

## Curriculum Vitae

**Date Prepared:** 4/10/2018  
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**Place of Birth:** Lincoln, Nebraska, U.S.A.

### Education:

1990	B.S.	Biochemistry	Trinity University
2001	M.D., Ph.D.	Medicine, Biological Chemistry	University of Texas Southwestern Medical Center

### Postdoctoral Training:

7/2001-6/2003	Resident	Internal Medicine	Massachusetts General Hospital
7/2003-6/2006	Clinical Fellow	Endocrinology	Massachusetts General Hospital
7/2004-7/2008	Research Fellow	C. Ronald Kahn	Joslin Diabetes Center

### Faculty Academic Appointments:

7/2006-3/2012	Instructor in Medicine	Harvard Medical School
4/2012-11/2017	Assistant Professor of Medicine	Harvard Medical School
12/2017-	Associate Professor of Medicine	Harvard Medical School

### Appointments at Hospitals/Affiliated Institutions:

7/2006-8/2015	Assistant in Medicine	Internal Medicine	Massachusetts General Hospital
8/2015-present	Assistant Physician	Internal Medicine	Massachusetts General Hospital

### Other Professional Positions:

1987-1990	NSF Summer Undergraduate Research Fellow	Trinity U., San Antonio, TX
2014-2016	Scientific Advisory Board (2-3 meetings per year)	Tandem Diabetes
2014-	Scientific Advisory Board (2-3 meetings per year)	Companion Medical
2016-	Scientific Advisory Board	βeta βionics
2017-	Scientific Advisory Board (2 meetings per year)	Unomedical

### Committee Service:

#### Local

2003-2006	Teaching & Training Council	MGH Department of Medicine Member, fellow representative
2005-2006	Perioperative Diabetes Management Taskforce	Massachusetts General Hospital, member

#### National

2012-	Initiative to Advance Pediatric Therapeutics	National Institute of Child Health and Human Development, member of Diabetes Core Group
2012-	Clinical Development Advisory Panel	California Institute of Regenerative Medicine, member
2013-	Glu Research Advisory Board	T1D Exchange, member

**Professional Societies:**

1991-	American Medical Association
2001-	American College of Physicians
2005-	Endocrine Society
2005-2012	Longevity Consortium
2007-2012	American Aging Association
2007-	American Diabetes Association

**Grant Review Activities:**

2011	Artificial Pancreas Study Section (SBIR)	NIH/NIDDK, ad-hoc member
2011-12	National Scientific Advisory Council	American Foundation for Aging Research
2012	Medical Research Council (UK)	Medical Research Council (UK), ad-hoc reviewer
2012	Strategic Partnership Awards review panel	California Institute for Regenerative Medicine, member
2012-14	Clinical Development Advisory Panel	California Institute for Regenerative Medicine, member
2013	A*Star Biomedical Engineering Program (BEP) grant	Center for Integration of Engineering and Medicine, ad hoc reviewer
2013	CIRM Translational Portfolio Assessment	California Institute for Regenerative Medicine, member
2013-14	Grants Working Group	California Institute of Regenerative Medicine, member
2013	Disease Team Therapy Development III Awards review panel	California Institute for Regenerative Medicine, member
2014	Fellowship Grant Evaluation Committee	The Danish Diabetes Academy, ad hoc reviewer
2014	Women's Health Research at Yale	Yale University School of Medicine, external reviewer
2014	Stem Cell Alpha Clinics review panel	California Institute for Regenerative Medicine, member
2015	ZRG1 EMNR-P 03 M, Member Conflict SEP for Diabetes and Obesity research	NIH / CIDO, chair
2015-	Clinical Advisory Panel – Viacyte Project	California Institute for Regenerative Medicine, scientific advisor
2016-	Grants Working Group	California Institute for Regenerative Medicine, member
2017	Harvard Data Ideation Challenge: Good Questions Meet Big Data	Harvard Clinical and Translational Science Center, reviewer
2017-	Helmsley Charitable Trust	Helmsley Charitable Trust, ad-hoc External Reviewer

**Editorial Activities: Reviewer**

Aging Cell

Annals of the New York Academy of Sciences  
 BioEssays  
 BMJ Open Diabetes Research & Care  
 Diabetes  
 Diabetes Care  
 Diabetes, Obesity and Metabolism  
 Diabetes Technology and Therapeutics  
 The Journal of Pharmacological and Toxicological Methods  
 The FASEB Journal  
 The Journal of Diabetes Science and Technology  
 The Lancet  
 The Lancet Diabetes & Endocrinology  
 Molecular and Cellular Endocrinology  
 The New England Journal of Medicine  
 PLoS ONE

### Other Editorial Roles

2010	Co-editor, Symposium: Glucagon Physiology and Pharmacology (Vol. 4, Issue 6, November 2010)	Journal of Diabetes Science and Technology
2012-	Section Editor, Technological Developments in Diabetes Therapies (Vol. 12, Issue 6, December 2012)	Current Diabetes Reports
2012-	Member, Advisory Board	diaTribe, diabetes CloseUp, and CloserLook (Close Concerns)
2015-2017	Member, International Advisory Board Abstract reviewer, American Diabetes Association Annual Scientific Sessions	Lancet Diabetes and Endocrinology Diabetes

### Honors and Prizes:

1986-1990	President's/Trustee Scholarship	Trinity University	National Merit Finalist
1994	High Pass	University of Texas Southwestern, Biochemistry & Molecular Biology Graduate Program	Outstanding qualifying exam proposal in NIH grant form
1997	Young Scientists' Program Fellowship	American Society for Biochemistry and Molecular Biology / International Union of Biochemistry and Molecular Biology	Abstract competition
1997-1998	Presenter	29th and 30th Annual Sigma Xi Graduate Student Research Forum	Abstract competition
1997	Sigma Xi Membership	Sigma Xi	
1997	Exceptional presentation	Graduate Student Illustrations and Presentations Session	Poster competition
2000	Alpha Omega Alpha Membership	Alpha Omega Alpha	
2008	Scholarship to MBL Molecular Biology of Aging Course	Ellison Medical Foundation	
2013	Granite Gala Honoree	Juvenile Diabetes Research Foundation – Northern New England Chapter	With Edward Damiano, awarded for work on the bionic pancreas

2015	Panel Chair	NIH CIDO Member Conflict SEP for Diabetes and Obesity research	
2016	Stephen M. Krane, MD Lectureship Award	Massachusetts General Hospital Department of Medicine Research Council	Outstanding Young Investigator

## **Report of Funded and Unfunded Projects**

### **Funding Information:**

#### **Past**

2006-2007	Adipocyte Insulin Signaling in Metabolism and Aging NIH, Ruth L. Kirschstein National Research Service Award (1 F32 AG028265-01) PI (\$52,048) The goal of this study was to investigate how insulin signaling in adipocytes regulates lifespan in long-lived fat-specific insulin receptor knockout (FIRKO) mice.
2007	Closed-loop blood-glucose regulation in type 1 diabetes: A clinical trial Wallace H. Coulter Foundation, Translational Partners Award MGH PI (\$0 - full budget of \$100,000 spent on preclinical development at Boston University site) The goal of this project was to complete preclinical experiments on a closed-loop blood glucose control system and to prepare an IDE application for human studies.
2007-2010	Utility of Continuous Glucose Monitoring for Maintenance of Normoglycemia in ICU Patients Abbott Diabetes Care PI (\$110,000) The goal of this study was to test the accuracy of a continuous glucose monitoring device that measures interstitial fluid glucose (Abbott Navigator) in critically ill ICU patients.
2009-2011	Development and preclinical testing of a closed-loop control system for blood-glucose regulation in the ICU Wallace H. Coulter Foundation, Translational Partners Award MGH PI (\$0 - full budget of \$200,000 spent on preclinical development at Boston University site) The objective of this program was to perform pre-clinical experiments on a closed-loop control system for regulating blood glucose in critically ill patients.
2009-2011	Adipocyte Insulin Signaling in Metabolism and Aging NIH/NIA, ARRA Supplement (3 K08 AG032869-02S1) PI (\$99,937) This is an American Reinvestment and Recovery act supplement to 1 K08 AG032869-01 to fund hiring of a research assistant and purchase of equipment.
2007-2011	Closed-loop glucose control for automated management of type 1 diabetes Juvenile Diabetes Research Foundation, Clinical Investigations Research Grant MGH PI (\$1,034,092) The objective of this project was to test the ability of a closed-loop control system to regulate blood glucose in adults with type 1 diabetes.
2010-2012	In-patient trials of automated glucose control in children with type 1 diabetes Leona M. and Harry B. Helmsley Charitable Trust, MGH PI (\$640,635) The objective of this project is to test the ability of a closed-loop control system to regulate blood glucose in children with type 1 diabetes.
2008-2013	Adipocyte Insulin Signaling in Metabolism and Aging NIH/NIA-American Foundation for Aging Research, Paul Beeson Career Development Award in Aging Research (1 K08 AG032869-01)

- PI (\$799,719)  
The goal of this study is to investigate how insulin signaling in adipocytes regulates lifespan in long-lived fat-specific insulin receptor knockout (FIRKO) mice.
- 2009-2013 Clinical trials of a closed-loop control system for type 1 diabetes management  
NIH/NIDDK (1R01DK085633-01)  
MGH PI (\$1,812,925)  
The goal of this trial is to test the safety and efficacy a bi-hormonal closed-loop blood glucose control system in adults with type 1 diabetes.
- 2010-2014 Selecting Insulin Analogs for Closed-loop Control Using Multiplex Pharmacokinetic Profiling  
Leona M. and Harry B. Helmsley Charitable Trust (09-T1D038)  
PI (\$526,700)  
The objective of this study is to determine whether the pharmacokinetic characteristics of rapid acting insulin preparations vary within a single individual.
- 2011-2013 Subcutaneous continuous glucose monitoring and intravenous dosing of insulin and dextrose for automated glycemic control in the in-patient setting: A clinical trial in the MGH CRC  
Wallace H. Coulter Foundation, Translational Partners Grant  
MGH PI (\$90,000)  
This is a first-in-man closed-loop blood glucose control system for inpatient application using interstitial fluid continuous glucose monitoring intravenous insulin and dextrose.
- 2012-2014 Pharmacokinetic Comparison of Intradermal vs. Sub-cutaneous Insulin and Glucagon Delivery in Volunteers with Type 1 Diabetes  
Leona M. and Harry B. Helmsley Charitable Trust  
PI (\$87,959)  
This study is designed to determine the impact on insulin and glucagon pharmacokinetics of intradermal vs. subcutaneous delivery.
- 2013-2014 Testing a bi-hormonal bionic pancreas in an outpatient study in children with type 1 diabetes at the Clara Barton/Joslin Camps  
Helmsley Trust Foundation (2014PG-T1D006)  
MGH PI (\$416,000)  
The goal of this project is to test the ability of a wearable bihormonal bionic pancreas to provide BG control in pediatric volunteers with type 1 diabetes (ages 12-20) in the setting of a summer diabetes camp outpatient study.
- 2012-2015 Closed loop microdose glucagon administration for the automated prevention and treatment of hypoglycemia  
American Diabetes Association (7-12-HYPO-07)  
PI (\$499,998)  
This project is a randomized, double-blinded, placebo controlled trial of automated, closed-loop microdose glucagon delivery for prevention and treatment of hypoglycemia in patients with type 1 diabetes.
- 2014-2015 Testing a bionic pancreas in an outpatient study in preadolescent children with type 1 diabetes at the Clara Barton/Joslin Camps  
Helmsley Trust Foundation (2014PG-T1D032)  
MGH PI (\$514,300)  
The goal of this project is to test the ability of a wearable bihormonal bionic pancreas to provide BG control in pediatric volunteers (ages 6-11) with type 1 diabetes in the setting of a summer diabetes camp outpatient study.
- 2012-2016 Translational studies of a bionic pancreas for out-patient diabetes management  
NIH/NIDDK (1R01DK097657-01)  
PI (\$2,911,229)  
The project will test a fully automated, wearable, bi-hormonal closed-loop bionic pancreas in adults and children over extended periods (up to six days of wear) in environments that will approximate the rigors of the outpatient environment. Adults

- experiments will last five days while subjects live in a hotel and interact with the city environment, experiments in children will last six days in a diabetes camp environment.
- 2013-2016 A multicenter outpatient trial of a bihormonal bionic pancreas  
NIH/NIDDK (1DP3DK101084)  
PI (\$2,880,000)  
The goal is to test fully automated, wearable, bi-hormonal closed-loop bionic pancreas in adults over extended periods (12 days of wear) at home and at work in four US centers with MGH as the coordinating center.
- 2012-2016 Bionic Pancreas with Minimally Invasive Continuous Insulin Monitoring  
Juvenile Diabetes Research Foundation – JDRF (17-2013-485)  
PI (\$765,360)  
The goal of this project is to develop continuous insulin monitor. The device will use a probe about the same size as an infusion set. It will continuously sample the insulin that has been absorbed from the blood into the tissues using microdialysis and measure it will a flow-through microfluidic immunoassay.
- 2014-2016 Equivalence of a Stable Liquid Glucagon Formulation with Freshly Reconstituted Lyophilized Glucagon  
Helmsley Trust Foundation (2014PG-T1D006)  
PI (\$174,130)  
The goal of this project is to test the equivalence of a stable glucagon formulation with freshly reconstituted samples of a formulation that has been used successfully in a bionic pancreas, but it not stable enough for prolonged use.
- 2015-2016 The Set-point Study: Evaluating Effects of Changing Glucose Target on Bionic Pancreas Performance  
Helmsley Charitable Trust  
PI (\$996,041)  
This study is designed to determine the effect on mean glucose, hypoglycemia, glucagon usage, and insulin usage of adjusting upward the glucose target of the bihormonal bionic pancreas (BP), and determine whether there is a target at which adequate glycemic control is achieved by an insulin-only BP with minimal hypoglycemia. An outpatient trial will compare 6 periods of 3 days in random order, of usual care, bihormonal BP targeting 100, 115, and 130 mg/dl, and insulin-only BP targeting 130 and 145 mg/dl, with in-clinic exercise in the fasted state at the end of the 130 mg/dl insulin-only and bihormonal periods.
- Current**
- 2016-2017 The iLet Feasibility Trial Testing the iLet, a Fully Integrated Bihormonal Bionic Pancreas with ZP4207  
Zealand Pharmaceuticals  
PI (\$145,377)  
This is the first study testing the stable glucagon analog ZP4207 in an automated glucose management application. It will be tested in the iLet bionic pancreas in an in-clinic study primarily testing safety and tolerability in comparison to freshly reconstituted Lilly glucagon. Secondary outcomes include glycemic control metrics.
- 2015-2019 Final clinical studies for submission of a pre-market approval application to the FDA for a Bionic Pancreas that automates type 1 diabetes management  
NIH/NIDDK (1UC4DK108612-01 / 1UC4DK108612-01S1)  
PI (\$1,498,323 [-01] / \$11,957,319 [-01S1])  
The goals of this grant are to do the first-in-humans testing of the fully integrated bionic pancreas iLet in its final form in a bridging study (-01) as well as to perform the pivotal study of the iLet in the bihormonal configuration (-01S1).
- 2015-2017 The Glucagon and Alcohol Study: Evaluating the Effect of Ethanol on Glucagon Effectiveness  
The Helmsley Charitable Trust Foundation

- PI (\$474,423)  
The goal of this project is to evaluate the effect of intoxication with ethanol on the effectiveness of glucagon in preventing hypoglycemia.
- 2017-2018 The Monitoring Study for Bionic Pancreas  
The Helmsley Charitable Trust Foundation  
PI (\$755,626)  
The goal of this study is to determine the difference in observed hypoglycemia with and without remote monitoring for hypoglycemia in usual care, insulin-only bionic pancreas, and bihormonal bionic pancreas. A second goal is to test 2 new CGM technologies in the outpatient setting and possibly qualify them as inputs to the bionic pancreas.
- 2017-2018 Analysis of Breath and Sweat for Volatile Organic Compound Markers of Hypoglycemia  
The MITRE Corporation  
PI (\$89,661 + \$50,000 supplement)  
The goal of this study is to collect and analyzed breath and sweat samples from participants in a bionic pancreas study for VOC markers of hypoglycemia.
- 2017-2018 Bihormonal Bionic Pancreas for the Treatment of Diabetes Post-Pancreatectomy in Children with Congenital Hyperinsulinism – A Pilot Study  
Zealand Pharma  
MGH PI (\$100,000)  
The goal of this study is to perform an inpatient pilot feasibility study of the bihormonal bionic pancreas in patient with congenital hyperinsulinism who were treated with subtotal pancreatectomy and have now developed insulin dependent diabetes.

### **Projects Submitted for Funding**

- 2018 Safety and Efficacy of a Novel Insulin Infusion Set  
Beta Bionics  
PI (\$74,700)  
The goal of this study is to test a novel infusion set with a steel cannula intended for use with the Beta Bionics iLet by comparing it with a comparable commercially available infusion set, the Contact Detach.
- 2018-2019 Bihormonal Bionic Pancreas for the Treatment of Diabetes Post-Pancreatectomy in Children with Congenital Hyperinsulinism – A Pilot Study  
Penn Orphan Disease Center 2017 Million Dollar Bike Ride Pilot Grant Program  
MGH PI (\$87,109)  
This is an application to supplement the funding for this study already obtained from Zealand Pharma.
- 2018 Effect of Accelerated Insulin Pharmacokinetics on Bionic Pancreas Performance  
Novo Nordisk  
MGH PI (\$182,352)  
The goal of this study is to add an arm to an NIH-funded bridging study with the insulin-only configuration of the bionic pancreas in which it delivers faster aspart, an ultra-fast insulin. The hypothesis is that faster insulin PK will improve glycemic control without adjustment of the algorithmic assumptions about insulin PK built into the bionic pancreas.
- 2019-2021 Effect of Insulin Analog Choice on the Performance of the Bionic Pancreas  
The Helmsley Charitable Trust Foundation  
PI (\$851,235)  
The goal of this study is to compare the performance of the bionic pancreas with three different insulin analogs (insulin aspart, insulin lispro, and insulin glulisine) in individuals for whom there are differences in the pharmacokinetic characteristic different insulin analogs. A second goal is to develop assays for anti-insulin antibodies that are specific to insulin analogs and do not cross-react with human insulin or other analogs.

## **Unfunded Current Projects**

- 2016- Clinical studies of a bionic pancreas for automated glucose management of insulin dependent type 2 diabetes mellitus  
PI (no funding – revising an R01 application)  
The goal of this pilot feasibility study is to test the safety and efficacy of the insulin-only configuration of the bionic pancreas in patients with type 2 diabetes who take both basal and meal bolus insulin daily.
- 2017- Efficacy of Glucagon In the Prevention of Hypoglycemia During Mild Exercise  
PI (no funding – will seek funding from Beta Bionics)  
The goal of this study is to demonstrate the incremental value of glucagon in preventing hypoglycemia by comparing the bihormonal and insulin-only configurations of the bionic pancreas using reference quality glucose measurements This study was mandated by the FDA Center for Drug Evaluation and Research, which does not allow CGM data to be used to primary outcomes, because they have a statutory obligation to obtain data showing all components of a drug-device combination product are necessary before the product can be approved. The study will use mild exercise in the fasted state to provoke hypoglycemia.
- 2017- Feasibility of Outpatient Automated Blood Glucose Control with the Bionic Pancreas for Treatment of Cystic Fibrosis Related Diabetes  
PI (no funding, preparing an R01 application)  
The goal of this pilot feasibility study is to test the safety and efficacy of the bionic pancreas in patients with cystic fibrosis-related diabetes. We intend to use the pilot data as preliminary data in an NIH grant.
- 2018-2019 Effect of Accelerated Insulin Pharmacokinetics and Algorithmic PK Settings on Bionic Pancreas Performance  
PI (to be funded by Novo Nordisk – protocol is currently under development with them)  
The goal of this study is to determine whether adjustment of algorithmic parameters relating to insulin pharmacokinetics can provide additional improvements in glycemic control when combined with the use of an ultrafast insulin, faster aspart.

## **Report of Local Teaching and Training**

### **Teaching of Students in Courses:**

2005-6	Patient-Doctor II 2 <sup>nd</sup> year medical students	Harvard Medical School Examiner, Endocrine section of OSCE
2007	Human Systems 1 <sup>st</sup> year medical students	Harvard Medical School Substitute tutor, Endocrine section
2014-15, 2017	HST-060 (Endocrinology) 1 <sup>st</sup> year HST (MD/PhD) students	Harvard Medical School Annual 75 minute lecture on type 1 diabetes

### **Formal Teaching of Residents, Clinical Fellows and Research Fellows (post-docs):**

2012-	Tools of Human Investigation Course for Internal Medicine Residents	Massachusetts General Hospital 90 minute lecture at least 4 times per year
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### **Clinical Supervisory and Training Responsibilities:**

2008-	Endocrine Consult Service Attending Physician	Rounds 8:30-10:00 daily, writing attending notes on new consults, 3 weeks annually
2010-	Endocrine Fellow Diabetes Clinic Preceptor	Occasional preceptor of fellows in clinic



**Laboratory and Other Research Supervisory and Training Responsibilities:**

2012-	Co-mentorship of Lindy Kahanovitz with Tania Konry (Lindy is a graduate student doing thesis work at MGH while still matriculating at Ben Gurion University because her husband took a postdoctoral fellowship at HMS)	At least weekly meetings; PhD thesis has been submitted.
2016-	Research mentor for Rabab Jafri, MD who completed her clinical fellowship in Pediatric Endocrinology	Primary mentoring and supervision; at least weekly meetings.
2017-	Research mentor for Jason Sloane, MD who completed his clinical fellowship in Adult Endocrinology	Primary mentoring and supervision; at least weekly meetings.
2017-	Research mentor for Jordan Sherwood, MD who completed his clinical fellowship in Pediatric Endocrinology	Primary mentoring and supervision; at least weekly meetings.

**Other Mentored Trainees and Faculty:**

1995-98	Supervision of 1st and 2nd year graduate students rotating through the laboratory my PhD mentor, University of Texas Southwestern Medical Center	Daily supervision of 7 rotation students for 3 months each
2007-12	Supervision of research assistants, Joslin Diabetes Center	Daily supervision and mentoring; On former RA has completed a PhD in Biology at Boston University
2012-14 (Fellow) 2014-15 (Instructor)	Research mentor for Manasi Sinha, MD, MPH, who completed her clinical fellowship in Pediatric Endocrinology	Primary mentoring and supervision; at least weekly meetings; we continue to work on papers although she is now at Covance.
2014-17	Research mentor for Laya Ekaspour, MD, who completed her clinical fellowship in Pediatric Endocrinology	Primary mentoring and supervision; at least weekly meetings; we continue to work on papers although she is now at Stanford.

**Formal Teaching of Peers (e.g., CME and other continuing education courses):*****No presentations below were sponsored by outside entities***

2013	Continuous Glucose Monitoring and Automated Glucose Control / invited lecture to Clinical Endocrinology 2013, Boston, MA	ACCME accredited CME course by MGH/HMS; participants were from US, Europe, Asia, and Latin America
2014	The Bionic Endocrine Pancreas: Automated Management of Glycemia / Invited lecture Clinical Endocrinology 2014 / Boston, MA	ACCME accredited CME course by MGH/HMS; participants were from US, Europe, Asia, and Latin America
2015	The Bionic Endocrine Pancreas: Automated Management of Glycemia / invited lecture Clinical Endocrinology 2015 / Boston, MA	ACCME accredited CME course by MGH/HMS; participants were from US, Europe, Asia, and Latin America
2016	Automating Glycemic Regulation in Diabetes Mellitus with a Bionic Pancreas / Invited lecture Clinical Endocrinology 2016 / Boston, MA	ACCME accredited CME course by MGH/HMS; participants were from US, Europe, Asia, and Latin America
2016	New Technologies in the Treatment of Diabetes /	Harvard Medical School CME

	Invited lecture Internal Medicine: Comprehensive Review and Update 2016 / Boston, MA	course
2017	New Technologies in the Treatment of Diabetes / Invited lecture Internal Medicine: Comprehensive Review and Update 2017 / Boston, MA	Harvard Medical School CME course
2018	The future of insulin delivery: The artificial pancreas / Invited lecture Internal Medicine: Comprehensive Review and Update 2018 / Boston, MA	Harvard Medical School CME course

**Local Invited Presentations:**

***No presentations below were sponsored by outside entities***

1997	Molecular Gears of Circadian Clocks / Biochemistry Department Graduate Student/Post-doctoral Fellow Colloquium University of Texas Southwestern Medical Center / Dallas, TX
2005	Diabetic Complications / Podiatry Department Seminar Massachusetts General Hospital / Boston, MA
2007	Continuous Glucose Monitoring / Special Interest Group Nursing Seminar Massachusetts General Hospital / Boston, MA
2008	Continuous Glucose Monitoring: Update / Diabetes Research Center Weekly Research Meeting Massachusetts General Hospital / Boston, MA
2008	Closed-loop Blood Glucose Control / Diabetes Research Center Weekly Research Meeting Massachusetts General Hospital / Boston, MA
2008	Closed-loop Blood Glucose Control / Pediatric Endocrinology conference Massachusetts General Hospital / Boston, MA
2009	Closed-loop Blood Glucose Control – Update on Clinical Trials / Diabetes Research Center Weekly Research Meeting Massachusetts General Hospital / Boston, MA
2009	Bi-hormonal Closed-loop Blood Glucose Control for Type 1 Diabetes Mellitus / Pediatric Endocrinology conference Massachusetts General Hospital / Boston, MA
2009	Bi-hormonal Closed-loop Blood Glucose Control for Type 1 Diabetes Mellitus / Endocrine Grand Rounds Massachusetts General Hospital / Boston, MA
2010	Regulation of Aging by Insulin Signaling in Mammals / Geriatric Medicine Grand Rounds Massachusetts General Hospital / Boston, MA
2010	Regulation of Aging by Insulin Signaling in Fat / Internal Seminar Series Joslin Diabetes Center / Boston, MA
2010	Regulation of Aging by Insulin Signaling in Mammals / Geriatric Medicine Research Conference Massachusetts General Hospital / Boston, MA
2011	Sponsoring and Conducting Research Under an IDE / Clinical Research Program Seminar Series Massachusetts General Hospital / Boston, MA
2011	“Compelling Applications” panel / panelist discussing Continuous Glucose Monitoring and Closed-loop Blood Glucose Control, CIMIT Innovation Workshop on “Next Generation Drug Delivery, Monitoring and Adherence Systems in Chronic Disease Management” CIMIT / Boston, MA
2011	Automated Glucose Management in Type 1 Diabetes with a Bi-hormonal Bionic Pancreas / The Center for Engineering in Medicine, Internal Seminar Series

- Massachusetts General Hospital / Boston, MA
- 2011 Continuous Glucose Monitoring and Closed-loop Blood Glucose Control in the ICU / Pulmonary and Critical Care Division Research Conference  
Massachusetts General Hospital / Boston, MA
- 2011 Automated Glucose Management in Type 1 Diabetes with a Bi-hormonal Bionic Pancreas / Endocrine Grand Rounds  
Beth Israel Deaconess Medical Center / Boston, MA
- 2011 Continuous Glucose Monitoring and Artificial Pancreas Update / Diabetes Research Center Research Meeting  
Massachusetts General Hospital / Boston, MA
- 2012 Automated Glucose Management in Type 1 Diabetes with a Bi-hormonal Bionic Pancreas / Pediatric Endocrinology conference  
Massachusetts General Hospital / Boston, MA
- 2012 Automation of Blood Glucose Management in Diabetes Mellitus with a Bionic Endocrine Pancreas / Medical Grand Rounds  
Massachusetts General Hospital / Boston, MA
- 2012 Continuous Glucose Monitoring and Automate Glucose Control / Diabetes Research Center Research Meeting  
Massachusetts General Hospital / Boston, MA
- 2013 Medical Devices: Sponsoring and Conducting Trials Under an IDE / Design and Conduct of Clinical Trials course, Clinical Research Program  
Massachusetts General Hospital / Boston, MA
- 2013 Automated Blood Glucose Management with a Bi-hormonal Bionic Pancreas / Division of Endocrinology Clinical Seminar  
Boston Children's Hospital / Boston, MA
- 2014 Update on Continuous Glucose Monitoring and Automated Glycemic Regulation / Diabetes Research Center Research Meeting  
Massachusetts General Hospital / Boston, MA
- 2014 Closing the Loop: Developing New Treatment for Type I Diabetes and Insights that Apply to Current Therapy / Lecture to an audience of chairs of endocrine departments in Chinese hospitals for the Harvard School of Public Health China Initiative  
Harvard School of Public Health / Boston, MA
- 2014 A Bionic Endocrine Pancreas for Automated Management of Glycemia in Diabetes Mellitus / Renal Grand Rounds  
Massachusetts General Hospital / Boston, MA
- 2015 Automating Glycemic Regulation with a Bionic Pancreas / Department of Medicine Leadership Counsel Meeting  
Massachusetts General Hospital / Boston, MA
- 2015 Automating Glycemic Control in Diabetes Mellitus With a Bionic Pancreas / Medical Grand Rounds  
Massachusetts General Hospital / Boston, MA
- 2017 Automating Management of Blood Glucose in Diabetes Mellitus and Related Disorders / Medical Grand Rounds – Stephen M. Krane, MD Lectureship  
Massachusetts General Hospital / Boston, MA
- 2017 Automating Glucose Management In Diabetes Mellitus With a Bionic Pancreas / Medical Grand Rounds  
Brigham and Women's Faulkner Hospital / Boston, MA
- 2017 Update on the Bionic Pancreas / Invited lecture to retention event for EDIC/DPPOS participants  
Massachusetts General Hospital / Boston, MA

## **Report of Regional, National and International Invited Teaching and Presentations**

***Those presentations below sponsored by outside entities are so noted and the sponsor(s) is (are) identified.***

### **Regional**

- 1996 Do the Protein Expression and Degradation Machineries of the Cell Share Common Components? / Biology Department Seminar  
Trinity University / San Antonio, TX
- 2010 Closed-loop Blood Glucose Control for Type 1 Diabetes and Critical Illness / Endocrinology Grand Rounds  
University of Massachusetts Medical Center / Worcester, MA
- 2010 On the Road to a Prosthetic Endocrine Pancreas / invited lecture (speakers chosen by Editor of Nature Medicine)  
SciCafe (Nature Publishing Group) / Boston, MA
- 2011 A Bi-Hormonal Closed-Loop Artificial Pancreas for Type 1 Diabetes / Pediatric Endocrinology seminar  
University of Massachusetts Medical Center / Worcester, MA
- 2011 A Bi-Hormonal Closed-Loop Artificial Pancreas for Type 1 Diabetes / Pediatric Grand Rounds  
Brown University Medical School / Providence, RI
- 2011 A Bi-hormonal Bionic Pancreas for Blood Glucose Control in Type 1 Diabetes / Endocrine Grand Rounds  
Yale University Medical School / New Haven, CT
- 2014 A Bionic Endocrine Pancreas for Automated Management of Glycemia in Diabetes Mellitus / Grand Rounds  
Emerson Hospital / Concord, MA
- 2014 A Bionic Endocrine Pancreas for Automated Management of Glycemia in Diabetes Mellitus / Medicine Grand Rounds  
University of Massachusetts Medical School / Worcester, MA
- 2015 Automating Glycemic Control in Diabetes Mellitus with a Bionic Pancreas / Clinical Diabetes and Metabolism Conference  
Joslin Diabetes Center / Boston, MA
- 2016 Artificial Pancreas: Too Sweet to Be True? / expert lunch session  
Evercore ISI MedTools Conference / Boston, MA
- 2017 Automating Glucose Management in Diabetes Mellitus with a Bionic Pancreas / Medical Grand Rounds  
St. Elizabeth's Medical Center / Boston, MA

### **National**

- 1996 Sug1 and Sug2 Proteins, Putative Transcriptional Co-activators, Are Components of the 26S Proteasome / abstract selected for oral presentation  
11th Annual M. D./ Ph. D. Student Conference / Aspen, CO
- 1997 Sug1 and Sug2: ATPase Family Components of the Yeast 26S Proteasome / abstract selected for oral presentation  
Young Scientist Program, International Congress of Biochemistry and Molecular Biology / Asilomar, CA
- 1999 A Novel Approach for Selective Inactivation of AAA Proteins / abstract selected for oral presentation  
Third International Conference on Cellular Functions of AAA Proteins / La Jolla, CA
- 1999 The 19S Regulatory Complex of the Proteasome Functions Independently of Proteolysis in Nucleotide Excision Repair / invited lecture  
Third International Conference on Cellular Functions of AAA Proteins / La Jolla, CA
- 2000 Role of the Proteasome and the Ubiquitin-like Domain of Rad23 in Nucleotide Excision Repair / abstract selected for oral presentation

- FASEB Summer Research Conference on Ubiquitin and Intracellular Protein Degradation / Saxton's River, VT
- 2004 Molecular Mechanisms of Aging in Mammals / invited lecture  
University of Texas Southwestern Medical Center Merck Scholars Symposium / Boston, MA (sponsored by Merck)
- 2007 Clinical Parameters for Closed-Loop Studies / invited lecture  
Juvenile Diabetes Research Foundation Artificial Pancreas Consortium Meeting / San Francisco, CA
- 2008 Design of Closed-loop Human Studies / invited lecture  
Juvenile Diabetes Research Foundation Artificial Pancreas Consortium Meeting / San Francisco, CA
- 2008 Design of Closed-loop Blood Glucose Control Trials in Human Subjects / invited lecture  
Towards an Artificial Pancreas: An FDA-NIH-JDRF Workshop / Bethesda, MD
- 2008 Regulation of Stress Resistance by Insulin Signaling in Fat / invited lecture  
Nathan Schock Aging Center Conference on Aging / Bandera, TX
- 2008 Validation of the Via Medical GlucoScout For Closed-loop Blood Glucose Control Trials / invited lecture  
Juvenile Diabetes Research Foundation Artificial Pancreas Consortium Meeting / Washington, DC
- 2009 A Clinical Feasibility Trial of Bi-hormonal Closed-loop Blood Glucose Control for Type 1 Diabetes / abstract selected for oral presentation  
American Diabetes Association Annual Scientific Session / New Orleans, LA
- 2010 The Artificial Pancreas: Closing the Loop on Insulin Delivery in the Treatment of Diabetes / invited lecturer and panelist  
BIO International Convention / Chicago, IL (sponsored by Abbott Diabetes Care)
- 2010 Bi-hormonal closed-loop blood glucose control using subcutaneous infusions of insulin and glucagon / invited lecture  
10th Annual Rachmiel Levine Diabetes and Obesity Symposium / Las Vegas, NV
- 2010 Key Areas of Innovation in Artificial Pancreas Development / invited lecture  
Medical Device Technology Innovation Partnership (MD-TIP) Project Workshop, U.S. Food and Drug Administration, Center for Devices and Radiological Health / Bethesda, MD
- 2010 Cell Non-Autonomous Regulation of Aging by Insulin Resistant Adipose Tissue / invited lecture  
Gerontological Society of America, 63rd Annual Scientific Meeting / New Orleans, LA
- 2010 Better Hormones for Fully Automated Glucose Control: Role of Glucagon / invited lecture  
Diabetes Technology Meeting / Bethesda Maryland
- 2011 Artificial Pancreas Platform Panel Discussion / panelist  
NIH / Juvenile Diabetes Research Foundation Artificial Pancreas Consortium Meeting (concurrent with American Diabetes Association Annual Scientific Sessions) / San Diego, CA
- 2012 Automated Management of Blood Glucose with a Closed-loop Bi-hormonal Bionic Pancreas / Invited lecture  
Phacilitate Autoimmune and Inflammation Leaders' Forum (Workshop – Picking the Winning Modalities in the Race to Address Type 1 Diabetes) / San Francisco, CA
- 2012 Automated glucose management in type 1 diabetes with a bi-hormonal bionic pancreas / Invited lecture  
Pediatric Endocrine Society Annual Meeting / Boston, MA
- 2012 A Bionic Pancreas Delivering Insulin and Microdose Glucagon Automates Blood Glucose Control in Type 1 Diabetes / Invited lecture  
American Diabetes Association Annual Scientific Session / Philadelphia, PA
- 2012 A Comparative Analysis of Three Continuous Glucose Monitors: Not All Are Created Equal / Abstract selected for oral presentation  
American Diabetes Association Annual Scientific Session / Philadelphia, PA
- 2012 A Bionic Pancreas Delivering Insulin and Microdose Glucagon Automates Blood Glucose Control in Type 1 Diabetes / Invited lecture (co-presented with Ed Damiano)

- Lilly & Co / Indianapolis, IN
- 2012 Automated Glucose Control with a Bi-hormonal Bionic (Artificial) Pancreas in Children and Adults with Type 1 Diabetes / Invited lecture - Sumner J. Yaffe Memorial Lecture Series in Pediatric Clinical Pharmacology  
Webinar sponsored by the Eunice Kennedy Shriver National Institute of Child Health and Human Development
- 2013 Automated Blood Glucose Control with a Bi-hormonal Bionic Pancreas / Invited lecture  
University of North Carolina School of Medicine, Endocrinology and Metabolism Research Conference / Chapel Hill, North Carolina
- 2013 Automatic Blood Glucose Control with a Bi-hormonal Bionic Pancreas / Keynote lecture  
JDRF 6th Annual 'Diabetes Today and Tomorrow' Conference / Belleville, MI
- 2013 Real World Insights / Panelist  
T1D Exchange Annual Meeting: What Does it Take to Get Therapies and Devices to Market? / Boston, MA
- 2013 A Robustly Adaptive Bi-Hormonal Bionic Pancreas for Automated Glucose Control in Children and Adults / Abstract selected for oral presentation  
American Diabetes Association Annual Scientific Session / Chicago, IL
- 2013 A Comparative Analysis of Three Continuous Glucose Monitors / Abstract selected for oral presentation  
American Diabetes Association Annual Scientific Session / Chicago, IL
- 2013 Standardization of Trial Reporting / Panelist  
JDRF/NIH Closed-Loop Research Meeting (concurrent with American Diabetes Association Annual Scientific Sessions) / Chicago, IL
- 2013 A Bionic Pancreas in the Wild: The Beacon Hill and Summer Camp Studies / Keynote presentation  
14th North American Conference on Diabetes and Exercise "New Frontiers in Diabetes and Sport" / San Diego, CA (sponsored by Tandem Diabetes Care)
- 2014 A Bionic Pancreas in the Wild: Outpatient Studies / Invited lecture  
14<sup>th</sup> Annual Rachmiel Levine Diabetes and Obesity Symposium / Pasadena, CA
- 2014 Why Endocrinology? Themes of a Career Journey / Keynote lecture  
Close Concerns Alumni Summit / Aspen, CO
- 2014 Outpatient Glycemic Control in Type 1 Diabetes with a Bihormonal Bionic Pancreas / Eli Lilly Grand Rounds  
Lilly & Co./ Indianapolis, IN (sponsored by Eli Lilly)
- 2014 Automated Glycemic Control In Diabetes with a Bihormonal Bionic Pancreas / Invited lecture  
Celebrating Chemistry at Trinity – Research Symposium, Trinity University / San Antonio, TX
- 2014 Multiday Outpatient Glycemic Control in Adolescents with Type 1 Diabetes Using a Bihormonal Bionic Pancreas: The Barton Center Summer Camp Study / Abstract selected for oral presentation  
74<sup>th</sup> Annual American Diabetes Association Scientific Sessions / San Francisco, CA
- 2014 Outpatient Glycemic Control in Type 1 Diabetes with a Bihormonal Bionic Pancreas / Invited lecture  
Clinical Application of Real-Time CGM: Professional Use, Pediatrics and the Pathway to the Artificial Pancreas (Corporate Symposium held during the 74th Annual American Diabetes Association Scientific Sessions) / San Francisco, CA (sponsored by Dexcom)
- 2014 Managing Hyperglycemia on the Ward and in the ICU: Challenges, Controversy, and New Technology / Invited lectures X2 (Meet the Professor sessions)  
Endocrine Society Diabetes Diagnosis and Management workshop / Chicago, IL
- 2014 Artificial and Bionic Pancreas Technology / Invited lecture  
Endocrine Society Diabetes Diagnosis and Management workshop / Chicago, IL
- 2014 Multiday Outpatient Glycemic Control in Adults with Type 1 Diabetes Using a Bihormonal Bionic Pancreas: The Beacon Hill Study / Abstract selected for oral presentation  
ICE/ENDO 2014 (International Congress of Endocrinology / Endocrine Society's 96<sup>th</sup> Annual

- Meeting) / Chicago, IL
- 2014 A Bionic Endocrine Pancreas for Automated Management of Glycemia in Diabetes Mellitus / Paul B. Beeson graduating scholar presentation  
The Paul B. Beeson Career Development Awards in Aging Research Program Annual Meeting / San Diego, CA
- 2014 Artificial vs. Bionic Pancreas / Invited lecture  
1<sup>st</sup> Cleveland Clinic Beta Cell Therapy Symposium: Advances in the Management of Diabetes (organized by the Cleveland Clinic) / Cleveland, OH
- 2015 Automated Control of Glycemia in Type 1 Diabetes with a Bionic Endocrine Pancreas / Invited lecture  
Weekly Seminar Series on Diabetes, Obesity & Metabolism / UT Southwestern Medical Center, Dallas, TX
- 2015 Automated Control of Glycemia in Type 1 Diabetes with a Bionic Endocrine Pancreas / Endocrinology Grand Rounds  
Department of Internal Medicine, UT Southwestern Medical Center / Dallas, TX
- 2015 Diabetes Devices and Management Tools / Panelist, along with Howard Wolpert and Gary Scheiner  
Cowen and Company 35th Annual Health Care Conference / Boston, MA
- 2015 Automating Glycemic Regulation with a Bionic Pancreas / Invited plenary lecture  
Diabetes Diagnosis & Management, ENDO 2015 (97<sup>th</sup> Annual Meeting of the Endocrine Society) / San Diego, CA
- 2015 Autonomous and Continuous Adaptation of a Bihormonal Bionic Pancreas in Adults and Adolescents with Type 1 Diabetes / Invited lecture  
The Best of JCEM 2014 – Symposium in which the 10 papers with the best reviewer scores in their respective areas for 2014 were presented - our paper was chosen as the best in Diabetes, ENDO 2015 (Endocrine Society's 97<sup>th</sup> Annual Meeting) / San Diego, CA
- 2015 Bionic Pancreas: Getting Closer (with Yash Sabharwal, Chief Operating Officer, Xeris Pharmaceuticals) / session selected by the SXSW PanelPicker process  
SXSW Interactive (Health and MedTech) / Austin, TX (notably NOT sponsored by Xeris Pharmaceuticals)
- 2015 Insulin pumps and sensors: How close are we to an external pancreas? / Invited lecture  
Diabetes for the Internist (Pre-Course prior to the American College of Physicians Internal Medicine Meeting 2015) / Boston, MA
- 2015 High-stakes Quantified Self: Devices and Tools for Diabetes Management / Invited lecture  
GTCbio Diabetes Summit 2015 / Boston, MA
- 2015 Automating Glycemic Control in Diabetes Mellitus with a Bionic Pancreas / Jean D. Wilson Distinguished Alumnus Lecture  
University of Texas Southwestern Medical Center Medical Scientist Training Program Retreat 2015 / Pottsboro, TX
- 2015 New Technologies: Tools in Research / Invited lecture  
American Diabetes Association Focus on Fellows, pre-meeting to the 2015 ADA Annual Scientific Sessions / Boston, MA
- 2015 Bionic Pancreas Pivotal Trial / invited speaker and panelist  
Large Efficacy Studies for Artificial Pancreas Systems section, JDRF/NIH Artificial Pancreas Dinner Meeting (associated with the 2015 ADA Scientific Sessions) / Boston, MA
- 2015 Outpatient Glycemic Control with a Bionic Pancreas in Pre-adolescents with Type 1 Diabetes / Abstract selected for oral presentation  
American Diabetes Association Annual Scientific Sessions 2015 / Boston, MA
- 2015 A Bionic Pancreas: Automating Diabetes Care / Invited lecture  
Fidelity Senior Leadership Forum (audience of the top 250 Fidelity executives, TED Conference format) / Boston, MA
- 2015 Automating Glycemic Control in Diabetes Mellitus with a Bionic Pancreas / Plenary lecture  
American Association of Diabetes Educators 15<sup>th</sup> Annual Meeting / New Orleans, LA
- 2015 Automating Glycemic Control in Diabetes Mellitus with a Bionic Pancreas / Invited lecture

- Sanofi Diabetes Education Summit (national meeting of Sanofi medical liaison staff) / Bridgewater, NJ
- 2015 A Bionic Pancreas – Automating Diabetes Care / Invited plenary lecture  
American Academy of Pediatrics 2015 National Conference & Exhibition / Washington, DC
- 2015 Automating Glycemic Control in Diabetes Mellitus with a Bionic Pancreas / Medical Grand Rounds  
Department of Internal Medicine, Henry Ford Hospital / Detroit, MI
- 2015 Automating Glycemic Regulation in T1D with a Bionic Pancreas / Invited lecture  
17th Annual Columbia University College of Physicians and Surgeons Naomi Berrie Diabetes Center Frontiers in Diabetes Research Conference: *Can Diabetes Be Cured?* / New York, NY
- 2016 Automating Glycemic Control in Diabetes Mellitus with a Bionic Pancreas / Invited lecture  
Scripps Diabetes Care and Prevention – Scripps Memorial Hospital / La Jolla, CA
- 2016 Automating Glycemic Management in Diabetes Mellitus with a Bionic Pancreas / Invited lecture  
Annual Meeting of the Endocrine Nursing Society / Boston, MA
- 2016 Automating Glycemic Management in Diabetes Mellitus with a Bionic Pancreas / Invited lecture  
ENDO 2016 (98<sup>th</sup> Annual Meeting of the Endocrine Society) / Boston, MA
- 2016 Broadening the Use of Research Technologies / Invited lecture  
American Diabetes Association Focus on Fellows, pre-meeting to the 2016 ADA Annual Scientific Sessions / New Orleans, LA
- 2016 Design Considerations for Artificial Pancreas Pivotal Studies / Invited lecture  
JDRF/NIH Closed-Loop Consortium Meeting (associated with the 2016 ADA Scientific Sessions) / New Orleans, LA
- 2016 Dual/Multi-hormone Artificial Pancreas Systems / Invited lecture  
Fourth Artificial Pancreas Workshop: Testing and Adoption of Current and Emerging Technologies / Bethesda, MD
- 2016 Bionic Pancreas / Invited lecture  
World Diabetes Day – Greenville Health Systems / Greenville, SC
- 2017 Automating Glycemic Management in Diabetes Mellitus / Invited lecture  
Clinical Pharmacology Distinguished Speaker series, Health University of Utah Department of Pharmacology Department / Salt Lake City, UT
- 2017 Automating Glycemic Management in Diabetes Mellitus / Endocrine Grand Rounds  
Health University of Utah / Salt Lake City, UT
- 2017 Advances in Automation of Glucose Management in Diabetes Mellitus / Invited lecture  
GTCbio Diabetes Summit 2017 / Boston, MA
- 2017 Automating Glucose Management in Diabetes Mellitus with a Bionic Pancreas / Department of Medicine Grand Rounds  
University of Pittsburgh / Pittsburgh, PA
- 2017 Automating Glucose Management in Diabetes Mellitus with a Bionic Pancreas / Invited special lecture to adult and pediatric endocrine faculty  
University of Pittsburgh / Pittsburgh, PA
- 2017 Exercise and Dietary Management—Implications for Artificial Pancreas Systems / Invited lecture  
2017 ADA Annual Scientific Sessions / San Diego, CA
- 2017 Automating Glucose Control with a Bionic Pancreas / Invited lecture  
2017 Congenital Hyperinsulinism Family Conference / Galloway, NJ
- 2017 Zilretta in Patients with Type 2 Diabetes / Invited lecture  
Flexion Therapeutics Analyst Day / New York, NY
- 2017 Progress Toward Closed Loop Insulin Delivery / Invited lectures X 2 (Meet the Professor sessions)  
Endocrine Society Clinical Endocrinology Update 2017 / Chicago, IL
- 2017 Closed-Loop Systems for Diabetes Management / Invited lecture  
44<sup>th</sup> Annual Washington University Kilo Diabetes Symposium 2017 / St. Louis, MO



- 2018 The Future of Insulin Delivery: The Artificial Pancreas / Keynote Presentation onset 5 (NN118-3854) Results Meeting / Miami, FL (sponsored by Novo Nordisk)
- 2018 Update on Automated Glucose Control with the Bionic Pancreas / Invited lecture GTCbio 11<sup>th</sup> Diabetes Summit / Boston, MA

### International

- 1997 Isolation and Characterization of Sug2, a Novel ATPase Family Component of the Yeast 26S Proteasome / invited lecture  
EMBO Workshop on Cellular Functions of AAA Proteins / Tutzing, Germany
- 2010 Diabetes, Thyroid Disease, and Osteoporosis / invited lecturer  
International Medical Corps CME course for displaced Iraqi physicians / Amman, Jordan
- 2010 A Bi-Hormonal Closed-Loop Artificial Pancreas for Type 1 Diabetes / invited lecture  
Sanofi Aventis / Frankfurt, Germany
- 2012 Automated Management of Blood Glucose in Type 1 Diabetes with a Bi-hormonal Bionic Pancreas / invited lecture  
Bringing the Artificial Pancreas Home (AP@home) meeting / Barcelona, Spain
- 2012 Automated Management of Blood Glucose in Type 1 Diabetes with a Bihormonal Bionic Pancreas / abstract selected for oral presentation  
5<sup>th</sup> International Conference on Advanced Technologies & Treatments for Diabetes meeting / Barcelona, Spain
- 2013 Progress Towards Automated Glucose Control in Type 1 Diabetes with a Bi-hormonal Bionic Endocrine Pancreas / invited lecture  
6th Accu-Chek Network Meeting / Riga, Latvia (sponsored by Roche)
- 2013 Clinical Experience with a Bihormonal Bionic Endocrine Pancreas / invited lecture  
Danish Diabetes Academy Diabetes and Technology Meeting / Copenhagen, Denmark
- 2013 Accuracy, Precision, and Reliability of Continuous Glucose Monitors / invited lecture  
Diabetes and Technology Meeting (Danish Diabetes Academy) / Copenhagen, Denmark
- 2013 Challenges in the Development and Testing of Bihormonal Bionic Pancreas / invited lecture  
Danish Diabetes Academy Workshop, Hvidovre Hospital / Copenhagen, Denmark
- 2014 Automated Control of Blood Glucose with a Bionic Pancreas / invited lecture  
JDRF Canada 2014 Diabetes Research Infosium / Toronto, Canada
- 2014 The Artificial and Bionic Pancreas: Update on Where We Are Today / invited lecture to the International Forum for the Advancement of Diabetes Research and Care / Berlin, Germany (sponsored by Sanofi Aventis)
- 2014 A Bionic Endocrine Pancreas for Automated Management of Glycemia in Diabetes Mellitus / Invited webinar  
Mercodia Webinars at [www.mercodia.se](http://www.mercodia.se) / Uppsala, Sweden (attendees from 10 countries)
- 2014 An Overview of Advancements in Artificial Pancreas / Invited lecture  
First Oman Diabetes Summit / Muscat, Oman
- 2014 Management of Inpatient Hyperglycemia / Invited lecture  
First Oman Diabetes Summit / Muscat, Oman
- 2014 Diabetes Technology / Invited lecture  
National Center for Diabetes and Endocrinology / Muscat, Oman
- 2014 Inpatient Management of Diabetes / Invited lecture  
Second International Conference on Endocrinology and Diabetes / Riyadh, Kingdom of Saudi Arabia
- 2014 Technology and Diabetes / Meet the Professor session  
Second International Conference on Endocrinology and Diabetes / Riyadh, Kingdom of Saudi Arabia
- 2014 Artificial Pancreas: State of the Art / Plenary Lecture  
Second International Conference on Endocrinology and Diabetes / Riyadh, Kingdom of Saudi Arabia
- 2015 The Bionic Pancreas – When Will the Dream Come True? / Invited lecture

- European Association for the Study of Diabetes (EASD) Diabetes Technology Meeting / Dusseldorf, Germany
- 2015 Automating Glycemic Control in Diabetes Mellitus With a Bionic Pancreas / Invited lecture
- State of the Art Management of the the Adult with Type1 Diabetes - The 4th Annual Charles H. Best Diabetes Centre Continuing Health Education Day / Toronto, Ontario, Canada
- 2015 The Bionic Pancreas: When Will the Dream Come True? / Invited lecture, EASD/ADA Symposium: Devices
- European Association for the Study of Diabetes 51<sup>st</sup> Annual Meeting / Stockholm, Sweden
- 2015 Outpatient Glycemic Control with a Bionic Pancreas in Type 1 Diabetes / Invited lecture
- Endopäivät (EndoDays) 2015 - 68th Annual Meeting of the Finnish Endocrine Society / Helsinki, Finland
- 2015 Diabetes Technology: Towards Automated Glucose Management / invited lecture
- Endocrine Society Dimensions in Diabetes / Chennai, India
- 2016 Dual-hormone Is the Way To Go / invited lecture (part of session called Parallel Debate on Single vs. Dual-Hormone Closed-loop, with the other lecture being Insulin-only Systems Is the Way To Go)
- 9<sup>th</sup> International Conference on Advanced Technologies and Treatments for Diabetes / Milan, Italy
- 2016 Automating Glycemic Management in Diabetes Mellitus with a Bionic Pancreas
- Current Trends in Pediatric Endocrinology: A PES Perspective / Istanbul, Turkey
- 2016 Dual Hormone Is The Way To Go: Reprised and expanded from the ATTD 2016 debate / invited lecture
- Zealand Pharma AS / Copenhagen, Denmark
- 2016 The Bionic Pancreas / invited plenary lecture
- European Congress of Endocrinology / Munich, Germany
- 2016 Home use of a bihormonal bionic pancreas vs conventional insulin pump therapy in adults with type 1 diabetes: a multicenter randomized clinical trial / abstract selected for oral presentation
- European Association for the Study of Diabetes 52<sup>nd</sup> Annual Meeting / Munich, Germany
- 2016 Bihormonal Artificial Pancreas / invited lecture
- Appropriatezza in Diabetologia: la lezione dei grandi trials, meeting of the Societa Italiana di Diabetologia / Parma, Italy
- 2017 Tek Hormon mu, Cift Hormon mu? Biyonik Pankreas (Single or Dual Hormone? Bionic Pancreas) / invited lecture
1. Diyabet Teknolojileri Sempozyumu – 1<sup>st</sup> National Diabetes Technology Symposium / Izmir, Turkey
- 2017 The Bionic Pancreas / Invited plenary lecture
- Annual Meeting of the Dutch Endocrine Society / Noordwijkerhout, Netherlands
- 2017 Automated Glycemic Regulation with a Bionic Pancreas Delivering Insulin and Glucagon – the Boston Approach / Invited lecture
- The 10<sup>th</sup> International Conference on Advanced Technologies and Treatments for Diabetes / Paris, France
- 2017 Automated Control of Glycaemia with a Bihormonal Bionic Pancreas / Invited lecture
- Diabetes UK Professional Conference / Manchester, United Kingdom
- 2017 Advancements in Technology for Diabetes Management / Invited lectures X2 (Meet the Expert Sessions)
- Global Diabetes Summit / Rio de Janeiro, Brazil (sponsored by Novo Nordisk)
- 2017 Automatic Regulation of Glycemia with a Bionic Pancreas / Invited lecture
- Seoul International Conference of Endocrinology and Metabolism / Seoul, South Korea
- 2017 Advancements in Technology for Diabetes Management / Invited lectures X 2 (Meet the Expert Sessions)
- Global Diabetes Summit / Madrid, Spain (sponsored by Novo Nordisk) – two trips, each with 2 of the same lecture

- 2017 Technology for the Treatment of Diabetes / invited lecture  
Third Affiliated Hospital of Nanchang University / Nanchang, China
- 2017 Novel Therapy in DM Type 1 / invited lecture  
Second Qatar International Endocrinology Conference 2017 / Doha, Qatar
- 2017 Bionic Pancreas / invited lecture  
Second Qatar International Endocrinology Conference 2017 / Doha, Qatar
- 2017 The Eversense Implantable CGM System / invited lecture  
International Diabetes Foundation Symposium 2017 / Abu Dhabi, United Arab Emirates  
(sponsored by Roche – competing CGM systems were also described along with comparative accuracy data from a study sponsored by the Helmsley Charitable Trust; the sponsor had no role in determining the content of the presentation)
- 2018 Bionic Pancreas Treats Adults with Type 1 Diabetes / Invited lecture  
Advanced Technology for the Treatment of Diabetes (ATTD) 2018 / Vienna, Austria
- 2018 The Importance of Accurate BGM for Artificial Pancreas / Invited lecture  
Advanced Technology for the Treatment of Diabetes (ATTD) 2018 / Vienna, Austria  
(sponsored by Ascensia)
- 2018 State of the Art in Continuous Glucose Monitoring / Invited lecture  
Press event associated with Advanced Technology for the Treatment of Diabetes (ATTD) 2018 / Vienna, Austria (sponsored by Roche – competing CGM systems were also described along with comparative accuracy data from a study sponsored by the Helmsley Charitable Trust; the sponsor had no role in determining the content of the presentation)
- 2018 The Stable Glucagon Analog Dasiglucagon Is Well-Tolerated and as Effective as Recombinant Human Glucagon When Delivered By the Bionic Pancreas In Response To Insulin Excess / abstract selected for oral presentation  
Advanced Technology for the Treatment of Diabetes (ATTD) 2018 / Vienna, Austria

## **Report of Clinical Activities and Innovations**

### **Current Licensure and Certification:**

- 2004- Massachusetts Medical License
- 2004-14 Diplomate, American Board of Internal Medicine – Internal Medicine (allowed to lapse in 2014)
- 2006- Diplomate, American Board of Internal Medicine – Endocrinology, Diabetes, and Metabolism (certified until 2027)

### **Practice Activities:**

- |         |                                   |  |                      |
|---------|-----------------------------------|--|----------------------|
| 2006-07 | Ambulatory<br>neuroendocrine care | Neuroendocrinology<br>Massachusetts General Hospital | 2 sessions per month |
| 2006-14 | Ambulatory diabetes<br>care       | Massachusetts General Hospital                       | 2 session per month  |
| 2014-   | Ambulatory diabetes<br>care       | Massachusetts General Hospital                       | 1 session per week   |
| 2006-   | Inpatient consults                | Massachusetts General Hospital                       | ~8 weekend per year  |

### **Clinical Innovations:**

- Data driven choice of CGM technology      My team performed the first head-head-head comparative effectiveness of all commercially available continuous glucose monitor (CGM) devices, allowing data driven recommendations to patients based on accuracy and reliability performance. This has changed practice in our MGH diabetes units (adult and pediatric) when prescribing CGM monitoring and when interpreting data collected by patients. These data have also been presented widely and have helped to motivate more work on improved glucose sensors by medical device

companies. We have now tested three generations of sensors, reported in two publications, and continue to test new technologies as they near clinical use. We recently tested an implantable CGM and a CGM that requires no calibrations against the only CGM that is approved as a fingerstick replacement, the Dexcom G5, in an outpatient study.

Data driven choice of point-of-care glucose meters

We performed and published a head-to-head study of the accuracy of 17 commonly used point-of-care glucose meters and found that the accuracy varies widely between devices, with average errors as low as 6% for the best devices and 20% for the worst performing devices. This study includes more meters in a single study than any other of which we are aware. The results of this study have affected clinical practice at our center as well as others.

## **Report of Technological and Other Scientific Innovations**

Bi-hormonal automated BG control in type 1 diabetes

I have collaborated with engineering colleagues since 2006 on development, optimization, and clinical testing of closed-loop blood glucose (BG) technology utilizing both insulin and glucagon. This bi-hormonal closed-loop glucose control approach provides more effective BG control than is possible with insulin-only approaches. We were the first in the world to complete an outpatient trial of automated glucose control during the day and nighttime (other groups had completed nighttime only trials). We have now completed five outpatient, day-and-night trials in adults and adolescents, including the first outpatient trials in pre-adolescent children and the first home-use trials in adults. The results make clear that this device will dramatically change the way type 1 diabetes is managed. I have an issued patent (US 9833570 B2, Blood glucose control system, priority date 10/31/2010, inventors: El-Khatib, Damiano, Russell) on the bionic pancreas control algorithms (also published as CA2816314A1, EP2633456A1, US20130245547, WO2012058694A2). Two of my engineering collaborators have formed a company, Beta Bionics, to commercialize this technology. I did not co-found the company because it would have meant ending my research on this topic in the academic environment due to conflict of interest rules. However, I do advise the company on the continue development and testing of the technology and I will be directing the pivotal trials of the bionic pancreas. We are targeting FDA approval in 2019 and commercialization shortly thereafter.

Automated delivery of micro-dose glucagon for hypoglycemia prevention and treatment

We have performed a home-use, double-blinded, randomized study of configuration of the bionic pancreas system that automatically delivers glucagon to prevent hypoglycemia. Subjects manage their own insulin delivery. The amount of glucagon delivered was very similar to that delivered by the bihormonal bionic pancreas in our home use study. This study showed that micro-dose glucagon is highly effective for hypoglycemia prevention. One of the most interesting findings from this study was that when glucagon was delivered in a blinded fashion participants were not able to guess when they were delivering it and reported no more nausea on days when they received glucagon than when they did not. A manuscript describing these data will be submitted soon.

Characterized rapid-acting insulin pharmacokinetics

In the course of closed-loop BG control studies we found that the pharmacokinetic (PK) behavior of insulin lispro varied much more between individuals, and across a wider range, than expected based on published data

describing populations of patients. In some patients, insulin lispro was absorbed even more slowly than regular human insulin. This has led to modification of insulin-on-board parameters programmed into patient pumps and an increased awareness of the potential role of insulin PK in failure to achieve glycemic goals and development of hypoglycemia among patients in the adult and pediatric diabetes practices at MGH. In addition, it motivated a study to test whether there are differences between the PK characteristics of different rapid-acting insulin analogs within single individuals. In order to do this I developed a novel method to perform multiplexed PK analysis of multiple rapid-acting insulin analogs in a single visit using novel, analog-specific insulin assays that we have developed for this purpose. A patent application on the novel insulin assays is nearing submission. The study showed that in most individuals two commonly used rapid-acting insulin are comparable, but that in ~20% of study population one of these insulins was consistently absorbed faster than the other. This presents the opportunity for personalizing insulin analog choice to improve glycemic control. A paper is in preparation.

Validation of CGM technology for the ICU environment

We have performed a clinical trial demonstrating that a continuous glucose monitor is as accurate in the ICU as in the outpatient environment when calibrated more frequently than in the outpatient environment (e.g. every 6 hours). A manuscript is in preparation. This finding has not, as yet, led to usage of CGM in MGH ICUs, because the CGM that was used in the study was withdrawn from the US market for business reasons. However, this finding may pave the way to improved safety and efficacy of tight glycemic control in the ICU, in particular through the use of CGM as the input limb to a closed-loop BG control device because the CGM technology that was tested may be returning to the US market soon.

Closed-loop blood glucose control in critical illness

I have guided adaption by engineering collaborators of closed-loop technology developed for use in type 1 diabetes to use in the critical care setting. We have completed a clinical trial of closed-loop device using CGM sensing and automated IV insulin and dextrose dosing. The system provided a very tight clamp on glucose levels in both subjects with type 1 and type 2 diabetes. These data are now being prepared for publication. A validated device for automated BG control in the ICU will be critical for finally performing a definitive test of the hypothesis that tight glycemic control can reduce mortality and morbidity in critically ill patients, which has been the subject of much controversy.

Evaluation of intradermal insulin delivery for improvement of insulin and glucagon pharmacokinetics

Preliminary studies by other investigators have suggested that intradermal delivery of insulin can significantly improve its pharmacokinetics. We performed a study using a proprietary microneedle technology developed in Israel. The data show that intradermal delivery speeds the absorption of insulin, and that the benefit is greatest for participants with slower absorption of insulin from the subcutaneous tissues. In the same study, we tested whether intradermal delivery improved the pharmacokinetics of glucagon and found that it did not. We collaborated with a pharmacology group for the analysis of this study and the paper is nearing submission.

Continuous insulin monitoring

The pharmacokinetics of insulin is an important determinant of success for closed-loop control. Unfortunately, the PK characteristics of rapid acting insulins vary greatly between individuals and to a lesser degree within an individual from infusion site to infusion site. Setting the parameters of a closed-loop bionic pancreas such that slow insulin absorption is assumed avoids

insulin stacking but leads to loss of peak performance. In collaboration with engineering colleagues (distinct from those involved in the bionic pancreas project) I am developing a device that assays the levels of insulin in microdialysis fluid obtained continuously from the subcutaneous space. We have now published results showing the feasibility of the device in vitro. We have also performed animal studies and preliminary studies in humans showing that we can detect insulin in the interstitial fluid, both basal levels and peaks after subcutaneous delivery of the rapid-acting insulin lispro.

Validation of novel, stable glucagon formulations and analogs

We have performed a hyperinsulinemic normoglycemic clamp study to compare the pharmacodynamics and pharmacokinetic properties of a stable formulation of glucagon (Xeris Pharmaceuticals) with freshly reconstituted glucagon (Eli Lilly) that is known to be unstable after reconstitution. A stable formulation of glucagon is critical to the development of a bionic pancreas. This study is investigator initiated, foundation funded, and I am the sponsor of the IND. The study is complete and the data are being analyzed. We are currently performing a separate study to test the equivalence of a stable glucagon analog (produced by Zealand Pharma) with Lilly glucagon. We are currently planning trials of a glucagon formulation (produced by Adocia Pharma) and a new glucagon analog from Eli Lilly.

Evaluation of the effects of ethanol intoxication on the antihypoglycemic action of glucagon

Ethanol intoxication is associated with an increased risk of hypoglycemia in patients with type 1 diabetes, and ethanol is known to inhibit gluconeogenesis. We have performed hyperinsulinemic normoglycemic clamp study in which each participant was clamped twice, once while ethanol intoxicated (blood alcohol content clamped at 0.1% using a computer controlled infusion of ethanol) and once in the absence of ethanol. We delivered the same dose of glucagon during each clamp and compared the area over the curve of the glucose infusion rate. We found that there was no statistically significant difference in the anti-hypoglycemic action of glucagon in the presence or absence of ethanol intoxication. These data are currently being prepared for publication.

Use of CGM technology to evaluate the effects of a novel sustained release intra-articular steroid on glycemic management in patients with type 2 diabetes

Approximately 30% of patients with type 2 diabetes mellitus have knee osteoarthritis. Intra-articular corticosteroids used to manage osteoarthritis pain can elevate blood glucose in these patients. We used CGM to compare BG levels following intra-articular injection of FX006, an extended-release, microsphere-based triamcinolone acetonide (TA) formulation, versus standard TA crystalline suspension (TAc) in diabetic patients with knee osteoarthritis. We found that administration of FX006 caused no statistically significant change in BG control whereas TAc caused significant hyperglycemia over 72 hours after injection. This may allow treatment of knee osteoarthritis in patients with diabetes without disruption of glucose control.

## **Report of Education of Patients and Service to the Community**

***No presentations below were sponsored by outside entities***

### **Activities**

- 1990-91 Spartanburg Day School / Teacher  
Taught 7th grade Biology, Sophomore Chemistry, and Junior Physics
- 1996-99 Dallas Morning News-Toyota Regional Science & Engineering Fair, Dallas, TX  
Judge 1996-1999, Grand Awards Judge 1998

- 2011- Speaker at Type 1 Diabetes education course run by MGH Diabetes Center several times each year.
- 2013 Panelist for Type 1 Diabetes Exchange Glu online community Bionic Pancreas Open House (took questions submitted online by members of Glu and live questions from attendees)
- 2015 Met with Youth Ambassadors for the ADA Tour de Cure to describe our research and answer questions

### **Educational Material for Patients and the Lay Community:**

#### ***Patient educational material***

- |      |  |  |  |
|------|--|--|--|
| 2005 | Guide to potassium in foods for patients with diabetes | Patient handout (adapted from handout for non-diabetics) | MGH Primary Care Office Insight, Patient Information |
|------|--|--|--|

### **Report of Scholarship**

#### **Peer-Reviewed Scholarship in print or other media:**

##### **Research Investigations**

1. Plummer BF, **Russell SJ**, Reese WG, Watson WH, Krawiec M. Sterically Congested Polycyclic Aromatic Hydrocarbons with Nonoptimal Geometries. 4,5-Didehydroacenaphthene as a Precursor for the Synthesis of 7,14 Diphenyl-8,9-(1',8'-naphthenylene)acephenanthrene. Journal of Organic Chemistry 1991; 56:3219-23.
2. Plummer BF, Currey JA, **Russell SJ**, Steffen LK, Watson WH, Bourne SA. The Synthesis and X-ray Crystallographic Analysis of a Stable Norbornadienone: 17-oxo-7,16-methano-7,16-diphenylcyclopenta[d,e]tribenzo[a,h,i]anthracene. Structural Chemistry 1995; 6: 167-73.
3. **Russell SJ**, Sathyanarayana UG, Johnston SA. Isolation and Characterization of SUG2: A Novel ATPase Family Component of the Yeast 26S Proteasome. Journal of Biological Chemistry 1996; 271:32810-7.
4. **Russell SJ**, Steger KA, Johnston SA. Sub-cellular Localization, Stoichiometry, and Protein Levels of 26S Proteasome Subunits in Yeast. Journal of Biological Chemistry 1999; 274:21943-52.
5. **Russell SJ**, Reed SH, Huang W, Friedberg EC, Johnston SA. The 19S Regulatory Complex of the Proteasome Functions Independently of Proteolysis in Nucleotide Excision Repair. Molecular Cell 1999; 3:687-95.
6. **Russell SJ**, Johnston SA. Evidence that Proteolysis of Gal4 Can Not Explain the Transcriptional Effects of Proteasome ATPase Mutations. Journal of Biological Chemistry 2001; 276:9825-31.
7. **Russell SJ**, Gonzalez F, Joshua-Tor L, Johnston SA. Selective Chemical Inactivation of AAA Proteins Reveals Distinct Functions of Proteasomal ATPases. Chemistry & Biology 2001; 8:941-50.
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9. Laustsen PG, **Russell SJ**, Cui L, Entingh-Pearsall A, Holzenberger M, Liao R, Kahn CR. Essential Role of Insulin and IGF-1 Receptor Signaling in Cardiac Development and Function. Molecular and Cellular Biology 2007; 27:1649-1664. PMID: PMC1820447.
10. Katic M, Kennedy AR, Leykin I, Norris A, McGettrick A, Gesta S, **Russell SJ**, Bluher M, Maratos-Flier E, Kahn CR. Mitochondrial Gene Expression and Increased Oxidative Metabolism: Role in

Increased Lifespan of Fat-Specific Insulin Receptor Knockout Mice. Aging Cell 2007; 6:827-839.

11. El-Khatib FH\*, **Russell SJ**#, Nathan DM, Sutherlin RG, Damiano ER. A Bi-Hormonal Closed-Loop Blood Glucose Control Device for Type 1 Diabetes. Science Translational Medicine 2010; 2:27 27ra27. PMID: PMC4242106. (\*Co-first authors; #, Corresponding author)

12. **Russell SJ**, El-Khatib FH, Nathan DM, Damiano ER. Efficacy Determinants of Subcutaneous Micro-Dose Glucagon during Closed-Loop Control. Journal of Diabetes Science and Technology 2010; 4:1288-1304. PMID: PMC3005038.

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14. **Russell SJ**\*, El-Khatib FH\*, Nathan DM, Magyar KL, Jiang J, Damiano ER. Blood glucose control in type 1 diabetes with a bihormonal bionic endocrine pancreas. Diabetes Care 2012; 11:2148-55. PMID: PMC3476884. (\*Equal responsibility)

15. Mori MA, Raghavan P, Thomou T, Boucher J, Robida-Stubbs S, Macotela Y, **Russell SJ**, Kirkland JL, Blackwell TK, Kahn CR. Role of microRNA Processing in Adipose Tissue in Stress Defense and Longevity. Cell Metabolism 2012; 16:336-47. PMID: PMC3461823.

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17. Damiano ER, El-Khatib FH, Zheng H, Nathan DM, **Russell SJ**. A Comparative Effectiveness Analysis of Three Continuous Glucose Monitors. Diabetes Care 2013; 36:251-9. PMID: PMC3554299.

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19. El-Khatib FH\*, **Russell SJ**#, Magyar KL, Sinha M, McKeon, K, Nathan DM, Damiano ER. Autonomous and continuous adaptation of a bihormonal bionic pancreas in adults and adolescents with type 1 diabetes. Journal of Clinical Endocrinology and Metabolism 2014; 99:101-1711. PMID: PMC4010702. (\*Contributed equally; #, Corresponding author) (Chosen as the best diabetes paper published by JCEM in 2014 by the editors, was re-published in a special issue of JCEM coinciding with a symposium and an update lecture at ENDO 2015).

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22. **Russell SJ**, Hillard MA, Balliro C, Magyar KL, Selagamsetty R, Sinha M, Grennan K, Mondesir D, Ehkhaspour L, Zheng H, Damiano ER, El-Khatib FH. Randomized Outpatient Trial Comparing Day and Night Glycemic Control between a Bionic Pancreas and Conventional Insulin Pump Therapy in Pre-adolescent Children with Type 1 Diabetes. Lancet Diabetes and Endocrinology 2016; 4:233-43. PMID: PMC4799495.



23. Kahanovitz L, Seker E, Marks RS, Yarmush ML, Konry T, **Russell SJ**. Development of a Microsphere-based System To Facilitate Real-time Insulin Monitoring. Journal of Diabetes Science and Technology 2016; 10:689-696.

24. **Russell SJ**, Beck RW. Design Considerations for Artificial Pancreas Pivotal Studies. Diabetes Care 2016; 39:1161–1167. PMC Journal – In Process.

25. Maahs DM, Block J, Buckingham BA, Castle JR, Cinar A, Damiano ER, Dassau E, Desborough L, DeVries JH, Doyle III FJ, Griffen SC, Haidar H, Heinemann J, Hovorka R, Jones TW, Kollman C, Kovatchev B, Levy B, O’Neal D, Nimri R, Philip M, Renard E, **Russell SJ**, Weinzimer SA, Zisser H, Lum JW. Endpoints for Artificial Pancreas Clinical Trials: A Consensus Statement. Diabetes Care 2016; 39:1175–1179. PMC Journal – In Process.

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27. El-Khatib FH, Balliro C, Hillard MA, Magyar KL, Ekhlaspour L, Sinha M, Mondesir D, Esmaeili A, Hartigan C, Thompson MJ, Malkani S, Lock JP, Harlan DM, Clinton P, Frank E, Wilson D, DeSalvo D, Norlander L, Ly T, Buckingham B, Diner J, Dezube M, Young LA, Goley A, Kirkman MS, Buse JB, Zheng H, Selagamsetty RR, Damiano ER, **Russell SJ**. Home use of a bihormonal bionic pancreas versus insulin pump therapy in adults with type 1 diabetes: a multicenter randomised crossover trial. The Lancet 2017; 389:369–380. (Online First, December 20, 2016).

27. Cohen N, Sabhachandani P, Sarkar S, Kahanovitz L, Lautsch N, **Russell SJ**, Konry T. Microsphere based continuous-flow immunoassay in a microfluidic device for determination of clinically relevant insulin levels. Microchimica Acta 2017; 1-7.

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29. Weissberg-Benchell J, Hessler J, Fisher L, **Russell SJ**, Polonsky WH. Impact of an Automated Bi-Hormonal Delivery System on Psychosocial Outcomes in Adults with Type 1 Diabetes. Diabetes Technology and Therapeutics 2017. November 2017, ahead of print. <https://doi.org/10.1089/dia.2017.0174>

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NCBI My Bibliography:

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#### **Non-peer reviewed scholarship in print or other media:**

##### **Reviews, chapters, monographs and editorials**

1. **Russell SJ**, Kahn CR. Endocrine Regulation of Aging. Nature Reviews Molecular Cell Biology 2007; 8:681-691. (Review)

2. **Russell SJ**, Miller KK. Pituitary Apoplexy. Diagnosis and Management of Pituitary Disorders.

Swearingen B, Biller BMK (Eds). Humana Press, 2008. (Chapter)

3. **Russell SJ**. Continuous Glucose Monitoring Awaits Its "Killer App". Journal of Diabetes Science and Technology 2008; 2:490-494. (Editorial) PMID: PMC2769737.

4. **Russell SJ**, Miller KK. Pituitary Apoplexy. A Case-Based Guide to Clinical Endocrinology. Terry Davies (Ed). Springer, 2008. (Chapter)

5. **Russell SJ**, Thompson T. Endocrine Disorders and Glucose Management. Critical Care Handbook of the Massachusetts General Hospital. Luca M. Bigatello (Ed). Lippincott Williams and Wilkins 2009. (Chapter)

6. Nathan DM, **Russell SJ**. The Future of Care for Type 1 Diabetes. Canadian Medical Association Journal 2013; 185:285–286. (Editorial) PMID: PMC3589303.

7. **Russell SJ**. When you come to a fork in the road, take it! The Lancet Diabetes & Endocrinology. 2014 3:2-3. (Editorial)

8. **Russell SJ**. Progress of artificial pancreas devices towards clinical use: the first outpatient studies. Current Opinion in Endocrinology, Diabetes, and Obesity 2015; 22(2):106-111. (Review) PMID: PMC4383642.

9. Kahanovitz L, Sluss PM, **Russell SJ**. Type 1 Diabetes - A Clinical Perspective. Point of Care: The Journal of Near-Patient Testing and Technology. 2017; 16:37-40.

10. **Russell, SJ**. Artificial pancreas research: you can observe a lot by watching. The Lancet Diabetes & Endocrinology 2017; 2017 5:484-485. (Editorial)

#### **Professional educational materials or reports, in print or other media:**

1. Pituitary Apoplexy (review), MGH Neuroendocrine Clinical Center Newsletter, 2008 (intended for continuing medical education of referring physicians)

2. Russell S. Control of Nocturnal Hypoglycemia in Children With Type 1 Diabetes. PracticeUpdate website. Available at: <http://www.practiceupdate.com/c/27855>, 2015 (intended to summarize significant literature for practicing physicians)

3. New England Journal of Medicine Group Open Forum: The Prospects for a Bionic Pancreas. Available at <https://medstro.com/groups/nejm-group-open-forum/discussions/401>, 2017 (served as an Expert and responded to questions in the forum)

#### **Clinical Guidelines and Reports:**

1. Diabetic Ketoacidosis (review and clinical protocol), MGH Department of Medicine Teaching Handout, 2003 (intended for use by medical residents while managing diabetic ketoacidosis)

#### **Thesis:**

Studies of SUG1 and SUG2, ATPases of the 26S Proteasome and Their Contributions to Proteolysis, Nucleotide Excision Repair, and Gene Transcription. Dallas (TX): University of Texas Southwestern Medical Center; 1999

#### **Abstracts, Poster Presentations and Exhibits Presented at Professional Meetings:**

Abstracts from approximately the last 3 years are listed.

A Robustly Adaptive Bi-Hormonal Bionic Pancreas for Automated Glucose Control in Children and Adults. Steven J. Russell, Firas H. El-Khatib, Hui Zheng, David M. Nathan, Edward R. Damiano. American Diabetes Association Annual Scientific Session, Chicago, IL (2013)

A Comparative Effectiveness Analysis of Three Continuous Glucose Monitors. Edward R. Damiano, Firas H. El-Khatib, Hui Zheng, David M. Nathan, Steven J. Russell. American Diabetes Association Annual Scientific Session, Chicago, IL (2013)

Optimizing Insulin PK to Improve Glucose Control with a Bionic Pancreas. Manasi Sinha, Firas H. El-Khatib, Edward R. Damiano, Steven J. Russell. American Diabetes Association Annual Scientific Session, Chicago, IL (2013)

Pharmacokinetics and Pharmacodynamics of a Chemically Stable Micro-Dosed Glucagon in a Diabetic Swine Model of Type 1 Diabetes. John Jiang, Katherine M. McKeon, Firas H. El-Khatib, Steven J. Prestrelski, Nancy L. Scott, Brett Newswanger, Patrick Sluss, Steven J. Russell. Edward R. Damiano, American Diabetes Association Annual Scientific Session, Chicago, IL (2013)

Optimizing Insulin Pharmacokinetics to Improve Glucose Control with a Bionic Pancreas (Adult Cohort). Manasi Sinha, Firas H. El-Khatib, Edward R. Damiano, Steven J. Russell. American Diabetes Association Annual Scientific Session, Chicago, IL (2013)

Optimizing Insulin Pharmacokinetics to Improve Glucose Control with a Bionic Pancreas (Adult and Pediatric Cohort). Manasi Sinha, Firas H. El-Khatib, Edward R. Damiano, Steven J. Russell. Pediatric Academic Societies/ Pediatric Endocrine Society Annual Meeting, Washington D.C. (2013)

Multiday Outpatient Glycemic Control in Adults with Type 1 Diabetes Using a Bihormonal Bionic Pancreas: The Beacon Hill Study. Steven Jon Russell, Firas H. El-Khatib, Kendra L Magyar, Manasi Sinha, Laura G Goergen, Courtney Balliro, Katherine McKeon, David M. Nathan and Edward R Damiano. Endocrine Society's 96th Annual Meeting and Expo, Chicago, IL (2014)

Population Pharmacokinetics of Intradermal versus Subcutaneous Insulin Delivery in Patients with Type 1 Diabetes. Tian Yu, Manasi Sinha, Mallory A. Hillard<sup>2</sup>, Catherine M.T. Sherwin, Steven J. Russell, Michael G. Spigarelli. American Society for Clinical Pharmacology and Therapeutics (ASCPT) New Orleans, Louisiana (2015)

Outpatient Glycemic Control with a Bionic Pancreas in Preadolescents with Type 1 Diabetes. FH El-Khatib, SJ Russell, KL Magyar, C Balliro, MA Hillard, et al. DIABETES 64, A58-A59, 2015.

Comparison of the Intradermal vs. Subcutaneous Delivery of Insulin and Glucagon in T1DM. M Sinha, T Yu, CMT Sherwin, MA Hillard, MG Spigarelli, SJ Russell. DIABETES 64, A276-A27, 2015.

POPULATION PHARMACOKINETICS OF INTRADERMAL VS. SUBCUTANEOUS INSULIN DELIVERY IN PATIENTS WITH TYPE 1 DIABETES. T Yu, M Sinha, M Hillard, C Sherwin, S Russell, M Spigarelli. CLINICAL PHARMACOLOGY & THERAPEUTICS 97, S48-S49, 2015.

Effects of Glucose Target on the Performance of a Bihormonal Bionic Pancreas. Firas Elkhatib, Laya Ekhlaspour, Courtney Balliro, Rajendranath Selagamsetty, Aryan Esmaeili, Mallory Hillard, Debbie Mondesir, Edward R Damiano, Steven J Russell. DIABETES 2016; 65:A259-A259

Home use of a bi-hormonal bionic pancreas vs conventional insulin pump therapy in adults with type 1 diabetes: a multicenter randomized clinical trial. SJ Russell, FH El-Khatib, B Buckingham, J Buse, D Harlan, T Ly, S Kirkman, S Malkani, M Thompson, L Ekhlaspour, ER Damiano. DIABETOLOGIA 2016; 59:S97-S97

Home Use of a Bihormonal Bionic Pancreas vs. Conventional Insulin Pump Therapy in Adults with Type 1 Diabetes: A Multicenter, Randomized Clinical Trial. Firas Elkhatib, Bruce A Buckingham, John B Buse, David M Harlan, Kendra Magyar, Trang T Ly, M Sue Kirkman, Samir Malkani, Michael J Thompson, John Paul Lock, Laya Ekhlaspour, Paula Clinton, Jaimie Diner, Milana Dezube, Celia Hartigan, Courtney Balliro, Rajendranath Selagamsetty, Aryan Esmaeili, Manasi Sinha, Mallory Hillard, Debbie Mondesir, Edward R Damiano, Steven J Russell. *Diabetes* 2016; 65:A20-A20

Relationship between Sleep Duration and Hypoglycemia during a Bionic Pancreas Study. A Esmaeili, LJ Ekhlaspour, C Balliro, D Mondesir, SJ Russell. *Diabetes* 2016; 65:A102-A102

Closed-Loop Glucagon Administration for the Automated Prevention and Treatment of Hypoglycemia in Type 1 Diabetes. Courtney Balliro, Laya Ekhlaspour, Firas Elkhatib, Debbie Mondesir, Manasi Sinha, Kendra Magyar, Mallory Hillard, Rajendranath Selagamsetty, Lisa Dao, Aryan Esmaeili, Steven J Russell. *Diabetes* 2016; 65:A99-A99

Outpatient Glycemic Management in Type 1 Diabetes with Insulin-Only vs. Bihormonal Configurations of a Bionic Pancreas. Laya Ekhlaspour, Firas Elkhatib, Courtney Balliro, Rajendranath Selagamsetty, Aryan Esmaeili, Mallory Hillard, Debbie Mondesir, Steven J Russell, Edward R Damiano. *Diabetes* 2016; 65:A21-A21

Automating Glycemic Management in Diabetes Mellitus with a Bionic Pancreas. SJ Russell. *Journal of Clinical Research in Pediatric Endocrinology* 2016; 8 (1)

Automated Glucagon Administration for Treatment of Postbariatric Hypoglycemia. Jafri, RZ, Maheno M, Balliro CA, Cuko L, Mondesir D, El-Khatib FH, Ekhlaspour L, Russell SJ. *Diabetes* 2017; 66(S1):[9-LB]

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Development of Analog-Specific Immunoassays for Pharmacokinetic Studies of Insulin Lispro and Insulin Aspart. Kahanovitz L, Sluss PM, Lautsch NW, Marks RS, Russell SJ. *Diabetes* 2017; 66(S1):A271.

Effect of a Lower Glucose Target on Glycemic Outcomes with an Insulin-Only Bionic Pancreas. Balliro CA, Ekhlaspour L, Esmaeili A, El-Khatib FH, Mondesir D, Selagamsett R, Hillard MA, Maheno M, Jafri RZ, Damiano ER, Russell SJ. *Diabetes* 2017; 66(S1):A280.

Demonstration of Continuous Insulin Monitoring (CIM) in the Interstitial Fluid. Kahanovitz L, Cohen N, Sabhachandani P, Lautsch NW, Konry T, Russell SJ. *Diabetes* 2017; 66(S1):A280.

In Type 2 Diabetes Mellitus Patients with Knee Osteoarthritis Intra-Articular Injection of FX006 (Extended Release Triamcinolone) Is Associated with Reduced Blood Glucose Elevation vs. Standard Triamcinolone: A Randomized, Blinded, Parallel-Group Study. Russell SJ, Sala R, Conaghan PG, Habib G, Vo Q, Manning R, Kivitz A, Davis Y, Lufkin J, Johnson JR, Kelley S, Bodick N. *Diabetes* 2017; 66(S1):A289.

Comparing the Patient Experience of an Insulin-Only and Bihormonal Bionic Pancreas. Balliro CA, Hillard MA, Mondesir D, Russell SJ, Larkin ME. *Diabetes* 2017; 66(S1):A226

## **Narrative Report**

My research effort is focused on translational and clinical investigation. Its most important contribution has been the development and clinical testing of a system for automated glycemic management in patients with type 1 diabetes, a bionic pancreas. I spend 85% of my time on research, 10% on clinical care, and 5% on teaching.

In collaboration with Dr. Edward Damiano, a Biomedical Engineer at Boston University, we have developed and validated a bionic pancreas that automatically delivers both insulin and micro-doses of glucagon to regulate blood glucose. The collaboration began in 2006, and after initial inpatient studies (4 publications) we progressed to the first ever day-and-night outpatient studies of automated glycemic regulation in adults and adolescents. These studies, published in the NEJM in 2014, demonstrated the bionic pancreas to be superior to self-management with an insulin pump in reducing both mean glucose and hypoglycemia simultaneously. We next completed an outpatient study in pre-adolescent children in fall of 2014 (published in The Lancet, Diabetes and Endocrinology in 2016) and in May 2015 we completed a multi-center home use study, the first of its kind, wherein each subject went about their normal routine for 11 days in both arms in (published in The Lancet in 2016). Both studies showed statistically and clinically significant reductions in mean glucose and the incidence of hypoglycemia. A fully integrated bionic product (not the prototypes used to date) will be ready for its first human test in December 2017. In collaboration with the FDA, we designed a pivotal study that will provide the data necessary for FDA approval. In 2016, we received funds (~\$12M) to support the pivotal trials to begin in the fourth quarter of 2018.

We recently completed a study on a glucagon-only version of the bionic pancreas (manuscript in preparation) and a study testing the effect of manipulating the glucose target on the performance of the bionic pancreas. I have applied for funding to test the bionic pancreas in patients with insulin-dependent type 2 diabetes, in older adults with type 1 and type 2 diabetes, and in people with type 1 diabetes who have no prior experience with diabetes technology (pump and sensor naïve).

My contributions to the development of the bionic pancreas algorithms have led to a patent (US 9833570 B2, inventors: El-Khatib, Damiano, Russell) and several patents pending, with the portfolio licensed to  $\beta$ et $\alpha$   $\beta$ ionics by Partners HealthCare Innovation.

I am also working in related areas, including comparative evaluation of glucose sensing and measurement technologies (manuscript on glucose meter accuracy submitted), development and testing of a system for automated glycemic regulation in the inpatient setting (study completed, manuscript in preparation), evaluation of a stabilized form of glucagon in a clamp study (study completed, manuscript in preparation), development of assays specific for individual insulin analogs (manuscript in preparation) comparative evaluation of the PK of different insulin analogs in a single individual (manuscript in preparation), development of a system for continuous measurement of interstitial insulin levels using microdialysis and a microfluidic immunoassay (two published manuscript), and evaluation of the effect of ethanol intoxication on the anti-hypoglycemic activity of glucagon (manuscript in preparation).

I actively participate in academic activities such as grant and manuscript review, serve on a number of advisory boards (e.g. for the California Institute of Regenerative Medicine, Glu/T1D Exchange, Lancet Diabetes and Endocrinology, diaTribe/diabetes CloseUp/CloserLook), mentor fellows, mentor a graduate student in the area of diabetes technology (dissertation has been submitted), and teach medical students (lectures to the Harvard/MIT HST program), medical residents in the Internal Medicine residency program (lectures to the Tools of Human Investigation course), and medical residents and

endocrine fellows in my role as Visit on the Endocrine consult service. I speak nationally and internationally about automated glucose management and related issues. I consult for a number of companies on clinical trial design, diabetes technology, and strategic questions in the diabetes care space.

My work has established me as an expert in the clinical investigation of automated glycemic regulation nationally and internationally and I have developed a portfolio of funded projects focused on improving the care of diabetes patients through the innovative use of technology.