

An Academic Tribute to Louis Gerald Keith, MD, PhD, ScD (Hon), FACOG, FRCOG, FACS, FICS, FRSM, FRSH, 1935–2014: A Multidisciplinary Mentor to Many

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FIGURE 1
(Colour online) Portrait of Louis G. Keith, MD, PhD, ScD (Hon).

The world of twin research and the medical specialty of Obstetrics and Gynecology have lost a giant. Dr Louis G. Keith passed away on July 6, 2014 at the age of 79. Always

full of optimism and energy, and considered indefatigable by friends and family, Dr Louis Keith returned from one of his many world lecture tours in June of this year and after two days of feeling tired received a surprise diagnosis of an occult Stage 4 kidney cancer. He died comfortably at home 2 weeks later surrounded by family and friends. His practical and elegant charm was intact to the end, as he counseled those close to him *not* to be sad, saying, ‘We should all celebrate that I have been fortunate to have the most amazing life imaginable.’

A Champion for the Understanding of Multiple Gestation

Louis and his surviving twin brother Donald were arguably the most productive, respected, and beloved pair of academic monozygotic (MZ) twins the world has known. Together, they made major contributions to twin science, to the management of all types of multiple pregnancies, and to twin parenting and the public understanding of twin issues.

Perhaps of most importance to the readership of this journal, Dr Keith played an early and critical role in establishing an infrastructure for the world of twin studies. Recognizing the need for and benefits of formalizing academic activity, Louis Keith, Luigi Gedda, and colleagues founded the International Society of Twin Studies (ISTS) in Rome in 1974. Forty years later, this journal — *Twin*

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FIGURE 2

(Colour online) Louis and Donald Keith, Northwestern Memorial Hospital, June 26, 2014. *Copyright David Teplica, MD, MFA.

Research and Human Genetics— serves as the official organ for the ISTS and is the leading vehicle for the dissemination of information among a dynamic and global array of twin researchers. Louis served on the journal's editorial board, and further contributed as Co-President of the ISTS from 2001–2004. In April 2009, he was recognized as Honorary President of the 1st World Congress of Twin Pregnancy held in Venice, Italy, and received that same recognition for the Joint 2nd World Congress on Twin Pregnancy and the 14th Congress of the ISTS that took place in Florence, Italy, in April of 2012.

Louis's MZ twin brother Donald created the Center for Study of Multiple Birth (CSMB) in 1981. Louis quickly and enthusiastically embraced this novel academic and public outreach entity and CSMB soon became the pre-eminent foundation in the United States devoted to twin research and the dissemination of information to families dealing with multiple birth (<http://www.multiplebirth.com/index.html>). Under the umbrella of this organization, Louis published more than 175 abstracts, articles, and chapters on topics relating to twins with a global array of collaborators. Louis Keith also edited over a dozen twin-related

textbooks, including six major monographs that are now considered definitive references on twin pregnancy and multiple birth:

- *Multiple Pregnancy: Epidemiology, Gestation & Perinatal Outcome*, with Émile Papiernik, Donald Keith, and Barbara Luke in 1995 (Papiernik et al., 1995).
- *Atlas of Multiple Pregnancy: Biology and Pathology*, with Geoffrey Machin in 1999 (Machin & Keith, 1999).
- *Iatrogenic Multiple Pregnancy: Clinical Implications*, with Isaac Blickstein in 2001 (Blickstein & Keith, 2001).
- *Triplet Pregnancies and Their Consequences*, with Isaac Blickstein, Jarek Oleszczuk, and Donald Keith in 2002 (Keith et al., 2002).
- *Multiple Pregnancy: Epidemiology, Gestation & Perinatal Outcome*, Second Edition, with Isaac Blickstein, Associate Editor Donald Keith, and Special Photography by David Teplica in 2005. This volume was awarded the 2005 Book of the Year in Obstetrics and Gynecology by the British Medical Association (Blickstein et al., 2005).
- *Prenatal Assessment of Multiple Pregnancy*, with Isaac Blickstein in 2007 (Blickstein & Keith, 2007).

Educational Background and Academic Responsibilities

Louis Keith did his undergraduate work at the University of Illinois, and received his MD degree from the Chicago Medical School (now known as the Rosalind Franklin University of Medicine and Science) in 1960. He completed his Residency in Obstetrics and Gynecology at Cook County Hospital in Chicago and gained certification from the American Board of Obstetrics and Gynecology in 1967. Louis attained the rank of full Professor at a very young age at Cook County Hospital. In 1975 he was recruited for full Professorship at Northwestern University by then Chairman, Dr John J. Sciarra. While at Northwestern, Louis also served as Director of the Section of Undergraduate Education and Medical Student Affairs, supervising the training of more than 5,000 medical students in the principles of Obstetrics and Gynecology. Keith and Sciarra enjoyed a career-long friendship and one of the most academically fruitful collaborations possible.

On top of full-time academic responsibilities, Louis Keith earned his PhD from the Karol Marcinkowski University of Medical Sciences in Poznan, Poland, in October of 2002 with a dissertation titled 'Triplet Pregnancies in Women Age 40 or More'. Dr Keith retired in 2004 with Professor Emeritus status, but remained extremely active in the academic world, with the receipt of many dozens of invitations for visiting professorships, ongoing research projects, invited lectures, and requests for his editing talents. He also served as Adjunct Professor in the Department of Maternal and Child Health at the University Of Alabama School of Public Health at Birmingham, and as Affiliate Professor in the College of Public Health at the University of South Florida in Tampa.

Honors and Awards

Over the course of his career, Louis Keith received more than two dozen awards for his academic and scientific work. Among these was his election by colleagues to membership and/or fellowship in numerous professional societies in the United States and overseas, including the American College of Obstetricians and Gynecologists, the American College of Surgeons, the American Association of Gynecological Laparoscopists, the Royal Society of Medicine (UK) and the Royal Society of Health (UK).

In 1995, he was named 'Distinguished Alumnus' of The Chicago Medical School. In 2000, he was awarded the Golden Officer's Cross of the Order of Merit from the President of the Republic of Poland, Aleksander Kwasiewski, and in that same year was inducted as 'Knight' in the International Order of Smile (UNESCO). Then in 2007, the Medical Academy of Lublin, Poland awarded Louis Keith an Honorary Doctor of Science degree. Louis received an honor rarely bestowed upon an American surgeon when he was granted *Fellowship ad Eundem* in the Royal College of Obstetricians and Gynecologists in London in 2010, honoring his lifelong commitment to the health and wellbeing of women worldwide.

A Multidimensional Career

In recent years it became increasingly evident that Louis Keith's major contributions to a host of disciplines were often unknown to academic practitioners in other, often unrelated fields. With gentle encouragement shortly after receiving the diagnosis of metastatic cancer, Louis was able to spend time reflecting on the broad diversity of his career beyond his twin contributions noted above (personal communication, June 22, 2014). Those insights, embellished with information gleaned from his tome-like curriculum vitae (<http://www.louisgkeith.com/id23.htm>), and with input and corroboration from Donald Keith (personal communications, June–August 2014), serve as the basis for the following summary of Dr Keith's academic and public activities that extend beyond the twin world. They are presented below in general academic categories and in relative chronologic order:

Women's Reproductive Health and Rights

Early in his career (from the mid-1960s to the early 1980s), Louis Keith boldly produced a wide array of presentations and publications squarely addressing the controversial topics of sexually transmitted diseases, contraception, and considerations of safety and technique regarding the termination of pregnancy. As a result, Louis received honors and awards from regional and national organizations, including the Civil Liberties Award of the Roger Baldwin Foundation from the American Civil Liberties Union in 1991, which was presented on the occasion of the Bicentennial of the Bill of Rights of the United States of America for his out-

standing contributions to defending the civil liberties of women.

Gynecologic Laparoscopy

Dr Louis Keith was one of the four founders of the American Association of Gynecologic Laparoscopists in 1972 (<http://www.aagl.org/service/about-aagl/founders/>). He served as a member of the Board of Directors for many years and as its President in 1979, all the while working to promote minimally invasive surgical and diagnostic techniques. Anticipating the since-proven major benefits of laparoscopy, Dr Keith and colleagues were more than a decade ahead of the wide adoption of endoscopy by general surgeons and nearly all other surgical subspecialties. Worldwide, millions of patients have since benefited from those early efforts, enjoying decreased complication rates and more rapid recoveries from both diagnostic and surgical procedures.

Anatomic Mirroring

In 1988, under the umbrella of the CSMB, Louis and Donald Keith decided to support an anatomic investigation of the concordance of facial anatomy proposed by David Teplica of the University of Chicago. Over a 2-year period the three captured approximately 10,000 highly standardized photographs of MZ twin facial anatomy, creating an image databank now known as the 'Twinsburg Archive'. Image analysis proved the existence of the long-rumored 'mirror twin' phenomenon. The archive has since been used to develop diagnostic methodology, determine the incidence of anatomic mirroring among twins, and to better understand the embryologic and developmental underpinnings of the phenomenon. Once mirroring was accounted for, evaluation of the skin surface showed that nearly all secondary skin features were encoded for spatial orientation as well as the timing of expression to a degree never previously imagined. The data suggest that behavior and environmental influences have little effect on human anatomy. Skin surface lesions, aging patterns, and asymmetries of facial- and body shape are all in lock-step concordance or mirrored concordance within any given MZ twin pair (Teplica, 1996, 1999; Teplica & Keith, 1996; Teplica & Peekna, 2005).

In 2003, under the auspices of the CSMB, David Teplica, Louis Keith and Kaley Peekna, along with Catherine and Robert Derom of the East Flanders Prospective Twin Survey in Belgium developed and tested a digital subtraction technique to diagnose anatomic mirroring. The method successfully identified mirroring or the lack thereof in facial shape and showed that this was in concert with skin findings in each case, therefore serving as a tool to cross-check results. The study also quantified the incidence of the mirror phenomenon in subsets of MZ twins, with 52% of pairs exhibiting reflective symmetry (Teplica & Peekna, 2005). With no correlation between the phenomenon and any pair's chorionicity or amnionicity, it was shown that

mirroring was not a function of the timing of the split of the ovum. In addition, it was found that if two twins were of opposite handedness, then they were statistically far more likely to be mirrored for skin surface features, suggesting that skin ectoderm and neural ectoderm are spatially aligned in a consistent way during embryogenesis (Teplica et al., 2007). These findings have been presented, published in abstract form, and partially documented in the periodic literature and as a text chapter (Teplica, 2011; Teplica et al., 2010, November; 2010; 2012). Preparation of the full manuscript — with coauthors David Teplica, Catherine Derom, Evert Thiery, and Kalev Peekna — had begun prior to the time of Louis Keith's death and submission is anticipated for 2015.

In 2008, a Chicago research team recognized that a small subset of single-birth individuals exhibited extreme concordance of skin features in nearly mirror opposite configurations on both sides of the body. This phenomenon was identified and documented using the same methodologies developed for the analysis of twins. This unexpected and previously undescribed anatomic entity bolstered the earlier descriptions of extreme concordance or mirrored concordance seen in MZ pairs, and added credence to the notion that environment plays little role in development of normal human anatomy. A solid foundation was laid for a new concept of 'anatomic predetermination', suggesting that an individual's lifelong three-dimensional anatomic expression — whether as an individual or part of a twin pair — is encoded from a single fertilized egg. David Teplica, Louis Keith, Sean Lee, and Jonathan Bank have presented these findings at major meetings and published the material in abstract form, but the full manuscript was in final edit and approaching submission at the time of Louis Keith's demise (Bank et al., 2012; Teplica et al., 2013).

Children's Burn Awareness Program

In the early 1990s, along with colleagues David Teplica, Lawrence Gottlieb, and Victoria Duran, Louis Keith helped oversee and direct North American release of the first major, visually-based, children's burn prevention initiative to combat the grossly under-recognized problem of childhood burn trauma. The Program received the endorsement of the American Medical Association, the American Burn Association, and the President of Mexico. It was also the first major initiative to bring attention to the widely under-recognized problem of child abuse by the intentional infliction of burn wounds (Teplica, 1994; Teplica et al., 1992).

Postpartum Hemorrhage (PPH)

In recent years, Louis Keith was considered one of the world's leading authorities on PPH, a greatly under-recognized cause of death among otherwise healthy mothers. He played the lead role in the conception and editing of the first major treatise on the topic, working with colleagues Christopher B-Lynch, André Lalonde, and Ma-

hantesh Karoshi. *A Textbook of Postpartum Hemorrhage: A Comprehensive Guide to Evaluation, Management and Surgical Intervention* (B-Lynch et al., 2006) is believed to be the first medical text in history to receive the endorsement and imprimatur of the British Royal Family. With support from Dr Keith's longtime friend and publisher David Bloomer, and underwriting by Sapiens Publishing and the Society of Obstetricians and Gynecologists of Canada, the volume was made available online at no cost so that impoverished and developing communities can protect the lives of women during childbirth (<http://www.sapienspublishing.com/pph/pdf>). Chinese, Turkish, and Ukrainian translations have since been released.

In 2010, Louis established the Postpartum Hemorrhage Foundation, the first charitable entity devoted exclusively to increasing awareness of this devastating worldwide problem and to serve as a vehicle to promote broad understanding, provide treatment strategies, and to foster ongoing academic activity. In October 2012, Dr Keith released the second edition of *A Comprehensive Textbook of Postpartum Hemorrhage: An Essential Clinical Reference for Effective Management*, published by Sapiens Publishing of London (Arulkumaran et al., 2012). It is likely that this volume will remain the definitive source of information on PPH for many years to come. As a result of all of these efforts, Louis Keith can be credited with saving the lives of countless thousands of women around the globe.

Polydimensional Analysis of Gender and Sexuality

In 2011, Louis Keith co-launched an initiative to refine and test a system designed by colleague David Teplica to analyze and categorize human gender and sexuality in an innovative way. Greatly expanding upon Alfred Kinsey's initial linear classification system ('The Kinsey Scale'), this unique polydimensional construct would account for the many independent genetic, anatomic, and physiologic variables elucidated since Kinsey published his important early work in 1948. The system of analysis provides a base-10 structure for quantifying each independent variable to better define, understand, and classify the full breadth of human gender and sexual expression. Working alongside colleagues David Teplica, Eileen Jeffers, John Sylla, and the senior faculty of The Kinsey Institute (Julia Heiman, Stephanie Sanders, and Erick Janssen) and with major funding from the American Institute of Bisexuality, protocols are in final development and formal testing should begin in 2015.

Creation of The 803 Foundation

In 2012, Louis Keith and co-founders Eileen Jeffers and David Teplica established a new charitable research and education entity designed to foster interdisciplinary activities at the Art/Science interface. To date, the organization has supported workshops, exhibitions, and scientific investigation, with particular emphasis placed on anatomic research

making use of investigative tools from the imaging arts and medicine. Ongoing projects that Louis Keith helped formulate and direct include:

- creation and publication of imaging protocols that use the visible light spectrum to produce highly standardized records of the entire body surface — including the face, torso (Teplica et al., in press), hands, feet, and genitalia — to allow detailed phenotypic analysis and to track anatomic changes that occur with time (along with David Teplica, Daniel Schuleman, Michael Peres, Omar Masri, Joseph Ciarrocchi, Joey Cieniewicz, Eileen Jeffers, and Lawrence Gottlieb)
- elucidation of adult vestiges of the embryologic mammary ridge to define previously unrecognized subpopulations of yellow subcutaneous fat that behave differently in the face of hormonal influence, disease, and auto-transplantation (with Grant Kovich, David Teplica, Eileen Jeffers, Jamey Srock, Robert Whitaker, Jeffrey Wu, and Amir Djavid)
- visualization and quantification of the anatomic changes induced by pregnancy using a unique and highly standardized rotational imaging system for the time-lapse capture of the 3-D expansion of the female body through an entire pregnancy (with David Teplica, Eileen Jeffers, Yuliana Resnikova, Joey Cieniewicz, Alex VanOeveren, and Donald Keith)
- determination of the differential anatomy of gender by quantification of focal adiposity in healthy, lean male and female subjects (with David Teplica and Eileen Jeffers)
- evaluation of differential brain activity patterns in subsets of individuals of known sexualities using fMRI, as well as the quantification of differential fatty anatomy of the face in the same subsets of subjects, with major support from the American Institute of Bisexuality (with Michael Bailey, Adam Safron, Victoria Klimaj, and David Teplica).

Lifelong Passion to Promote the Aspirations of Others

Unlike many academics in medical and scientific fields who of necessity focus on the rigors of scholarly ascent, Louis Keith was a rare individual who got great pleasure identifying and promoting the talents of *others*:

Career Coaching and Assistance with Manuscript Preparation

With no easy way to identify individuals inspired by or assisted by Dr Keith (even in the age of easy web searches), it is hard to compile a definitive list of ‘mentees’. However, it can be said that scores of fortunate individuals were coached to academic greatness and now contribute in significant ways at institutions worldwide. In addition, over a span of five decades in many disciplines and many major academic institutions, Louis selflessly assisted and encouraged hundreds more to their personal bests — whether they

were undergraduates, medical students, Masters and PhD candidates, residents, junior faculty, or colleagues. His mentoring was blind to gender, creed, nationality, race, social status, politics, and age. In the past 5 years alone, Louis provided major support to individuals from a wide array of academic stations, including (in alphanumeric order):

- The 803 Foundation and its Research Associates and Fellows, Chicago, IL
- Cook County Hospital, Chicago, IL
- Dartmouth College, Hanover, NH
- Geisel School of Medicine, Dartmouth College, Lebanon, NH
- Harvard University, Cambridge, MA
- Indiana University, Bloomington, IN
- The Kinsey Institute, Bloomington, IN
- Northwestern University, Evanston, IL
- Northwestern Feinberg School of Medicine, Chicago, IL
- Northwestern Memorial Hospital, Chicago, IL
- University of Oxford, United Kingdom
- Penn State University, University Park, PA
- Poznan University of Medical Sciences, Poznan, Poland
- University of Alabama, Birmingham, AL
- University of Chicago, Chicago, IL
- University of Illinois at Chicago, Chicago, IL
- University of Lublin, Poland
- and numerous independent scholars and practitioners around the globe

Editorial Activities

Louis Keith was a gifted medical editor, who was not only facile, but also insightful. He devoted himself to editorial work for many important journals, including *Acta Geneticae Medicae et Gemellologiae*, its successor *Acta Geneticae Medicae et Gemellologiae: Twin Research*, and the current format of this journal, *Twin Research and Human Genetics*. In addition, the *International Journal of Fertility, Gynecology and Reproduction* (Associate Editor, 1985–2002), the *International Journal of Fertility and Women’s Health* (Editor-in-chief, 2002–2009), and the *International Journal of Gynecology and Obstetrics* (Assistant Editor, 1989–2012), and other periodicals benefitted from his talent to conceptualize and present information in written form (<http://www.louisgkeith.com/id23.htm>).

In addition to his formal editing appointments, Louis thrilled at helping authors, convert even the most difficult and dense manuscripts into cogent and readable prose. His enviable capacity to edit extended his personal insights and contributions into one of the widest arrays of disciplines imaginable in academia. Louis’ impact will remain unquantifiable, since he enjoyed ‘ghost-editing’ (at times completely recrafting manuscripts) for friends, colleagues, and near-strangers, while politely refusing authorship or financial support. From his specialty in Obstetrics and Gynecology, to the dissimilar fields of

infectious diseases, sleep science, basic anatomy, human embryology, developmental biology, plastic and reconstructive surgery, management of HIV, disease prevention, awareness of childhood burn abuse, public health issues, twin research, nutrition in pregnancy, standardized photography, human sexuality, and vitamin supplementation, one can see that the curious mind of a true polymath had few boundaries.

Lecture Tours Workshops and Research Travel

Dr Keith traveled extensively, giving invited lectures throughout Europe, Asia, and the Middle East, with forays into South America and Africa. To the amazement of all around him, Louis often made several around-the-world lecture trips a year. Then, without missing a beat, he would call colleagues after clearing customs, in Chicago offering ‘to come straight over to finish editing that manuscript’.

In order to promote awareness of PPH, Louis often lectured and then he and coworkers led hands-on workshops that taught non-invasive and operative skills to stop maternal bleeding following delivery. He also consulted for and lectured on behalf of Vitabiotics Ltd. regarding nutrition and the importance of vitamin supplementation. In the last several years, Louis and a research team made regular trips to The Kinsey Institute in Bloomington, Indiana to collaborate with colleagues, report research progress, and refine protocols for their ongoing gender/sexuality project.

Promotion of the Visual Arts, Dance, and Music

Louis was an avid patron of the arts, but he also enjoyed exposing others to the richness of creative expression — especially physicians or scientists who were otherwise tightly focused. He was a lifelong supporter of the Chicago Symphony and the Lyric Opera, but also traveled the globe to see and to hear. He avidly collected paintings, drawings, prints, and photographs that explored and celebrated the human form and the social implications of bodily representation. With a passion to uphold the figurative/anatomic tradition in modern art, and during a time when abstract expressionism ruled, Louis befriended and became one of the most significant patrons of Puerto Rican figurative painter Alfonso Arana.

Taking his commitment one step further, Louis promoted the infusion of artistic media and concepts into various forms of scientific communication and medical education. For example, Louis often covered and filled his texts with creative imagery. His insights also helped craft a major retrospective of creative *and* scientific twin photographs, ‘Gemelli: Arte e Scienza’, which was installed in the galleries of the Istituto degli Innocenti in Florence in conjunction with the scientific twin congress held in Italy in 2012. Louis then asked if he and his twin could contribute an essay for the exhibition catalog and published the monograph under the auspices of the CSMB (Jeffers, 2012).

Finally, in what would be his last years, Louis Keith completed the libretto for a new children’s opera composed by Joseph Cancellero. It is unfortunate that Louis will not oversee production of the première performance.

Legacy

It is very clear from both the diversity and depth of the accomplishments described above that the legacy of Louis Keith will be sustained for generations to come. The academic twin community as a whole enjoys a more formalized structure of societies and periodicals (not to mention gigabytes of vital, well-edited information) because of the early efforts of Dr Keith. Importantly, the world will continue to benefit from those individuals who Louis mentored as they continue to make valuable contributions instigated, inspired, and/or promoted by the multifaceted Louis or the dynamic Keith twin pair. Hundreds more from around the globe had their own careers sparked and lives enriched by a gentle but driven and elegant but practical role model, Dr Louis Keith.

Perhaps even more dramatic are the contributions Louis made for the betterment of the humanity. It is hard to quantify how less-invasive endoscopic procedures have improved the lives of millions, or how his sometimes controversial scientific/anatomic research would inform, enrich, and steer human experience. It may be easier to conceive how many thousands of twins and other higher order multiples will owe their lives or their improved existences to this same man, or how countless hundreds of thousands of women will have survived PPH because of the efforts and insights of Dr Keith.

The full impact of Louis’ work will never be known. However, it can be said that individuals rarely have a major, ongoing, and *permanent* positive impact on the human race. Dr Louis G. Keith is solidly one of the few who has.

Author Note

I personally owe Louis Keith an immense debt for launching, steering, and enriching a fascinating career. His insights, drive, collegial spirit, and immense capacity to understand and distill difficult concepts into elegant prose will be greatly missed. From a personal point of view, a rich 26-year friendship and nonstop collaboration — filled with humor, nudging, and a genuine and mutual thrill for discovery — will never be matched.

We of the twin world must also acknowledge the major contributions of the Keith Twin *Pair* and be sensitive to the immense loss that Donald Keith must be experiencing. Ever ‘Twin A’, Donald assures me that he will help complete important projects that were left unfinished. He has also committed to now serve as a champion for the cause of ‘twinless twins’, those who survive what is widely regarded as the most traumatic form of human loss.

Acknowledgments

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