



Karthik Balakrishnan

Associate Professor of Otolaryngology-Head and Neck Surgery (Pediatrics) at the Stanford University Medical Center

Otolaryngology - Head & Neck Surgery Divisions

CLINICAL OFFICES

- **Respiratory Specialties and ENT**

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Bio

BIO

Dr. Balakrishnan is a pediatric otolaryngologist specializing in the care of children with complex disorders of breathing, voice, and swallowing. He has a special interest in complex surgical reconstruction of the larynx (voice box) and trachea (windpipe) and in vascular anomalies of the head and neck. He has interests in improving the quality, safety, and value of pediatric surgical care, reducing costs of care, and optimizing the patient and caregiver healthcare experience. He has also developed expertise in how cognitive and implicit bias may affect medical decision-making and quality of patient care.

Dr. Balakrishnan has nationally and internationally recognized expertise in these areas, with multiple national and international invited presentations. He has published over 40 peer-reviewed papers, multiple textbook chapters, and one textbook (Evidence-Based Management of Head and Neck Vascular Anomalies, 2019). He has also served as Associate Editor for the journal Otolaryngology – Head and Neck Surgery. He serves on multiple national and institutional quality committees and is founding co-chair of the national multicenter Aerodigestive Research Collaborative. His commitment to quality care for children and surgical patients has been recognized with fellowships in the American College of Surgeons and American Academy of Pediatrics.

Dr. Balakrishnan was born and raised in Baltimore, Maryland and attended college at Harvard University. After taking a year to work as a high school teacher in Baltimore, he attended medical school at Johns Hopkins, with an additional year to complete a Howard Hughes Medical Institute research fellowship. He then completed residency in Otolaryngology – Head & Neck Surgery at the University of Washington. During residency, Dr. Balakrishnan completed a two-year NIH-funded research fellowship and a Master of Public Health degree with a focus on Health Services. He then completed a two-year fellowship at Cincinnati Children's Hospital with a focus on complex reconstruction of the pediatric larynx and trachea and pediatric aerodigestive disorders.

In 2014, Dr. Balakrishnan joined the otolaryngology faculty at Mayo Clinic in Rochester, Minnesota, where he had a busy pediatric airway and aerodigestive practice and was a key contributor to the multidisciplinary aerodigestive, vascular anomalies, and velopharyngeal insufficiency programs. At the Mayo Clinic Children's Center, Dr. Balakrishnan also served as a surgical quality leader and championed the development of a comprehensive pediatric surgical quality program. Dr. Balakrishnan joined the Stanford Department of Otolaryngology – Head & Neck Surgery and Lucile Packard Children's Hospital faculty as associate professor in early 2020. With this appointment, he also took on the role of medical director for surgical performance improvement at Stanford Lucile Packard Children's Hospital.

CLINICAL FOCUS

- Pediatric Otolaryngology
- Airway Reconstruction
- Airway Obstruction
- Laryngeal Stenosis
- Tracheal Stenosis
- Vocal Cord Paralysis
- Airway
- Airway Surgery
- Choanal Atresia
- Vascular Anomalies
- Tracheostomy
- Tracheostomy Dependence
- Swallowing Disorders
- Aspiration

ACADEMIC APPOINTMENTS

- Associate Professor - Med Center Line, Otolaryngology - Head & Neck Surgery Divisions
- Member, Bio-X
- Member, Maternal & Child Health Research Institute (MCHRI)

ADMINISTRATIVE APPOINTMENTS

- Medical Director of Surgical Performance Improvement, Lucile Packard Children's Hospital, Stanford, (2020- present)

HONORS AND AWARDS

- Fellow, American College of Surgeons
- Fellow, American Academy of Pediatrics

PROFESSIONAL EDUCATION

- MPH, University of Washington , Health Services (2008)
- Board Certification: Otolaryngology, American Board of Otolaryngology (2013)
- Residency: University of Washington Otolaryngology Residency (2012) WA
- Internship: University of Washington Dept of Surgery (2006) WA
- Medical Education: Johns Hopkins University School of Medicine (2005) MD
- Fellowship: Cincinnati Children's Medical Center Pediatric Otolaryngology OH

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Dr. Balakrishnan studies ways to improve outcomes of pediatric airway reconstruction for diseases such as laryngotracheal, subglottic and tracheal stenosis, congenital tracheal stenosis and complete tracheal rings, laryngeal clefts, and vocal fold immobility and paralysis. He also examines the same questions for vascular malformations such as lymphatic malformations, venous malformations and hemangiomas.

Dr. Balakrishnan's research focuses on ways to standardize treatments and measure outcomes in these complex diseases, as well as ways to reduce treatment costs and medical errors, particularly those related to cognitive bias. By improving outcomes and reducing costs, he aims to improve the value of care, while also optimizing patient and caregiver experience during the care process.

Focus areas

1. Standardizing outcomes and processes in pediatric airway reconstruction. Dr. Balakrishnan co-leads unique international and national multidisciplinary collaborative groups to develop standard processes and outcome measures for airway surgery and aerodigestive (breathing/voice/swallowing) care in children. His previous work

has led to the development of similar standards for lymphatic malformations in the head and neck and for reconstructive surgery of the larynx (voice box) and trachea (windpipe) in children. He has internationally recognized expertise in developing consensus statements for these complex questions.

2. Costs of otolaryngology care. Dr. Balakrishnan has studied thousands of patients and otolaryngology operations to identify factors that may predict more costly medical care. This will lead to process improvements that will allow Stanford and other institutions to reduce the cost burden that patients and the U.S. health care system face while maintaining quality and access to care. Dr. Balakrishnan's current work connects these costs to the outcomes and value of care provided.
3. Cognitive bias and implicit bias and medical error. Dr. Balakrishnan is working to improve otolaryngology resident and provider education related to the effects of cognitive and implicit bias on medical decision-making, and ways to reduce medical errors related to those biases.
4. Evidence-based care of vascular anomalies. Dr. Balakrishnan leads a task force of colleagues around the country to develop better scientific evidence to guide the care of challenging vascular anomalies such as lymphatic malformations.
5. Innovative approaches to pediatric airway reconstruction. Dr. Balakrishnan has studied several minimally invasive endoscopic approaches to airway surgery and is currently developing new robotic techniques to reconstruct the airway.

Significance to patient care

Complex and rare conditions such as airway stenosis and vascular malformations greatly impact children's survival and quality of life, but treatment pathways and standardization of care are still lacking. Dr. Balakrishnan hopes that increasing standardization of care and outcome reporting for these conditions will help doctors provide better care for these patients, with reduced costs and a better experience for children and their families and caregivers. Meanwhile, by developing and studying new and potentially better ways to do airway surgery, Dr. Balakrishnan hopes to provide families with innovative options that may better suit their children's needs.

Publications

PUBLICATIONS

- **Patient Safety/Quality Improvement Primer, Part II: Prevention of Harm Through Root Cause Analysis and Action (RCA(2))** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
Balakrishnan, K., Brenner, M. J., Gosbee, J. W., Schmalbach, C. E.
2019; 161 (6): 911–21
- **Predictors of High Costs of Care among Otolaryngology Patients** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
Balakrishnan, K., Moriarty, J. P., Rosedahl, J., Driscoll, C. L., Borah, B. J.
2019; 161 (2): 271–77
- **The Impact of Cognitive and Implicit Bias on Patient Safety and Quality** *OTOLARYNGOLOGIC CLINICS OF NORTH AMERICA*
Balakrishnan, K., Arjmand, E. M.
2019; 52 (1): 35–46
- **Outcome measures for pediatric laryngotracheal reconstruction: International consensus statement** *LARYNGOSCOPE*
Balakrishnan, K., Sidell, D. R., Bauman, N. M., Bellia-Munzon, G. F., Boesch, R., Bromwich, M., Cofer, S. A., Daines, C., de Alarcon, A., Garabedian, N., Hart, C. K., Ida, J. B., Leboulanger, et al
2019; 129 (1): 244–55
- **International Pediatric Otolaryngology Group (IPOG): Juvenile-onset recurrent respiratory papillomatosis consensus recommendations.** *International journal of pediatric otorhinolaryngology*
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- **Interdisciplinary aerodigestive care model improves risk, cost, and efficiency** *INTERNATIONAL JOURNAL OF PEDIATRIC OTORHINOLARYNGOLOGY*
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2018; 113: 119–23
- **Fetoscopic Therapy for Severe Pulmonary Hypoplasia in Congenital Diaphragmatic Hernia: A First in Prenatal Regenerative Medicine at Mayo Clinic** *MAYO CLINIC PROCEEDINGS*

- Ruano, R., Klinkner, D. B., Balakrishnan, K., Novoa, V., Davies, N., Potter, D. D., Carey, W. A., Colby, C. E., Kolbe, A. B., Arendt, K. W., Segura, L., Sviggum, H. P., Lemens, et al
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- **Structure and Functions of Pediatric Aerodigestive Programs: A Consensus Statement** *PEDIATRICS*
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 - **Outcomes and Resource Utilization of Endoscopic Mass-Closure Technique for Laryngeal Clefts** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
Balakrishnan, K., Cheng, E., de Alarcon, A., Sidell, D. R., Hart, C. K., Rutter, M. J.
2015; 153 (1): 119-123
 - **Standardized Outcome and Reporting Measures in Pediatric Head and Neck Lymphatic Malformations** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
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 - **Primary Surgery vs Primary Sclerotherapy for Head and Neck Lymphatic Malformations** *JAMA OTOLARYNGOLOGY-HEAD & NECK SURGERY*
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2014; 140 (1): 41–45
 - **Functional and Symptom Impacts of Pediatric Head and Neck Lymphatic Malformations: Developing a Patient-Derived Instrument**
Balakrishnan, K., Edwards, T. C., Perkins, J. A.
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 - **Pediatric tracheostomy practice patterns.** *International journal of pediatric otorhinolaryngology*
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2020; 133: 109982
 - **Sclerotherapy for lymphatic malformations of head and neck: Systematic review and meta-analysis.** *Journal of vascular surgery: Venous and lymphatic disorders*
De Maria, L., De Sanctis, P., Balakrishnan, K., Tollefson, M., Brinjikji, W.
2020; 8 (1): 154–64
 - **Sclerotherapy for Venous Malformations of Head and Neck: Systematic Review and Meta-Analysis.** *Neurointervention*
De Maria, L., De Sanctis, P., Balakrishnan, K., Tollefson, M., Brinjikji, W.
2020
 - **The Relationship between Croup and Gastroesophageal Reflux: A Systematic Review and Meta-Analysis.** *The Laryngoscope*
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2020
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 - **International Pediatric ORL Group (IPOG) Robin Sequence consensus recommendations.** *International journal of pediatric otorhinolaryngology*
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2019; 130: 109855
 - **Inability to Mask Ventilate During Myringotomy Tube Replacement: A Case Report.** *A&A practice*
Wong, A. V., Balakrishnan, K., Nemergut, M. E.
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 - **Competency-Based Assessment Tool for Pediatric Tracheotomy: International Modified Delphi Consensus.** *The Laryngoscope*
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- **Revision Thoracic Slide Tracheoplasty: Outcomes Following Unsuccessful Tracheal Reconstruction** *LARYNGOSCOPE*
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2018; 128 (9): 2181–86
- **Cost comparison and safety of emergency department conscious sedation for the removal of ear foreign bodies** *INTERNATIONAL JOURNAL OF PEDIATRIC OTORHINOLARYNGOLOGY*
Olson, M. D., Saw, J., Visscher, S. L., Balakrishnan, K.
2018; 110: 140–43
- **Revision thoracic slide tracheoplasty: Outcomes following unsuccessful tracheal reconstruction.** *The Laryngoscope*
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- **Indirect management of full-thickness tracheal erosion in a complex pediatric patient** *INTERNATIONAL JOURNAL OF PEDIATRIC OTORHINOLARYNGOLOGY*
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- **Definitive airway management after prehospital supraglottic rescue airway in pediatric trauma**
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- **National Multispecialty Survey Results: Comparing Morbidity and Mortality Conference Practices within and outside Otolaryngology** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
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- **Primary cervical leiomyoma: A rare cause of a posterior neck mass in a pediatric patient** *INTERNATIONAL JOURNAL OF PEDIATRIC OTORHINOLARYNGOLOGY*

- Oliver, J. D., Anzalone, C., Balakrishnan, K.
2018; 104: 166–69
- **International Pediatric Otolaryngology Group: Consensus guidelines on the diagnosis and management of type I laryngeal clefts** *INTERNATIONAL JOURNAL OF PEDIATRIC OTORHINOLARYNGOLOGY*
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 - **Three-dimensional printed models in multidisciplinary planning of complex tracheal reconstruction** *LARYNGOSCOPE*
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 - **Endoscopic anterior-posterior cricoid split for pediatric bilateral vocal fold paralysis.** *Laryngoscope*
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2017
 - **Education on, Exposure to, and Management of Vascular Anomalies During Otolaryngology Residency and Pediatric Otolaryngology Fellowship** *JAMA OTOLARYNGOLOGY-HEAD & NECK SURGERY*
Chun, R., Jabbour, N., Balakrishnan, K., Bauman, N., Darrow, D. H., Elluru, R., Grimmer, J., Perkins, J., Richter, G., Shin, J.
2016; 142 (7): 648–51
 - **Predicting CPAP Use and Treatment Outcomes Using Composite Indices of Sleep Apnea Severity** *JOURNAL OF CLINICAL SLEEP MEDICINE*
Balakrishnan, K., James, K. T., Weaver, E. M.
2016; 12 (6): 849–54
 - **The Lymphatic Malformation Function (LMF) Instrument** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
Kirkham, E. M., Edwards, T. C., Weaver, E. M., Balakrishnan, K., Perkins, J. A.
2015; 153 (4): 656–62
 - **Applying Cost Accounting to Operating Room Staffing in Otolaryngology: Time-Driven Activity-Based Costing and Outpatient Adenotonsillectomy** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
Balakrishnan, K., Goico, B., Arjmand, E. M.
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 - **Prognostic Value of a Simplified Anatomically Based Nomenclature for Fetal Nuchal Lymphatic Anomalies** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
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2015; 152 (2): 342–47
 - **Composite Severity Indices Reflect Sleep Apnea Disease Burden More Comprehensively Than the Apnea-Hypopnea Index** *OTOLARYNGOLOGY-HEAD AND NECK SURGERY*
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 - **Management of Head and Neck Lymphatic Malformations** *FACIAL PLASTIC SURGERY*
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 - **Applications and Outcomes of Orbital and Transorbital Endoscopic Surgery**
Balakrishnan, K., Moe, K. S.
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 - **Head and Neck Lymphatic Tumors and Bony Abnormalities: A Clinical and Molecular Review** *LYMPHATIC RESEARCH AND BIOLOGY*
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 - **Management of airway hemangiomas.** *Expert review of respiratory medicine*
Balakrishnan, K., Perkins, J. A.
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