

INPATIENT GLYCEMIC MANAGEMENT:
FROM BEDSIDE TO THE CLOUD

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STATE OF THE UNION

- BASAL – BOLUS REGIMEN SUPERIOR TO TRADITIONAL SLIDING SCALE
- AVAILABILITY OF PROTOCOLS AND TOOLS TO HELP WITH IMPLEMENTATION
- GLUCOSE MONITORING ADVANCES
- HYPOGLYCEMIA: BOTH CAUSE AND ASSOCIATION WITH ADVERSE OUTCOMES

Clement S. Diabetes Technology & Therapeutics 2016: Vol 18: 4-8

2016: EVOLVING IPGM

- TARGETS OF CONTROL – ICU VS NON – ICU
- ORAL AGENTS – TOTALLY OUT?
- INSULINS – RETURN OF SOME OLD FRIENDS (N, 70/30, U-500) : STEROIDS, TUBE FEEDS
- AVOIDING HYPOGLYCEMIA
- ADVANCES IN POC GLUCOSE TESTING
- INDIVIDUALIZING PROTOCOLS TO SPECIFIC SCENARIOS
- MOVING TO BASAL – PRANDIAL – CORRECTIONAL REGIMEN
- TIME TO SHARPEN THE AXE

Horton W, Subauste J, American Journal of Medicine, 2016: Vol 129: pp136-141
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- HYPERGLYCEMIA
 - DECREASED GLUCOSE UTILIZATION
 - O₂ DEFICIT
 - REDUCED MACROPHAGE FUNCTION
 - DYSFUNCTIONAL COMPLEMENT PATHWAY
 - WIDESPREAD MICROVASCULAR DISEASE
 - ? STRESS-RELATED HYPERGLYCEMIA
- HYPOGLYCEMIA
 - BIO-MARKER OF MORBIDITY AND MORTALITY
 - INCREASED RELEASE OF INFLAMMATORY MARKERS
 - ? STRESS-ASSOCIATED HYPOGLYCEMIA

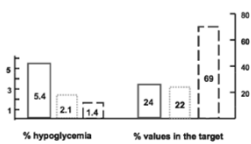
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STEROIDS IN THE HOSPITAL

- DIFFERENTIATE BETWEEN PREDNISONE AND DECADRON
- TYPICAL PATTERN ON PREDNISONE: AM NORMOGLYCEMIA AND PM HYPERGLYCEMIA
- UTILITY OF MORNING NPH INSULIN
- MAY NOT NEED BEDTIME BASAL INSULIN
- CHALLENGE OF RESPONDING TO STEROID EFFECTS AS DOSE IS INCREASED AND TAPERED

ENTERAL TUBE FEEDS: LET THE TREATMENT FIT THE SCENARIO

Clinical Observation
Comparison of 70/30 Biphasic Insulin With Glargine/Lispro Regimen in Non-Critically Ill Diabetic Patients on Continuous Enteral Nutrition Therapy
 Eliza Hain, MD, Steven A. Suggs, RN, MS, CDE, James Gilks, PA-C, Nicole Rasmussen, MD, and Bruce D'Amico, MD, PhD



- CONTINUOUS TUBE FEEDS
- OVERNIGHT TUBE FEEDS
- PREPARATION FOR PLANNED OR ARBITRARY DISCONTINUATION OF TUBE FEEDS
- CONSIDER 70/30 IN THREE Q 8 H DOSES FOR 24 HR COVERAGE AND TWO Q 6 H DOSES FOR OVERNIGHT
- PROBLEM WITH LONG-ACTING BASAL INSULIN COVERAGE
- DON'T TRY TO ABSOLUTELY CORRECT WITH THE LONG-ACTING FORMULATIONS: AIM FOR 150 MG/DL TARGET AND CORRECT WITH SLIDING SCALE

Additional Reading:
https://www.aace.com/sites/all/files/enduring_materials/Enteral_Nutrition_Mechanick-v2.pdf

U-500 INSULIN: RESURGENT POPULARITY (ALWAYS TRICKY TO USE IN HOSPITAL SETTING)

- FOR SEVERE INSULIN-RESISTANT PATIENTS
- COST: DETERMINED PER UNIT OF INSULIN (APP \$ 0.17)
- NEW PEN DEVICE : TO REDUCE ADMINISTRATION ERRORS
 - UP TO 300 UNITS AS SINGLE BOLUS
- BID OR TID



THE NURSE EDUCATION AND TRANSITION (NEAT) MODEL: EDUCATING THE HOSPITALIZED PATIENT WITH DIABETES KRALL JS ET AL. CLINICAL DIABETES AND ENDOCRINOLOGY: 2016:2:1

Table 1 NEAT key elements

- Brief video vignettes focused on diabetes self-management "survival skills"
 - Nutrition
 - Medication taking
 - Insulin injections
 - Blood glucose monitoring
 - Hypoglycemia
- Patient knowledge assessment
- Nurse "cheat" sheet to aid in patient knowledge acquisition
- Survival skills take home sheet
- Diabetes education resource list to aid in scheduling outpatient visits prior to discharge
- Uniform documentation guidance in electronic medical record

Table 2 NEAT protocol

1. Assess patient diabetes self-management needs
2. Prioritize learning needs critical to assuring a safe transition to home, e.g., injection skills, identifying and treating hypoglycemia, emergency call numbers, etc.
3. Select appropriate videos accordingly.
4. Deliver and review video/iPad with patient
5. Assess knowledge through teach back with quiz
6. Provide patient/caregivers with "Survival Skill" take home sheet
7. Make appointment for diabetes educator on discharge
8. Document in the electronic medical record

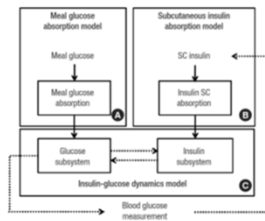
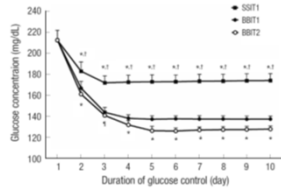


Fig. 1. Schematic of input-output relationships in the model depending on exogenous inputs. (A) Meal glucose absorption model, (B) subcutaneous insulin absorption model, and (C) insulin-glucose dynamics model. Solid lines represent direct relationships, whereas dotted lines represent indirect relationships among the subsystems. SC stands for subcutaneous.

J Korean Med Sci 2016; 31: 231-239

IN SILICO TRIAL OF INPATIENT GLYCEMIC MANAGEMENT
 J KOREAN MED SCI 2016; 31: 231-239

- SSIT
- BBIT1 : BASAL ADJUSTMENT ONLY
- BBIT2: BASAL + BOLUS ADJUSTMENT



Kim S. et al. J Korean Med Sci 2016; 31: 231-239

Fig. 2. Changes in daily mean blood glucose level in virtual patients with normal renal function treated with BBIT1 (●), BBIT2 (○), and SSIT1 (■). Data are presented as the mean ± SD. *P < 0.001, **P < 0.01 vs. BBIT1; †P < 0.001 vs. BBIT2.

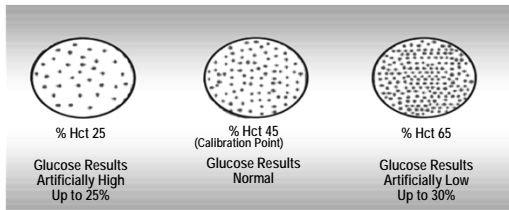
GLUCOSE MONITORS:
 NOT TO BE TAKEN FOR GRANTED

- 1997 - 2009: 13 HOSPITAL DEATHS ATTRIBUTED TO GLUCOSE MONITORS (GDH - PQQ)
 - ** PERITONEAL DIALYSATE FLUID - ICODEXTRIN
 - ACCU-CHEK (ROCHE), FREESTYLE (ABBOTT DIABETES CARE), TRUETEST (HOME DIAGNOSTICS)
 - GDH-NAD, GDH -FAD AND GOD SYSTEMS OK
- VIALS OF STRIPS LIKELY TO HARBOR BACTERIA / VIRUSES AND ENGEDNER TRANSMISSION
- ANEMIA, O2 TENSION, HYPOTENSION, AND OTHER CONFOUNDING VARIABLES IN CRITICAL CARE UNITS

Harper CC. FDA/CDRH Public Meeting: Blood Glucose Meters. Presented at the meeting of the U.S. Food and Drug Administration/Center for Devices and Radiological Health, Gaithersburg, MD. 2010.
http://www.gluco-safety.com/us/pdf/country-specific_gluco-safety_list.pdf

J Diabetes Sci Technol Vol 3, Issue 4, July 2009

Hematocrit Interference Effect



FDA Approved StatStrip® Multi-Well™ Technology Measures and Corrects Hematocrit Interference

POINT OF CARE TESTING: EARLY CHALLENGES

- QUALITY CONTROL
- OPERATOR CONSISTENCY
- STAND ALONE STATION WITH PAPER CHARTING

Point of Care Testing – Nichols, J. Point of Care 2015: Dec: 103-106

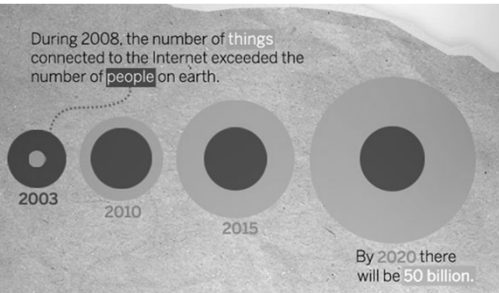
ARE WE READY FOR REAL-TIME CGM IN THE HOSPITAL?

- IDEALLY FOR ICU PATIENTS ON IV INSULIN DRIPS
- CONCERNS ABOUT ACCURACY IN THOSE WITH REDUCED PERIPHERAL PERFUSION
- FALL-OUT FROM NICE- SUGAR STUDIES RE. TARGETS
- ANTWERP: COMPARISON OF CGM (GLUCODAY) VS. NON- CGM AND IV INSULIN PROTOCOL (YALE) IN MICU
 - DURING 96 HRS OF MONITORING, NO DIFFERENCES IN GLYCEMIC CONTROL, GLYCEMIC EXCURSIONS OR HYPOGLYCEMIA
- ALL OF THE CGM DEVICES APPEAR TO BE ACCURATE IN ICU PATIENTS IN SHOCK OR ON VASOPRESSORS BUT CLINICAL UTILITY TO BETTER THAN CURRENT STANDARD REMAINS TO BE SEEN.

DeBlock C. et al, Diabetes Tech & Therapeutics 2015;12: pp 889-899

“THING” CONNECTED TO THE INTERNET

During 2008, the number of things connected to the Internet exceeded the number of people on earth.



Sources: Cisco IBSG, Jim Cicconi, AT&T, Steve Leibson, Computer History Museum, CNN, University of Michigan, Fraunhofer

INTERNET OF THINGS.....KEVIN ASHTON, 1999
 ENDOCRINOLOGY OF LIFE.....REDDY, 2016

INDIVIDUAL

- CELL
- CELL...CELL - PARACRINE
- CELLCELL - NEURAL
- ORGANORGAN - ENDOCRINE

SOCIETY

- INDIVIDUAL - TECHNICIAN - PROVIDER
- INDIVIDUAL...FAMILY, FRIENDS - CURRENT ENDO
- SOCIAL UNIT...ENVIRONMENT - FUTURE ENDO

CONNECTIVITY: EASIER SAID THAN DONE
 INTEGRATED INTEROPERABILITY



RALS Web 3 from Alere Informatics,
 Telcor QML,
 UniPOC from Conworx
 and Roche Cobas IT 1000.

Temporary Filter/Search		Main User Filters		Apply User Filter: No Filter		Remove Filter		
Biochemistry		Start: Sep 3, 2015 23:59						
Date/Time	Today	Description	Req. C.	Perf. C.	Result	Unit	Abn	Ref Int
Sep 03 2015 13:51	*	Glucose by POC Glucose Meter	C	C	6.4	mmol/L		3.9-11.0
Sep 03 2015 00:10	*	Ha	C	C	136	mmol/L		136-145
Sep 03 2015 00:10	*	K	C	C	5.4	mmol/L	H	3.5-5.2
Sep 03 2015 00:10	*	Cl	C	C	105	mmol/L		98-107
Sep 03 2015 00:10	*	CO2	C	C	23	mmol/L		21-32
Sep 03 2015 00:10	*	Anion Gap	C	C	9	mmol/L		5-12
Sep 03 2015 00:10	*	Urea	C	C	10.2	mmol/L	H	2.1-6.8
Sep 03 2015 00:10	*	Creatinine	C	C	147	umol/L	H	49-93
Sep 03 2015 00:10	*	Albumin	C	C	30	g/L	L	34-46

POINT OF CARE TESTING
 JULIE SHAW
 PRACTICAL LABORATORY MEDICINE; 2016; 4:22-29

- BIDIRECTIONAL COMMUNICATION
- PATIENT IDENTIFICATION
- QUALITY ASSURANCE
- WIRELESS +/- LANDLINE

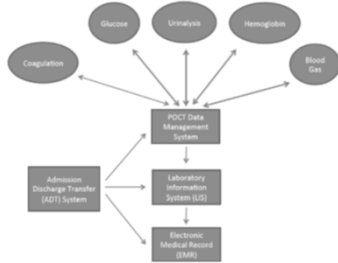
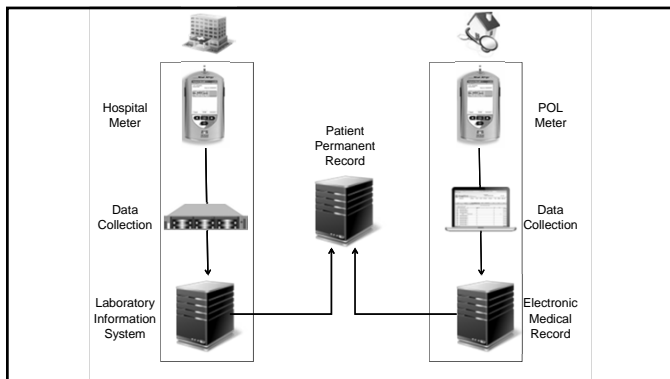


Fig. 2. Schematic representation of POCT device connectivity.

CONNECTIVITY: LESSONS FROM OUTPATIENT TO INPATIENT

- WHAT ARE DIABETES DEVICES?
 - GLUCOSE MONITOR, CGM, INSULIN PUMP, PHONE, FITNESS TRACKER, BP MONITOR, SLEEP MONITOR, INSULIN PENS, BATHROOM SCALE, REFRIGERATOR?
- MOVING FROM PROPRIETARY TO SMART-POOLING
- HOSPITALS CAN NOT AFFORD TO MAINTAIN MULTIPLE DISCRETE SILO'D DATASETS
- IMPROVED COMMUNICATION LEADING TO IMPROVED GLUCOSE REGULATION AND INCREASED SAFETY

Walsh J, et al Diabetes Science & Technology 2015: 1-5



OBSTACLES TO CONNECTIVITY

- PRIVACY AND OWNERSHIP
- NEED FOR SMARTER ALGORITHMS
- DATA ANALYSIS TO JUST-IN-TIME EXPERT ADVICE (EG WELLDOC INC.)
- A 'SPOONFUL' OF REGULATORY OVERSIGHT WILL HELP
- NEED FOR NEW PLAYERS (GOOGLE, APPLE, MS, SAMSUNG, VERIZON, COMCAST)

BENEFITS OF POCT CONNECTIVITY

- PATIENT IDENTIFICATION
- OPERATOR IDENTIFICATION
- DATA MANAGEMENT.....LIVE DATA.....INTERVENTION
- QUALITY CONTROL

Rajendran R, Rayman G. Diabetes Science & Tech 2014; 1-10

WHY CONNECTIVITY MATTERS

- PROVIDES ACCESS TO A PATIENT'S TESTING HISTORY & TRENDS
 - 100% OF A PATIENT'S DATA IS CAPTURED
 - DATA IS ACCESSIBLE AS PATIENT MOVES AND AFTER DISCHARGE
- REDUCES MEDICAL ERRORS
 - ELIMINATES TRANSCRIPTION ERRORS
 - ENABLES POSITIVE PATIENT ID
- ENABLES CARE TEAM PROCESSES AND ALERTS
- CREATES DATA FOR PRODUCTIVITY AND QUALITY MEASUREMENTS
- IMPROVES STAFF COMPLIANCE

