Perspectives on the Rapidly Growing Number of POCT Tests

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Disclosures

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- Equity: miDiagnostics
- Honorarium/Expenses: J&J
- Intellectual Property/Royalty Income: None

Objectives

- Describe the current POCT landscape – including existing technologies and emerging needs
- Discuss challenges associated with the rapidly growing number of available POCT applications
- Formulate strategies for efficiently managing a growing POCT program

In Vitro Diagnostics Market in $B

POCT is strongest growing segment

Point of Test	2013	2014	2015	2020	CAGR (2015-2020)
Laboratory	12.2	12.9	13.7	17.4	4.9%
Hospitals	23.2	24.7	26.3	34.9	5.8%
Academic Institutes	1.9	2.0	2.1	2.6	4.1%
Point-of-Care	5.4	5.9	6.5	9.7	8.5%
Patient Self-Testing (Point-of-Need)	4.6	4.9	5.2	6.9	5.7%
Others (include blood banks, local public health laboratories, community clinics labs, home health agencies, nursing homes, etc)	2.6	2.7	2.9	3.6	4.6%
Total	**49.9**	**53.1**	**56.7**	**75.1**	**5.8%**

(MarketsandMarkets, 2015)

Trends & Challenges

- **Empowerment and Access**

- Care shifts from in- to outpatients
- Patients and consumers are more health conscious
- Emerging economies aim to improve health care
- Increasing cost pressure within the health care systems

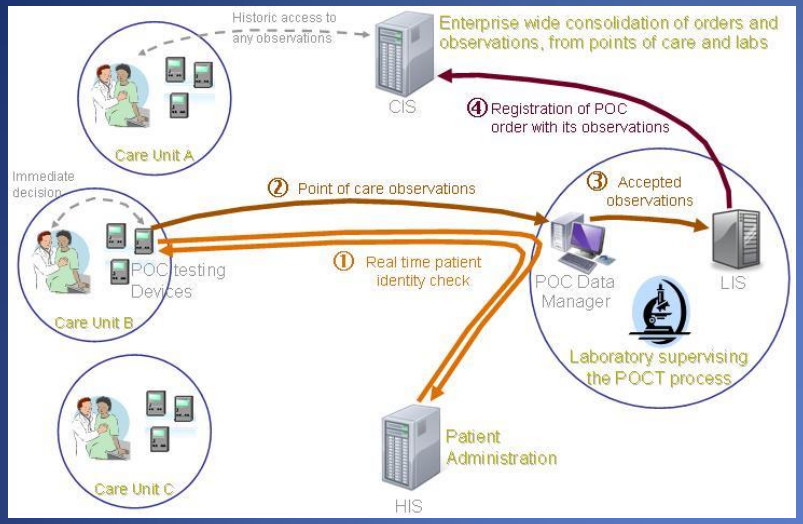
- **Inefficiencies and negative impacts on patient outcome**

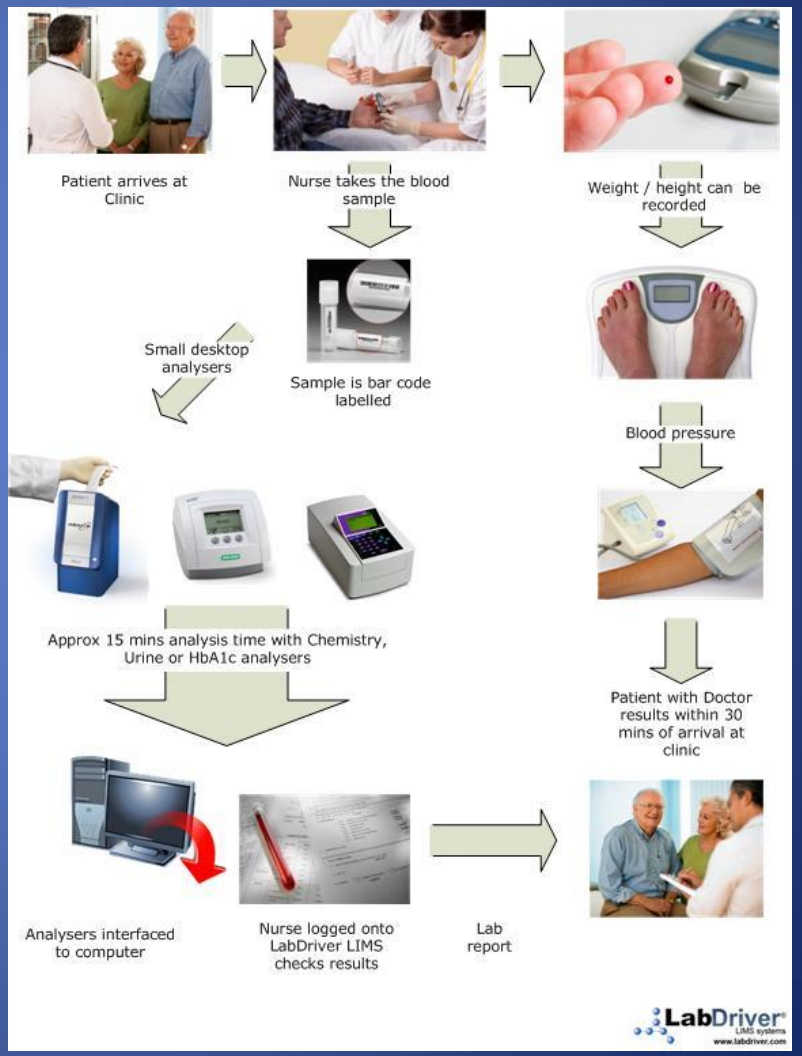
- Context disruptions for health care professionals
- Delayed or false treatment
- Infrastructure gaps

Accountable Care Organizations

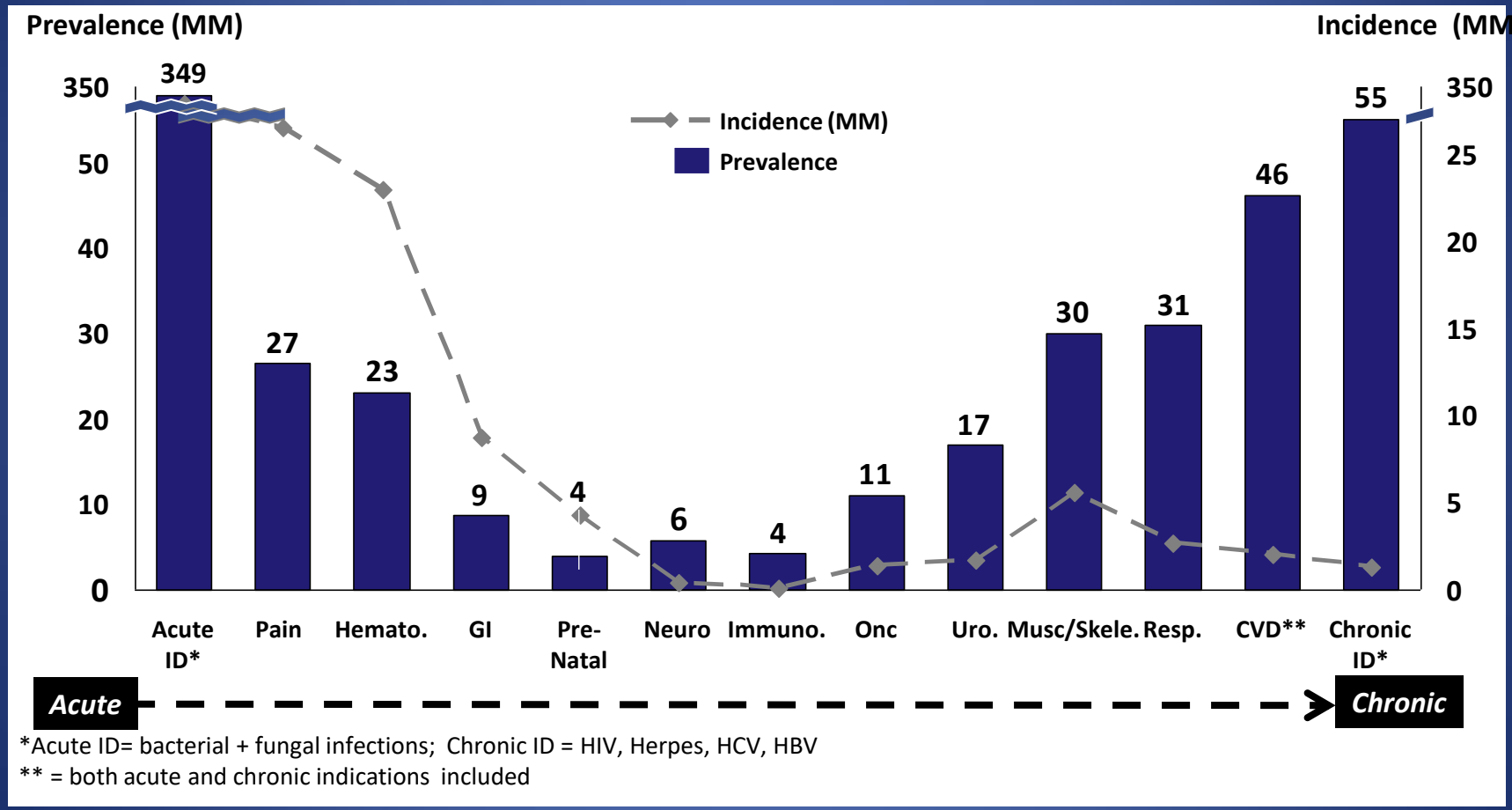
http://modernpractices.com/2013/06/20/accountable-care-organizations-impact-on-behavioral-health-providers/

Home Health Testing





Disease Incidence & Prevalence (US)



Sources. Cowen Report March 2010, NIH, CDC, NHLI, Wrongdiagnosis.com, emedicine.com, CMS CPT codes, NIAID, NCI

Comprehensive Role of Diagnostics

Diagnostics can help clinicians optimally manage patients through the continuum of care.

	Risk Assessment	Screening	Diagnosis	Staging and Prognosis	Therapy Selection	Monitoring
Description	Diagnostic tests to complement traditional risk factors	Applied to high-risk patient to identify disease early	Use for definitive diagnosis and general typing	Assess severity and/or risk of recurrence Inform adjuvent therapy decision	Used to predict efficacy or safety response to specific treatments	Recurrence monitoring Monotoring for treatment efficacy
Clinical Implications	Implement wellness programs proactively	Nip disease in the bud with early treatment	Refer to the appropriate specialist	Determine whether treatment is necessary	Do not waste unproductive therapy	Control disease progression with changes in treatment

SOURCE: DxInsights White Paper January 2012

FIGURE 1: Role of diagnostics through the continuum of health care.

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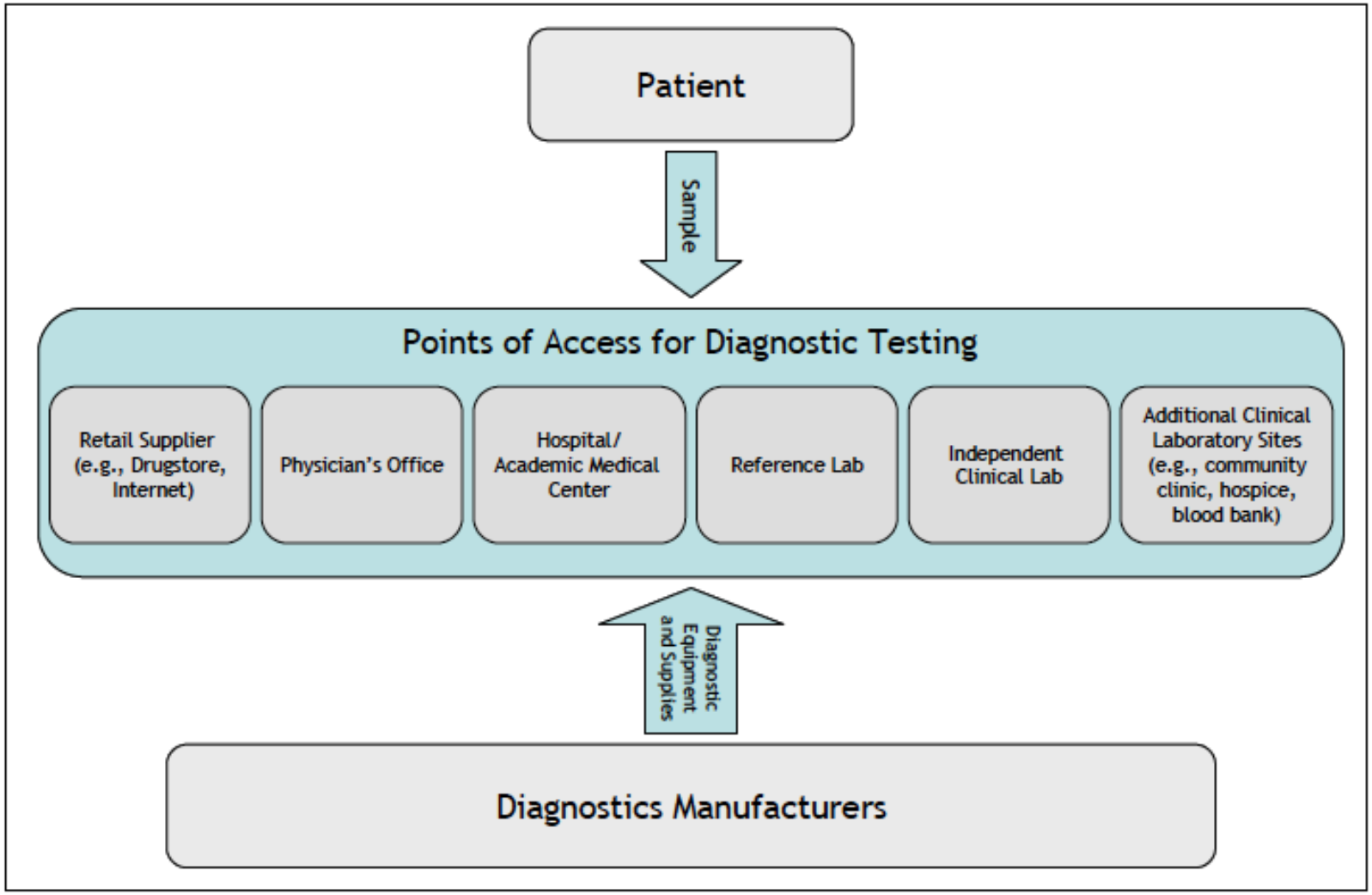
SOURCE: DxInsights White [illegible] ary 2012

FIGURE 1: Role of diagnostics thr[illegible]he continuum [illegible]lth care.

Figure 1.5
Points of Entry in the Diagnostics Supply Chain



Source: The Lewin Group, Inc.

Figure 1.5
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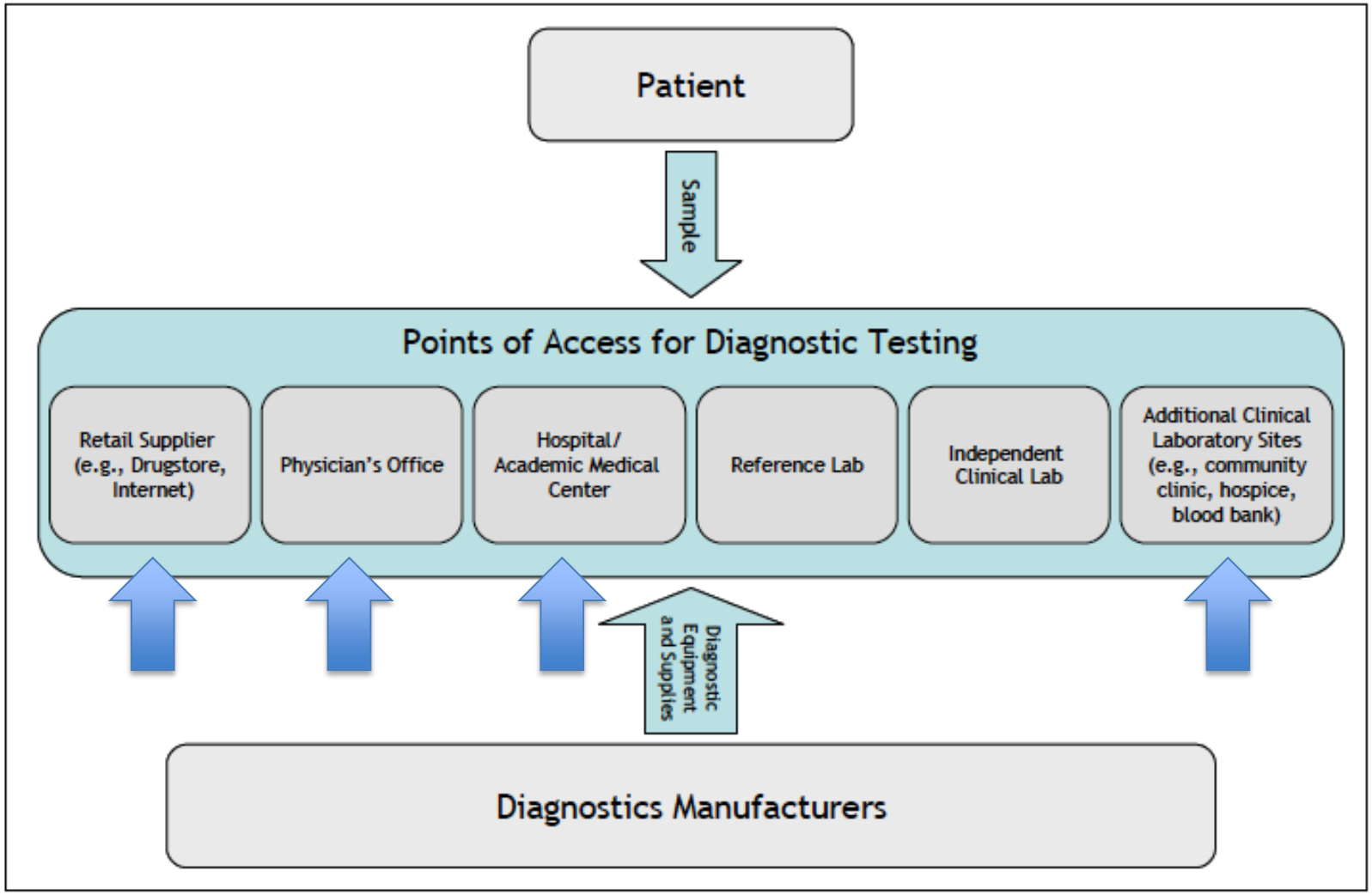
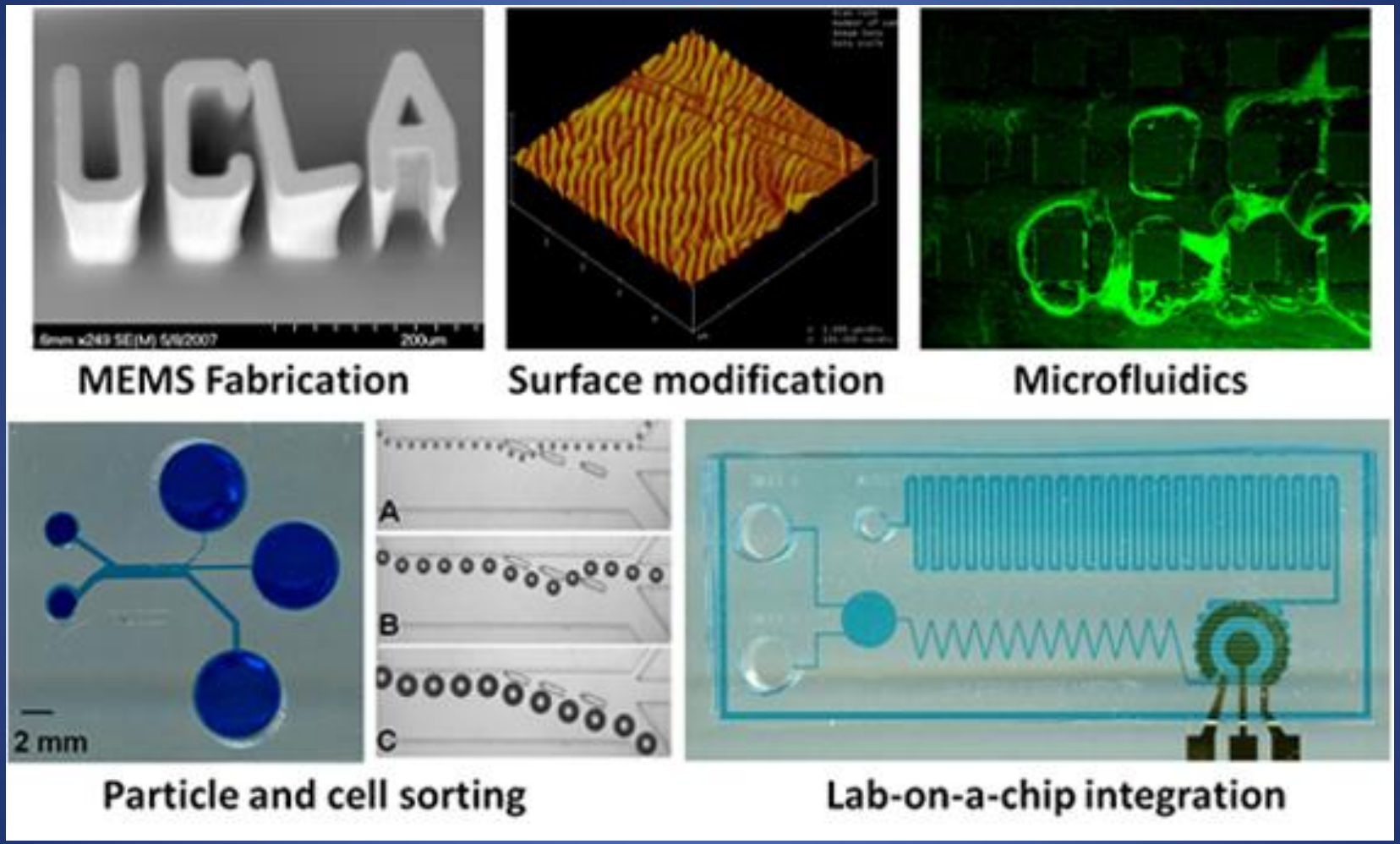
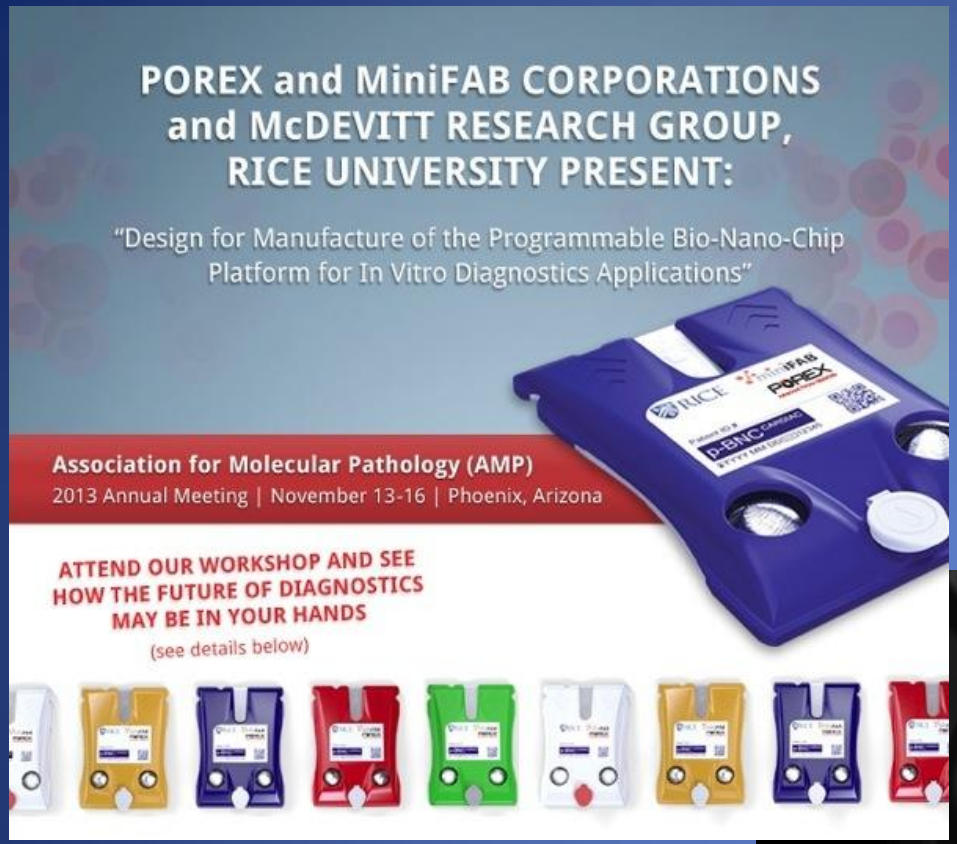


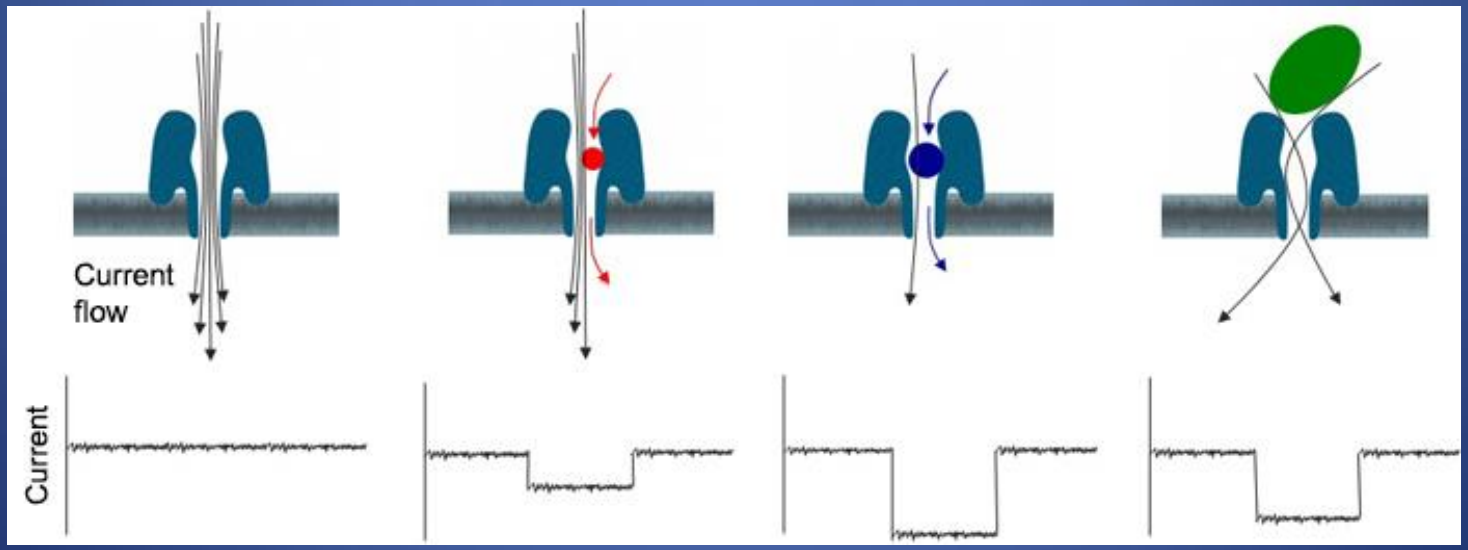
Source: The Lewin Group, Inc.



http://ho.seas.ucla.edu/group-members/postdoctoral-researchers/peter-lillehoj



http://dental.nyu.edu/faculty/biomaterials/mcdevitt-research-group.html



www.nanoporetech.com/technology/

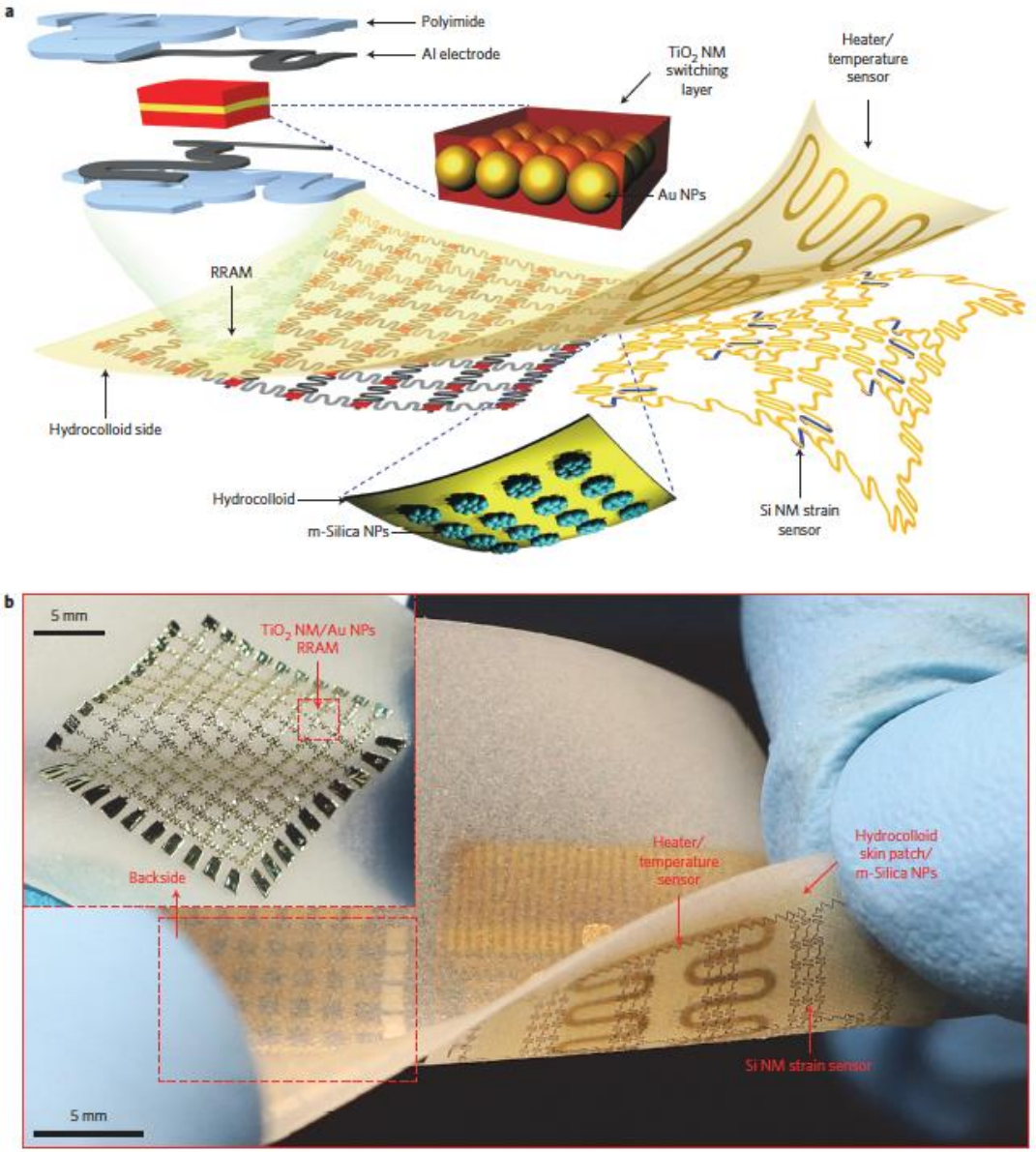


Figure 1 | Wearable electronic patch composed of data storage modules, diagnostic tools and therapeutic actuating elements. a, Wearable memory array consisting of a TiO_2 NM–Au NPs–TiO_2 NM switching layer and Al electrodes (top left inset: layer information). The memory array was transfer-printed on the bottom side of an elastomeric hydrocolloid skin patch. The electroresistive heater/temperature sensor was fabricated on the top-side of the patch, with the Si strain sensor on the opposite side. The m-silica NP array was transfer-printed on the hydrocolloid side of the patch. **b**, Corresponding image of **a**, showing the wearable bio-integrated system. Inset: Wearable 10 × 10 RRAM array on the hydrocolloid side of the patch.

NEAR-TERM EMERGING TECHNOLOGIES


Preparing Test
Insert cartridge
stop
TEG6s

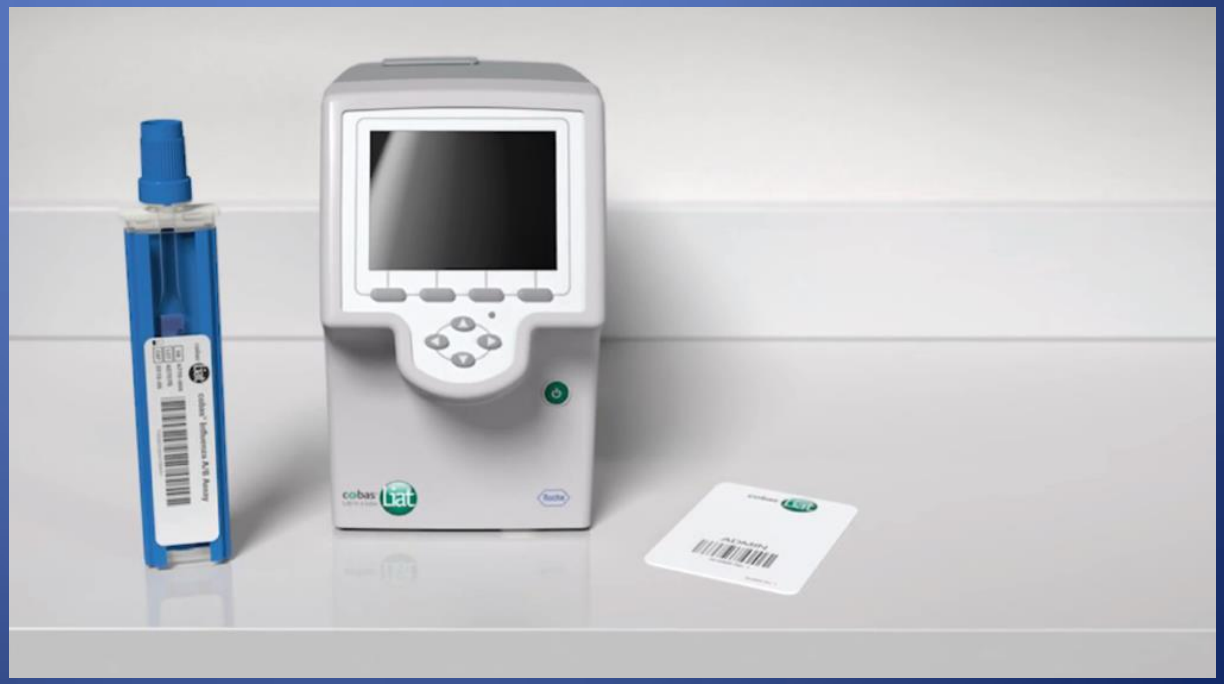

VerifyNow
SYSTEM


ROTEM
ROTEM

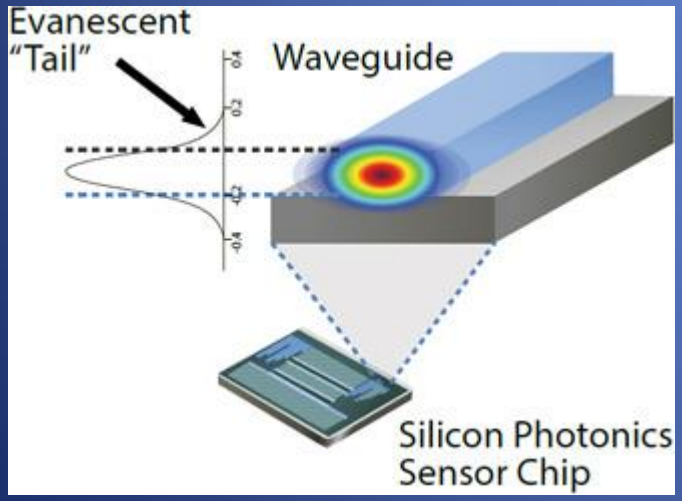
INTRODUCING THE

Alere™ q

Molecular Made Easy




Maverick™
DETECTION SYSTEM
Genalyte


Evanescent
"Tail"
Waveguide
Silicon Photonics
Sensor Chip

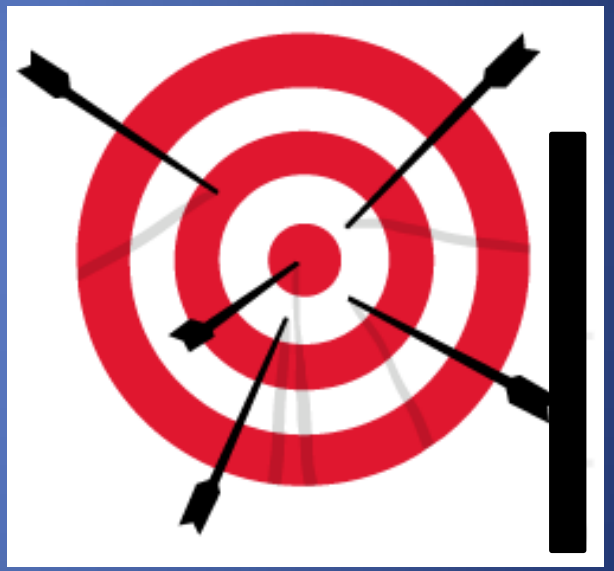

0100004593
Genalyte

CONSIDERATIONS FOR NEW TECHNOLOGIES

Accuracy of Laboratory Measurements

- Accuracy = closeness of measurement to "truth"
  - Often standard reference is a substitute for "truth"
- Inaccuracy is a function of 2 things:
  - Bias
  - Imprecision
- There is no perfect analytical method

Perception vs. Reality



Pre-Analytical Factors

- Poor technique in washing hands
  - Residual disinfectant
  - External contamination (e.g. juice)
- Inappropriate sampling
  - Poor perfusion
  - Peripherial Vascular Disease
  - Shock/dehydration

How to address inaccuracy?

How to address inaccuracy?

- Assumption of parameters/relationships
- Active correction
- Correction through device offsets
- Standardization of Devices

Capillary Sampling

Drop-to-Drop Variation in the Cellular Components of Fingerprick Blood

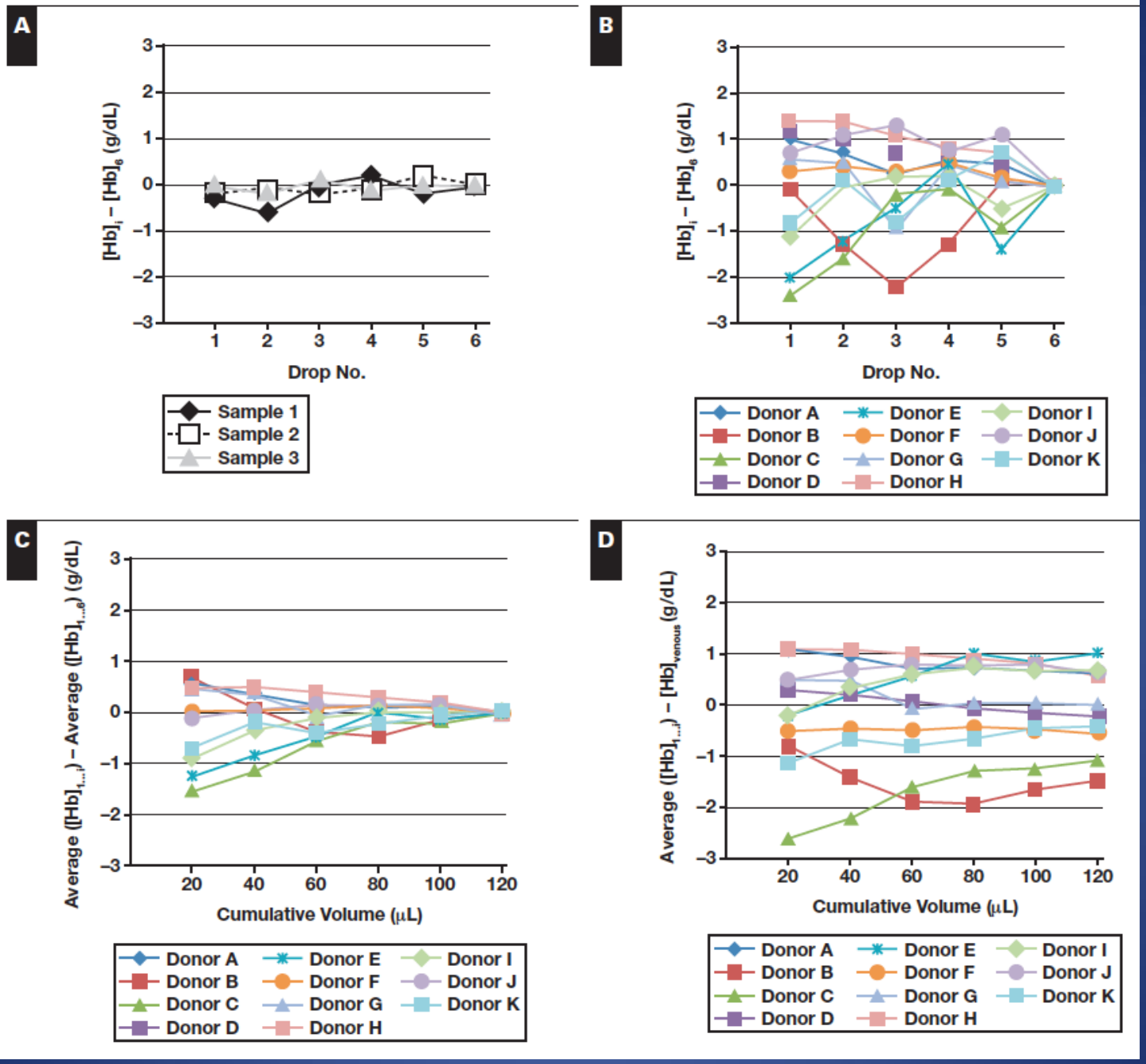
Implications for Point-of-Care Diagnostic Development

Meaghan M. Bond and Rebecca R. Richards-Kortum, PhD

From the Department of Bioengineering, Rice University, Houston, TX.

Key Words: Point-of-care diagnostics; Fingerprick blood; Fingerstick blood; Capillary blood; Hemoglobin; WBC

Am J Clin Pathol December 2015;144:885-894


A
B
C
D
$[Hb]_i - [Hb]_6$ (g/dL)
Drop No.
Sample 1
Sample 2
Sample 3
Donor A
Donor B
Donor C
Donor D
Donor E
Donor F
Donor G
Donor H
Donor I
Donor J
Donor K
Average $([Hb]_{1...i}) - $ Average $([Hb]_{1...6})$ (g/dL)
Cumulative Volume (µL)
Average $([Hb]_{1...i}) - [Hb]_{venous}$ (g/dL)

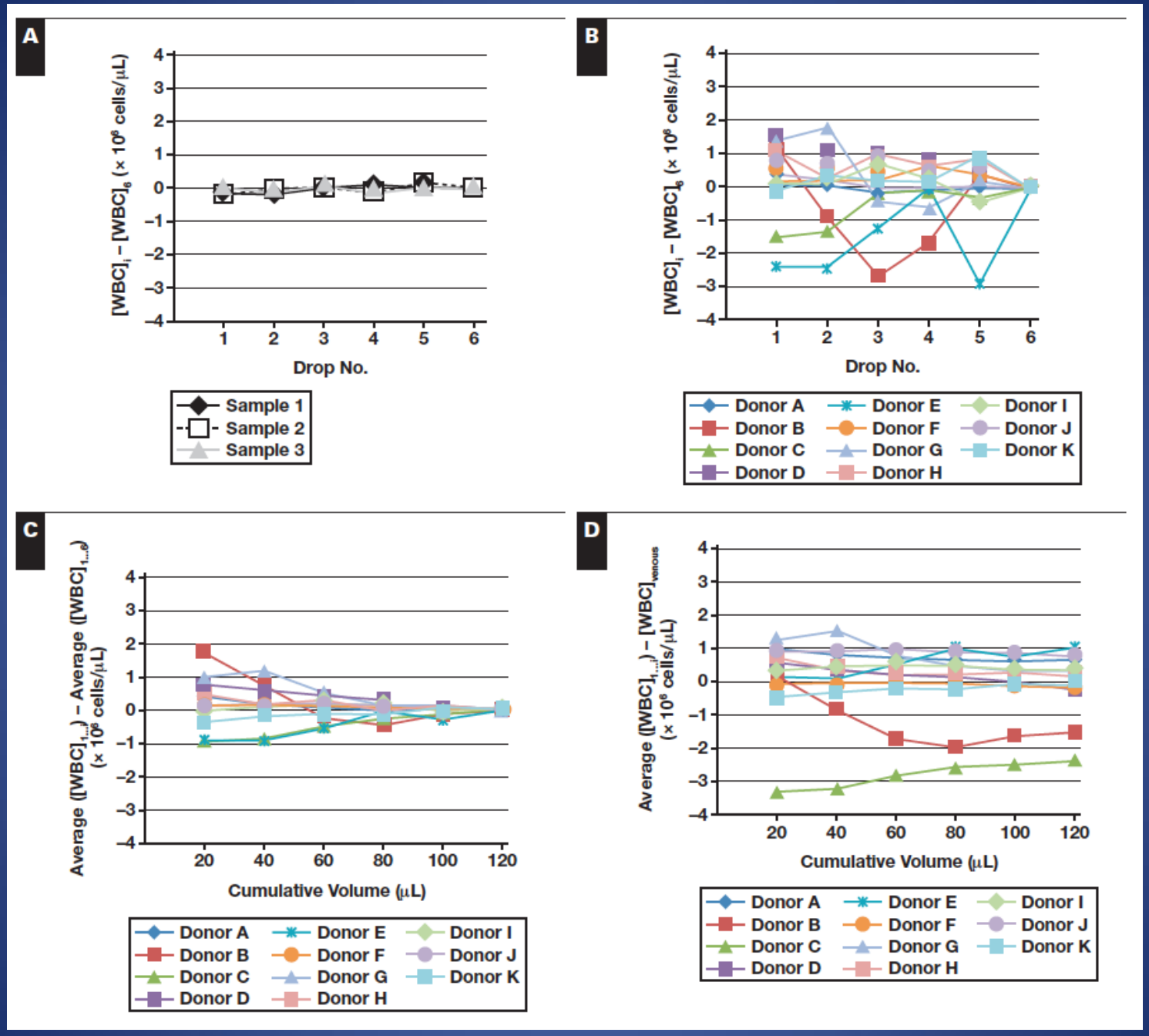

A
[WBC]i – [WBC]6 (× 10^6 cells/µL)
Drop No.
Sample 1
Sample 2
Sample 3
B
[WBC]i – [WBC]6 (× 10^6 cells/µL)
Drop No.
Donor A
Donor B
Donor C
Donor D
Donor E
Donor F
Donor G
Donor H
Donor I
Donor J
Donor K
C
Average ([WBC]1...6) – Average ([WBC]1...6) (× 10^6 cells/µL)
Cumulative Volume (µL)
D
Average ([WBC]1...6) – [WBC]venous (× 10^6 cells/µL)
Cumulative Volume (µL)

Table 2

WBC Concentration and Three-Part Differential Measured Using a Hematology Analyzer[a]

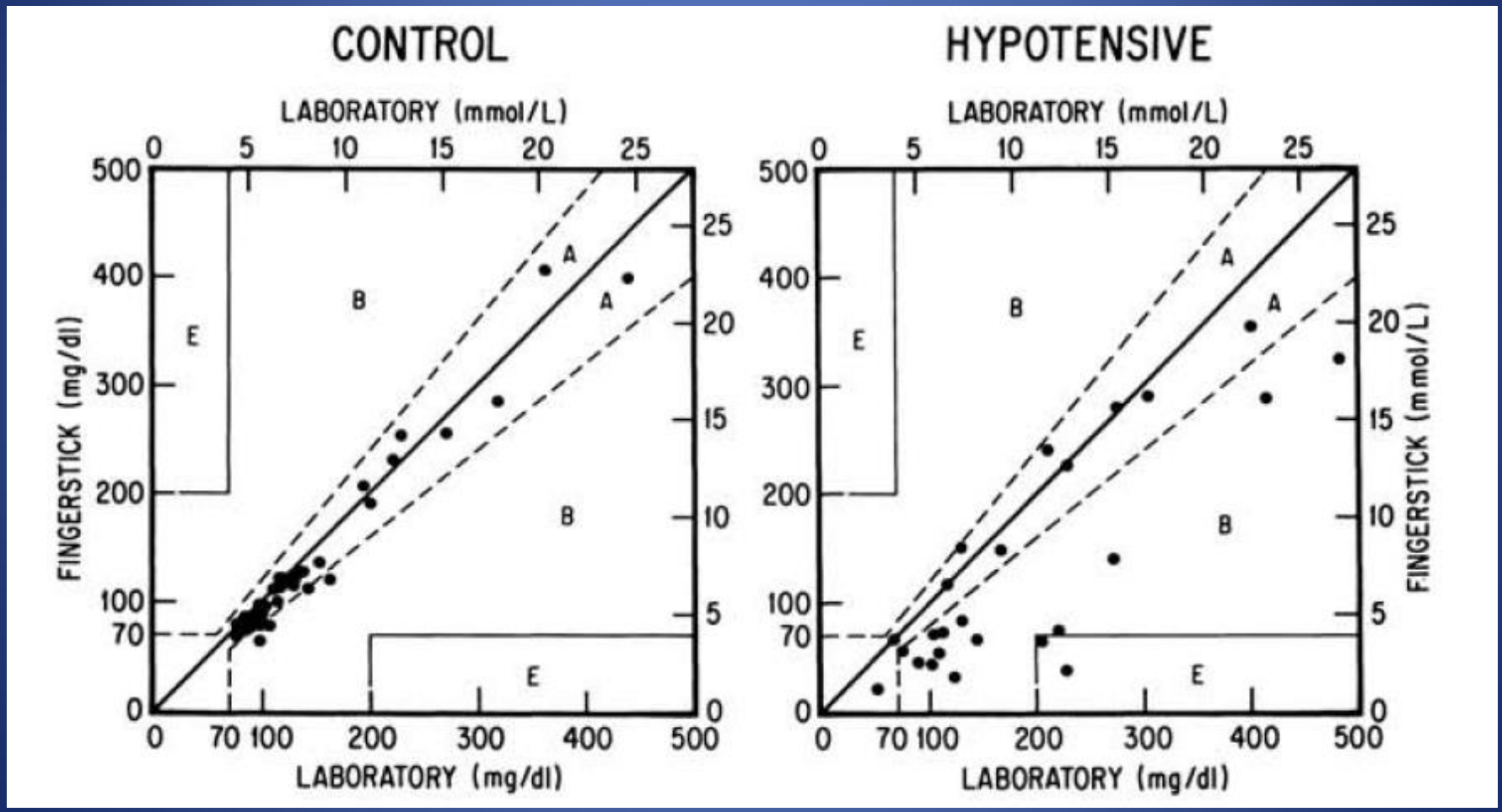
Characteristic	Successive 20-µL Drops of Venous Blood			Successive 20-µL Drops of Fingerprick Blood, Average
	Sample 1	Sample 2	Sample 3	
WBC concentration, $\times 10^6$ cells/µL				
Mean (SD)	6.8 (0.10)	6.5 (0.13)	4.8 (0.11)	0.60
%CV	1.5	2.1	2.2	8.6
Range	0.3	0.4	0.3	1.6
Lymphocyte count, $\times 10^6$ cells/µL				
Mean (SD)	1.7 (0.04)	1.5 (0.08)	1.2 (0.05)	0.18
%CV	2.4	5.1	4.3	7.2
Range	0.1	0.2	0.1	0.5
Granulocyte count, $\times 10^6$ cells/µL				
Mean (SD)	4.8 (0.06)	4.8 (0.15)	3.4 (0.08)	0.42
%CV	1.3	3.1	2.2	10
Range	0.2	0.4	0.2	1.1
Monocyte count, $\times 10^6$ cells/µL				
Mean (SD)	0.3 (0.05)	0.2 (0.05)	0.1 (0.05)	0.08
%CV	21.9	36.5	37.4	30
Range	0.1	0.1	0.1	0.2

CV, coefficient of variation.

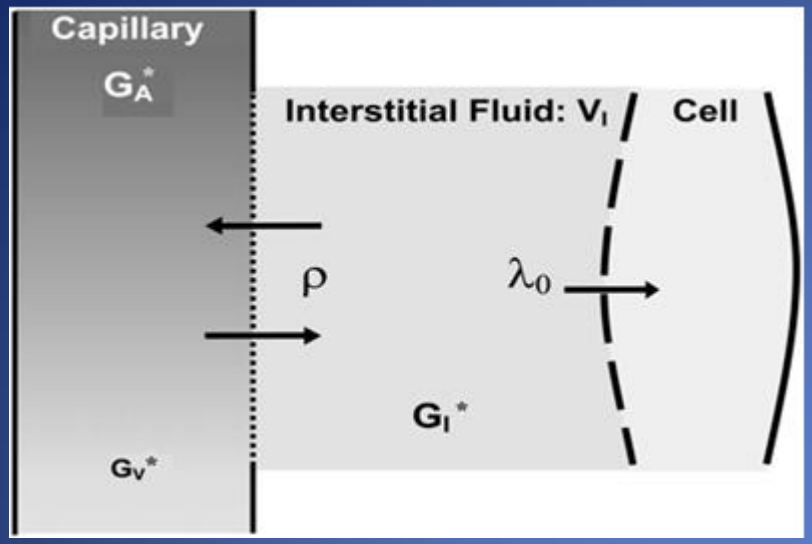
[a] The left side of the table shows the mean (SD), percent CV, and range (maximum – minimum value) of the samples depicted in Figure 2A (venous blood). The right side of the table shows statistics for samples shown in Figure 2B (fingerprick blood). For the fingerpricks, measures were calculated for six drops from one fingerprick of each donor, then averaged for all donors.

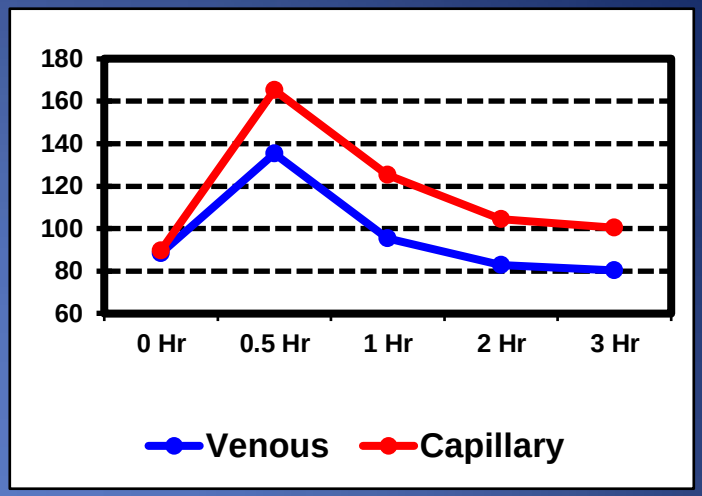
Fingerstick Glucose Determination in Shock

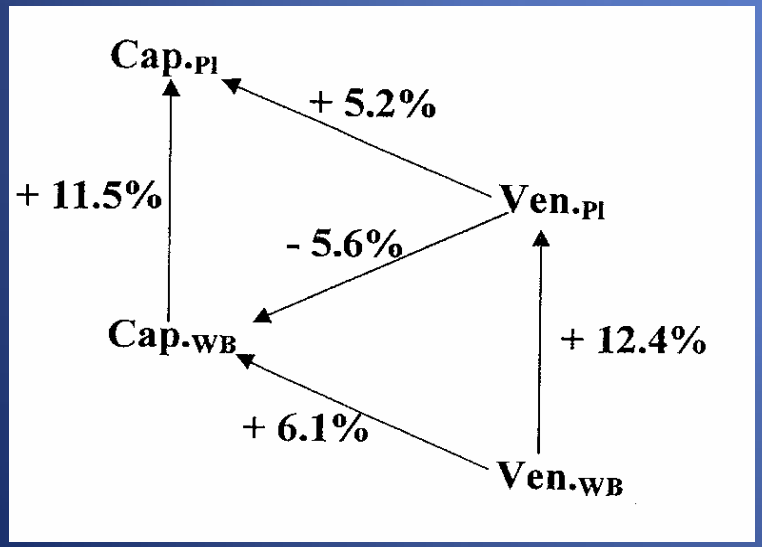
Suzanne H. Atkin, MD; Amita Dasmahapatra, MD; Michael A. Jaker, MD;
Mitchell I. Chorost, BS; and Suman Reddy, BS



Annals of Internal Medicine. 1991;114:1020-1024.







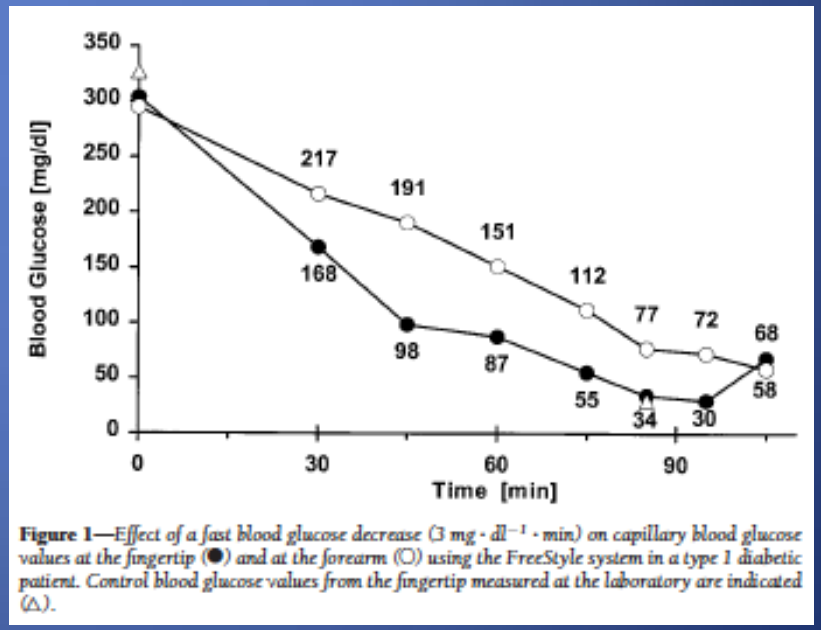


Figure 1—*Effect of a fast blood glucose decrease (3 mg · dl⁻¹ · min) on capillary blood glucose values at the fingertip (●) and at the forearm (○) using the FreeStyle system in a type 1 diabetic patient. Control blood glucose values from the fingertip measured at the laboratory are indicated (△).*

Davidson JK, Parker DR. Monitoring of blood and urine glucose and ketone levels. In Davidson JK, ed. *Clinical Diabetes Mellitus*

Regittnig W, et al. Am J Physiol Endocrinol Metab 2003 (285) E241.

Jungheim K, Koschinsky T. *Diabetes Care* 2001 (24) 1303.

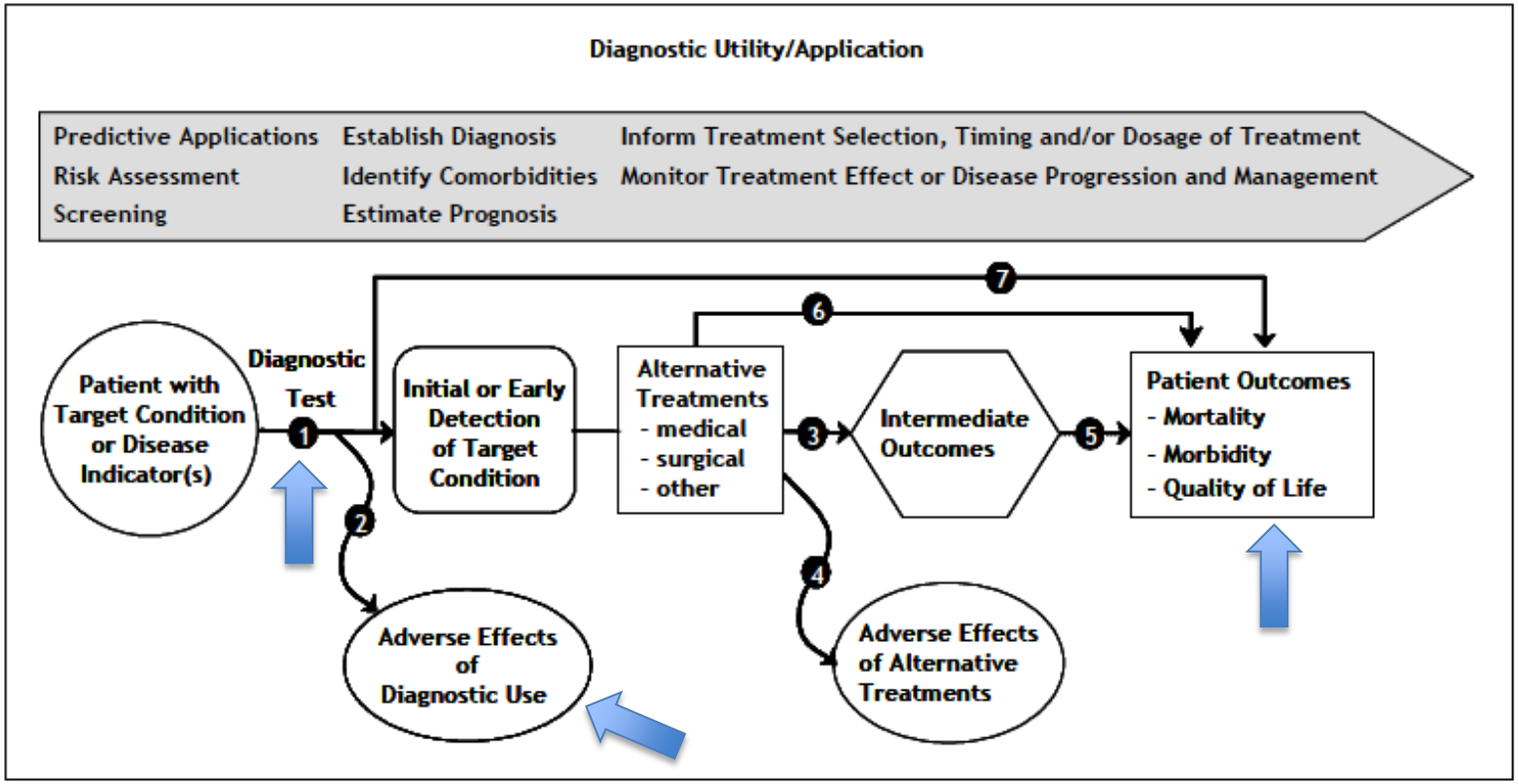
Clinical Utility

- POCT is not a “black box” fix; nor is it something to do just because it’s available
- Does the POCT request fix the problem?
  - Will the test allow rule-in or rule-out diagnosis?
  - Why does the central or critical care/satellite lab not meet the need?
  - Can therapy or consultation be initiated based on POCT result?

Clinical Utility

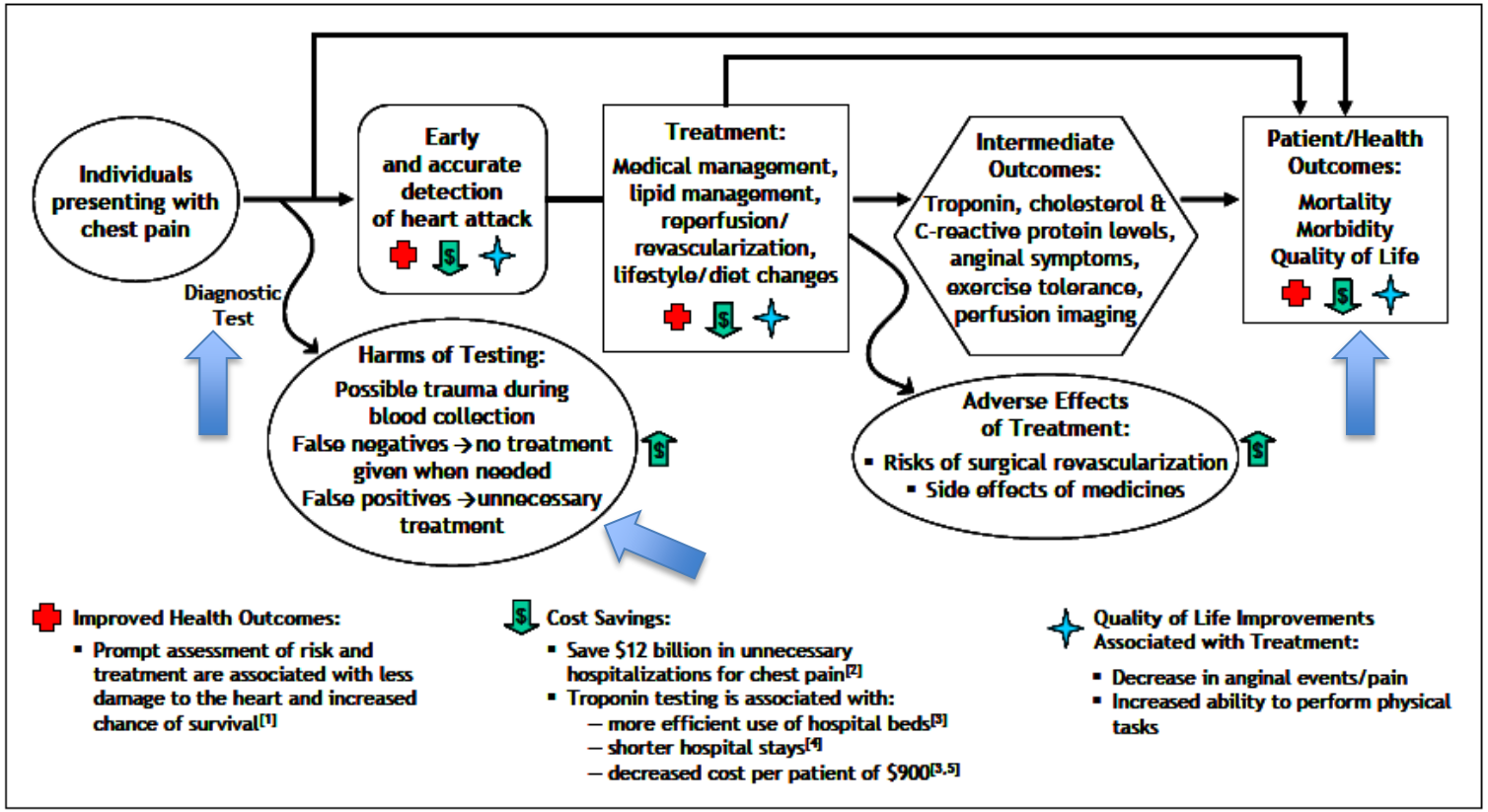
- Faster results does not guarantee improved clinical outcome
- To assess clinical utility, need to evaluate:
  - Reason for ordering test
  - How the result will be utilized for patient care
  - Is POCT method appropriate for patient needs in that particular setting?
- Communication with clinical staff is vital for determination of clinical utility and implementation

Figure 7.1
Sample Clinical Analytic Framework: From Diagnosis to Patient Outcomes



1. Is a particular diagnostic test accurate for the target condition?
2. Does diagnostic use result in adverse effects or harms?
3. Do treatments change intermediate health outcomes? (e.g., cholesterol levels, tumor size)
4. Do treatments/health interventions result in adverse effects?
5. Are changes in intermediate outcomes associated with changes in health outcomes?
6. Does treatment improve health outcomes?
7. Is there direct evidence that diagnostic use improves health outcomes?
Source: Adapted from Harris, Helfand, Woolf, et al. 2001.

Figure 7.8
Analytic Framework for Troponin Testing for Detection of AMI



Sources:

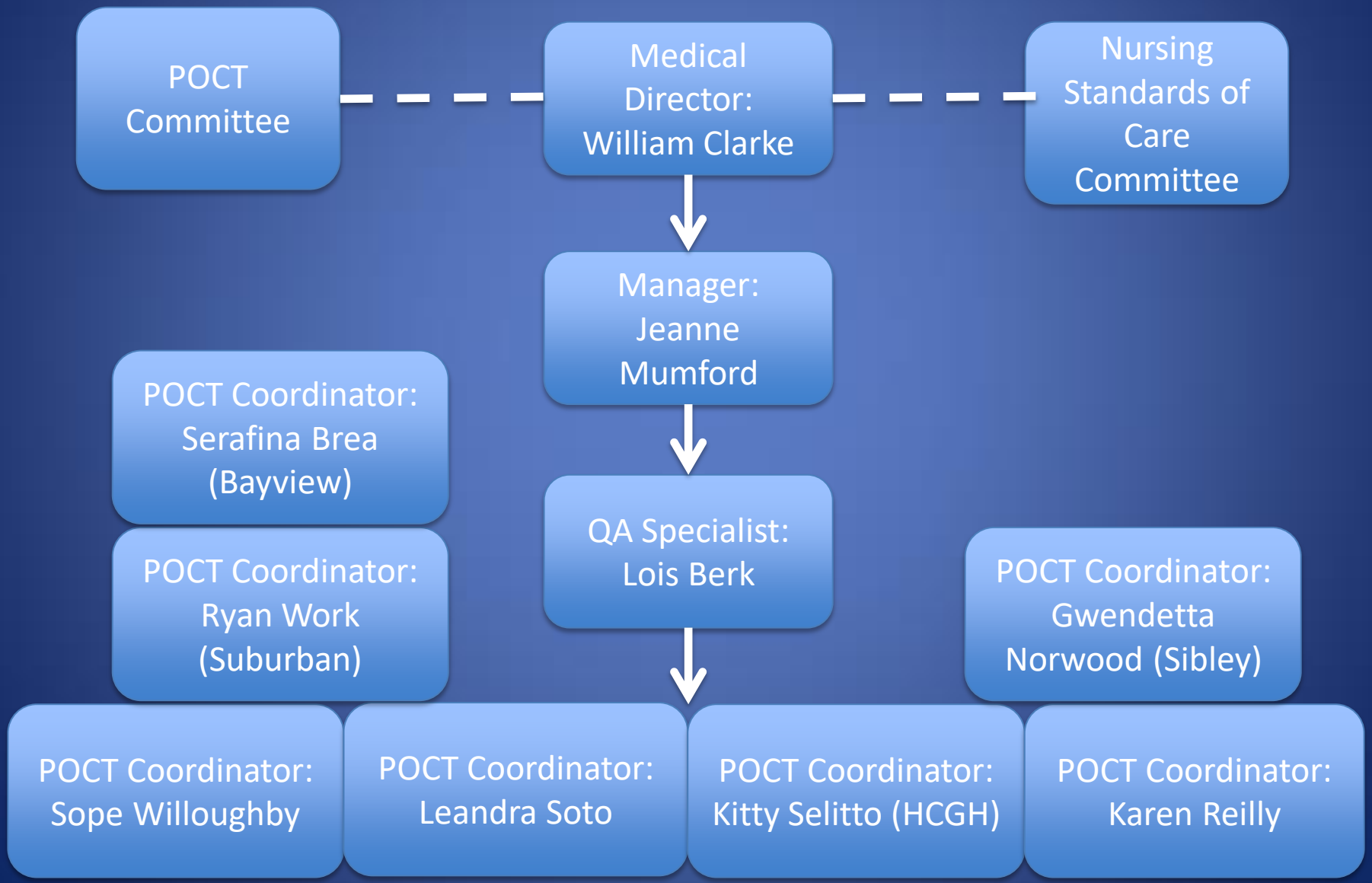
1. *Heart & stroke facts. Dallas, TX: American Heart Association, 2003.*
2. *DRG Handbook. Washington, DC: Academic Press, 1997.*
3. *Ng SM, Krishnaswamy P, Morissey R, et al. Ninety-minute accelerated critical pathway for chest pain evaluation. American Journal of Cardiology 2001;88(6):611-7.*
4. *Zarich S, Bradley K, Seymour J, et al. Impact of troponin T determinations on hospital resource utilization and costs in the evaluation of patients with suspected myocardial ischemia. American Journal of Cardiology 2001;88:732-6.*
5. *Cavanaugh N, Cassidy M. The effect of a change from conventional cardiac enzymes to troponin I on overall hospital costs in patients with suspected myocardial infarction. The Irish Journal of Medicine 2002; 95(1):16-7.*

MANAGING AN INCREASING VARIETY OF TESTS

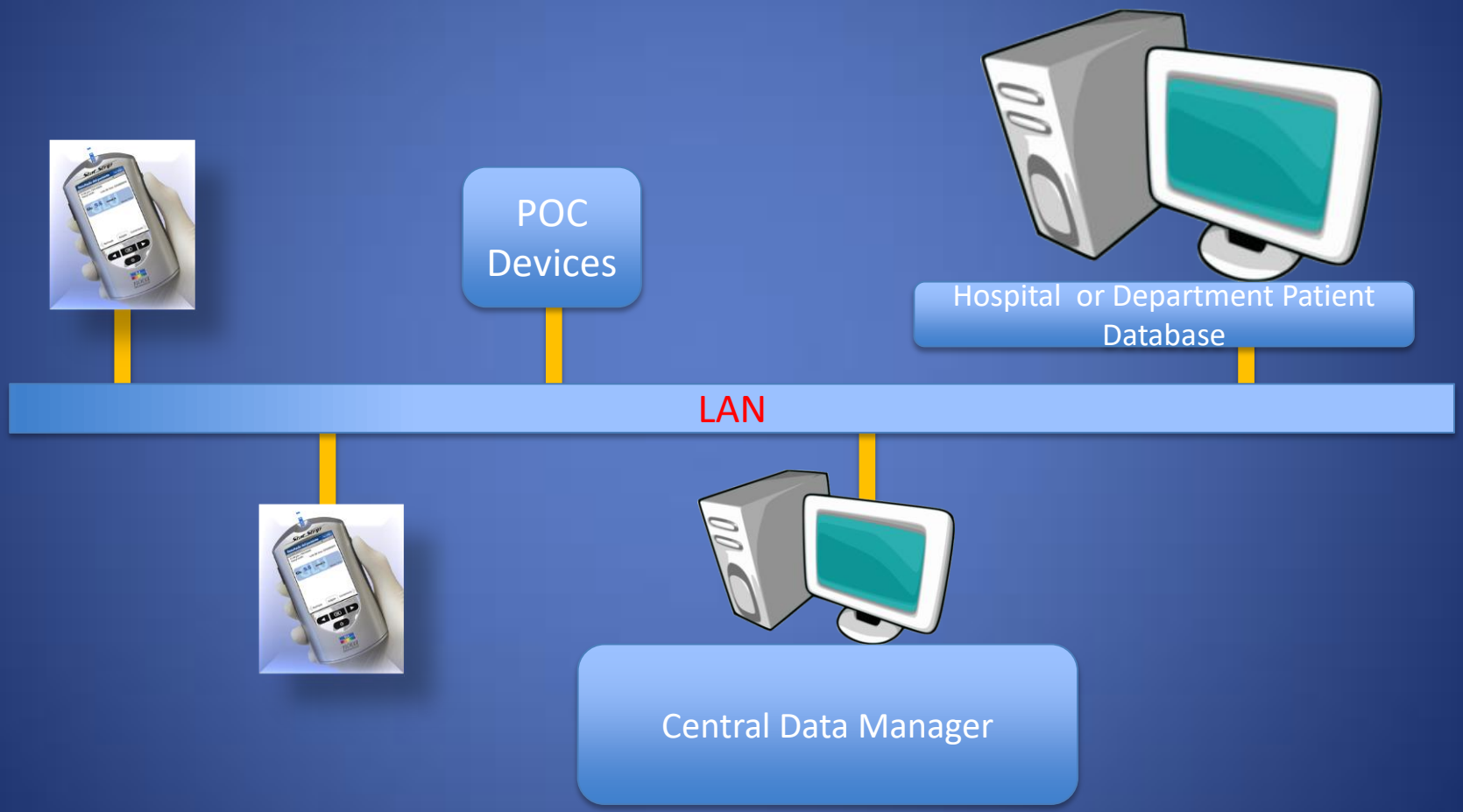
Joint Ownership of Program

- Important for each of the clinical testing sites to have active involvement in program management
  - Self-education and inspection (QA)
  - Take responsibility for ongoing training and education
- Schedule periodic joint leadership meetings
  - Allow communication of important points to users
  - Allow input from users for improved program efficiency

POCT Management at JHMI

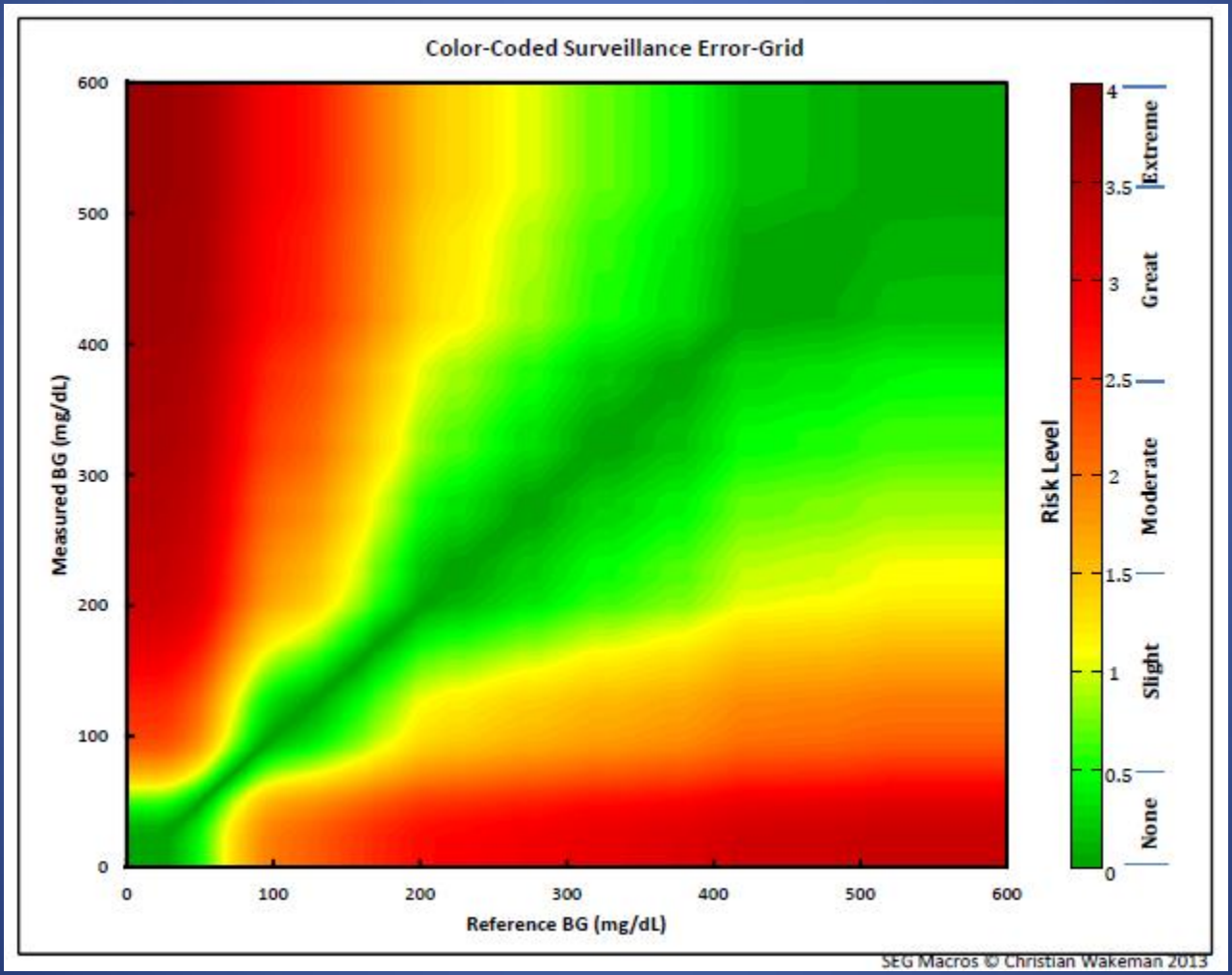


Connected POC Network



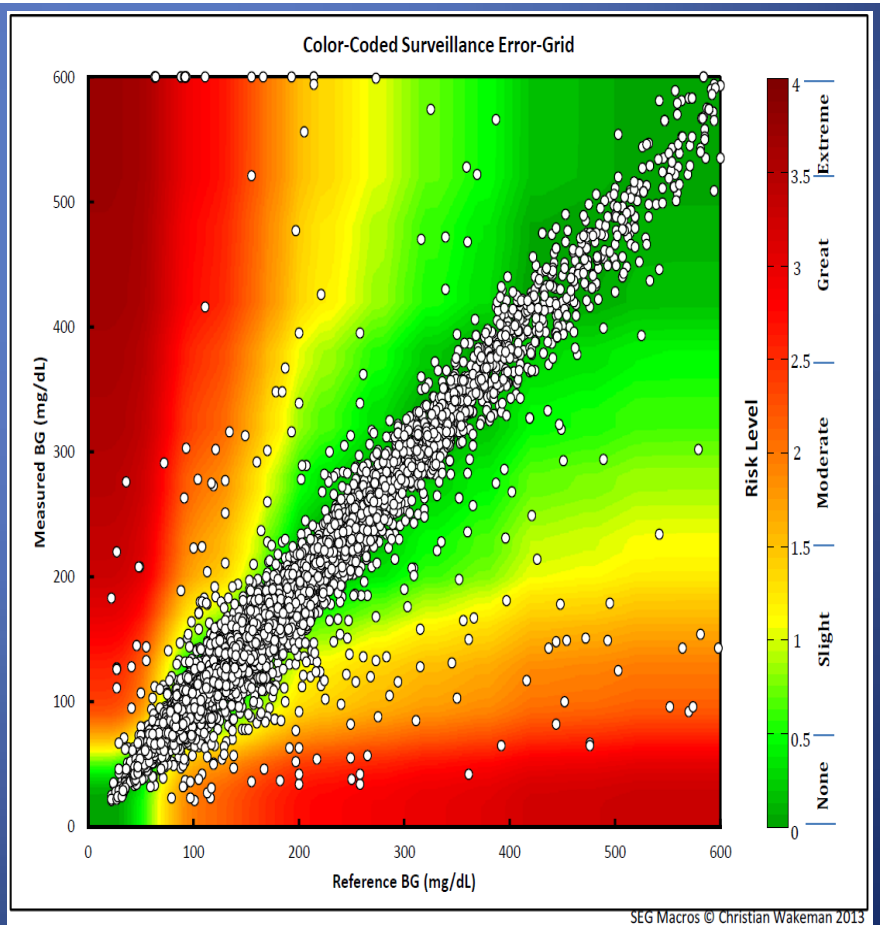
WHAT DO DATA-DRIVEN DECISIONS LOOK LIKE?

FDA Surveillance Grid



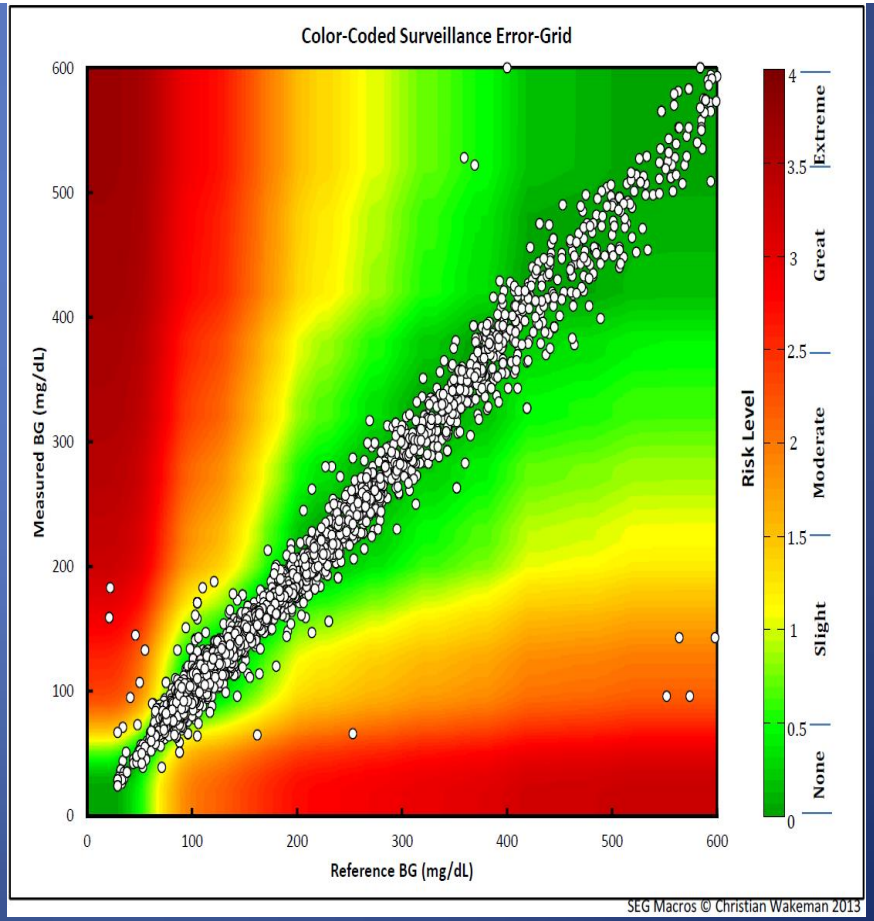
Hospital-Wide Analysis

Degree of Risk	Absolute Value	Color	# Hypo.	# Hyper.	# Total	Hypo. %	Hyper. %	Total %
None	0 - 0.5	D. Green	8173	13539	22730	33.81%	56.01%	94.03%
Slight, Lower	> 0.5 - 1.0	L. Green	509	611	1120	2.11%	2.53%	4.63%
Slight, Higher	> 1.0 - 1.5	Yellow	77	113	190	0.32%	0.47%	0.79%
Moderate, Lower	> 1.5 - 2.0	L. Orange	17	41	58	0.07%	0.17%	0.24%
Moderate, Higher	> 2.0 - 2.5	D. Orange	17	24	41	0.07%	0.10%	0.17%
Great, Lower	> 2.5 - 3.0	L. Red	17	9	26	0.07%	0.04%	0.11%
Great, Higher	> 3.0 - 3.5	D. Red	7	0	7	0.03%	0.00%	0.03%
Extreme	> 3.5	Brown	2	0	2	0.01%	0.00%	0.01%



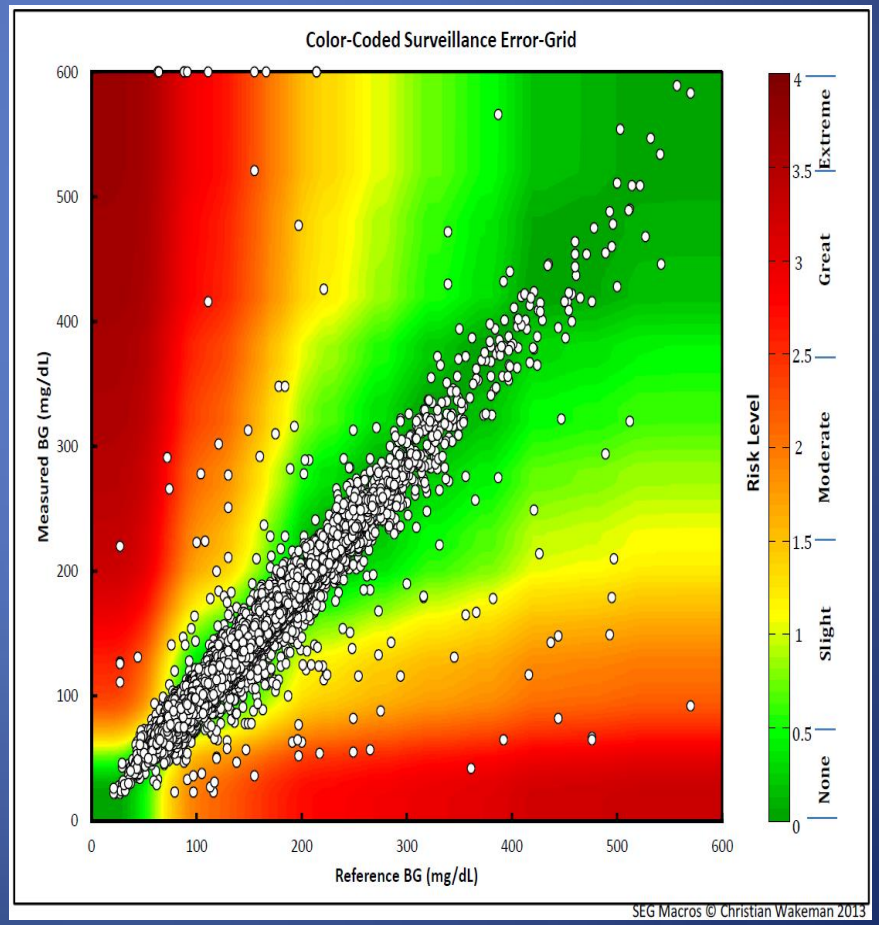
Adult and Pediatric Emergency Dept

Degree of Risk	Absolute Value	Color	# Hypo.	# Hyper.	# Total	Hypo. %	Hyper. %	Total %
None	0 - 0.5	D. Green	1782	2346	4324	39.66%	52.21%	96.24%
Slight, Lower	> 0.5 - 1.0	L. Green	72	59	131	1.60%	1.31%	2.92%
Slight, Higher	> 1.0 - 1.5	Yellow	12	12	24	0.27%	0.27%	0.53%
Moderate, Lower	> 1.5 - 2.0	L. Orange	2	3	5	0.04%	0.07%	0.11%
Moderate, Higher	> 2.0 - 2.5	D. Orange	3	3	6	0.07%	0.07%	0.13%
Great, Lower	> 2.5 - 3.0	L. Red	2	0	2	0.04%	0.00%	0.04%
Great, Higher	> 3.0 - 3.5	D. Red	1	0	1	0.02%	0.00%	0.02%
Extreme	> 3.5	Brown	0	0	0	0.00%	0.00%	0.00%



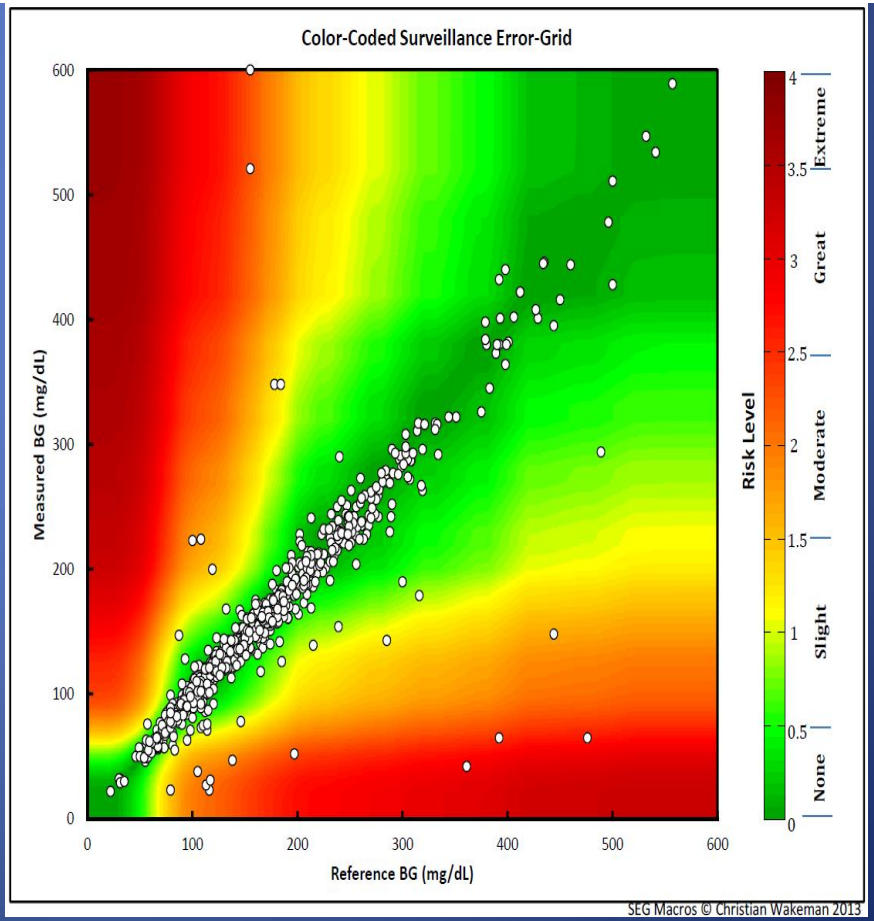
All JHH ICU's

Degree of Risk	Absolute Value	Color	# Hypo.	# Hyper.	# Total	Hypo. %	Hyper. %	Total %
None	0 - 0.5	D. Green	4044	7847	12496	30.35%	58.89%	93.78%
Slight, Lower	> 0.5 - 1.0	L. Green	292	378	670	2.19%	2.84%	5.03%
Slight, Higher	> 1.0 - 1.5	Yellow	33	57	90	0.25%	0.43%	0.68%
Moderate, Lower	> 1.5 - 2.0	L. Orange	8	21	29	0.06%	0.16%	0.22%
Moderate, Higher	> 2.0 - 2.5	D. Orange	7	14	21	0.05%	0.11%	0.16%
Great, Lower	> 2.5 - 3.0	L. Red	11	3	14	0.08%	0.02%	0.11%
Great, Higher	> 3.0 - 3.5	D. Red	3	0	3	0.02%	0.00%	0.02%
Extreme	> 3.5	Brown	2	0	2	0.02%	0.00%	0.02%



JHH MICU

Degree of Risk	Absolute Value	Color	# Hypo.	# Hyper.	# Total	Hypo. %	Hyper. %	Total %
None	0 - 0.5	D. Green	224	515	768	26.99%	62.05%	92.53%
Slight, Lower	> 0.5 - 1.0	L. Green	9	28	37	1.08%	3.37%	4.46%
Slight, Higher	> 1.0 - 1.5	Yellow	3	8	11	0.36%	0.96%	1.33%
Moderate, Lower	> 1.5 - 2.0	L. Orange	2	2	4	0.24%	0.24%	0.48%
Moderate, Higher	> 2.0 - 2.5	D. Orange	2	6	8	0.24%	0.72%	0.96%
Great, Lower	> 2.5 - 3.0	L. Red	0	2	2	0.00%	0.24%	0.24%
Great, Higher	> 3.0 - 3.5	D. Red	0	0	0	0.00%	0.00%	0.00%
Extreme	> 3.5	Brown	0	0	0	0.00%	0.00%	0.00%



Closing Thoughts

- POCT has the potential to dramatically impact the delivery of healthcare – particularly outside of the hospital
- Emerging technologies may significant increase the variety of testing platforms requested for POCT
- With new technologies, there are many considerations for successful implementation
- With increasing POCT, a thoughtful and efficient plan for management is crucial to a successful POCT program

QUESTIONS??

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