EDITORIAL

Who Could Know Who I Am? The Possibility of Patient Identification With Retinal Imaging

RICHARD K. PARRISH II, LOUIS R. PASQUALE, AARON Y. LEE, ROBERT FOLBERG, MICHAEL W. STEWART, AND SARAH L. DUNCAN POWERS

WHEN FUGITIVE JEAN VALJEAN RHETORICALLY asks, "Who am I?" in the musical version of Victor Hugo's *Les Miserables*, he feared what would happen if someone recognized his face and identified him by the convict number on his yellow passport. Almost 200 years later, digital imaging of unique biological characteristics has expanded the possible means of identification. Simon and Goldstein first described a unique patient-specific retinal vascular network for identification in 1935.[1] Since the concept's advent, several variations on the assessment of retinal vessels have been proposed to improve the accuracy of identification.[2–4] Hill developed a retinal identification system for use in humans,[5] but its application has mainly been limited to high-end security systems rather than patient care.[6] Beyond human use, county fairs have used retinal vessel patterns in fraud prevention to verify prize-winning livestock[7] and identify cattle[8] and sheep.[9,10]

In recent years, digital technologies, such as spectral-domain optical coherence tomography, have all but replaced film-based photographic images to record retinal, optic nerve, and choroidal anatomy. These digitally encoded data can be readily acquired, stored, and accessed. We estimate that more than 500,000 patient-specific retinal images exist at the University of Miami Miller School of Medicine alone (Rams I, personal communication, January 27, 2020). Although the use of these data to identify specific patients may seem farfetched, an artificial intelligence (AI) algorithm based on retinal photographs can identify not only age, but smoking status, systolic blood pressure, cardiac adverse events, and birth sex with 97% specificity.[11] An AI algorithm capable of distilling this level of information from a color fundus photograph could potentially reidentify a unique individual, given the retrieval of enough identifiers. The *New York Times* recently described the facial image identification algorithm by Clearview AI as follows: "The system—whose backbone is a database of more than three billion images that Clearview claims to have scraped from Facebook, YouTube, Venmo, and millions of other websites—goes far beyond anything ever constructed by the United States government or any Silicon Valley giant."[12] This app has successfully identified suspects of criminal activity based on facial characteristics, although Clare Garvie of the Georgetown University Center on Privacy and Technology warned, "We have no data to suggest this tool is accurate." The attorney general of New Jersey, fearing the misuse of patient identification, blocked the use of Clearview for facial recognition of criminal suspects in that state, while law enforcement officials elsewhere may use it without restriction.[13] Beyond Clearview AI, emerging experimental machine learning technologies may permit the creation of synthetic analogs of a specific image or train a model to mimic the distribution of images within a location. It is also possible to identify patients using unique iris and conjunctival vessel images.[14,15]

To safeguard the future confidentiality of a patient whose retinal, conjunctival, or iridial images may appear in a publication, the *American Journal of Ophthalmology* strives to prevent unauthorized access to possible protected health information. Going forward, the *Journal* will require that authors obtain written permission of patients to publish their retinal images, expanding on the current policy of obtaining consent for publishing full-face photographs. This policy change will not impede the exchange of critical information or limit ethical scientific communication. Although clinical trials may continue to serve as a repository for thousands of retinal images, written consent will be required only from patients whose images appear in print. Further, the *Journal* will work with authors to mask noncritical features in retinal photographs in ways that disable algorithms that could reidentify subjects. While these AI identification possibilities may yet be on the horizon as a danger to patient confidentiality, the *Journal* considers the following advice from Wayne Gretsky's father to his

Accepted for publication Mar 30, 2020.

From the University of Miami Miller School of Medicine, Department of Ophthalmology, Bascom Palmer Eye Institute, Miami, Florida, USA (R.K.P.); Einhorn Clinical Research Center, New York Eye and Ear Infirmary of Mount Sinai, New York, New York, USA (L.R.P.); University of Washington, Seattle, Washington, USA (A.Y.L.); Michigan State University College of Human Medicine, East Lansing, Michigan, USA (R.F.); Department of Ophthalmology, Mayo Clinic, Jacksonville, Florida, USA (M.W.S.); and American Journal of Ophthalmology, Saint Augustine, Florida, USA (S.L.D.P.).

Inquiries to Richard K. Parrish II, Miller School of Medicine, University of Miami, 900 NW 17th St, Miami, FL 33136, USA; e-mail: rparrish@med.miami.edu

0002-9394/$36.00
https://doi.org/10.1016/j.ajo.2020.03.039

famous son: "Skate to where the puck is going, not where it has been."

REFERENCES

1. Simon C, Goldstein I. A new scientific method of identification. *NY State J Med* 1935;35:901–906.
2. Rahman NA, Mohamed AS, Rasmy ME. Retinal identification. *Proceedings of the 2008 Cairo International Biomedical Engineering Conference* 1-4.
3. Kose CA, Ikibas C. A personal identification system using retinal vasculature in retinal fundus images. *Expert Syst Appl* 2011;38:13670–13681.
4. Meng X, Yin Y, Yang G, Xi X. Retinal identification based on an improved circular Gabor filter and scale invariant feature transform. *Sensors* 2013;13:9248–9266.
5. Hill RB. Retina identification. In: Jain A, Bolle R, Pantaki S, eds. Biometrics: Personal identification in Networked Society. Berlin: Springer; 2005:126.
6. Amiri MD, Tab FA, Barkhoda W. Retinal identification based on the pattern of blood vessels using angular and radial partitioning. *Lecture Notes in Computer Science* 2009;5807: 732–739.
7. Weld County Government. Retinal imagining verifies ID of showmanship livestock. Available at www.weldcountyfair.com/livestock. Accessed January 13, 2020.
8. Allen A, Golden B, Taylor M, et al. Evaluation of retinal imaging technology for the biometric identification of bovine animals in Northern Ireland. *Livest Sci* 2008;116:42–52.
9. Gonzales-Barron U, Corkery G, Barry B, et al. Assessment of retinal recognition technology as a biometric method for sheep identification. *Comput Electron Argic* 2008;60:156–166.
10. Rojas-Olivares MA, Caja G, Carne S, et al. Retinal image recognition for verifying the identity of fattening and replacement lambs. *J Anim Sci* 2011;89:2603–2613.
11. Poplin R, Varadarajan AV, Blumer K, et al. Prediction of cardiovascular risk factors from retinal fundus photographs via deep learning. *Nature Biomed Engin* 2018;2:158–164.
12. Hill K. The Secretive Company That Might End Privacy as We Know It. *The New York Times*. Available at ; 2020. www.nytimes.com/2020/01/18/technology/clearview-privacy-facial-recognition.html;. Accessed March 26, 2020.
13. Hill K. New Jersey Bars Police From Using Clearview Facial Recognition App. *The New York Times*. Available at ; 2020. www.nytimes.com/2020/01/24/technology/clearview-ai-new-jersey.html;. Accessed March 26, 2020.
14. Derakhshani R, Ross A. A texture-based neural network classifier for biometric identification using ocular surface vasculature. In: Proceedings of the International Joint Conference on Neural Networks. Orlando: IJCNN; 2007:2982–2987.
15. Masek L. Recognition of human iris patterns for biometric identification [thesis]. Perth, Western Australia: University of Western Australia; 2003.