

Final for AmStat News

Samuel W. Greenhouse, formerly of the National Institutes of Health and Professor Emeritus at the George Washington University, died on September 29 at the age of 82. He had fought valiantly against cancer for a year. He is survived by his four children, their spouses, and 11 grandchildren. His beloved wife Selma had preceded him in 1996.

Sam, as he was known to all, was born on January 13, 1918 in the Bronx, New York. He received his B.S. in Mathematics from the City College of New York in 1938 and thereafter moved to Washington, DC to begin his career in the Bureau of Census with Edward Deming (1940-2). He served in the Army during World War II and afterwards worked with the United Nations Relief and Rehabilitation Agency (1945-48). In 1948 he was recruited by Harold Dorn, along with Jerome Cornfield, Jacob Lieberman, Nathan Mantel and Marvin Schneiderman, to create the first biometry group at the National Institutes of Health (NIH), in the National Cancer Institute (NCI). The May 1997 issue of *Statistical Science* presents a description of the activities of this group including interviews with several of the early NIH statisticians, and Sam's own reminiscences and reflections on the development of statistics at the NIH.

In 1954, Sam left the NCI to become Chief of the Theoretical Statistics and Mathematics Section in the National Institute of Mental Health. In 1966, he was appointed Chief of the Epidemiology and Biometry Branch of the National Institute of Child Health and Human Development, where he rose to the position of Associate Director for Epidemiology and Biometry (1970-74) and Acting Associate Director of the Office of Program Planning and Evaluation (1969-74). He was the first statistician to hold such a high administrative position at the NIH. In 1974 Sam retired from government service and undertook a full time academic career.

Sam's affiliation with the Department of Statistics of The George Washington University had begun in 1946 when he was appointed professorial lecturer. While working full time at the NIH, he taught part-time *and* pursued his own graduate degrees in

the department, first an M.S. in 1954 and then a Ph.D. in 1959, both under the direction of Solomon Kullback. He continued teaching part-time until his retirement from the NIH in 1974 at which time he was appointed Professor of Statistics (with tenure) and assumed a full time teaching position. Sam served as Department Chair from 1976-9 and again in 1985-6. In 1988, he retired from the University faculty and was named Professor Emeritus. From 1979-80 Sam also served as Acting Director of the GWU Biostatistics Center that had been founded in 1972 by Jerome Cornfield as a research facility of the Department of Statistics. From 1988 until his death he served as the Associate Director for Research Development of the Biostatistics Center.

Sam was passionate about statistics. He relished the opportunity to teach and engage colleagues and young statisticians in statistical discourse. Many of the present leaders in the profession either studied with Sam or were mentored by him. He never forgot a student, and many considered his course at GWU in multivariate analysis one of the best ever taken. In 1985 he received the George Washington University Scholarly Excellence Award of the Columbian College of Arts and Sciences.

Whether giving a seminar, making a site visit, or on sabbatical, Sam was always a popular and stimulating visitor. In his career he took two sabbaticals, one from the NIMH and the other from GWU. In 1960, Sam moved Selma and the children to Palo Alto where he spent the year as a Visiting Professor in the Department of Statistics at Stanford University. This was a memorable year for Sam, not only for his interactions with the statistics faculty and students, but also for the opportunity to help turn a young mathematics graduate student named Brad Efron to statistics. Brad took his first graduate statistics course from Sam. Professor Efron recently wrote, "I remember how patient and nice Sam was with all of us. If Sam's course hadn't been inspiring I probably would have scampered back to the math department. I was always grateful for his kindness and statistical good sense." In 1981, Sam and Selma spent a wonderful year in Boston where he was a Visiting Professor in the Department of Biostatistics at Harvard University. On both leaves he taught courses and was actively engaged in all department matters.

It is a tribute to his energy and enthusiasm for statistics that Sam received many honors for his intellectual and professional contributions. The American Statistical

Association in 1993 recognized him with their prestigious Founders Award, and in 1997 videotaped a discussion with Sam as part of the ASA series of conversations with distinguished statisticians. Sam was a Fellow of the American Statistical Association, the Institute of Mathematical Statistics, the American Association for the Advancement of Science, and the Royal Statistical Society, and an elected member of the International Statistical Institute. He was also a Fellow of the American College of Epidemiology and of the Council of Epidemiology of the American Heart Association. In 1969 he received the Superior Service Honor Award from the NIH and in 1976 was named a Johns Hopkins University Centennial Scholar. In December, 1999, Sam was recognized by the Harvard Institute of Psychiatric Epidemiology and Genetics for his lifetime contributions to psychiatric epidemiology and biostatistics. Unfortunately, because of his illness, he was unable to travel to deliver the lecture that he had prepared in honor of this occasion.

Sam was active in many professional societies. He held positions in the American Statistical Association including Chairman of the Biometrics Section (1964-5), National Program Chair (1970), Chair of the Wilks Committee (1994), Associate Editor for the *Journal of the American Statistical Association* (1967-69), and President of the Washington Statistical Society (1967-8). He was elected secretary of the Institute of Mathematical Statistics (1963-1966) and served as a member of the IMS council (1977-9). Sam was also an elected council member of the International Biometrics Society and was active in the Eastern North American Region (ENAR) of the IBS, having served on the Executive Committee (1965-7) and as President (1969). Sam was a founding member and served on the Board of Directors of the Society for Clinical Trials (1983-6). He was a member of the Board of Directors of the American College of Epidemiology (1981-2) and their representative to the Council of Professional Associations for Federal Statistics from 1989 until his death. He chaired Section U (Statistics) of the American Association for the Advancement of Science, and was a member of the AAAS Council (1987-93) and Executive Committee (1987-9). He was also a member of the American Mathematical Association, the American Psychopathological Association and the Society for Epidemiologic Research.

Sam was a much sought after panel member. His reviews and advice were always fair, insightful, and expertly crafted. He worked tirelessly as an advisor and reviewer for a number of government agencies, including, the U.S. Public Health Service's Accident Prevention Study Section (1958-62), the Federal Aviation Agency Council of Research Advisors, Office of Aviation Medicine (1959-65), and the Food and Drug Administration's Biometric and Epidemiologic Methodology Committee (1967-72) which he chaired from 1969-72. Sam was a member of numerous committees at the NIH, during and after his tenure there, including the Biostatistics Fellowship Review Panel (1961-9), the Statistics and Mathematics Study Section (1963-70), the NCI Epidemiology and Biometry Contract Review Committee (1967-73), the Computer Sciences and Biomathematics Study Section (1974-8), and the NHLBI Clinical Trials Review Committee (1983-6). In the 1980's and 90's, he frequently served as a member of the *ad hoc* NIH study section that reviewed statistical methods grant applications. At the time of his death he was a member of the Board of Directors of the National Institutes of Health Alumni Association (since 1998).

Sam articulated many times that the primary mission of the statisticians at the NIH was to collaborate and provide statistical support for the NIH scientists. Yet, it was always understood that these collaborations would lead to opportunities for statistical research in methodology and theory. It was not unusual to find Sam and the other early NIH statisticians co-authoring papers in subject matter journals and publishing corresponding theory and methods papers in statistics journals. This pattern was evident in his early papers on the evaluation of diagnostic tests. Although this work with Mantel (*Biometrics*, 1950) and Dunn (*Public Health Reports*) was rooted in the need to implement non-invasive methods for cancer screening, it also addressed methodological issues, such as deriving the estimated variance of sensitivity and specificity for the case when the diagnostic cut-point for a quantitative test was also estimated from the data. While at the NIMH, his classic papers with Geisser (*Psychometrika*, 1959; and *Annals of Mathematical Statistics*, 1958), Halperin, Cornfield and Zalokar (*JASA*, 1955), and Halperin (*Biometrika*, 1958) evolved directly from the need for methods to analyze highly correlated psychological data. For example, he and Geisser derived an estimate of the degree of departure from the assumption of compound symmetry in the test of within-

subjects effects in ANOVA, and an adjustment to the degrees of freedom of the F-ratio when that assumption is violated. The Greenhouse-Geisser correction is now provided in virtually all computer packages for repeated measures analysis. Significantly, this work has been recognized as a Science and Social Science Citation Classic (July, 1982).

Sam was also influential in the early development of the theory and practice of clinical trials and shared an interest with Cornfield in methods for the sequential analysis of emerging data in clinical trials. (See, for example, his papers with Cornfield in the *Fifth Berkeley Symposium*, 1967; Cornfield and Halperin in *JASA*, 1969; and with D'Ambrosia in *Biometrics*, 1983 and *Communications in Statistics*, 1984). While at the NICHD, his collaborations focused more on observational data, e.g., assessing the safety of oral contraceptive use, and his interests returned to the development of methods for epidemiologic studies. His papers with Seigel (*Journal of Chronic Disease*, 1973; *American Journal of Epidemiology*, 1973), for example, showed that logistic regression could be applied to matched and unmatched case-control studies to obtain an adjusted estimate of the prospective odds ratio associated with a factor. At GWU in the late 1980's, Sam and Joe Gastwirth recognized similarities between a class of problems arising in legal settings and in epidemiologic studies. A collaboration began that was deeply grounded in the practical experiences of their respective fields of application. In *JASA*, 1987, they derived the MLE of a common odds ratio from a K-fold product binomial likelihood rather than the usual hypergeometric and showed that it has specific applications in the law. In *Statistics in Medicine*, 1995, they describe the use of logistic regression in the Peters-Belson or direct adjustment method, among other techniques.

However, if one asked Sam about the truly important work he was doing, he would inevitably talk about his scientific collaborations. For it was through the practice of statistics, he believed, that statisticians made their biggest impact on science, and it was through scientific collaborations that the important statistical problems were identified. He felt that every biostatistician should spend time in the trenches, such as in a laboratory or a clinical trial data center, to obtain practical experience. He practiced what he preached. While at the Biostatistics Center he continued to collaborate extensively with investigators in the Division of Cardiology at the GWU School of Medicine in the conduct of

supplemental analyses of the GUSTO and PACT trials. He served as a co-investigator of the Coordinating Center for the study of the Medical Treatment of Prostatic Symptoms sponsored by the National Institute of Diabetes Digestive and Kidney Diseases, an ongoing multi-center clinical trial of different pharmacologic treatments for benign prostatic hyperplasia. He also served as a member of the data monitoring committee for the POSCH trial funded by the NHLBI.

Sam was a much loved presence in the profession. He attended the annual meetings of ENAR, the Society of Clinical Trials, the ASA (JSM) and the AAAS without fail, and the ISI as often as he could. This past Spring, Sam attended ENAR in Chicago, his last professional meeting, and despite his obvious illness, he probably asked more questions or offered more comments from the floor than anyone else in attendance. This was his style. He was amazingly current and had strong opinions on all matters. He was not shy about asking questions of speakers, especially when he didn't understand a point (or felt that they didn't), and it would not be unusual for the discussion to continue in the hall or even later via e-mail until he felt the issues were resolved. This was true whether the topic was statistics, literature, music, politics, religion or sports. His intellectual curiosity was voracious.

Although one of Sam's most endearing features was his personal warmth and grin, he could also be quite the provocateur. In his 1997 *Statistical Science* article on his reminiscences of the NIH he wrote about how the group (Cornfield, Halperin, Mantel, he, and others) would often argue quite publicly over lunch about matters statistical and otherwise. We fondly remember times in the late 1970's and early 80s, when Sam would visit Max Halperin or Nathan Mantel at the Biostatistics Center. Sam loved nothing more than a friendly spirited argument and Max and Nathan were always eager to comply. Their dialogues are legendary. Sam was capable of arguing either side of an issue and often would, especially if it would get a rise out of Max or Nathan. He was a delightful rascal.

Sam was also well known and loved outside of statistical circles. With his engaging smile and sharp wit, he made a lasting impression on all he met. One physician, on learning of his death, said "I only met Sam once, but I felt as though I always knew him." Sam

touched the lives of many. He will be sorely missed, by the statistical community and far beyond.

Tax deductible donations may be made to the GWU Sam Greenhouse Memorial Fund, care of The Biostatistics Center, 6110 Executive Blvd., Rockville MD 20878.

Memorial sessions in Sam's honor are being planned. Contact jml@biostat.bsc.gwu.edu.

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