcome increases (1 predictive variable should be studied with a minimum of 10 outcome events[6]). Furthermore, logistic regression by itself does nothing to make the inputs actually independent of each other, and including statistically significant variables does not mean that they are important.[7] On the basis of performance of available classifiers in the test set, the American College of Surgeons NSQIP has replaced ordinary logistic regression models with hierarchical regression models for hospital classification. Although machine-learning classifiers produce a robust separation when big data are given, it would be difficult for surgeons to use them.

Use or review of propensity score (PS) methods for analysis of surgical data has increased from 32 reports in PubMed in 2008 to 642 in 2017, probably because the concept of PS is easy to understand and PS analysis could be considered as a quasi-randomized controlled trial. Propensity score is defined as the probability of being exposed to or receiving a particular treatment. The collection of predictors for exposure or treatment is collapsed into a single variable of the propensity using logistic regression or discriminant analysis. The PS lies between 0 and 1 by definition. Although the best method for variable selection for PS has not been established, a majority of biomedical statisticians recommend incorporating all observed variables into the analysis.[8] To avoid overfitting due to many variables, artificial intelligence is expected to select variables only related to outcomes, when prospective cohorts provide big training data.

Among several PS methods, PS-matched analysis is most frequently used, and it may be more effective than other methods for reducing the bias.[8] In PS-matched analysis, key methodologic components are justification of variable selection, matching ratio, method to choose the nearest neighbors, and balancing of each covariate in the matched pairs, as measured by standardized mean difference. Of the 97 studies assessing a surgical procedure using PS-matched analysis, only 9 (10%) reported all 4 key elements,[9] yielding a concern about correctness and reproducibility of the analysis. Because a substantial percentage of subjects may be discarded for PS-matching, sample size must be larger than for randomized trials, if treatment effects in the cohort are expected to be comparable with those in the trials.

Concurrently with acquiring the statistical skills, surgeons are encouraged to learn the basic concept of commonly used statistical models.

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Damage Control Partnerships: Trauma Care Capacity-Building Abroad

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More than 15% of the global burden of disease is attributable to surgical causes[1] and of these, 5 million deaths per year are attributed to injury—more than HIV/AIDS, tuberculosis, and malaria combined. Ninety percent of these occur in low-middle income countries.[2] Additionally, many Americans work in or travel through regions where outcomes from individual injury, natural disaster, or terrorist events are worsened by lack of access to adequate resources.

Department of Defense (DoD) personnel are not routinely exposed to managing complex trauma, especially in austere environments commonly encountered during deployment. Increasingly, as Dr Demetrios Demetriades reported,[3] they rely on predeployment immersion in American academic trauma centers, which have resources typically not available in combat theaters.[3]

To address this convergence of needs, the authors propose the following:

1. The DoD, along with the US Agency for International Development, the State Department, and the American College of Surgeons (ACS) invest in building surgical capacity at select hospitals in low-middle income countries, building on existing partnerships between the ACS and regional surgical colleges and other authorities.
2. The ACS Committee on Trauma partner with ACS Operation Giving Back to develop resource-appropriate trauma guidelines and training curricula in concert with the World Health Organization, regional surgical authorities, and partner nations' ministries of health. These stakeholders will identify the goals for DoD and partner nation trauma providers and work to establish 5-year roadmaps in low-middle income countries to build capacity.
3. The DoD and partner US civilian medical centers rotate staff to share best practices while learning how to manage trauma and acute surgical conditions in resource-constrained environments, as well as generate relevant clinical research.

In Rwanda, the US Agency for International Development is working with the WHO to develop a surgical workforce that includes 23 partners; the DoD could provide staffing and lessons learned from its Joint Trauma System. In Malawi, University of North Carolina-Chapel Hill already has a surgical exchange program, and the University of Cincinnati has a surgical exchange that recently sent a US Air Force surgeon. In many areas, the DoD will also need to continue to build patient movement capability (ie aeromedical transport) to support resilient, integrated trauma systems and optimize time to care, as has been done in Niger and elsewhere. The United Nations has also committed to building a medical training center in Uganda which could participate in this endeavor.

DoD trauma providers and medical planners largely agree that the US has a strategic interest in international trauma capacity-building (Director, International Health Specialist Program, Office of the Air Force Surgeon General, personal communication, May 2016). The US military recently gained useful experience working ad hoc with French medics in the Sahel, and German *Bundeswehr* providers already rotate in South Africa to achieve several of these same objectives.

To address the increasing global impact of trauma, the DoD and ACS will need to expand their partnerships to define resource-appropriate best practices and train individuals to serve in sustainable medical systems. For our nation and the millions around the world who also desire the benefits of good governance, such as stability and health, it is within our reach and in our interest to do so.