THE VOICE

The Voice

The Voice

IN THIS ISSUE:

SEPTEMBER NEWSLETTER:

- TVF and Chapter World Voice Day Events from 2013
- Gala 2013 Photos!

VOICE OF THE EDITOR

Nadine P. Connor, PhD

WHY DO WE NEED TO LOOK AT THE VOCAL FOLDS?

Looking at the larynx, by whatever means, is necessary to get an appreciation for its structure and its function. "Imaging" is a word used for the types of indirect viewing and recording methods necessary for this because of where the larynx resides in the body – deep within the pharynx (or throat), making direct examinations difficult or impossible. In addition to its physical location, the larynx offers other imaging challenges, such as poor lighting and the fact that the vocal folds vibrate at very high speeds – faster than most photography will allow and faster than the eye can see. How is it possible, then, to image the larynx at rest or during the act of voicing? This issue of *The Voice* addresses these questions, standard imaging methods used in the clinic today, and future innovations under development.

Understanding concepts of laryngeal imaging is important because of their widespread use in the area of voice. A complete voice evaluation routinely includes imaging of the vocal folds during voicing. Videostroboscopy is the imaging method used in most clinics. One survey found that 81% speech-language pathologists specializing in voice disorders used this method in their practice and in educating patients. Furthermore, 94% of speech-language pathologists felt that videostroboscopy was important for setting voice therapy goals. [3] When other types of assessment methods are considered, it appears that imaging the larynx is very important and understanding the methodology is critical for all of us.

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THE CLINICAL UTILITY OF LARYNGEAL IMAGING

By Bruce J. Poburka

Professionals who specialize in the care and use of the voice can certainly appreciate that the larynx is a complex instrument. It is a structural marvel; made of cartilages, muscles, ligaments, and membranes. The sound it produces is the result of a complex and delicate interaction between its many structures and the aerodynamic forces of breath. It's no surprise then, that voice quality can deteriorate quickly when the larynx is subjected to disease, neurological impairment, misuse, effects of psychological stress, and behavioral compensations that often co-occur [1].

When evaluating individuals with impaired voice, the examiner seeks to identify factors that combine to make up the constellation of

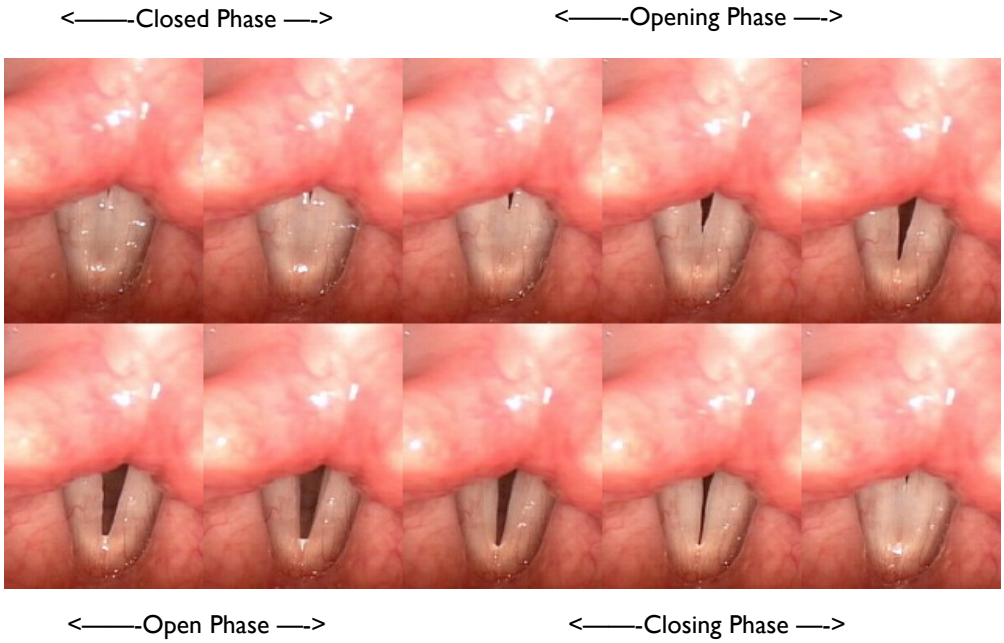
(Continued on page 3)

THE VOICE FOUNDATION BOARD OF DIRECTORS

MATTHEW SCHLONEGER PRESENTING HIS POSTER AT THE 42ND ANNUAL SYMPOSIUM IN JUNE

VIEWING THE VOCAL FOLDS

STROBOSCOPY MONTAGE OF NORMAL VOCAL FOLDS OBTAINED USING A RIGID ENDOSCOPE. IMAGE COURTESY OF DR. RITA PATEL



The Clinical Utility of Laryngeal Imaging, continued

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dysphonia. Depending on discipline and training, the examiner may use various methods of assessing voices. These may include instrumental measures like acoustic, aerodynamic, and electrophysiological assessment, or perceptual approaches such as auditory perceptual or visuoperceptual evaluation [2]. The latter approach involves imaging the larynx to ascertain information about the structure and function of the larynx. Current laryngeal imaging techniques include videostroboscopy and emerging technologies like high speed imaging and videokymography [3]. This article focuses on the clinical utility of videostroboscopy in voice assessment. The discussion will be general, but a table with more detailed information is provided. The information is presented primarily from the Speech-Language Pathologist's (SLP) perspective, but all readers are encouraged to consider how the discussion may be used within the context of their own profession.

Videostroboscopy is a laryngeal imaging technique that examines approximately 10 different aspects of voice vibratory function. Each parameter reveals information about the complex interaction of structures, tissue mechanics, muscle use patterns (technique), and aerodynamic forces [4]. Although various voice-care disciplines have overlapping interests in the findings, they may also have unique objectives as well. Physicians may seek information to help with diagnosis or to inform medical or surgical management [5]. Speech-language pathologists and voice instructors may be interested to know how the client's vocal technique or behavioral compensation may be contributing to dysphonia.

For this discussion, the stroboscopy parameters are grouped into subsets that correspond *roughly* to certain aspects of normal voice production. Please note that grouping the parameters this way is purely conceptual for the purpose of discussing their clinical utility. *The subsets are not exclusive and there is overlap among them.*

The parameters of glottal closure, free edge contour, and vertical plane all relate to the shape and configuration of structures that accomplish glottal closure and regulation of airflow [6]. Impairment is likely to contribute to breathy voice quality, reduced loudness, and vibratory instability. Various disciplines will use the exam to determine if problems are due to medical problems, muscle misuse, or both, and use the information to plan treatment accordingly.

The parameters of mucosal wave and nonvibrating portion relate to the physical health and structural integrity of the vocal fold tissues. Tissue changes may be benign or malignant. Impairment is likely to cause hoarseness and increased effort level for voicing. These parameters are of prime interest to physicians who will pursue more definitive testing as needed. These parameters are of interest to practitioners who conduct behavioral intervention because tissues changes often make it difficult to produce the voice, and clients may try to compensate and/or force the voice to work. Consequently, management may need to include strategies to normalize vocal technique and eliminate any counterproductive vocal behaviors that the client has developed.

Regularity and phase symmetry are in some ways a reflection of stability in the phonatory system. Impairment can result from structural problems (particularly unilateral or asymmetrical), poor vocal technique, or both. Vocal quality is diminished because of irregular movement and/or timing patterns. Because these parameters are an indicator of stability, they can be useful in assessing the effects of medical, sur-

(Continued on page 4)

"Various disciplines will use the exam to determine if problems are due to medical problems, muscle misuse, or both, and use the information to plan treatment accordingly."

The Clinical Utility of Laryngeal Imaging, continued

gical, or behavioral interventions.

The remaining parameters of supraglottic activity, phase closure, and amplitude don't necessarily fit well into a single subset, however, they all have the capacity to reveal information about the client's effort level. For example, speakers with hyperfunction/muscle strain may show excessive supraglottic activity [7] and a predominant closed phase. Hypofunctional clients tend to have a predominant open phase and reduced amplitude. These parameters can help inform management by giving the practitioner a general idea about treatment approaches (i.e., those designed to reduce strain and promote relaxation, or conversely, those designed to increase effort and promote better entrainment of the vocal mechanism).

In conclusion, videostroboscopy can be of considerable value to professionals working with the voice. It is a laryngeal imaging technique that reveals information about the complex interaction among laryngeal structures, muscle use patterns, and how the larynx responds to aerodynamic forces. The examination can be used to obtain information about specific parameters or to obtain a wider view of voice usage patterns. Practitioners use the information to make informed decisions about behavioral and/or medical management options and to assess their effectiveness.

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"Current laryngeal imaging techniques include videostroboscopy and emerging technologies like high speed imaging and videokymography."

STROBOSCOPY VERSUS HIGH-SPEED LARYNGEAL IMAGING

By Rita R. Patel

Laryngeal imaging techniques such as stroboscopy and high-speed imaging provide direct assessment of vocal fold structure and function. This information can then be used diagnosing and treating voice disorders. Imaging the larynx to view the rapid motion of the vocal folds has been a difficult problem. The naked eye is unable to view each and every cycle of the vocal fold motion because the vocal folds vibrate at an incredibly rapid rate. In adults, the vocal folds can move anywhere from 90-250 times per second. Children's vocal folds move at an even faster rate of up to 350 times per second! Without stroboscopy, these rapid vocal fold vibrations cannot be seen by the human eye and appear like a blur.

The current state-of-the art in laryngeal imaging is called stroboscopy, which seems to slow the movement of the vocal folds so that the human eye can observe it. However, it is not without problems. Information is lost with stroboscopy because each cycle of vibration is not recorded. It captures only parts of successive cycles of vocal fold motion and puts these pieces together in what we call "apparent" vocal fold motion. As mentioned in Jan's article, stroboscopy requires a strobe light that flashes at the same frequency as the voice to produce the slow movement of the vocal fold. Accordingly, it is unable to capture small or rapid changes in vocal fold motion like those observed during voice breaks, voice onset and offset, etc. Sometimes, children are able to sustain phonation for only a short duration (2-3 seconds) and this often does not work well with stroboscopy.

Moreover, stroboscopy does not work well when voice quality is severely affected because it the flashing light cannot synchronize well with irregular vibration. In two large scale studies, stroboscopy was not effective in imaging vocal fold vibration in most mild to severe voice disorders [1,2]. Vibratory features could not be interpreted in 100% of people with severe voice disorders.[1] Thus stroboscopy is not an adequate assessment tool for all voice types and voice disorders. High-speed imaging, on the other hand does not require synchronizing to pitch, and can be used to validly analyze dysphonia irrespective of the degree of the voice disturbance. In our lab, we have found great value in adding high-speed imaging for clinical assessment of vocal function, even for severely disordered voices.

Use of specialized high-speed viewing (high speed endoscopy) provides superior imaging capabilities especially of vocal fold motion in children and adults with normal and disorders voices. Unlike stroboscopy that records the "apparent" vocal fold motion at 30 frames per second, high-speed records vocal fold motion at 4000 frames per second or more (temporal resolution). High-speed imaging can help with differentiating muscle tension dysphonia from adductor spasmodic dysphonia,[3] vocal tremor,[4] diplophonia,[5] voice onset during singing and speaking,[6] and in cases of laryngeal cancer.[7] Like stroboscopy, the images can be analyzed both visually and quantitatively. However, unlike stroboscopy, information can be gained on each cycle of vocal fold vibration. High-speed imaging is superior to stroboscopy in assessing irregular vocal fold vibration.[1,2,8] The vibratory features noted in Bruce's article, such as amplitude, mucosal wave, phase symmetry, tissue pliability, and aperiodicity require the use of high-speed imaging for clinical interpretation. Structural features not dependent on vibration like vocal fold edge and plane difference between the vocal folds can be discerned with other imaging methods like stroboscopy or regular plain endoscopy.[1]

(Continued on page 6)

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"The current state-of-the art in laryngeal imaging is called stroboscopy, which seems to slow the movement of the vocal folds so that the human eye can observe it."

Stroboscopy versus High-Speed Laryngeal Imaging, continued

There are some pluses and minuses to the use of high speed imaging versus stroboscopy. First, use of high-speed imaging equipment requires training for use and interpretation. A standard recording protocol can be completed in 25-30 minutes with high-speed imaging, which may be longer than the time needed for stroboscopy protocols. This is because high-speed imaging requires multiple recordings to capture the standard recording tasks because the recording duration is limited to 4-10 seconds; depending on the frame rate of interest. Second, the light source with high-speed imaging is more powerful than stroboscopy. Hence, care must be taken to turn the light source down when saving the recordings on high speed system to prevent heating of the tip of the endoscope. Third, visual playback for long duration samples (e.g. 4 seconds) obtained from high-speed imaging can be time-consuming to assess at slow play back speeds needed to visualize the motion. Contrary to the above, it is less time consuming to analyze long duration samples with stroboscopy. Audio recordings can be played back simultaneously with stroboscopy but are not possible with high-speed. Third, due to the limitations of digital technology, high-speed has reduced number of pixels (spatial resolution) compared to stroboscopy, resulting in reduced image clarity. Stroboscopy can be obtained in both standard color and high-definition, however high-speed imaging is limited to either standard color or black and white recordings. The commercially available systems do not have the capability of obtaining high-speed imaging with flexible endoscopes. Last, data storage of high-speed examinations remains cumbersome for high patient volume clinics. Due to these limitations, high-speed has not gained widespread clinical acceptance.

The value of high-speed imaging to the understanding of voice production has been immeasurable. However, because of its recording limitations in its current form it augments rather than replaces stroboscopy. With further research, high-speed imaging with its improved temporal resolution has the potential for evolving a new lesion-specific classification based on vibratory motion for conditions that are challenging to differentially diagnose from the current clinical battery of voice examinations, e.g. nodules vs. polyps vs. cyst, adductor spasmodic dysphonia vs. muscle tension dysphonia, vocal fold paresis versus paralysis, etc. Because technology is changing rapidly some of the above limitations of high-speed will likely be overcome in the near future.

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"In our lab, we have found great value in adding high-speed imaging for clinical assessment of vocal function, even for severely disordered voices."

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ADVANCES IN LARYNGOSCOPY: VIDEOKYMOGRAPHY, HIGH-SPEED IMAGING AND MORE

By Jan G. Svec

Diagnosis of voice disorders has traditionally depended on looking at the vocal folds indirectly with laryngoscopy. This became possible with the invention of laryngeal mirror in 1855 by Manuel Garcia and through the years it has greatly advanced with the invention of specialized viewing equipment or "scopes" (endoscopes) and recording systems. These newer viewing methods include rigid and flexible endoscopes (most recently the so called "chip-on-the tip endoscopes"), video recording systems, endoscopic cameras, digital recording equipment and high definition TV systems. These advances allow for better quality images of the vocal folds and also discovery of small lesions that were difficult to observe previously. Viewing the larynx with these systems has an important role in the diagnosis of laryngeal disorders, but these methods do not provide much information on the way the vocal folds vibrate to produce voice. It is important to know about how the vocal folds are vibrating because abnormal vibration patterns are a factor in many voice disorders.

To observe the vibrations of the vocal folds, stroboscopic light has been used since the end of 19th century. Stroboscopes have also advanced considerably throughout the decades. The most notable innovations are the use of the electronic flashing lamp (since 1930s), systems for automatically detecting and triggering the flashing light with vocal fold vibration frequency (since 1940s) and computer-integrated videostroboscopic systems (in 1990s). However, even the most advanced of today's stroboscopic systems, allow observation of vocal fold vibrations only when they vibrate regularly. That is, the systems fail to perform when the vibrations are irregular, as in many voice disorders. This is because the stroboscopic flashes need to be synchronized with the vocal fold vibration, which is technically impossible in disturbed voices when the vibrations are irregular.[1]

As an alternative, high-speed video techniques can be used instead of stroboscopy. These techniques allow capturing the vocal fold vibration with the rates exceeding 1000 images per second. The vibration disturbances can then be visualized when the high-speed video recordings are played back at slow speed. High-speed laryngeal imaging has also undergone large progress since its first use in 1940s, the most notable being the invention of technology of digital imaging. Image quality was rather poor to begin with but nowadays the spatial resolution and image quality are often undistinguishable from that of regular video cameras. The growing popularity of this technology also caused its price to decline making it more accessible for the use in laryngology and voice research.[2]

Watching the high-speed videos is extremely time consuming, however: a five-second phonation recorded with the high-speed frame rate of 4000 images per second takes over 10 minutes to watch at regular video speed and can take over an hour when played slowly frame by frame. Obviously, this is not practical and therefore techniques have been developed to speed up and facilitate observation of the vocal fold vibration. The most basic method is called "kymography". This method displays the vibration of a selected portion of the vocal folds in a single image, called a "kymogram".[3]

Laryngeal kymographic imaging became practical and widely accepted after the invention of the high-speed videolaryngoscopic method called "videokymography" (VKG) in 1994.[4] The VKG method also has been advanced and today it makes use of a specially modified video camera that provides two images simultaneously in real time: in the

(Continued on page 8)

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"We live in an exciting time with new technology that allows us to gain much more insight into the nature of voice disorders than was ever possible."

Advances in laryngoscopy: videokymography, high-speed imaging and more, continued

left half it shows the standard laryngoscopic image of the vocal folds and laryngeal structures, and in the right half it shows their vibrational behaviour in the videokymographic image.[5] Videokymographic images are captured at high-speed rates exceeding 7000 line images per second.[5] The system allows immediate visual detection of various types of vibrational problems of the vocal folds, such as the left-right asymmetry, cycle-to-cycle disturbances, reduced mucosal waves, aberrations etc. Particularly useful is the use of videokymography in professional speakers and singers who do not suffer from any obvious structural pathology and yet they report voice problems. The use of videokymography allows discovering vibrational disturbances in these cases and allows for a more advanced diagnosis and better targeted treatment.

Inspired by videokymography, kymographic imaging has now been adopted also for extracting information about vocal fold vibration from the full high-speed video recordings and from videostroboscopic recordings. In these two methods the kymographic images are called "digital kymograms" and "strobokymograms", respectively. These two methods differ substantially from videokymography because the kymograms are not delivered in real time by a special camera. Instead, the images are extracted from previously recorded videolaryngoscopic recordings using special software. Discussion on the advantages as well as drawbacks of the three kymographic methods can be found in our recent paper.[3]

Advances in image processing of the high-speed videolaryngoscopic recordings have led to the development of another novel method of displaying the vocal fold vibration in a form of a single image called phonovibrography (PVG).[6] It allows quantifying the complex vibration pattern of the whole vocal fold in a sophisticated way and is particularly sensitive to anterior-posterior differences in vocal fold vibration.[7] Besides kymography, this method also shows great promise in better understanding the nature of various voice disorders.

Overall, the current state of the art of high-speed video imaging and kymography can be compared to the state of stroboscopy at the beginning of its exploration for use in voice. These methods allow detection of novel features, but have yet been largely under- or unexplored in clinical practice. *In this sense, progress in imaging technology is currently ahead of basic and clinical knowledge of voice production.*[3] Various image processing computer programs have been developed to allow definition of features of vocal fold vibration for use in clinical studies and practice. Interdisciplinary collaboration among clinicians, physicists and engineers has an essential role here since the knowledge on vibration and acoustics needs to be combined with medical knowledge. We live in an exciting time with new technology that allows us to gain much more insight into the nature of voice disorders than was ever possible.

"Inspired by videokymography, kymographic imaging has now been adopted also for extracting information about vocal fold vibration from the full high-speed video recordings and from videostroboscopic recordings."

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Call for

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Deadline: October 31, 2013

Abstracts must represent original work that has not been published elsewhere. Completed manuscripts must be submitted by the day of presentation at the Symposium and must be submitted for consideration for publication in *Journal of Voice*, unless prior arrangements have been made. There will also be a New Investigators Research Forum for works in progress.

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Voice professionals are invited to submit a proposal for a workshop to be considered for presentation at the Voice Foundation's 2014 Symposium. As you prepare your submission, please keep in mind that the focus of the workshop should be on the "live" demonstration of your techniques. Audience participation is desirable. The workshop duration is 55 minutes, and we request that you plan for the majority of the session to be spent in hands-on interaction with the participants. Be advised that workshops should be designed to be presented without the use of audiovisual aids such as overhead projectors, slide projectors, or videotapes.

ASHLEY ALDEN
SUSANNE MENTZER

Submission details will be available at www.voicefoundation.org/abstracts

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GREAT SYMPOSIUM MOMENTS

Friday Morning Session with
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Vy Higginsen
Barry Bittman

"This was an inspirational and informative session – too bad not video recorded. This was a *must see* session."

Douglas M. Hicks

BASIC SCIENCE TUTORIAL Q&A: RAHUL SHRIVASTAV, CHRISTY LUDLOW, RON SCHERER, MARGARET BARODY, JOHAN SUNDBERG, STEN TERNSTRÖM

CHRISTIAN HERBST RECEIVES THE 2ND ANNUAL HAMDAN AWARD FROM ROBERT T. SATALOFF AT THE 42ND ANNUAL SYMPOSIUM

DYNAMOS LEADING THE PRESENTATION OUTREACH COMMITTEE: EX-PRESIDENT LUCILLE RUBIN & INCOMING PRESIDENT DONNA SNOW

STROBOSCOPY OSCARS

The 2012 Sunday Medical Panel, **Stroboscopy Oscars**, educated us in an entertaining way. There was a call for strobe videos, which were presented with humorous titles and commentary. The audience, in the capacity of judges, voted on the best video. The winner was awarded the Oscar.

You will be happy to know that 2014 marks **The Return of the Stroboscopy Oscars** at the 43rd Annual Symposium: Care of the Professional Voice. The format will include different categories and special prizes.

Look out for our ***Call for Strobes*** in early 2014.

2012 STROBOSCOPY OSCAR FINALISTS LINDSAY ARVISO, AMY RUTT, CLAUDIO MILSTEIN, JAMES THOMAS, JOEL PORTNOY, MODERATORS MICHAEL M. JOHNS AND EVA VAN LEER. THE FIRST-PLACE WINNER, MARA BEHLAU, IS ABSENT

42ND ANNUAL SYMPOSIUM

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42ND ANNUAL SYMPOSIUM

STEN TERNSTROEM MIXED WITH THE KANSAS UNIVERSITY CONTINGENT MELISSA GRADY, KATHRYN HOM, JAMES DAUGHERTY, STEN TERNSTRÖM, JEREMY MANTERNACH, HEATHER NELSON, KATHY PRICE, AND TROY DARGIN.

CAROLINE MALKA RECEIVES THE BEST PAPER 2012 JOURNAL OF VOICE AWARD IN CLINICAL MEDICINE

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THE VOICE FOUNDATION

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MAY—JUNE 2014

SUN	MON	TUE	WED	THU	FRI	SAT
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			43RD ANNUAL SYMPOSIUM		GALA	
1 JUNE SYMP						

SCHEDULE OF EVENTS

- **October 31, 2013—Deadline Call for Papers, Posters & Workshops Abstract Submission**
- **Novermber 15, 2013—Van L. Lawrence Fellowship submission deadline.**
- **January 1, 2014—Registration for the 43rd Annual Symposium opens**
- **February 1, 2014—Submission Deadline for the Hamdan International Presenter Award**
- **March 1, 2014—Proposal Submission Deadline for New Investigator's Forum**
- **April 16, 2014—World Voice Day**
- **May 28—June 1, 2014 43rd Annual Symposium: Care of the Professional Voice**
- **May 30, 2014—Voices of Summer Gala**