DISASTER POINT OF CARE TESTING: FUNDAMENTAL CONCEPTS TO ENHANCE CRISIS STANDARDS OF CARE

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[Disclaimer: Device use must adhere to federal, national, and state regulations within the context of appropriate accreditation. Illustration of devices, including suggestions for disaster caches, does not imply endorsement. Research results may be preliminary. Final conclusions may differ. Please consult published papers.]

Please visit our YouTube site at http://www.youtube.com/POCTCTR

http://www.ucdmc.ucdavis.edu/pathology/poctcenter/

Point-of-Care Testing Center for Teaching and Research

POCT•CTR

Founded in 1995

LEARNING OBJECTIVES

- **To understand the role of needs assessment in formulating point-of-care (POC) resources for complex emergencies and disasters.**
- **To become familiar with environmental factors that can affect diagnostic testing performance.**
- **To prepare the POC Coordinator for crisis leadership in small-world networks.**
- **To gain knowledge that will enhance crisis standards of care, prepare the audience to comment on new guidelines, and help adapt them to local, national, and global needs.**
- **To learn about POC disaster caches and interactively design contents, plan use, and deploy successfully.**

THE GLOBAL VISION

"Point-of-care testing will improve crisis standards of care,* disaster preparedness, and at the same time, healthcare in small-world networks."

*The fundamental concept of the standard of care is based on the US case, *Vaughan v Menlove* (1837), wherein the judge instructed the jury to reason whether the defendant "proceed[ed] with such reasonable caution as a prudent man would have exercised under such circumstances."

Reference: Kost GJ, Sakaguchi A, Curtis CM, Tran NK, Katip P, Louie RF. Enhancing crisis standards of care using innovative point-of-care testing. *Am J Disaster Med*. 2011;6:351-368.

Kost GJ, Curtis CM, Ferguson WJ, Louie RF, Tang CS, Vy JH, Tran NK, Katip P. The role of point-of-care testing in complex emergency and disaster resiliency. In: Raskovic, B. & Mrdja, S., Eds. *Natural Disasters: Prevention, Risk Factors and Management*. Hauppauge, NY: NOVA Science Publishers. 2013. pp. 73-110.

Point-of-Care Testing (POCT)

- **Definition**

  POCT is medical testing at or near the site of care.

- **Fundamental Goals**

Significance	**Identify critical diagnoses, screen quickly**
Evidence	**Produce test results for decision-making**
Speed	**Accelerate triage and treatment**
Approach	**Enhance response using new technologies**
Impact	**Improve medical and economic outcomes**

Resources

1. G. Kost, Ed. *Principles and Practice of Point-of-Care Testing*. Lippincott Williams & Wilkins, 2002, 654 pp.
2. K. Hale…G. Kost. "Point-of-care testing for disaster and pandemic preparedness." In: *Point-of-Care Testing: Needs, Opportunity, and innovation*. AACC Press, 2010, 3rd edition, chapter 27, pp. 355-371.
3. *Point of Care*—the primary journal in the field, 11th year of production.

PRINCIPLES: 3 FUNDAMENTALS—SOLUTION, BALANCE, EFFICIENCY

- ***Solution:*** ***Past disasters demonstrate the role and feasibility of using POC testing.***

- ***Balance:*** ***Needs assessment guides POC invention, innovation, and technology development.***

- ***Efficiency:*** ***POC test clusters allow "mission matching"—one can select instruments and tests for triage, diagnosis, treatment, and/or monitoring.***

PRINCIPLES: 3 LEVELS—EVIDENCE, INTEGRATION, SYNTHESIS

- ***Evidence:*** ***POC technologies enable evidence-based decision-making at the point of need.***

- ***Integration:*** ***Strategic planning optimizes small-world networks where healthcare teams and patients become experienced with POC testing through education, training, and everyday use.***

- ***Synthesis:*** ***Value propositions generate tactics for placing POC testing appropriately in physical, demographic, and geographic settings, and for designing disaster caches (e.g., USA).***

PRINCIPLE #1

Past disasters demonstrate the role <u>and</u> feasibility of using POC testing.

Examples—

- Hurricane Katrina in New Orleans, 2005
- Bangkok Flood, 2011
- Hurricane Sandy in New York, 2012

Use of POC Testing in Hurricane Katrina

US Army 14th Combat Support Hospital

Ortho-Diagnostics Blood Typing: ABO Blood Group

US Navy

Cardiac STATus: cTnI, CK-MB, Myoglobin

US Army 14th Combat Support Hospital

Rapidpoint Coag: PT, aPTT, Heparin Management Test

US Military, Local Surveyed Hospital

i-STAT: ACT, PT/INR, glucose, creatinine, cTnI, Na^+, K^+, Cl^-, Ca^{++}, pH, pCO_2, pO_2, SO_2, Hct, Hb, BUN, CK-MB, BNP

Hospitals, Evacuation Sites

Capillary Blood Glucose Meters

US Army, Navy, Marine Corps

Piccolo: Albumin, ALP, ALT, amylase, AST, BUN, creatinine, Ca, Cl , K , Na , Mg, LD, HDL, cholesterol, triglycerides, CK, glucose, TP, phosphorous, total bilirubin, direct bilirubin, TCO_2, GGT, uric acid

Donation to Local Red Cross

45,000 Blood Glucose Meters

US Air Force

Triage

Cardiac Panel: cTnI, CK-MB, myoglobin

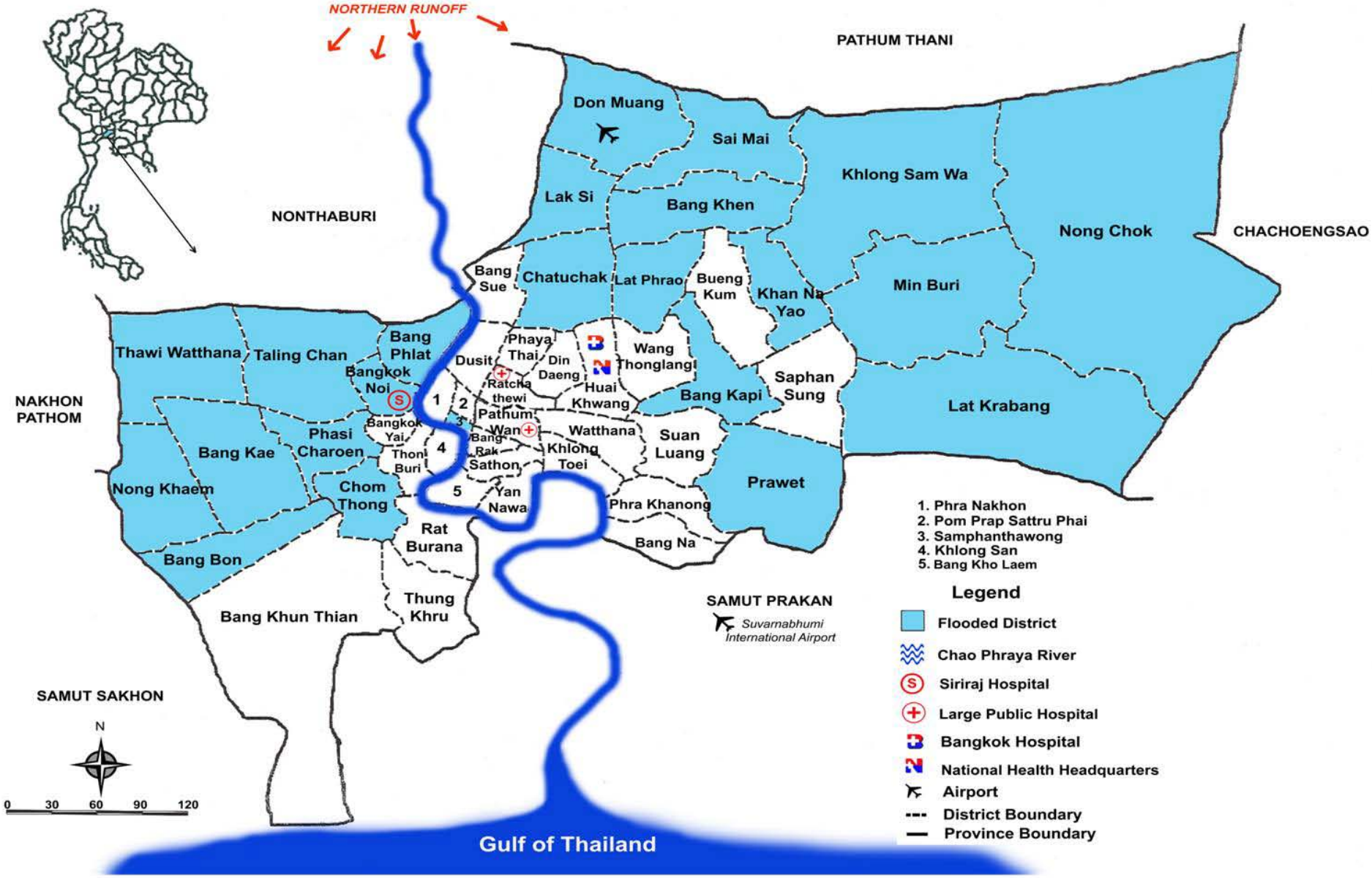
Drugs of Abuse: Amphetamines, Methamphetamines

Kost GJ, Tran NK, Tuntideelert M, et al. Katrina, the tsunami, and point-of-care testing: Optimizing rapid response diagnosis in disasters. *American Journal of Clinical Pathology.* 2006;126:513-520.

Shelters: Acute Monitoring, Chronic Diseases, and Public Health

Diagnostic Testing Strategies for Health Care Delivery During the Great Bangkok Flood and Other Weather Disasters

Gerald J. Kost, MD, PhD, MS, FACB,† Pratheep Katip, MT,‡ and Chuchart Vinitwatanakhun, MD§*



Destruction by Hurricane Sandy

NEWDEMICS: The Future is now!

- **Definition: *"Unexpected and disruptive problems that affect the health of large numbers of individuals in a crowded world."* [1]**

- **World population is 7 billion, 7 million children who did not exist found in China (parents hide children), humans reproduce at a rate of 25,000 every 10 seconds, first UN count started with 2.5 billion in 1950, & expect 9 billion in 2050, slowing to 10 billion by 2100.[2]**

- **Flood perils and tests: contamination (*Leptospirosis*, fungi), bites (centipedes, reptiles, crocodiles), infections (Hepatitis A, *E. Coli*, *Staphylococcus* endotoxin, enteroviruses, typhoid fever, cholera, poliomyelitis, malaria, Dengue fever), and stress (e.g., chest pain in ERs in Queensland, Australia--R/O AMI).[3]**

References

1. Kost GJ. Newdemics, public health, small-world networks, and point-of-care testing. *Point of Care*. 2006;5:138Y144.
2. Washington Post, October 2011.
3. Lalande G. The Perils in the Water. *The Nation (Bangkok)*. 2011(October 27);36 (53119):14.

PRINCIPLE #2

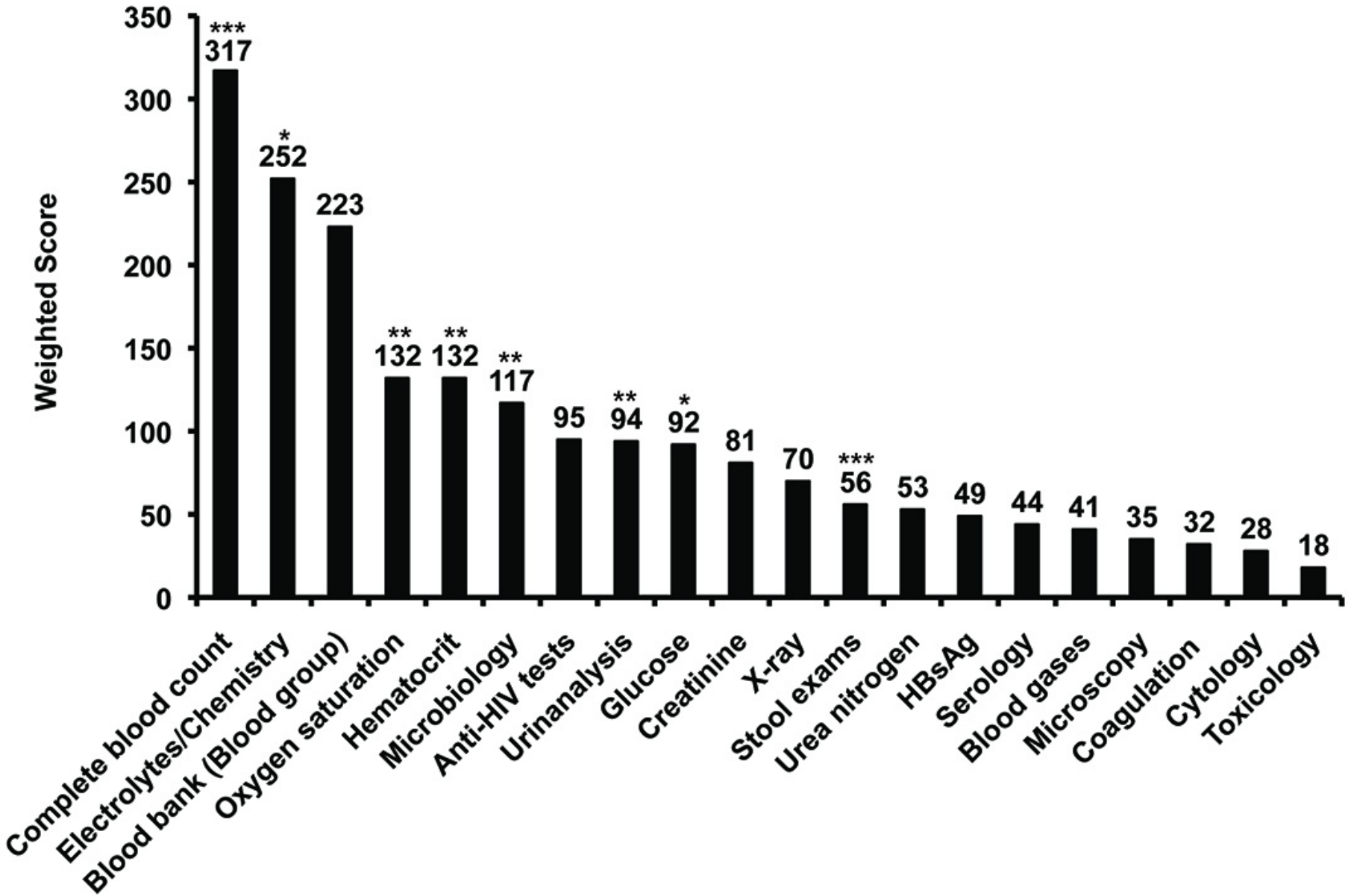
***Needs assessment guides POC invention, innovation, and technology development*… …but as Henry Ford said, "If I had asked people what they wanted, they would have said a faster horse!"**

References
Quote:
Sinek, S. *Start with Why: How Great Leaders Inspire Everyone to Take Action*. Portfolio, NY; 2009.

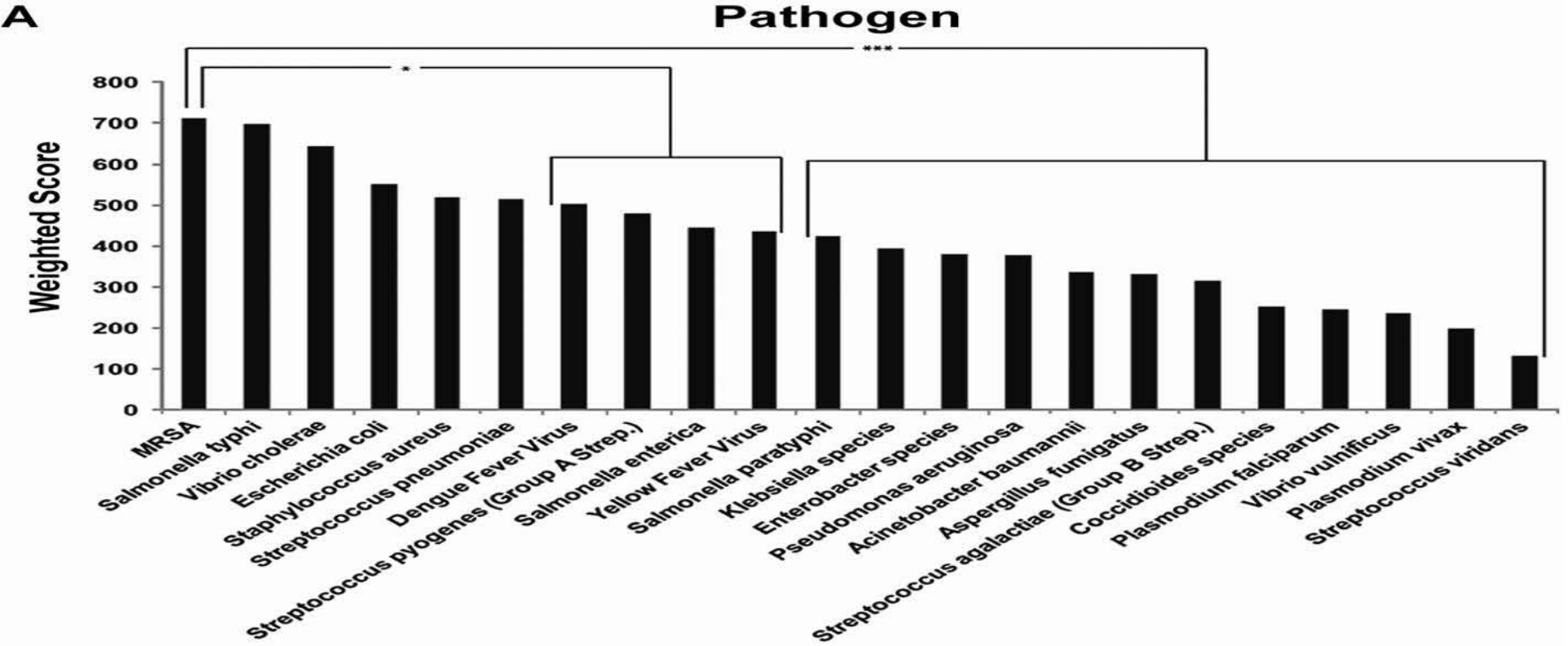
Needs Assessment Survey Knowledge Base

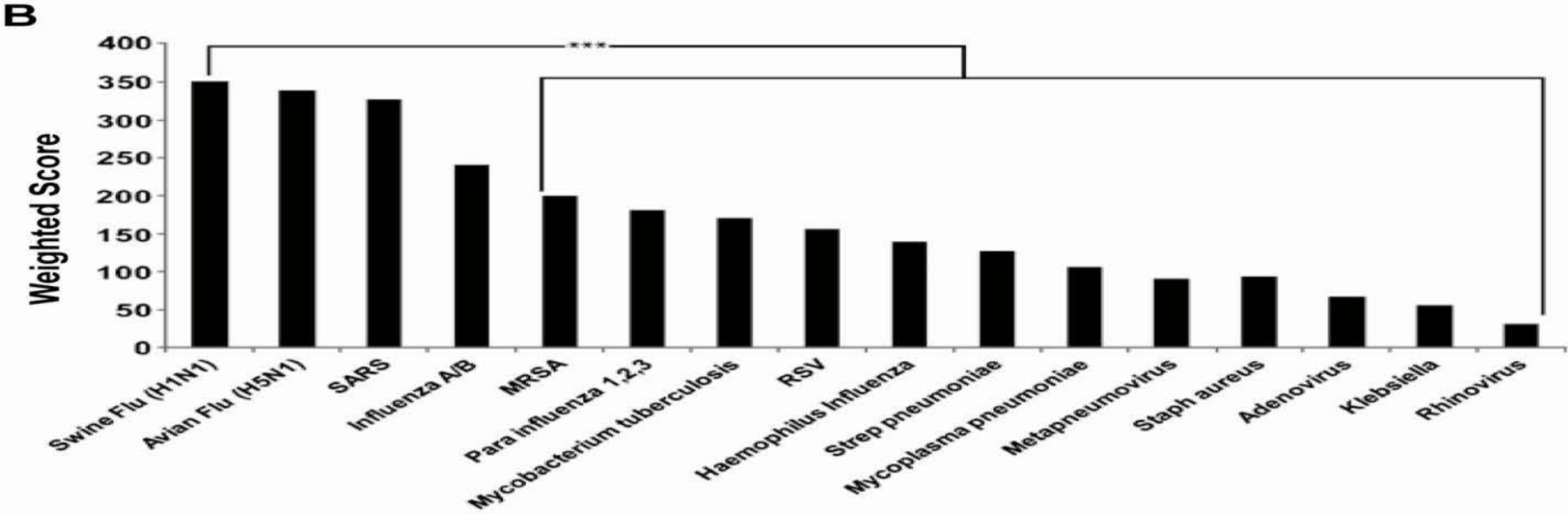
- Respondents preferred disaster-ready POC devices that sample blood directly into a test cassette, which stores all biohazard material for easy disposal.
- When asked to explain, they said minimize contamination when performing infectious disease testing outside of the laboratory.
- Respondents also wanted to draw a single sample and have multiple testing options to fully evaluate each patient.
- They wanted fast results, battery operation, handheld devices, and high sensitivity testing that they could perform themselves.

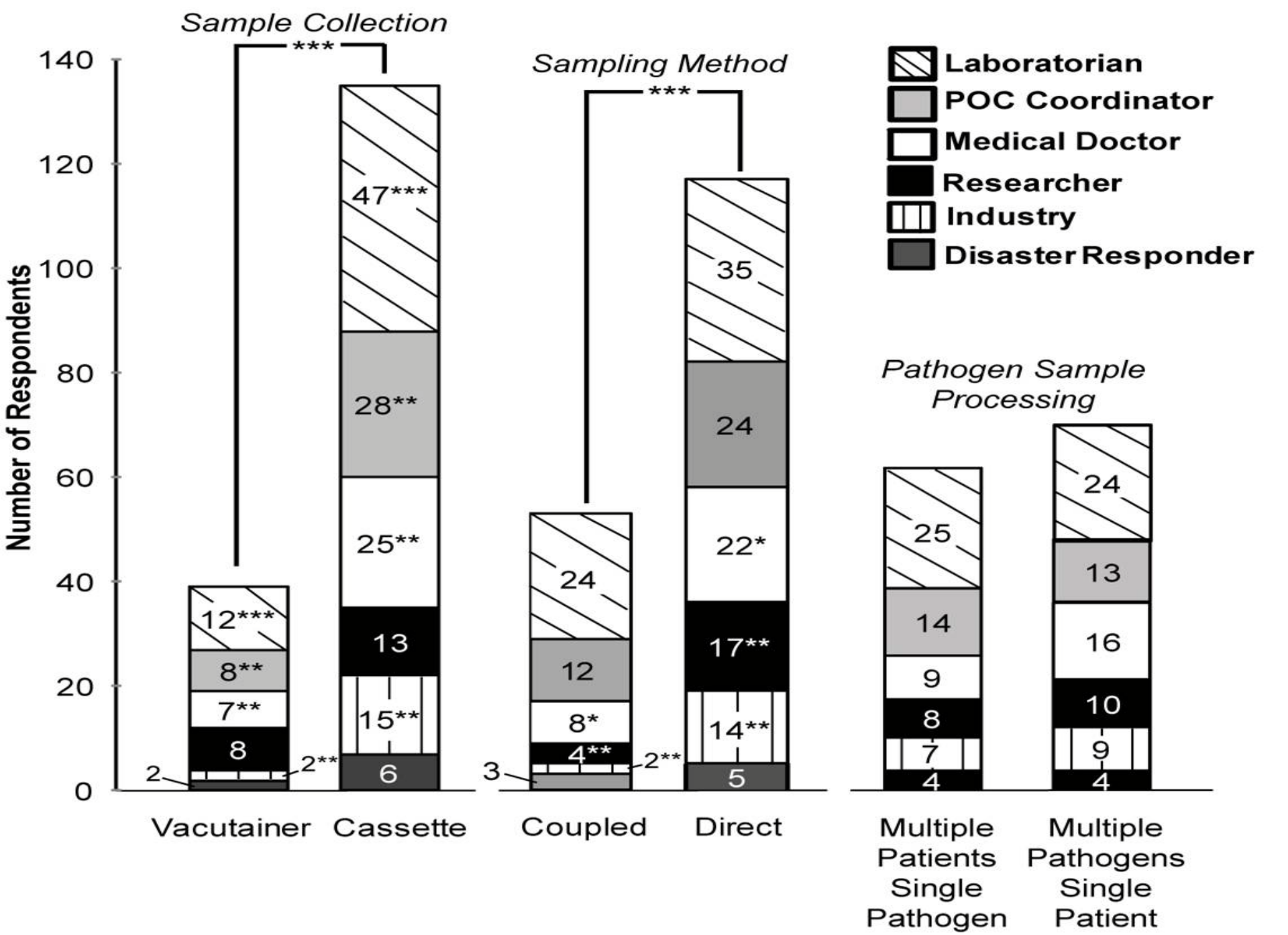
Reference #4. Kost GJ et al. *Point of Care.* 2012;11: in Press.

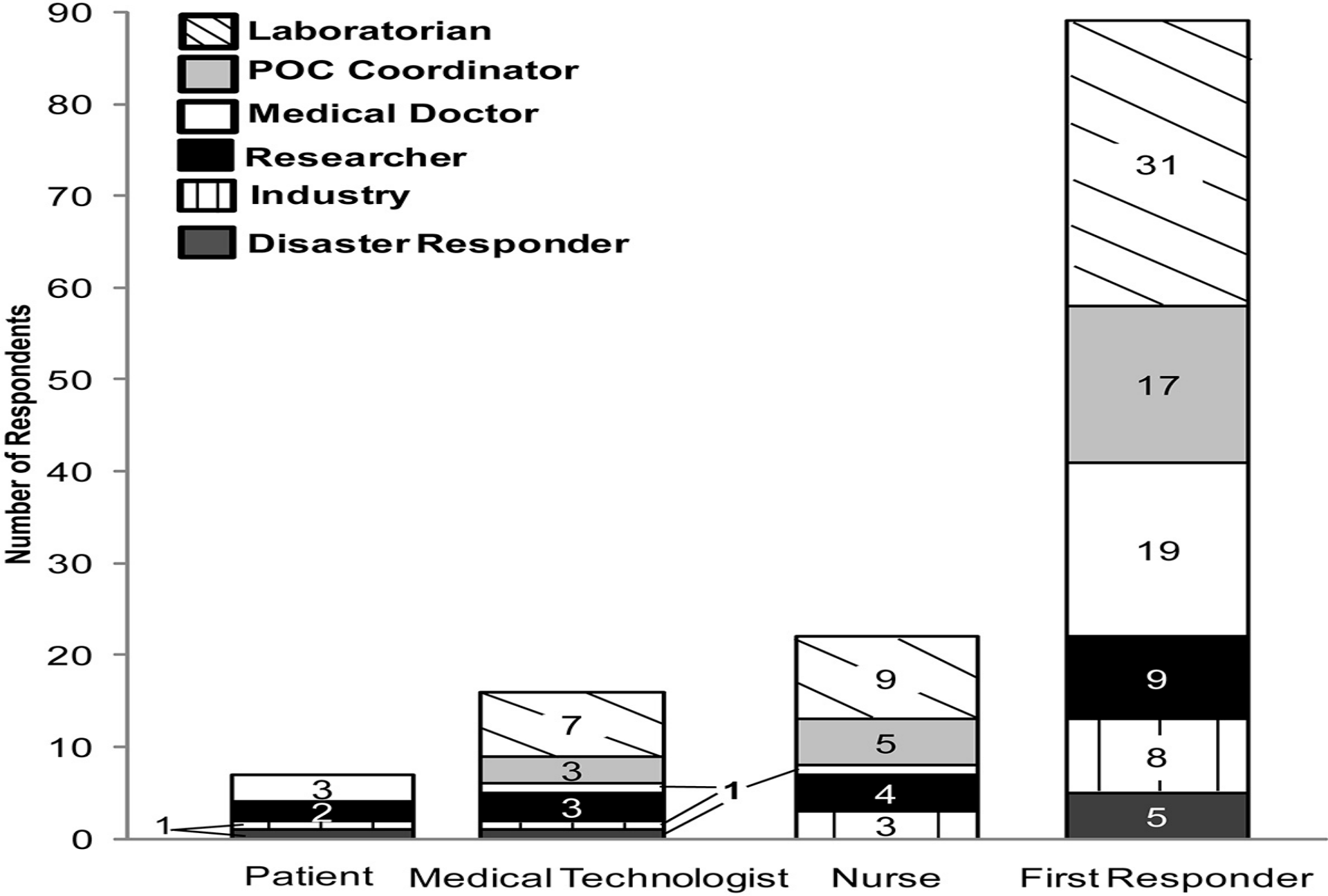


Kost GJ, Katip P, Curtis CM. Strategic point-of-care requirements of hospitals and public health for preparedness in regions at risk. *Point Care*. 2012;11:114-118.


A
Pathogen
***
*
Weighted Score
800
700
600
500
400
300
200
100
0
MRSA
Salmonella typhi
Vibrio cholerae
Escherichia coli
Staphylococcus aureus
Streptococcus pneumoniae
Dengue Fever Virus
Streptococcus pyogenes (Group A Strep.)
Salmonella enterica
Yellow Fever Virus
Salmonella paratyphi
Klebsiella species
Enterobacter species
Pseudomonas aeruginosa
Acinetobacter baumannii
Aspergillus fumigatus
Streptococcus agalactiae (Group B Strep.)
Coccidioides species
Plasmodium falciparum
Vibrio vulnificus
Plasmodium vivax
Streptococcus viridans


B
***
Weighted Score
400
350
300
250
200
150
100
50
0
Swine Flu (H1N1)
Avian Flu (H5N1)
SARS
Influenza A/B
MRSA
Para influenza 1,2,3
Mycobacterium tuberculosis
RSV
Haemophilus Influenza
Strep pneumoniae
Mycoplasma pneumoniae
Metapneumovirus
Staph aureus
Adenovirus
Klebsiella
Rhinovirus


Sample Collection
***
Sampling Method
***
Laboratorian
POC Coordinator
Medical Doctor
Researcher
Industry
Disaster Responder
Number of Respondents
140
120
100
80
60
40
20
0
12***
8**
7**
8
2
2**
47***
28**
25**
13
15**
6
24
12
8*
4**
3
2**
35
24
22*
17**
14**
5
Pathogen Sample Processing
25
14
9
8
7
4
24
13
16
10
9
4
Vacutainer
Cassette
Coupled
Direct
Multiple Patients Single Pathogen
Multiple Pathogens Single Patient



Kost GJ, Mecozzi DM, Brock TK, Curtis CM. Assessing point-of-care device specifications and needs for pathogen detection in emergencies and disasters. *Point Care*. 2012;11:119-125.

PRINCIPLE #3

<u>POC test clusters</u> allow "mission matching"—one can select instruments and tests for triage, diagnosis, treatment, and/or monitoring…but devices and reagents must be operated within environmental tolerances and legal constraints specified by the manufacturer.

Crisis Care Profile

Function/Target	Point of Care Pivot(s) or Rationale
Energy	Glucose, β-hydroxybutyrate Hemoglobin pO_2, O_2 saturation
Conduction	Potassium Sodium Ionized calcium (free calcium, Ca^{2+}), ionized magnesium (Mg^{2+})
Contraction	Ionized calcium, ionized magnesium
Perfusion	Lactate
Acid-Base	pH CO_2 content (TCO_2), pCO_2 End-tidal CO_2 tension Bicarbonate (calculated HCO_3^-)*
Osmolality	Measured osmolality Calculated osmolality

Crisis Care Profile

Function/ Target	Point of Care Pivot(s) or Rationale
Hemostasis	Hematocrit, hemoglobin Prothrombin time (PT), international normalized ratio (INR) Activated partial thromboplastin time (aPTT) Activated clotting time (ACT) D-dimer Platelet count and function (thromboelastogram)
Homeostasis	Creatinine, urea nitrogen B-type natriuretic peptide (BNP) Chloride, inorganic phosphate White blood cell count, hemoglobin E, fragility (thalasemia) Co-oximetry variables
Biomarker	Cardiovascular risk (cholesterol, HDL, LDL, tryglycerides; CRP, hs-CRP) Bone formation (bone-specific Alk Phos)* and resorption (NTx)* Cancer (prostate-specific antigen, urine NMP22– bladder cancer) Cardiac injury (troponin I/T, myglobin, CK-MB mass/isoforms) Endocrine (intraoperative parathyroid hormone) Trauma (S100 [brain injury marker])
Sepsis	Lactate, procalcitonin*, C-reactive protein*

Crisis Care Profile

Function/ Target	Point of Care Pivot(s) or Rationale
Birthing	Prenatal testing (glucose, urine protein, sexually transmitted diseases) Antenatal screening (genetic disorders) Delivery monitoring (fetal heart rate, group B *Streptococcus*) and transcutaneous neonatal bilirubin, pO_2, and pCO_2
Women's Health	Fertility (FSH) Pregnancy (β-hCG) Bone resorption (NTx)* Human papillomavirus* Cervical cancer*
Emergency Blood Donor Screening	HIV-1/2, Hepatitis B, and Hepatitis C
Transfusion	ABO blood typing, Rh class
Infectious Disease	HIV-1/2, H. pylori, Vibrio cholerae, leptospirosis, Dengue, *others*—rapid Dx-Rx with multiplex assays Primary care, public health, surveillance—prevention and control
Influenza Pandemic	Influenza A, influenza B, and subtypes (H1N1, 2009 H1N1, H3, H5N1) Drug resistance (oseltamivir, zanamivir, amantadine, rimantadine)

Crisis Care Profile

Function/ Target	Point of Care Pivot(s) or Rationale
Epidemic	Cholera (stool test, rectal swab) Tuberculosis (PPD skin test) Avian influenza* (FDA emergency use authorization, EUA)
Newdemic	Diabetes: glucose, hemoglobin A1c, estimated average glucose (eAG), urine albumin to creatinine ratio (ACR), fructosamine*
Biothreat	Anthrax, botulism, plague, tularemia, Ebola, West Nile

An asterisk ("*") indicates that a POC test is needed or in development.
CLIA-waived test are indicated by the green lettering.

Kost GJ, Curtis C, Louie R, Sakaguchi A. Disaster point-of-care testing: Fundamental concepts and new technologies. In: Arora, R. and P. Arora, Eds. Disaster Management: Medical Preparedness, Response, and Homeland Security. Wallingford, England: CABI International. 2013. [In Press]

Point-of-Care Device Requirements for Simplicity

Knowledge

Minimal scientific and technical knowledge is required to perform the test; and Knowledge required to perform the test may be obtained through on-the-job instruction.

Training and Experience

Minimal training is required for preanalytic, analytic and post-analytic phases of the testing process; and Limited experience is required to perform the test.

Reagents and Materials Preparation

Reagents and materials are generally stable and reliable; and Reagents and materials are prepackaged, or premeasured, or require no special handling, precautions or storage conditions

Characteristics of Operational Steps

Operational steps are either automatically executed (such as pipetting, temperature monitoring, or timing of steps), or are easily controlled

Calibration, Quality Control, and Proficiency Testing Materials

Calibration materials are stable and readily available; Quality control materials are stable and readily available; and External proficiency testing materials, when available, are stable

Test System Troubleshooting and Equipment Maintenance

Test system troubleshooting is automatic or self-correcting, or clearly described or requires minimal judgment; and Equipment maintenance is provided by the manufacturer, is seldom needed, or can easily be performed

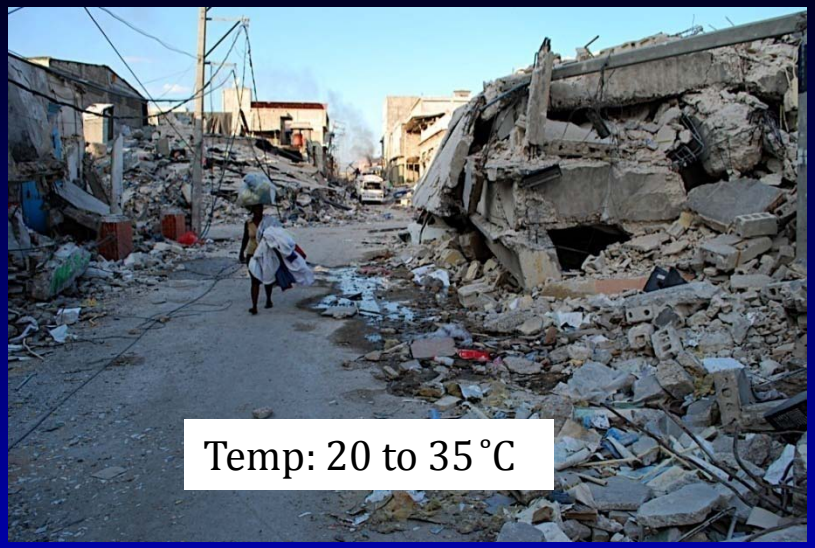
Interpretation and Judgment

Minimal interpretation and judgment are required to perform preanalytic, analytic and postanalytic processes; and Resolution of problems requires limited independent interpretation and judgment

Curtis CM, Kost GJ, Louie RF, Sonu RJ, Ammirati EB, Sumner SL. Point-of-care hematology and coagulation testing in primary, rural emergency, and disaster care scenarios. *Point Care*. 2012;11:140-145.

Temperature Extremes in Disasters

Hurricane Katrina[1], 2005



Haiti Earthquake[2], 2010

Japan Earthquake[3], 2011

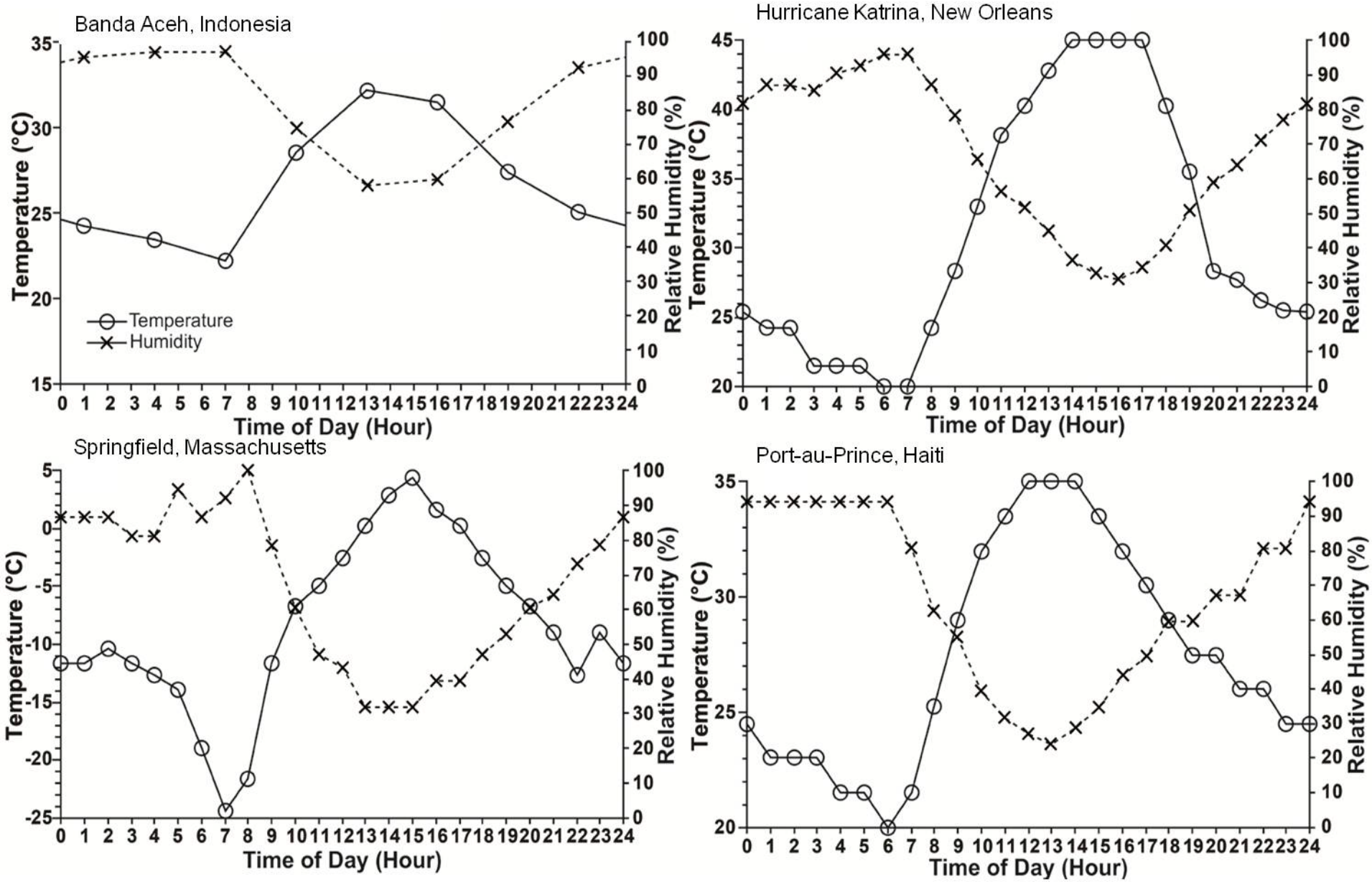
[1] http://www.gpoaccess.gov/serialset/creports/pdf/sr109-322/ch2.pdf
[2] Cavallo EA, et al. Inter-American Development Bank. 2010
[3] http://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf

Point-of-need Challenges

- During Hurricane Katrina new shipments of POCT failed after one week of use. (43.3ºC)
- In Springfield, Massachusetts, paramedics complained that cold temperatures caused glucose meter systems to shutdown during emergency response. (<12.8ºC)
- In Port-au-Prince, Haiti, i-STAT whole blood analyzers were inoperable due to high temperatures. (35ºC)

1) Klein KR, et al.. *Disaster Management and Response*. April-June 2007;5-2, 56-61.
2) Vanholder R, et al. *Nephron Clinical Practice*. 2011; 117: 184-197
3) Case Study, Courtesy of Dr. James Nichols, Baystate Health, Springfield, MA

Hot, Cold, and Humid Profiles

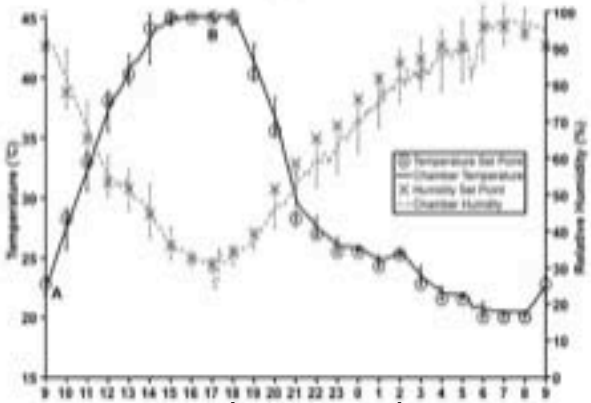


Environmental Stress Testing

POC Reagent Test Strips & Cartridges

Environmental Stress Testing Chamber & Profile

Tenney T2RC



Evaluate Test Strips & Cartridges

- Facilitate Device Design
- Enhance Development of Disaster Guideline

Hurricane Katrina

Environmental Stress Testing

Thermal stress and point-of-care testing performance: Suitability of glucose test strips and blood gas cartridges for disaster response

Conclusions: The performance of glucose test strips and blood gas cartridges was affected adversely by thermal stresses. Heating generated elevated results, and cooling depressed results. Disaster medical assistance teams and emergency medical responders should be aware of these risks. Field POCT devices must be robust to withstand adverse conditions. We recommend that industry produce POCT devices and reagents suitable for disaster medical assistance teams.

Louie RF, et al. *Disaster Med Public Health Prep*. 2009;3:13-17.

Ensuring quality control of point-of-care technologies: effects of dynamic temperature and humidity stresses on glucose quality control solutions

Conclusions: Dynamic stresses affected the performance of QC solutions and, consequently, results given by GMS1 and GMS2. To protect the efficacy and accuracy of POC technologies in emergency and disaster settings, proper monitoring, handling, and storage of QC reagents must be assured.

Tang CS, et al. *Point of Care*. 2012;11:147-151.

Preliminary evaluation of a point-of-care blood gas-electrolyte analyzer potentially robust in cold during emergencies and disasters: Evidence from evaluation of reagents in stress testing chambers

Conclusions: The epoc test cards do not appear to be affected significantly by the dynamic cold conditions observed during the 2011 Great East Japan Earthquake. Therefore, use of epoc blood gas systems may be feasible and should be explored with field trials.

Ferguson WJ, et al. *Point of Care*. 2012;11:152-156.

Effects of Dynamic Temperature and Humidity Stresses on Point-of-Care Glucose Testing for Disaster Care

Conclusions: The duration of dynamic stress affected the performance of both GMS1 and GMS2 glucose test strips. Therefore, proper monitoring, handling, and storage of point-of-care (POC) reagents are needed to ensure their integrity and quality of actionable results, thereby minimizing treatment errors in emergency and disaster settings.

Louie RF, et al. *Disaster Med Public Health Prep*. 2012;6:232.

Japan—A Cold Disaster!

- Magnitude 9.0 earthquake followed by tsunami and nuclear accidents on March 11, 2011
- Over 15,000 deaths and more than 125,000 buildings damaged or destroyed[1]
- About 80 percent of the combined 380 hospitals in Iwate, Miyagi, and Fukushima prefectures were completely or partially incapacitated[2]
- The temperature dropped to -5˚C[3]
- Scheduled power outages caused problems for the medical institutions in the disaster area[4]
- POCT was not adequately prepared

[1] http://www.npa.go.jp/archive/keibi/biki/higaijokyo_e.pdf
[2] http://search.japantimes.co.jp/cgi-bin/nn20110609a1.html
[3] National Climate Data Center
[4] http://www.med.or.jp/english/report/20110324.html

Epoc Blood Analysis System

- Handheld device heats test cards to 37˚C before measurements are performed
- Test cluster includes pH, pCO_2, pO_2, Na^+, K^+, Ca^{++}, glucose, and hematocrit
- Storage temperature for test cards is 15-30˚C

Kost GJ, Curtis CM, Louie RF, Sakaguchi AM. Disaster point-of-care testing: Fundamental concepts and new technologies. In: Arora R, Arora P, Eds. Disaster Management: Medical Preparedness, Response, and Homeland Security. Wallingford, England: CABI International, 2013. [In Press]

Thermomodulating Container

1st Generation container

Wiring Schematic

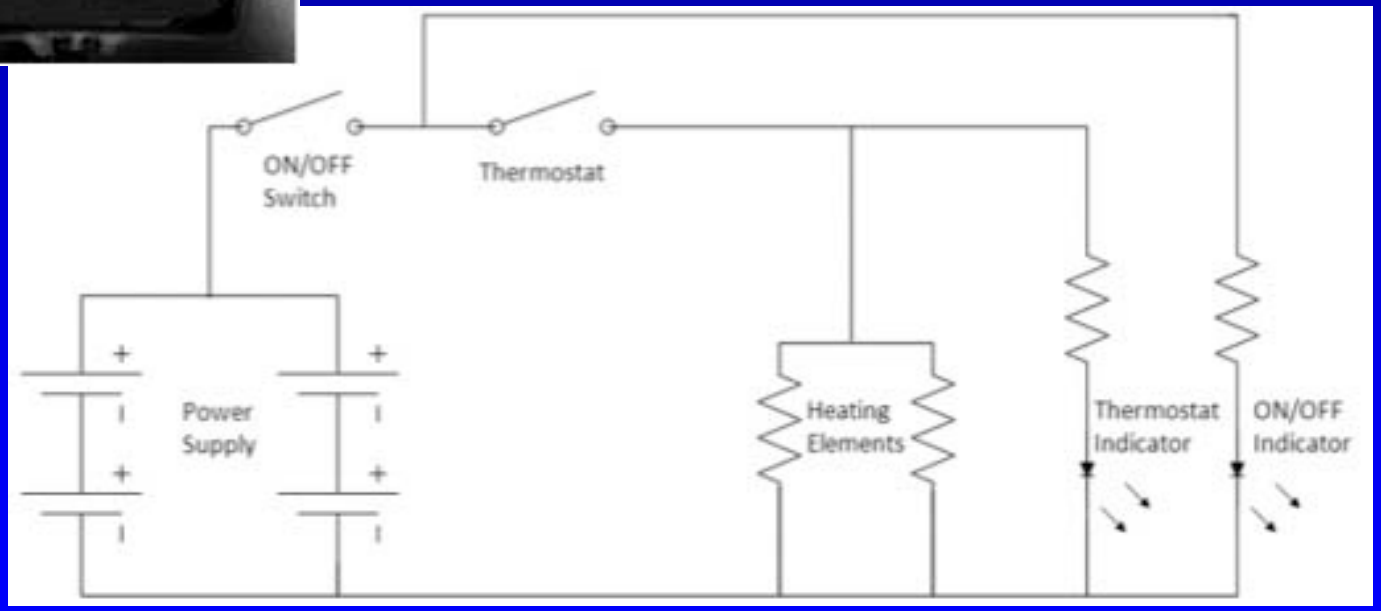


Figure 2: Rust MJ, Carlson NA, Nichols JH. A thermo-modulating container for transport and storage of glucose meters in a cold weather environment. *Point Care*. 2012;11:157-160.

PRINCIPLE #4

***POC technologies enable evidence-based decision-making at the point of need*...and also can *transfer ownership for personalized medicine there*!**

MMU Regional Span in Province SWN

Mobile Medical Unit (MMU): Rural Thailand

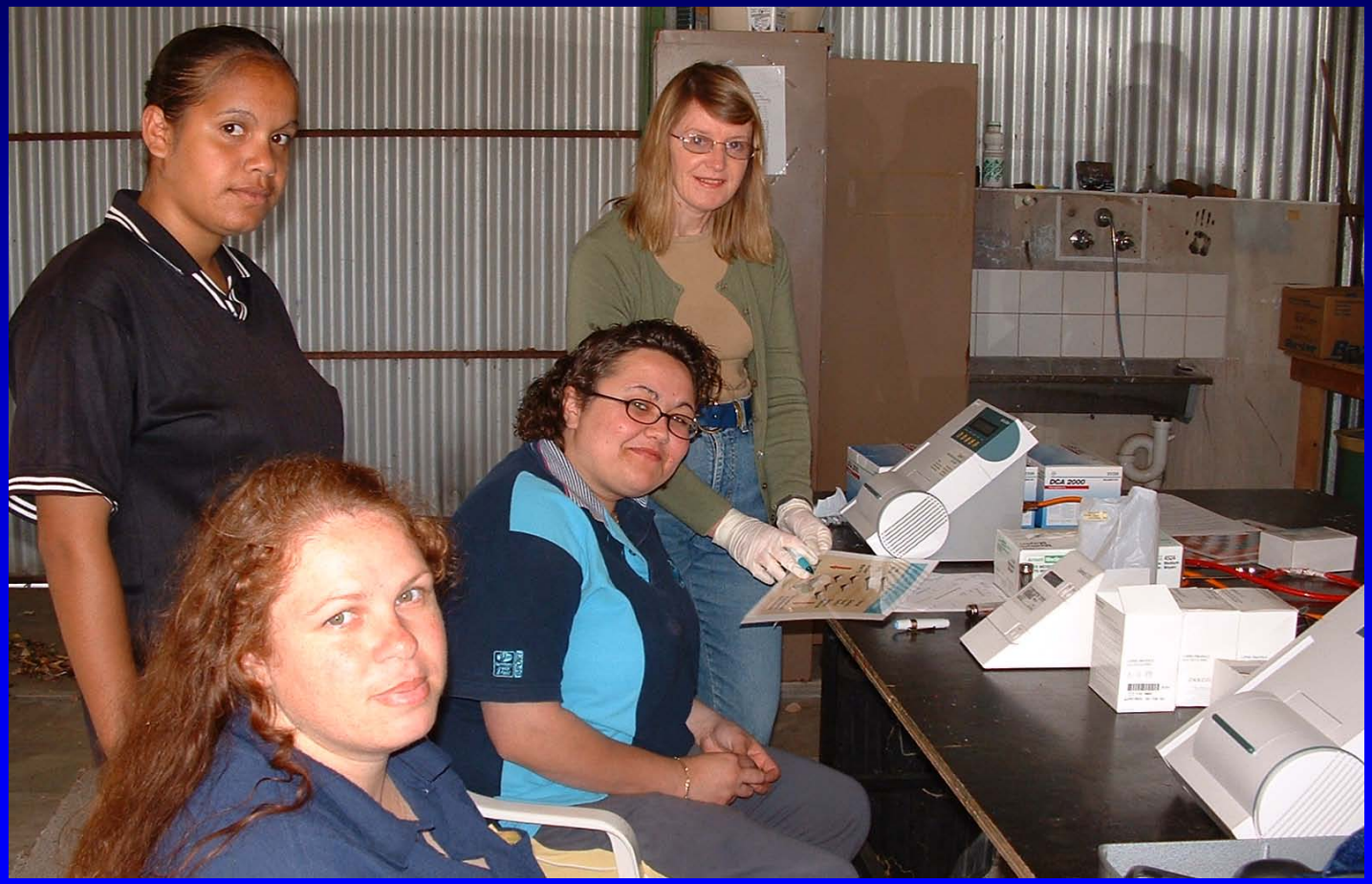
Empirical Judgment → *POCT* → Evidence-based Medicine

MMU Ownership and Empowerment

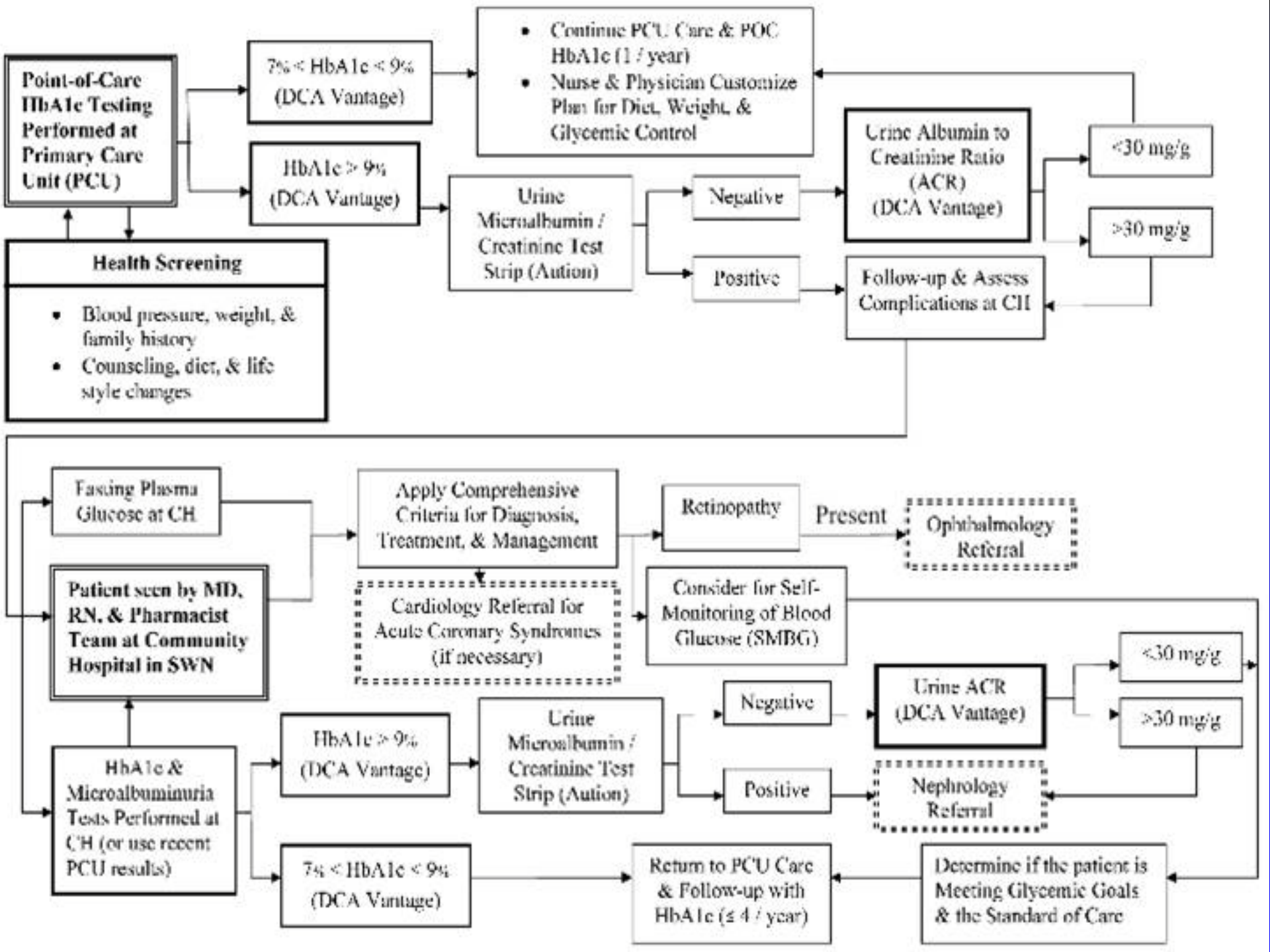
Australia: Primary and Point of Care

POC Testing is Adaptable and Transferable

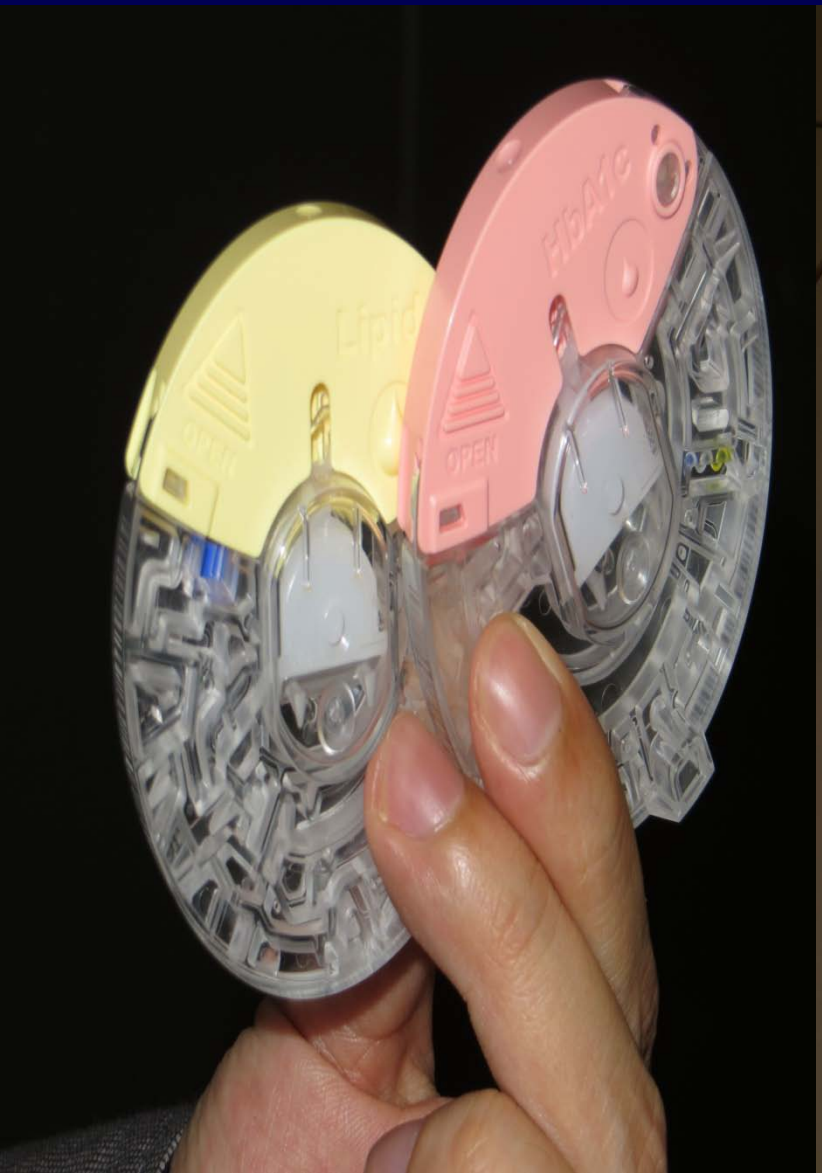
……at a local Aboriginal Women's Centre in Australia

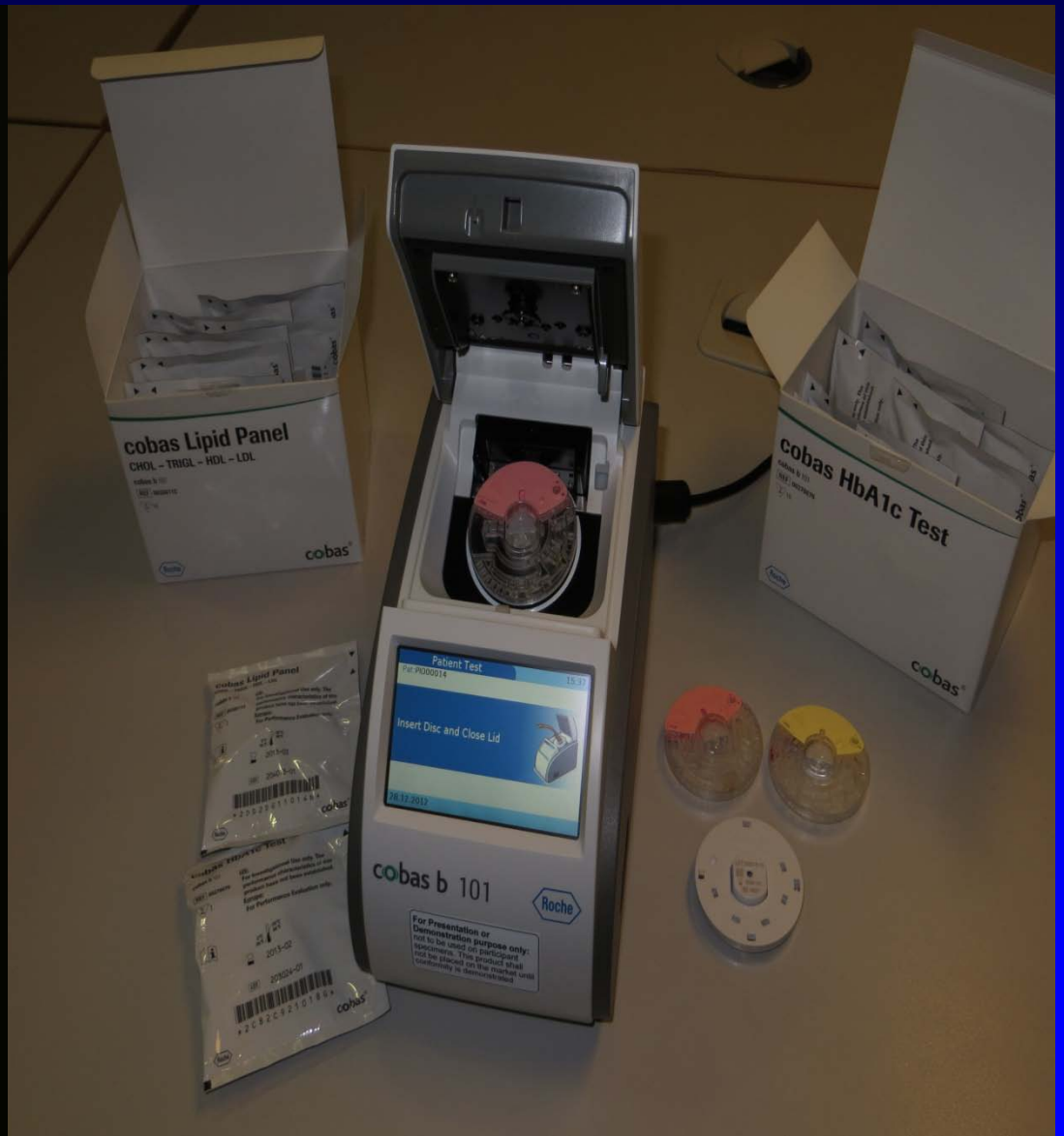


… in a tin shed !!!


Point-of-Care HbA1c Testing Performed at Primary Care Unit (PCU)
7% < HbA1c < 9% (DCA Vantage)
HbA1c > 9% (DCA Vantage)
Continue PCU Care & POC HbA1c (1 / year)
Nurse & Physician Customize Plan for Diet, Weight, & Glycemic Control
Urine Microalbumin / Creatinine Test Strip (Aution)
Negative
Positive
Urine Albumin to Creatinine Ratio (ACR) (DCA Vantage)
<30 mg/g
>30 mg/g
Follow-up & Assess Complications at CH
Health Screening
Blood pressure, weight, & family history
Counseling, diet, & life style changes
Fasting Plasma Glucose at CH
Patient seen by MD, RN, & Pharmacist Team at Community Hospital in SWN
Apply Comprehensive Criteria for Diagnosis, Treatment, & Management
Retinopathy
Present
Ophthalmology Referral
Cardiology Referral for Acute Coronary Syndromes (if necessary)
Consider for Self-Monitoring of Blood Glucose (SMBG)
HbA1c & Microalbuminuria Tests Performed at CH (or use recent PCU results)
HbA1c > 9% (DCA Vantage)
Urine Microalbumin / Creatinine Test Strip (Aution)
Negative
Positive
Urine ACR (DCA Vantage)
<30 mg/g
>30 mg/g
Nephrology Referral
7% < HbA1c < 9% (DCA Vantage)
Return to PCU Care & Follow-up with HbA1c (≤ 4 / year)
Determine if the patient is Meeting Glycemic Goals & the Standard of Care

HbA1c & Lipid Profile–Cobas 101





Point of Care Culture—The Final Frontier!

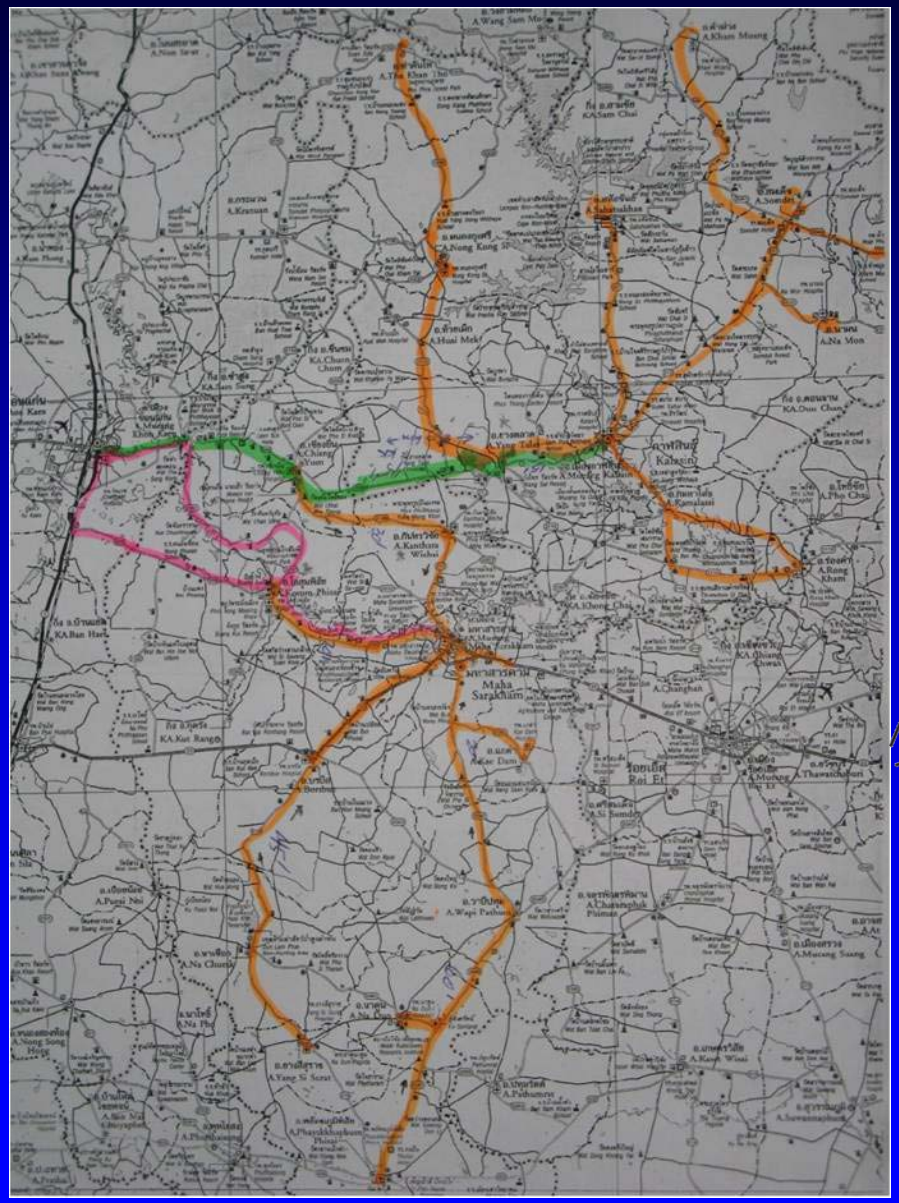
Point of care (POC) culture **is medical empowerment of the individual and family nucleus integrated with norms, behaviors, beliefs, attitudes, expectations, technology, and outcomes.**

Kost GJ et al. The final frontier for point of care: Performance, Resilience, and Culture. *Point of Care* 2013;12(1):1-8.

PRINCIPLE #5

Strategic planning optimizes <u>small-world networks</u> where <u>healthcare teams and patients</u> become experienced with POC testing through education, training, and <u>everyday use</u>.

Roadmap of Khon Kaen Regional Hospital and Heart Center Referral System in Isaan, Northeast Thailand.



Small-World Network Integration

Orange: SWNs
Green: Route to Khon Kaen Heart Center
Red: Ambulance connector

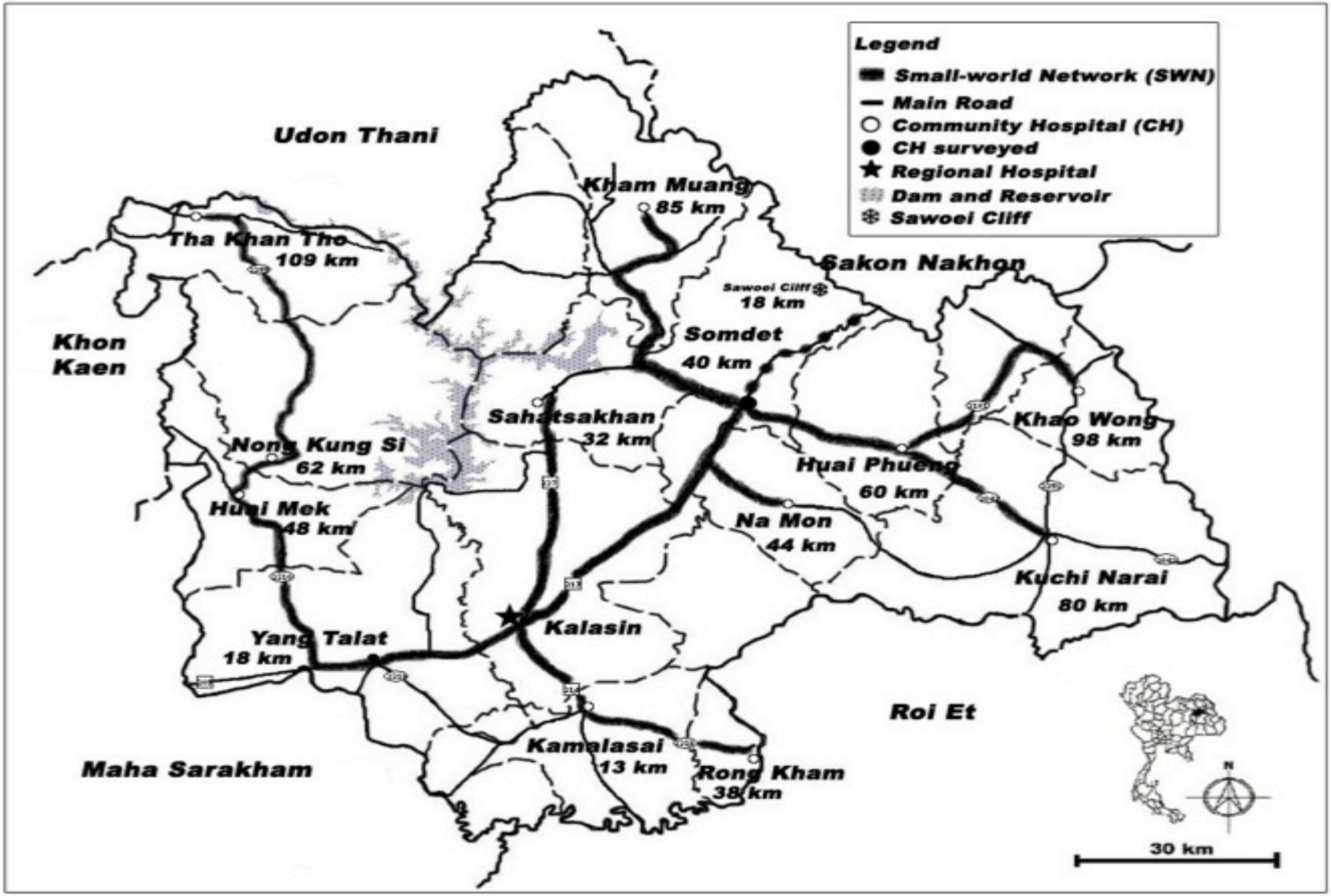
***Small-World Networks*…**

…are "like your family and friends…you have fun and work with them every day, and in times of need, you call on them for assistance!"

Examples—six degrees of separation between people, social influence networks, food chains, electric power grids, airline flights, and road maps.

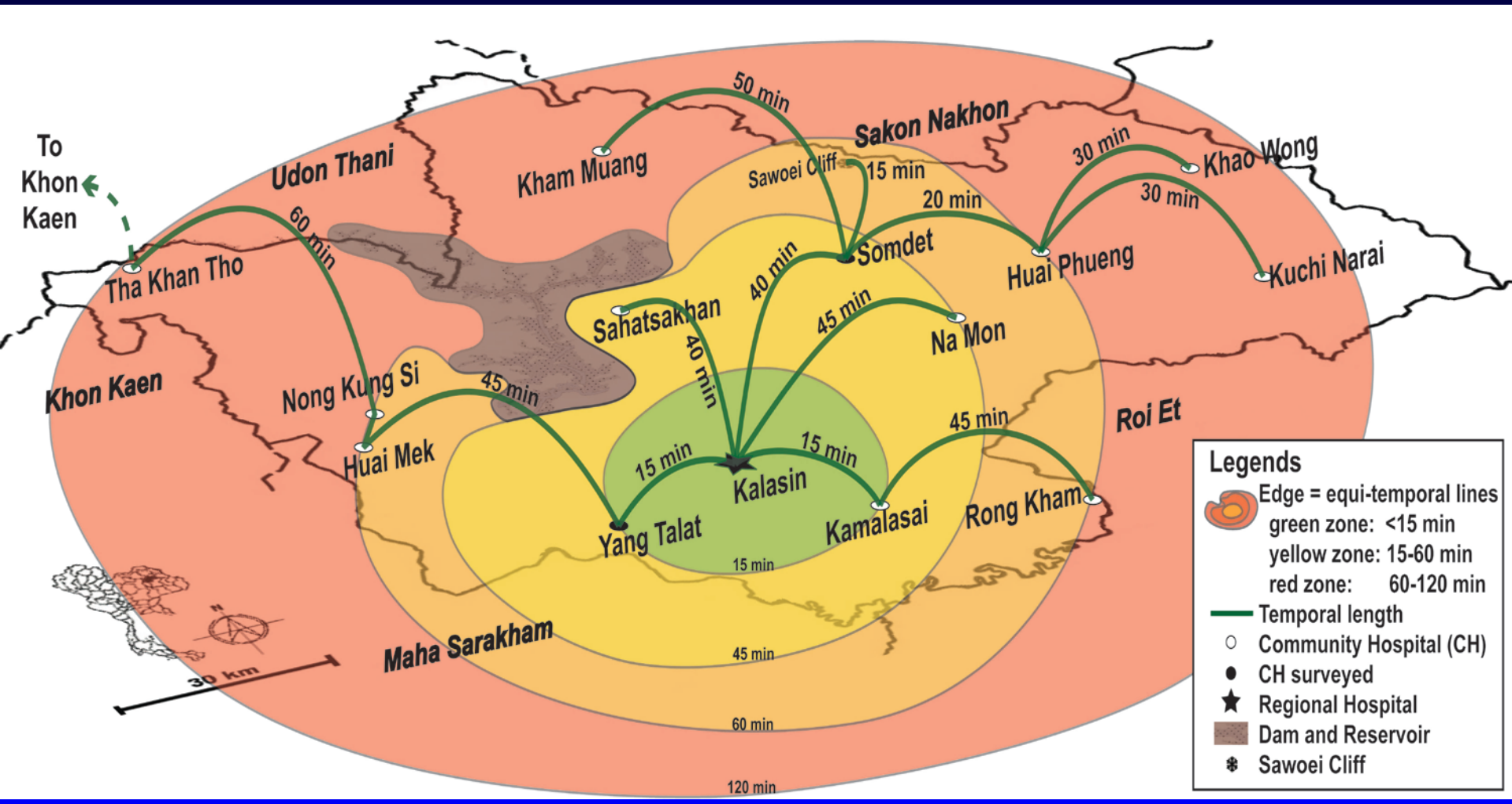
Attributes—most network nodes connected by at lease one short path, over abundance of hubs with high number of connections, and common connections mediating short path lengths between edges.

Features—develop demographically, match geography, interconnect regionally, reveal health resource disparities, and guide POCT allocations.



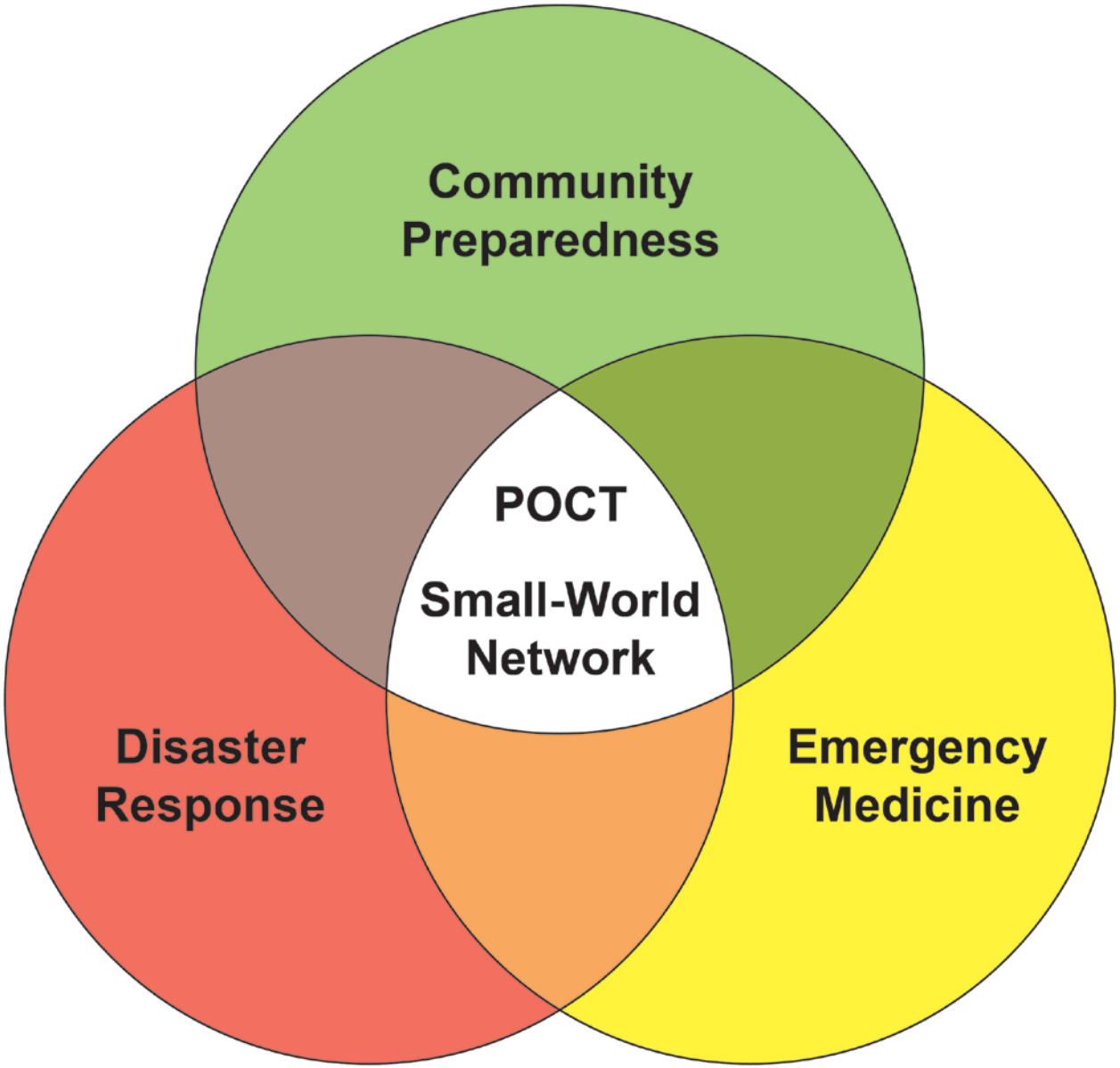
Reference: Kost GJ. Theory, principles, and practice of optimizing point-of-care small-world networks. *Point Care*. 2012;11:96-101.

Transformation of Distance to Time



Reference: Kost GJ. Theory, principles, and practice of optimizing point-of-care small-world networks. *Point Care*. 2012;11:96-101.

Kost GJ, Kost LE, Suwanyangyuen A, Cheema SK, Curtis CM, Sumner SL, Yu J, Louie RF. Emergency cardiac biomarkers and point-of-care testing: optimizing acute coronary syndrome care using small-world networks in rural settings. *Point Care*. 2010;9:53-64.



Reference: Kost GJ, Sakaguchi A, Curtis CM, Tran NK, Katip P, Louie RF. Enhancing crisis standards of care using innovative point-of-care testing. *Am J Disaster Med*. 2011;6:351-368.

PRINCIPLE #6

***Value propositions* generate tactics for *placing POC testing appropriately* in physical, demographic, and geographic settings.**

Corollary

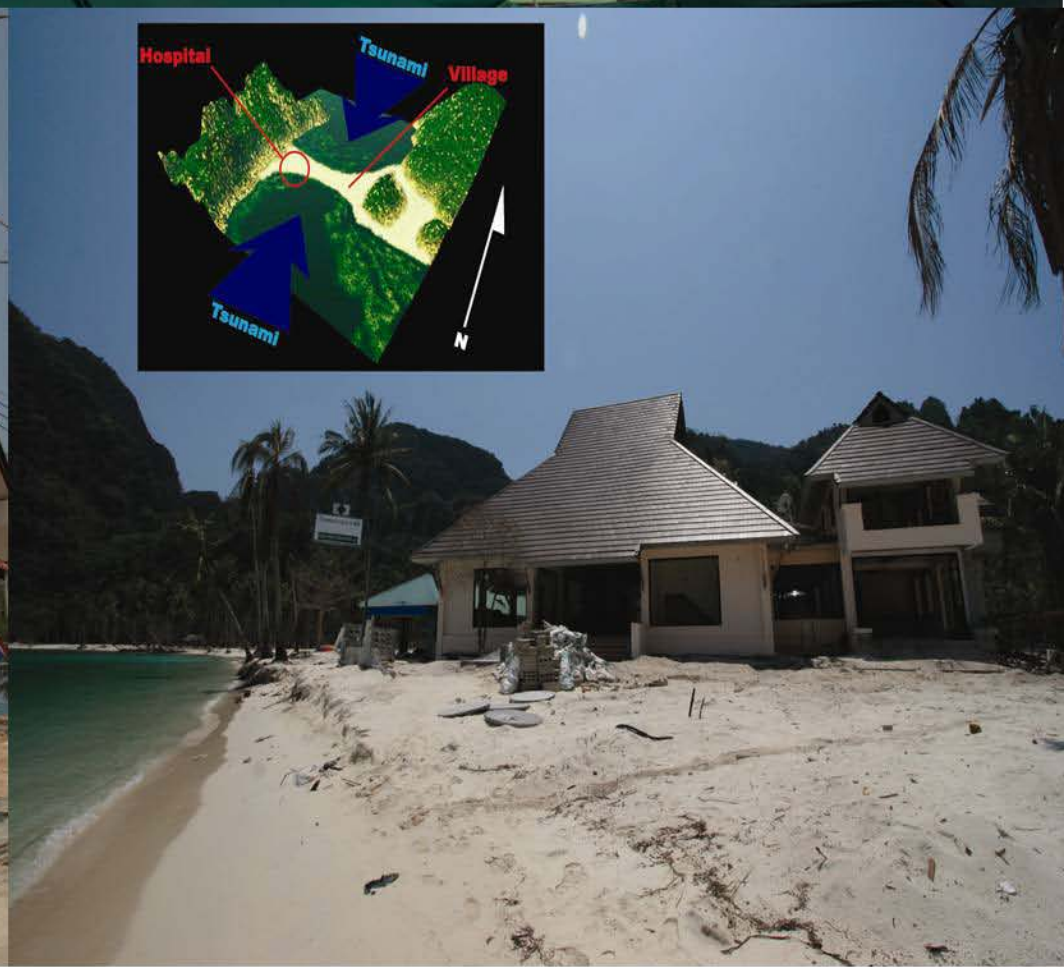
If POC testing does not impact decision-making or add value,

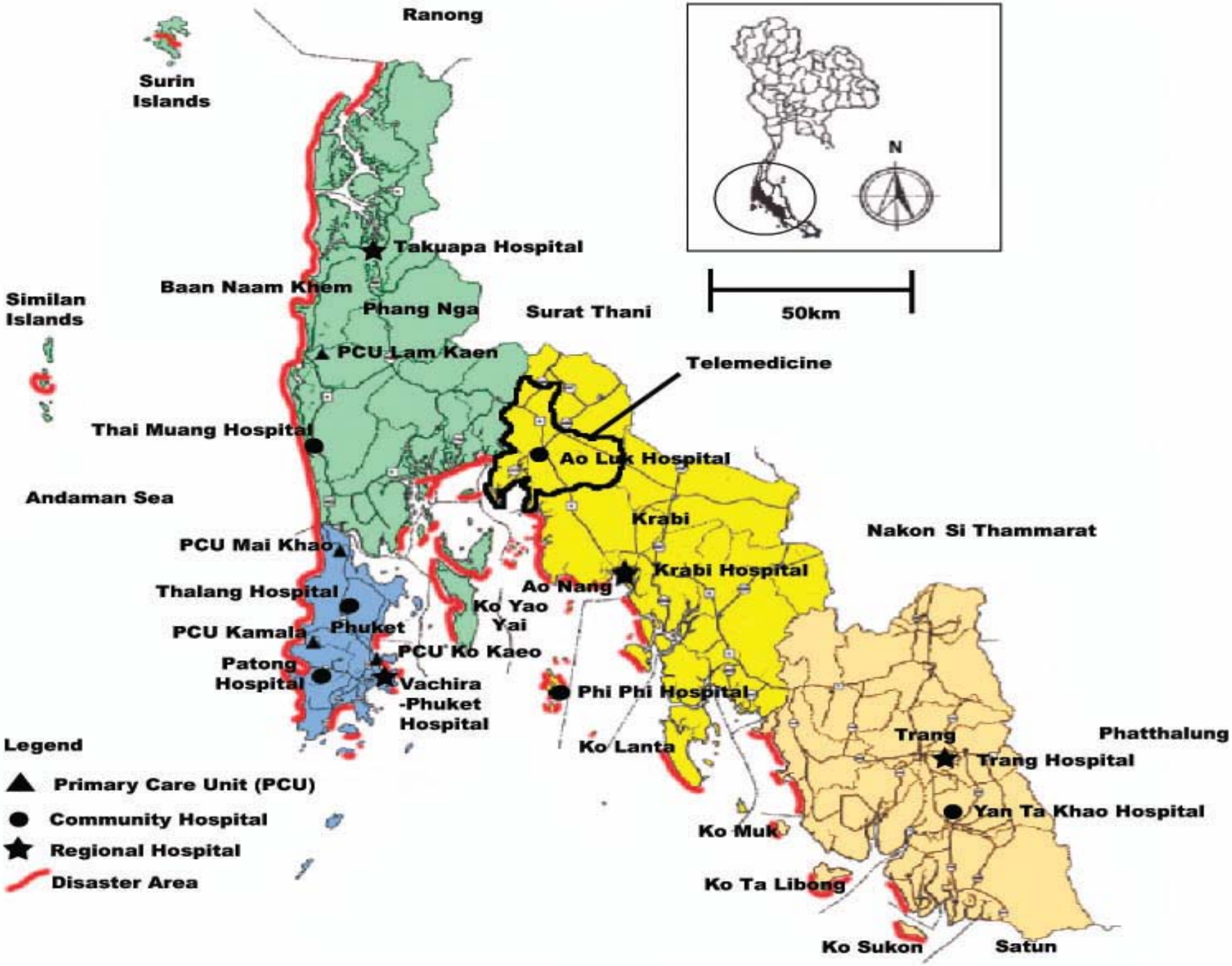
then do not use it!

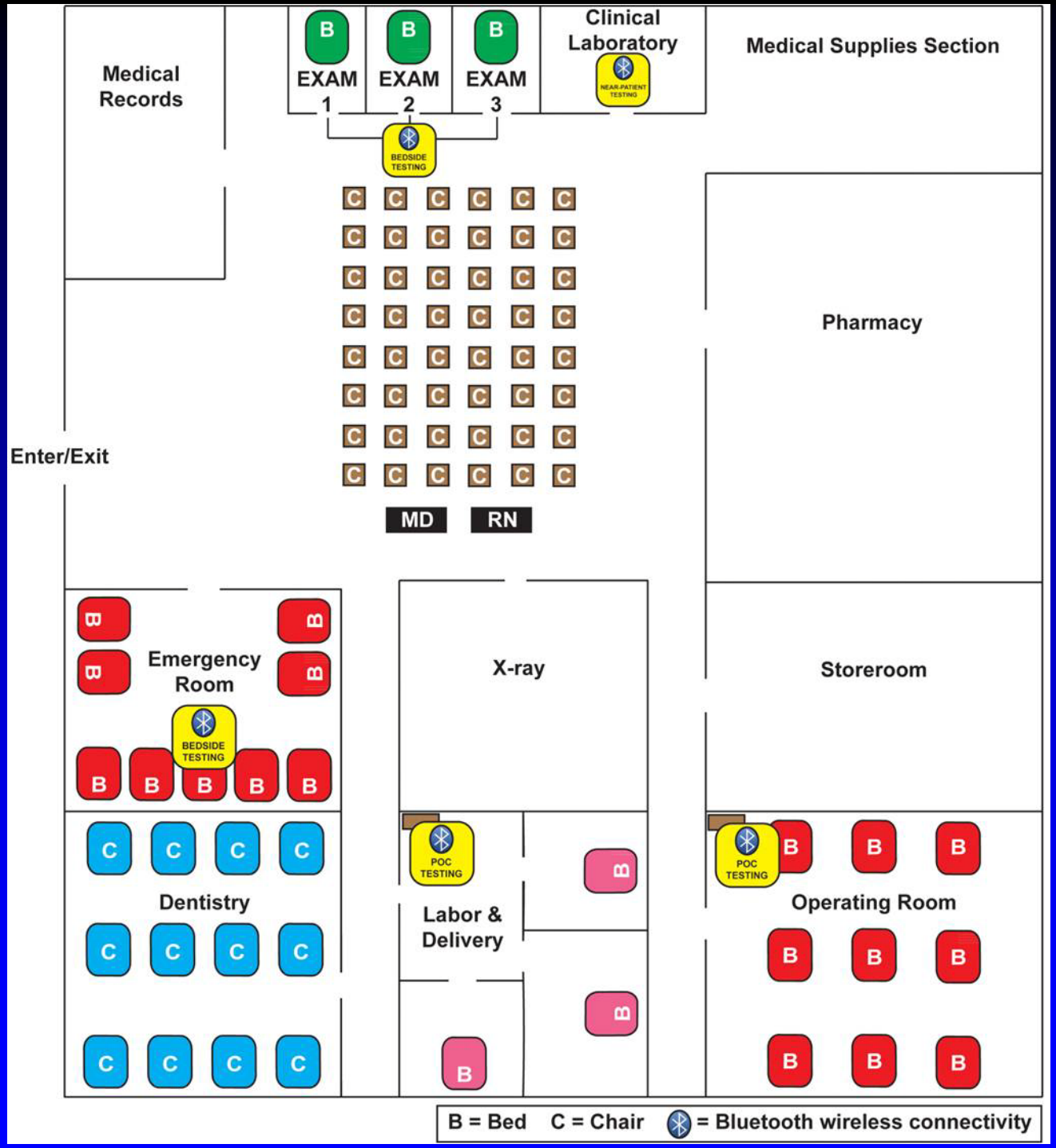
Value Proposition
Reduce Therapeutic Turnaround Time (TTAT) to Speed Critical Paths

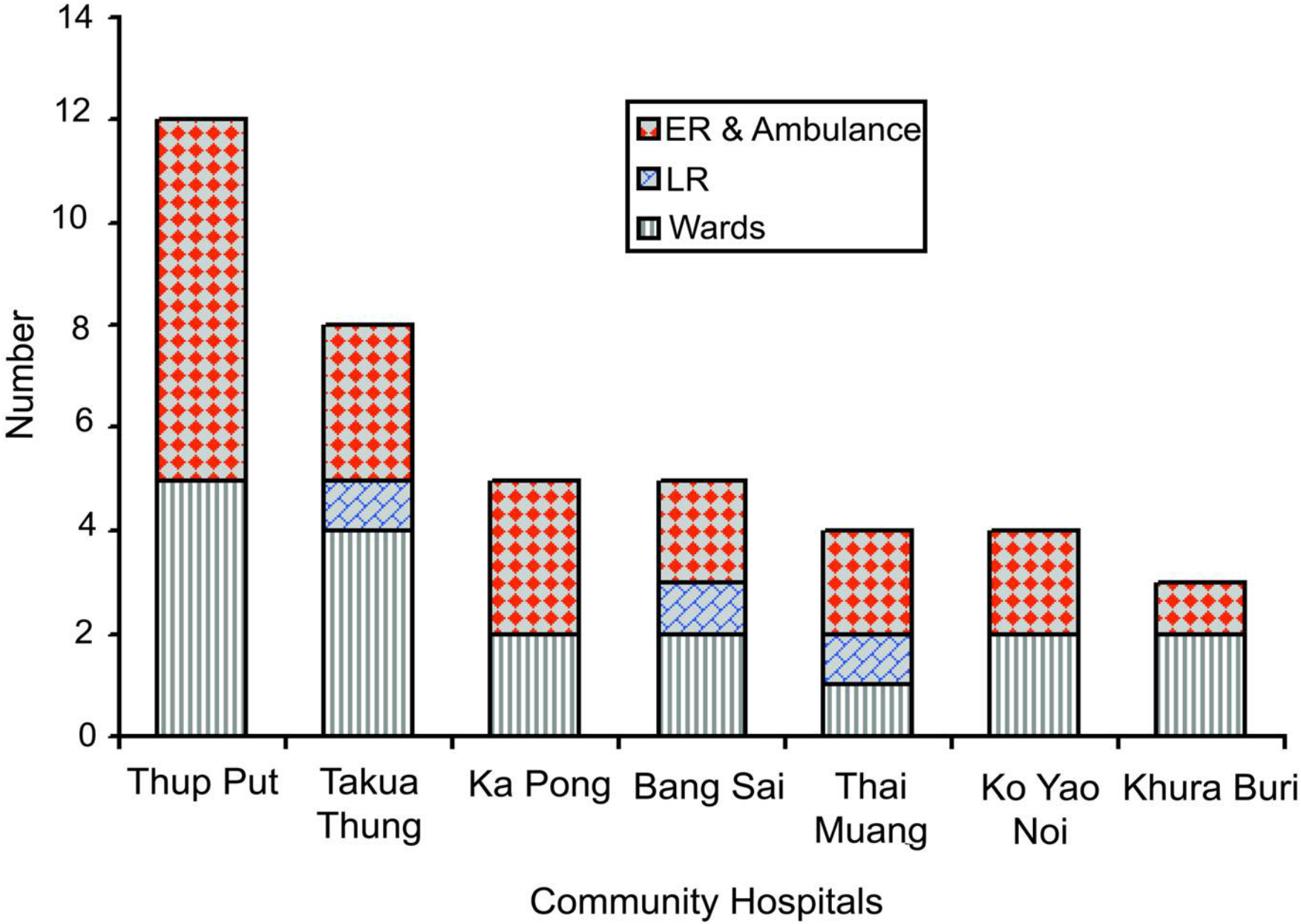
Evidence-based research shows that POC testing and *in vivo* monitoring decrease TTAT. Fast TTAT improves field and emergency room patient triage, treatment, and transfer, which observers deemed important during the Thai Tsunami response. Thus, rapid TTAT adds value and preparedness to the SWN.


TSUNAMI
EVACUATION
ROUTE
200m
เส้นทางหนี
คลื่นยักษ์


Hospital
Tsunami
Village
Tsunami
N


Ranong
Surin Islands
Similan Islands
Andaman Sea
Takuapa Hospital
Baan Naam Khem
Phang Nga
Surat Thani
PCU Lam Kaen
Telemedicine
Thai Muang Hospital
Ao Luk Hospital
Krabi
Nakon Si Thammarat
PCU Mai Khao
Krabi Hospital
Ao Nang
Thalang Hospital
Ko Yao Yai
PCU Kamala
Phuket
PCU Ko Kaeo
Patong Hospital
Vachira -Phuket Hospital
Phi Phi Hospital
Ko Lanta
Trang
Phatthalung
Trang Hospital
Yan Ta Khao Hospital
Ko Muk
Ko Ta Libong
Ko Sukon
Satun
N
50km
Legend
Primary Care Unit (PCU)
Community Hospital
Regional Hospital
Disaster Area


Medical Records
EXAM 1
EXAM 2
EXAM 3
Clinical Laboratory
NEAR-PATIENT TESTING
Medical Supplies Section
BEDSIDE TESTING
MD
RN
Pharmacy
Enter/Exit
Emergency Room
BEDSIDE TESTING
X-ray
Storeroom
Dentistry
POC TESTING
Labor & Delivery
POC TESTING
Operating Room
B = Bed C = Chair = Bluetooth wireless connectivity


14
12
10
8
6
4
2
0
Number
ER & Ambulance
LR
Wards
Thup Put
Takua Thung
Ka Pong
Bang Sai
Thai Muang
Ko Yao Noi
Khura Buri
Community Hospitals

Monitoring O_2 Saturation and Hemoglobin

Reference: Brock KT. Disaster Point-of-Care: Non-Invasive Monitoring. YouTube Presentation. Available at: http://www.youtube.com/watch?v=9ELSR7z0U4w. Accessed March 12, 2013.

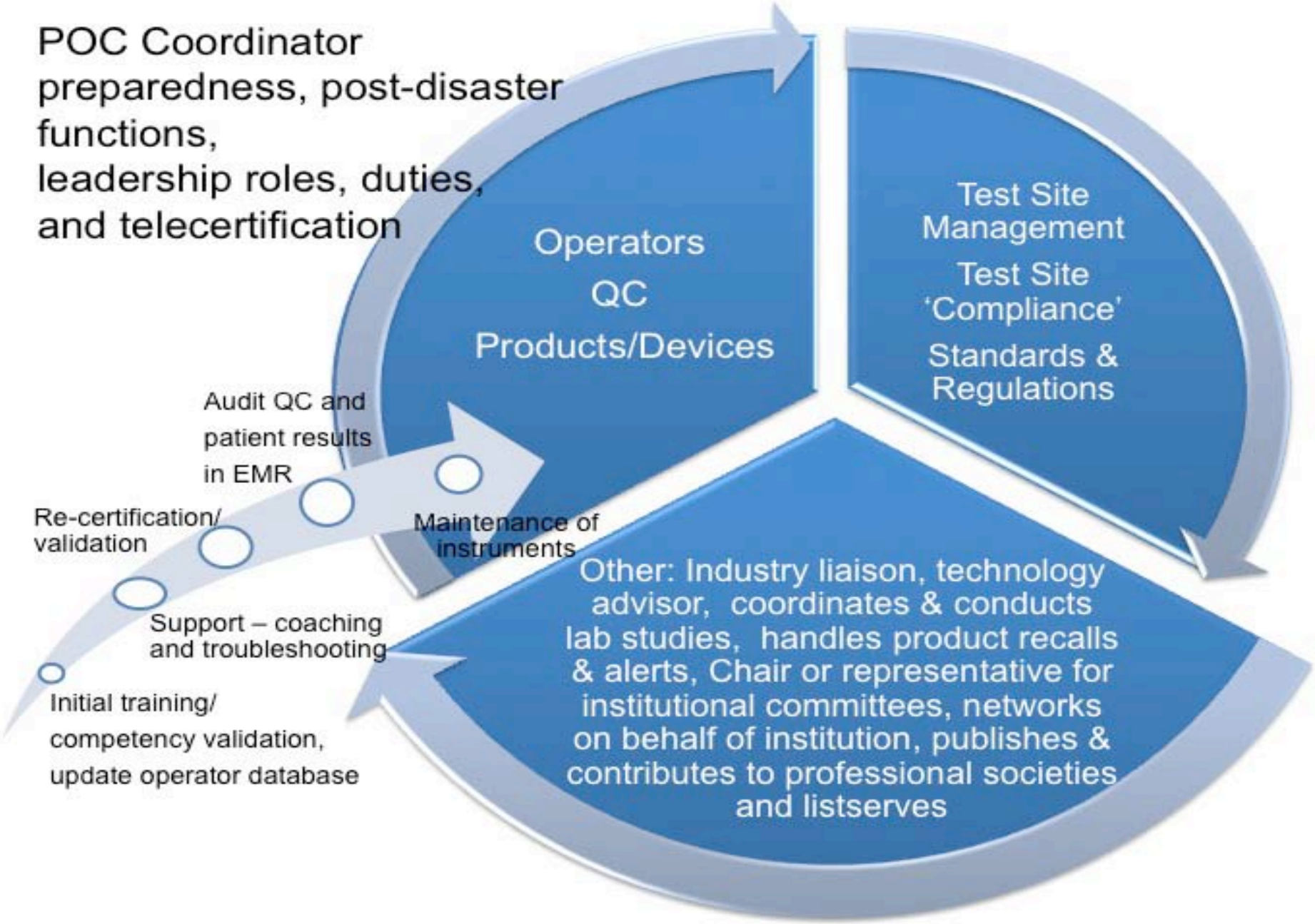
Value Proposition
Optimize Practitioner Experience with POCT

Tactical POCT should—

- **complement healthcare delivery resources,**
- **fulfill needs for simultaneous emergency care and disaster preparedness, and**
- **match geographic isolation, current or anticipated.**

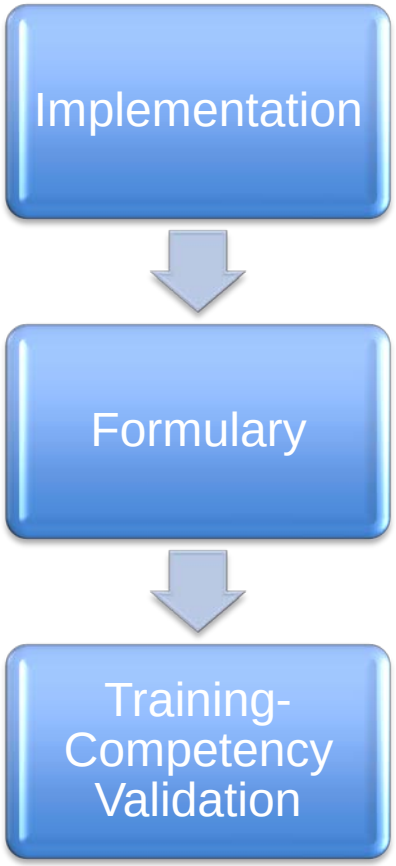
Therefore, routine daily use of POCT assures the high quality of trained operators, who become *"POC Coordinators"* and integrate POCT within and between small-world networks.

POC Coordinator preparedness, post-disaster functions, leadership roles, duties, and telecertification



Reference: Mann P, Kost GJ. Point-of-care coordinator leadership in preparedness, crisis, and recovery. *Point Care*. 2012;11:102-107.

POCC
Manager & Leader



Test Menu
Pre- and post-disaster

- ✓ POC A1c
- ✓ POC Hct
- ✓ POC Creatinine
- ✓ POC Hgb
- ✓ POC Glucose
- ✓ POC INR
- ✓ POC Occult Blood
- ✓ POC Rapid Streps
- ✓ POC Rapid Flu
- ✓ POC UA
- ✓ POC Urine hcg
- ✓ Non-invasive Bilirubin (Clia Exempt)

Reference: Mann P, Kost GJ. Point-of-care coordinator leadership in preparedness, crisis, and recovery. *Point Care*. 2012;11:102-107.

Essential Skills of the POC Coordinator for Readiness

- Perform needs assessment in advance of a crisis
- Participate in writing the emergency plan
- Periodically drill the emergency plan ➔ assess response ➔ revise plan
- Do annual "gap analysis" to identify and eliminate weak preparedness areas of high risk
- Communicate with surrounding communities in the small-world network and regionally
- Guarantee the competency of operators who respond outside the hospital
- Outline what is the process, who is in charge, and where is the command center

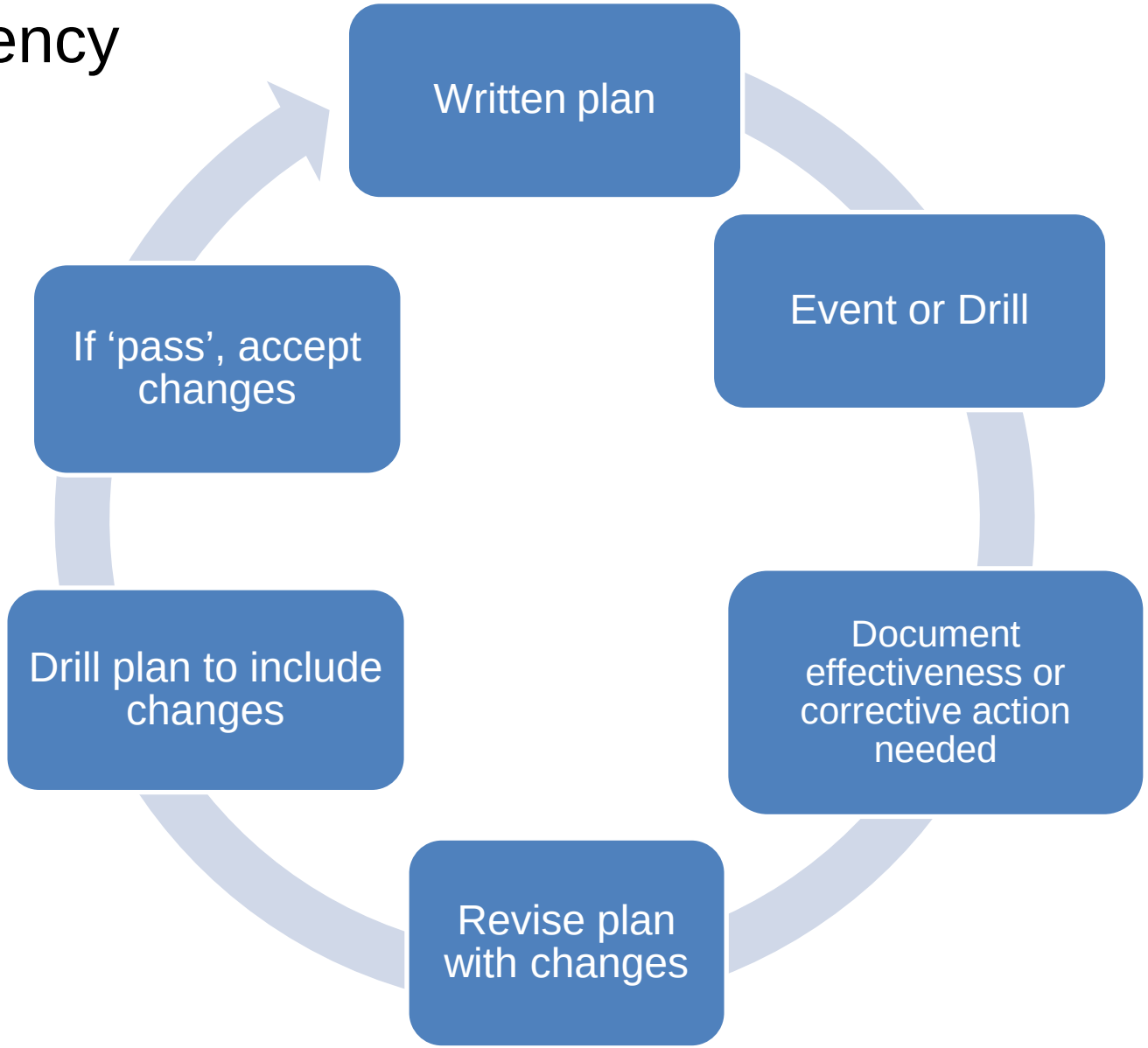
Essential Skills of the POCC (cont.)

- Include offsite training programs, telecertification, and validation
- Examine requirements such as power, durability, scan functions, and victim identification
- Standardize supplies for interchangeability during responses
- Consider the impact of environmental conditions on supplies and test performance
- Assess periodically the quality control of materials in caches
- Solve problems and troubleshoot
- Alert colleagues to username and password preservation and accessibility

Essential Skills of the POCC (cont.)

- Adapt resources to meet the needs of health care teams in the field
- Be mindful of regulatory requirements and any practice exceptions that occur
- Connect test results with the electronic medical record in real time and after the event
- Preplan using a reference laboratory and the supply chain for specimen transport
- Conduct table top all hazards disaster and pandemic isolation drills
- Maintain personnel, government agencies, and industry contact cal lists
- Practice communicating via text, long-range radios, and analog phones

Emergency Plan



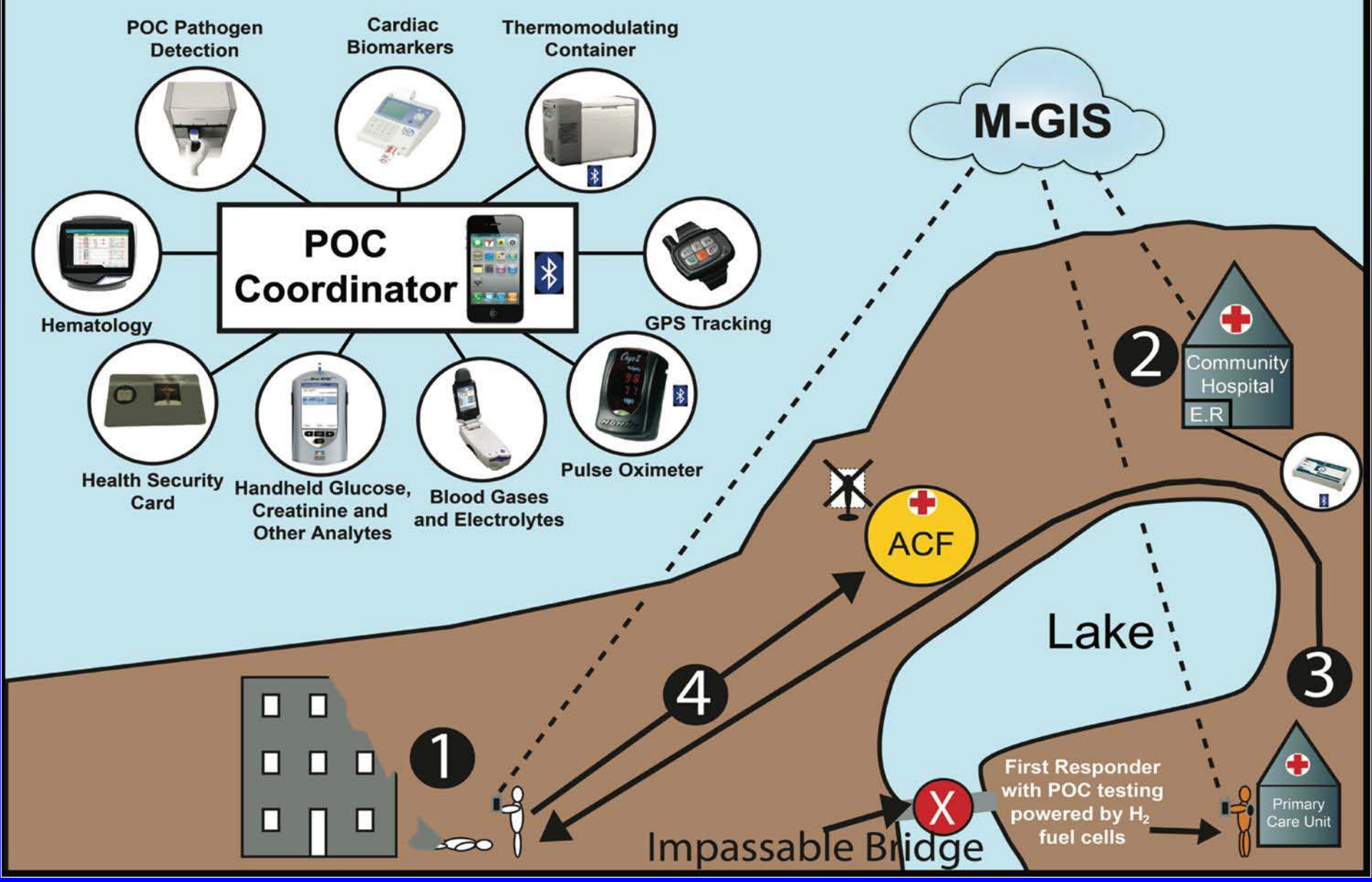
Reference: Mann P, Kost GJ. Point-of-care coordinator leadership in preparedness, crisis, and recovery. *Point Care*. 2012;11:102-107.

Value Proposition
Use POC Testing in High Impact Sites During Emergencies and Disasters

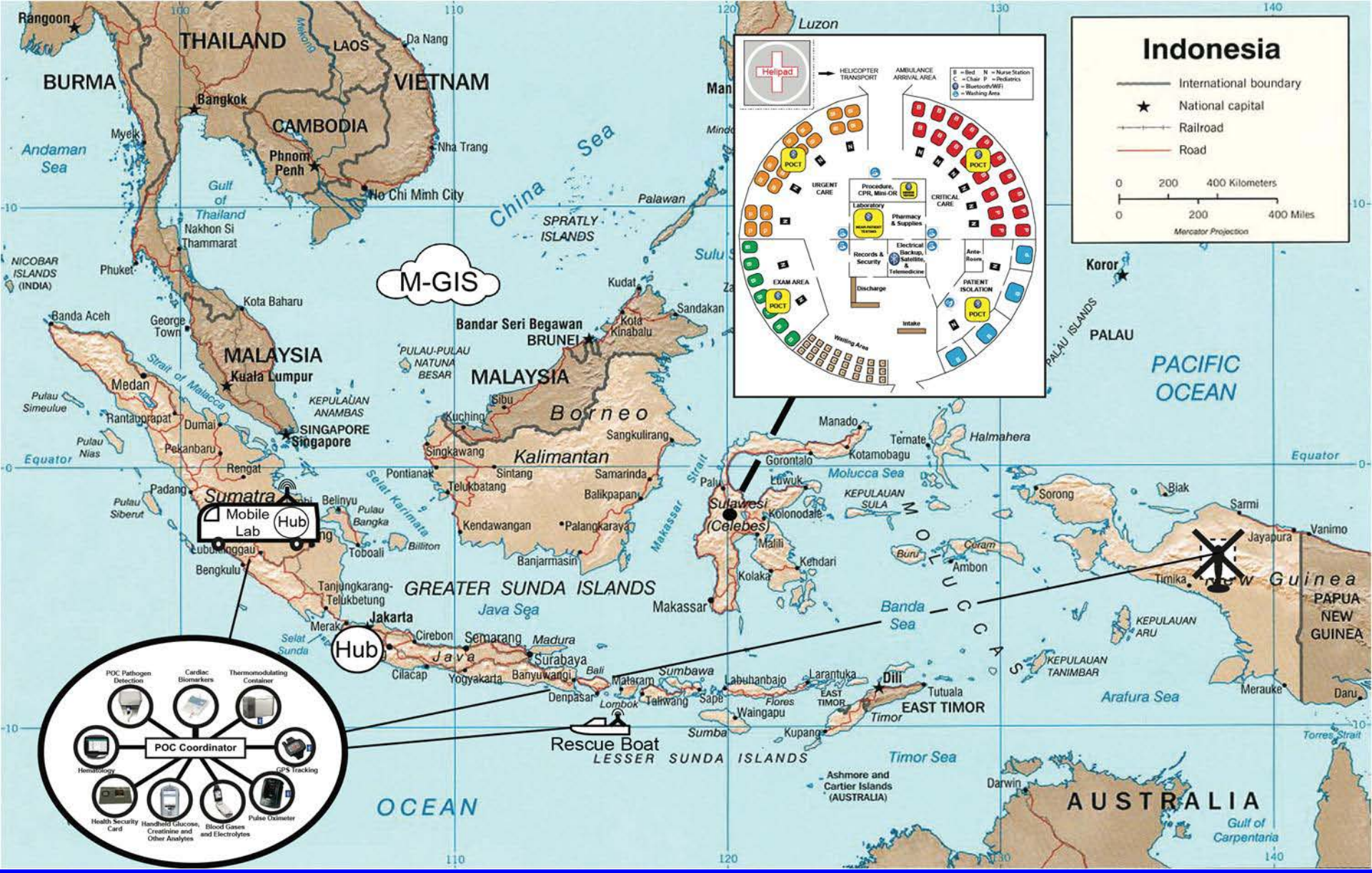
Physical: **Community hospitals, alternate care facilities, and shelters**

Demographic: **Rural areas, primary care, and regions with poor health resource scores**

Geographic: **Healthcare systems with challenging regional topographies at high risk of isolation**



Reference: Ferguson WJ, Louie RF, Tang CS, Vy JH, Wallace AP, Peng LS, Curtis CM, Kost GJ. Geographic information systems can enhance crisis standards of care during complex emergencies and disasters: a strategy for global positioning system—tracked, H_2 fuel cell-powered, and knowledge-optimized point-of-care medical intelligence. *Point Care*. 2012;11:184-190.



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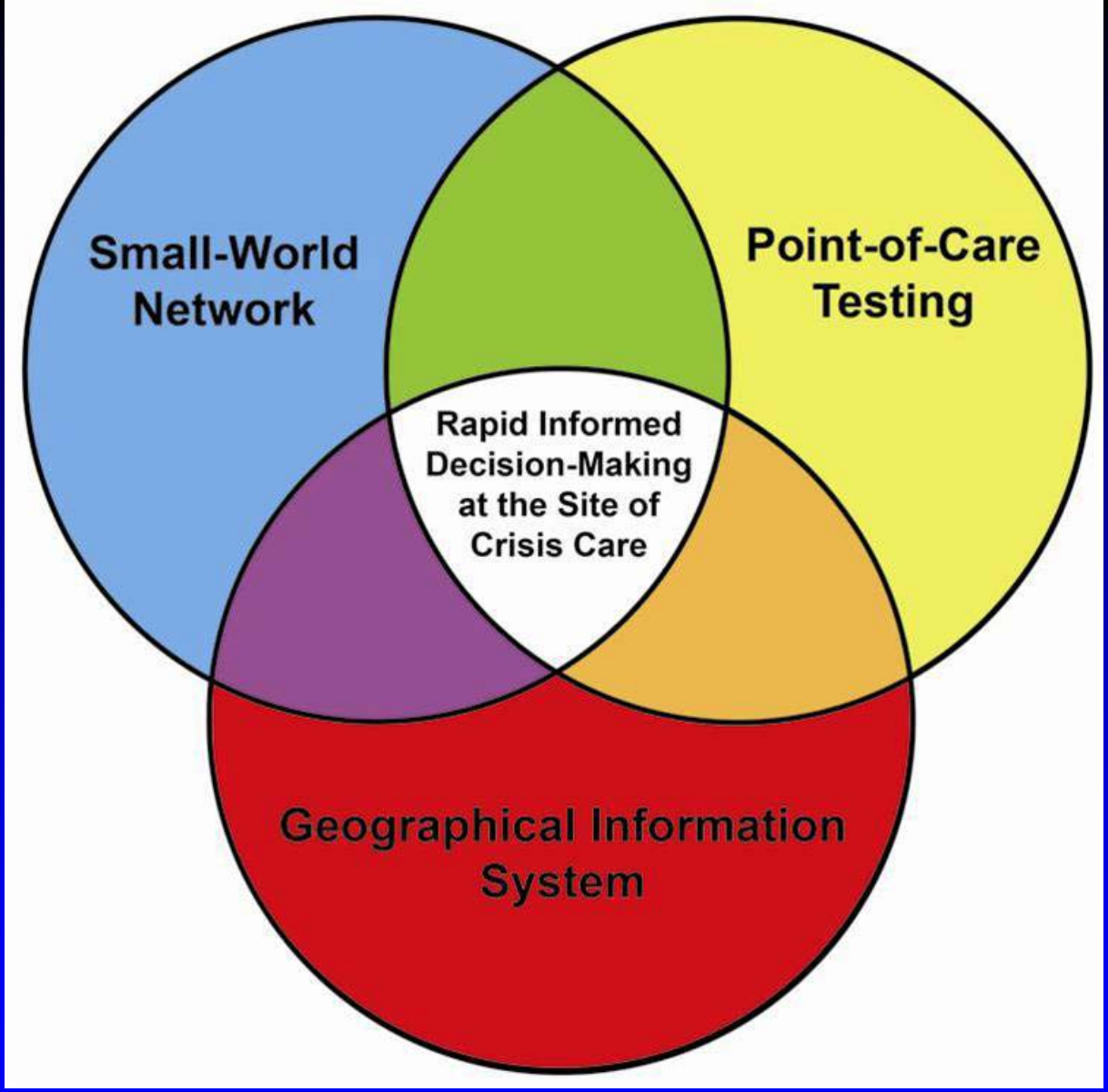


Reference: Ferguson WJ, Louie RF, Tang CS, Vy JH, Wallace AP, Peng LS, Curtis CM, Kost GJ. Geographic information systems can enhance crisis standards of care during complex emergencies and disasters: a strategy for global positioning system—tracked, H_2 fuel cell-powered, and knowledge-optimized point-of-care medical intelligence. *Point Care*. 2012;11:184-190.

CONCLUSIONS AND IMPACT!

- **Point-of-care coordinators can and should take responsibility for proper training, quality assurance, and test performance that will enhance standards of care, both routinely and during crises.**

- **Needs assessment and research a) describe point-of-care designs for emergency and disaster settings, b) reveal which devices and reagents can be used in different climates, and c) identify test clusters necessary for critical decision-making.**

- **Regardless of location, innovative point-of-care technologies empower people for personalized medicine and evidence-based practice, even under dire circumstances, and therefore, should be harmonized globally.**

- **Small-world networks + flexibly equipped hubs + strategically placed POC testing *create value*, that is, efficient urgent-emergency care, cost-effective disaster preparedness, and appropriate national disaster caches.**

- **The *Emergency and Disaster POC Testing* CLSI guideline (POCT15) soon will be available for public comment, so please review and contribute!**

National Disaster Caches: United States

We recommend enhancing US disaster point of care caches. Consider what resources should be available in other countries! We recommend that country caches be harmonized globally, accompanied by free Web tutorials for operator competency.

Lab Basic
[Briefcase ≤ 50 lbs]

i-STAT® with
25 Chem 8+ and
25 G3+ Cartridges

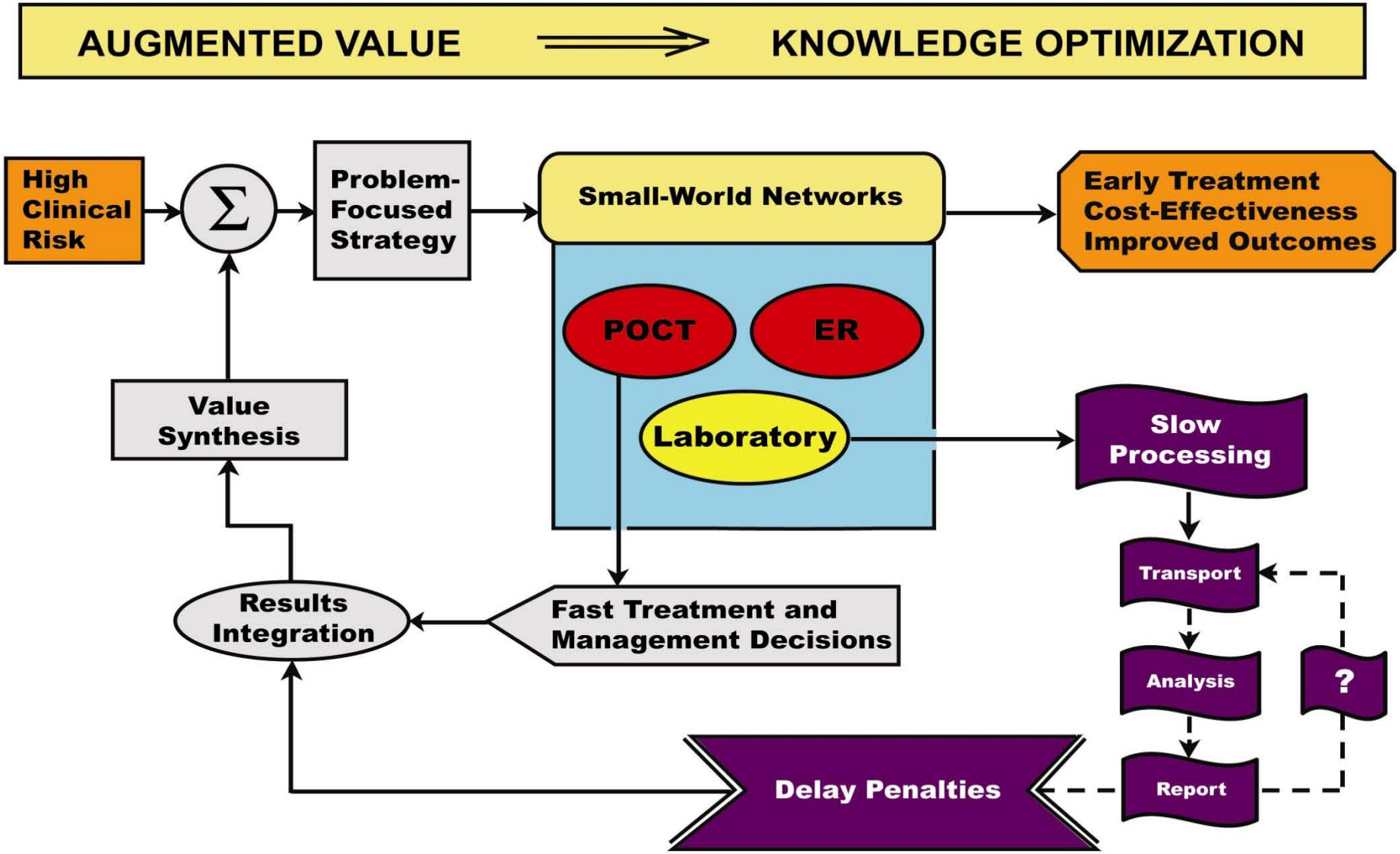
5 LifeSign® MI
Cartridges
(Qualitative)

5 Pregnancy
Test Strips

OneTouch® Ultra®

1 Box of CLINITEK® Urinalysis Test Strips

Value Proposition for POC Cardiac Biomarker Testing



POC and NPT for Acute Coronary Syndrome

i-STAT [1.4 lbs (0.6 kg)]
Abbott Laboratories

cTnI, CK-MB, BNP

Cobas h232 [1.4 lbs (0.6 kg)]
Roche Diagnostics

cTnT, NT-proBNP, CK-MB, Myoglobin, D-Dimer
(Not available in USA)

RAMP® Reader [4.6 lbs (2.1kg)]
Response Biomedical

cTnI, NT-proBNP, CK-MB, Myoglobin, D-Dimer

Triage® MeterPro [1.5 lbs (0.7 kg)]
Alere™

cTnI, BNP, CK-MB, Myoglobin, D-Dimer

PATHFAST® [72.8 lbs (33 kg)]
Mistubishi Chemical USA, Inc.

cTnI, NT-proBNP, CK-MB, Myoglobin, hsCRP, D-Dimer

mini VIDAS® [88 lbs (39.9 kg)]
bioMérieux

cTnI, NT-proBNP, D-dimer, Procalcitonin

AQT90 FLEX [77.2 lbs (35 kg)]
Radiometer

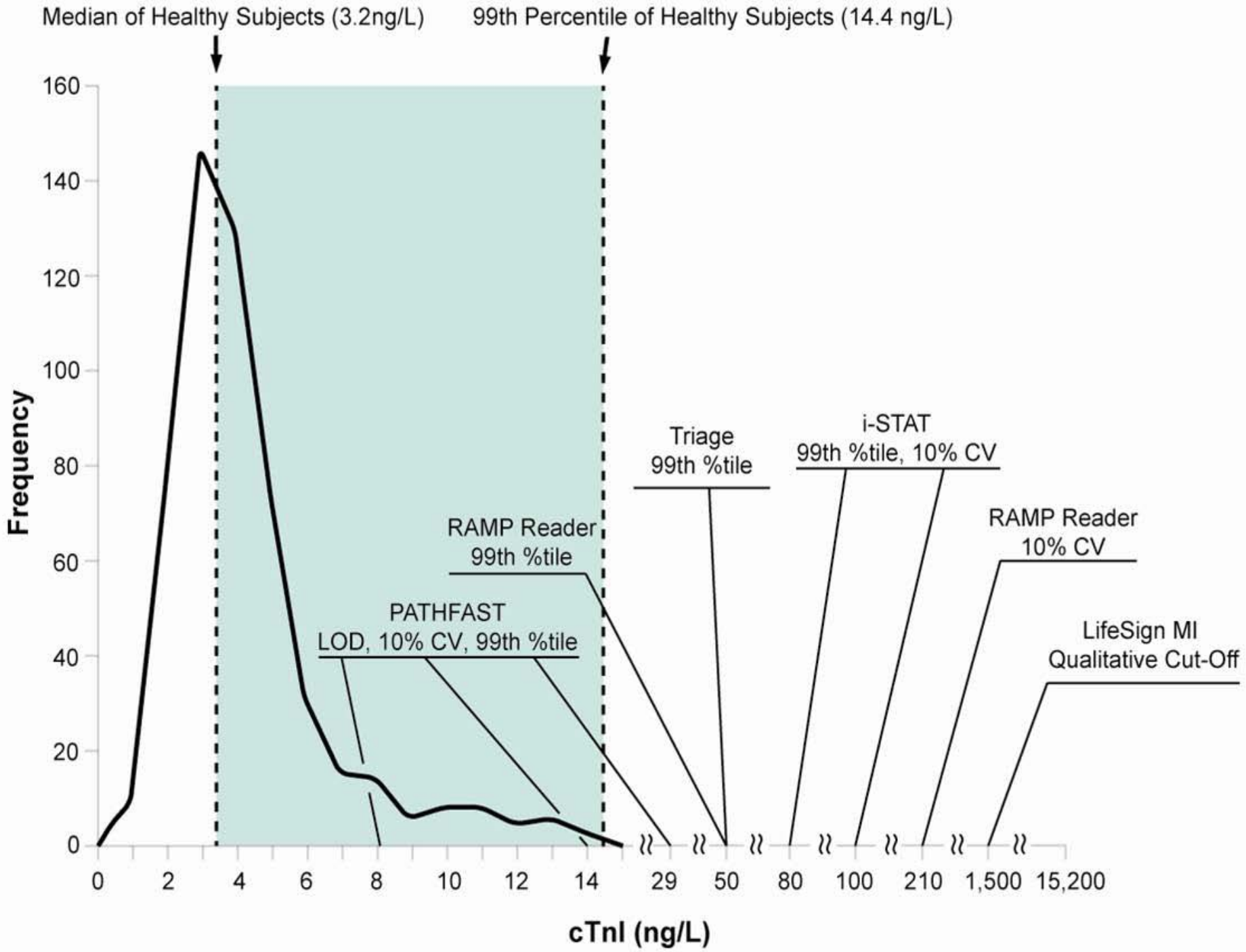
cTnI, cTnT, NT-proBNP, CK-MB, Myoglobin, D-dimer, CRP, βhCG

Stratus® CS [150 lbs (68 kg)]
Siemens

cTnI, NT-proBNP, CK-MB, Myoglobin, D-Dimer, hsCRP, βhCG

POC Cardiac Troponin I Sensitivity

Device	Limit of Detection (ng/L)
Mitsubishi PATHFAST®	8
Alere Triage®	10
Abbott i-STAT	20
Response Biomedical RAMP® Reader	30
Siemens Stratus CS	30
Roche Cardiac Reader	30 (cTnT Semi-Quantitative)
Roche Cobas h232	50 (cTnT Semi-Quantitative)
LifeSign MI®	1,500 (Qualitative)


Median of Healthy Subjects (3.2ng/L)
99th Percentile of Healthy Subjects (14.4 ng/L)
Frequency
160
140
120
100
80
60
40
20
0
Triage
99th %tile
i-STAT
99th %tile, 10% CV
RAMP Reader
99th %tile
RAMP Reader
10% CV
PATHFAST
LOD, 10% CV, 99th %tile
LifeSign MI
Qualitative Cut-Off
0
2
4
6
8
10
12
14
29
50
80
100
210
1,500
15,200
cTnI (ng/L)

Lab Basic Included

Lab Plus Package [~400 lbs]

Rapid tests for:
Strep Throat,
Mono,
and D-dimer

Hemoccult Immunochemical Chromatography Test

Piccolo Chemistry Analyzer
General Chem 13
Liver Panel

PT/INR Cartridge
(i-STAT)

Coulter AcT diff 2

Triage TOX
Drug Screen

Clinitek 50 Urine Analyzer

New Hematology Device
Ativa MicroCBC

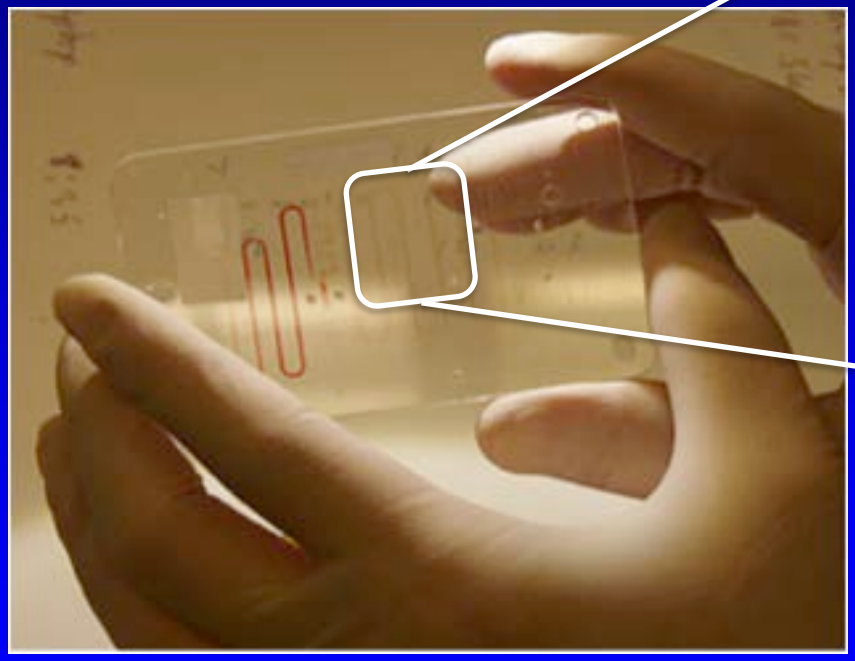
- **Three detection methods:**
  - **-optical light scatter**
  - **-colorimetric**
  - **-electrochemical**

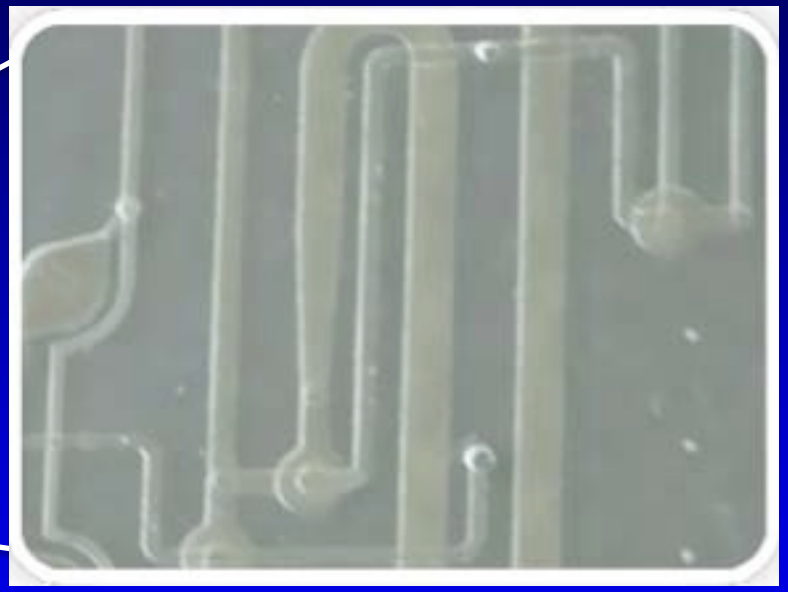
- **Single-use disposable test cards**

Reference: www.ativamed.com

MicroCBC Technology

CBC results in 3-5 minutes





- Microfluidic flow control through channels sandwiched between two plastic plates.

Reference: www.ativamed.com

Value Proposition
Assess POC Testing in Context

Critical information has value exceeding the costs of tests. Physicians assign high value because test results impact decisions. Nurses assign higher value than laboratorians. Speed has value, and often is life-saving. Patient self-care and responder welfare garner value as well! Total value depends on the sum of benefits minus costs—

$$Value = \Sigma\ [Benefits - Costs]$$

Disaster Point of Care

i-STAT® 1 Wireless with G3+ (blood gases), Chem 8+ (Electrolytes), PT/INR and cTnI Cartridges

Oraquick ADVANCE® HIV 1/2

Sure-Vue® Urine hCG Cartridge

Onyx® II 9560 Fingertip Pulse Oximeter

MicroCBC: RBC, WBC, neutrophil, lymphocyte, monocytes, Hb, PLT, MPV and MCV Hematology Analyzer (investigational use only)

Hemoccult®-Immunochemical Fecal Occult Blood Test

QuickVue® Influenza Test

ABORhCard® Blood Typing Test Card

CLINITEK® Urinalysis: Alb, Blood, Crea, Ketone, Leukocyte, Nitrite, pH, Protein, Alb to Crea ratio and Protein to Crea ratio

Triage® Drugs of Abuse Test Card

Statstrip Glucose, Lactate, ß-hydroxybutyrate and Creatinine

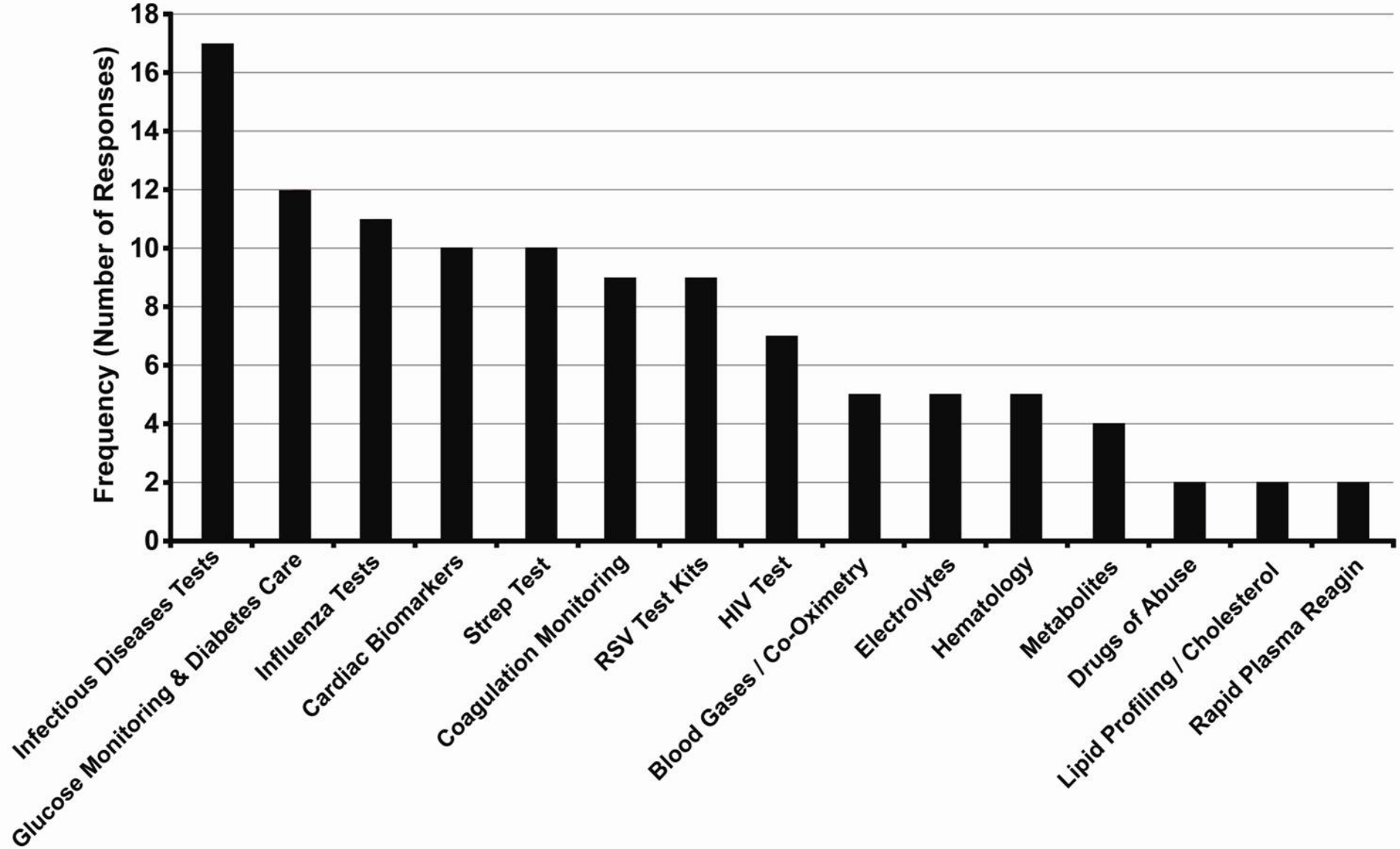
Masimo Rad-57™ Oxygen Saturation, Hgb plus pediatric probes

Min-Max Temp

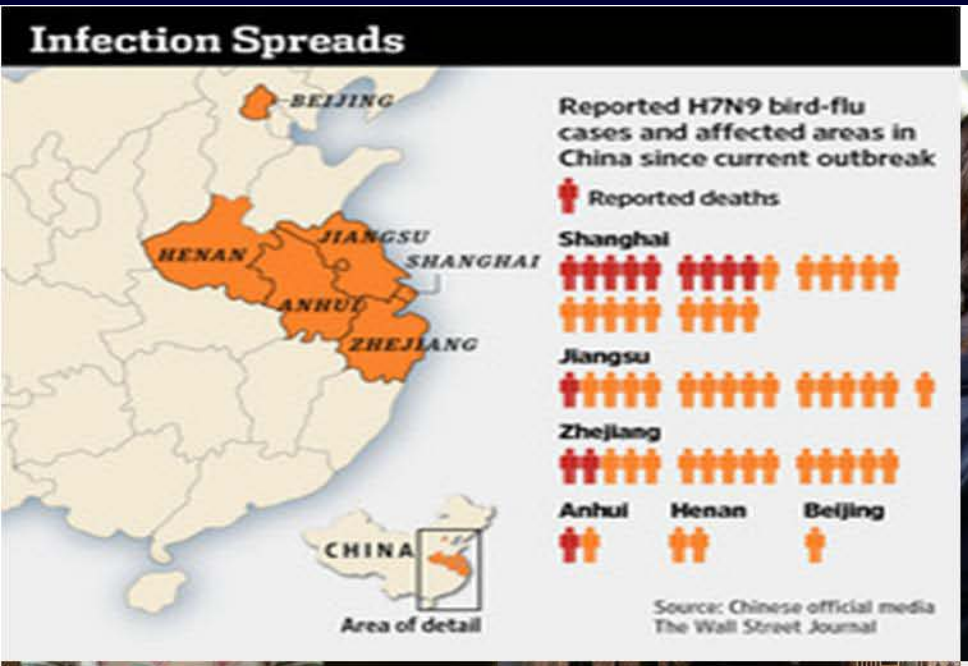
Point-of-care "Clusterettes"—Customized for Decision-Making

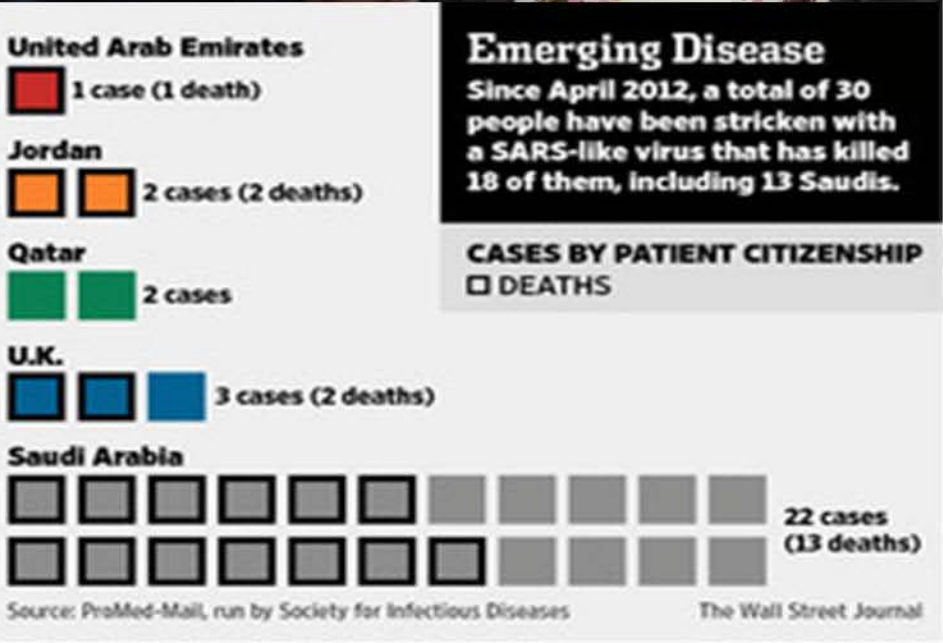
- Disaster Point of Care
  - Radiation exposure–detection, monitoring, and treatment
  - Crush Injury–electrolytes, hct/hgb, creatinine (renal failure)
- Infectious Diseases/Pandemic
  - MRSA, *S. aureus*, influenza (H7N9, "SARS-like" virus)
- Chemical and Biothreats
  - Anthrax, Tularemia, nerve agents
- Alternate Care Facility
  - Whole-blood analysis—multiplex blood gases, pH, Hct/Hgb, and electrolytes, including Ca^{+2}
  - Glucose, Glu/βOH butyrate, creatinine, lactate
- Imaging
  - Portable ultrasound

WHAT DO YOU THINK IS MISSING?
NEW YORK CITY HEALTHCARE WORKERS:



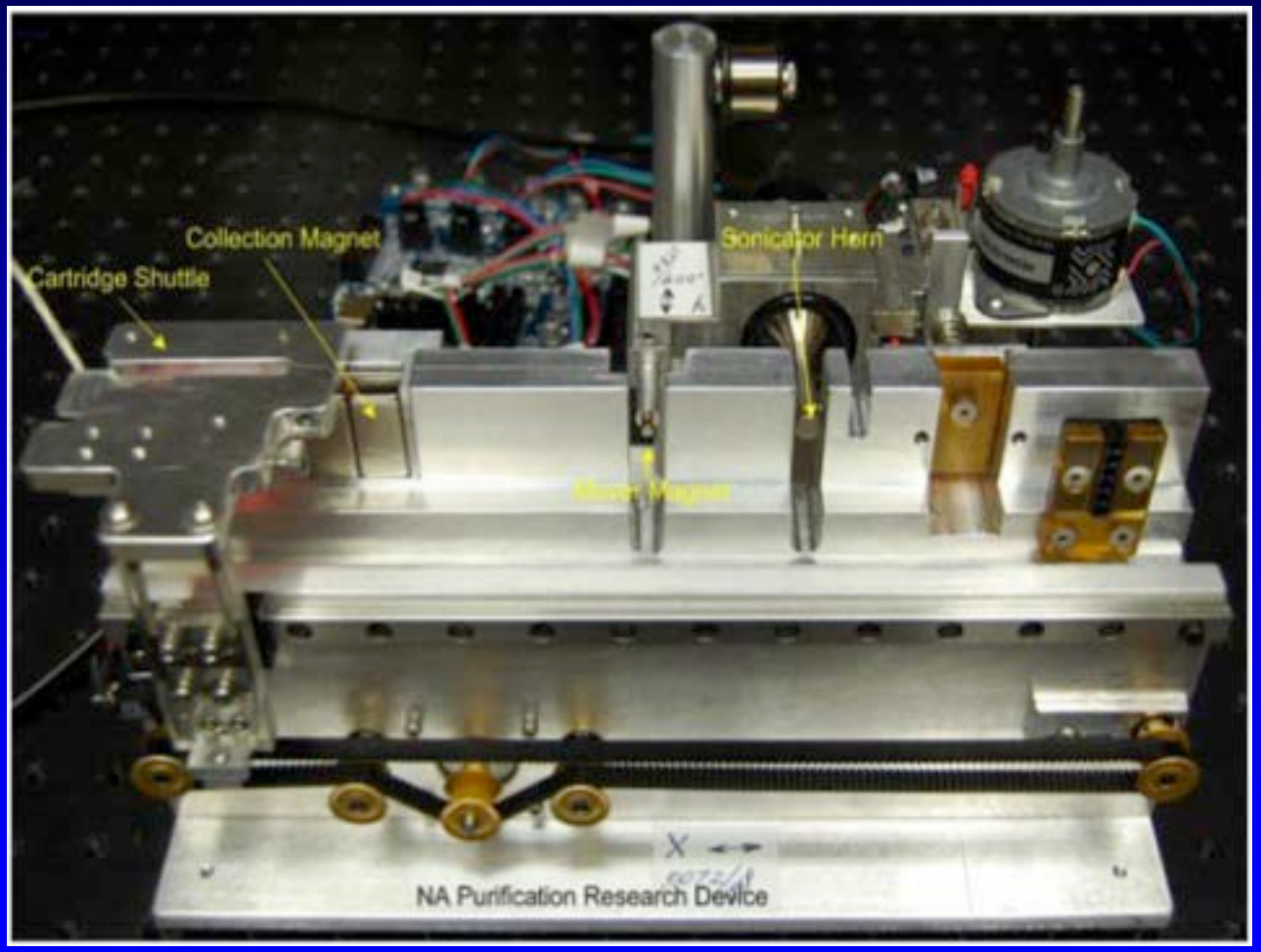
H7N9—128 cases, 27 dead; SARS-like—30, 18 (May 7)





New Influenza POC Device

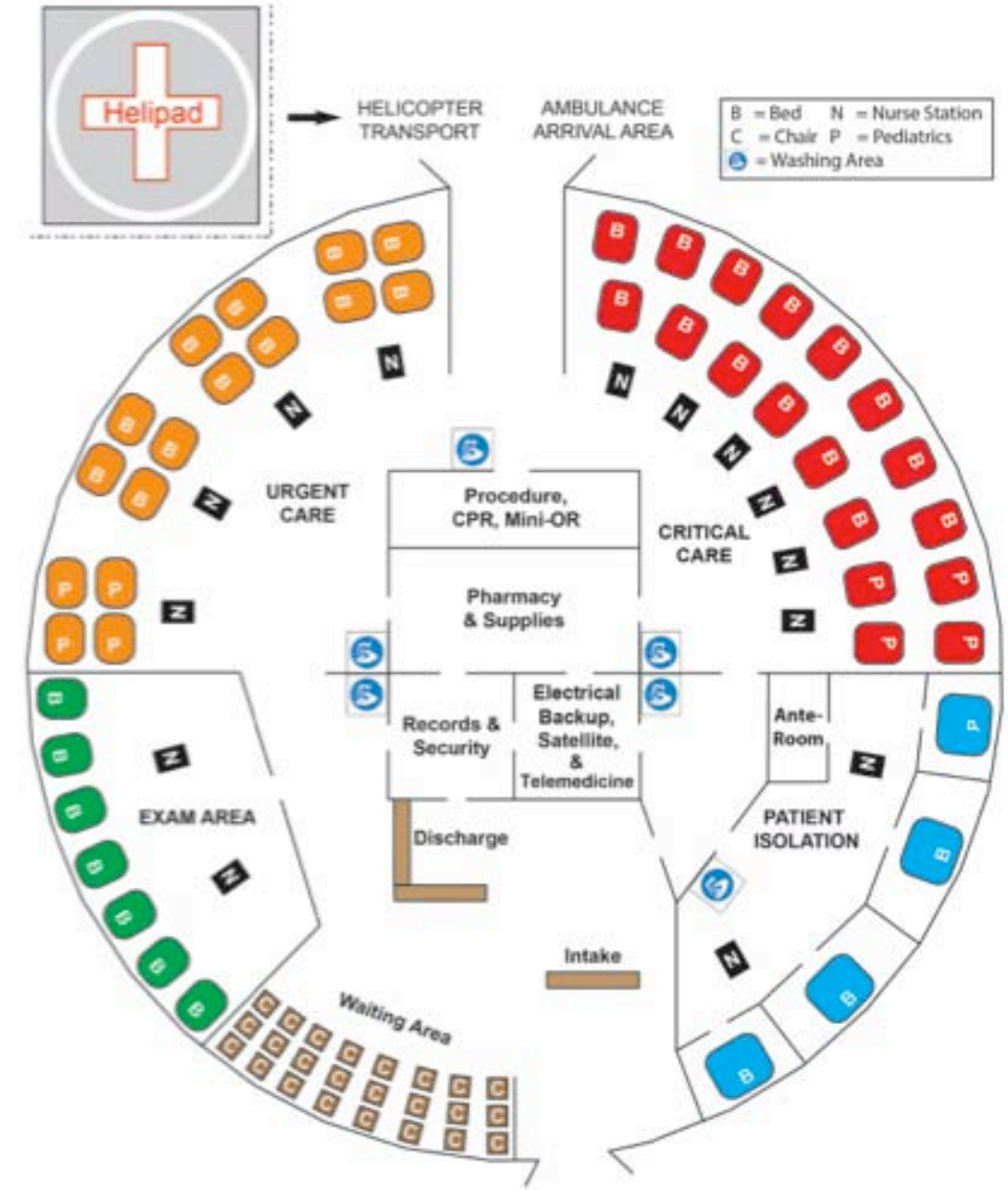
- Automated
- Integrated POC platform for molecular diagnostic testing
- Influenza subtyping
- Antiviral resistance testing (i.e., Tamiflu)



Provided Courtesy of David Kelso at Northwestern University & Karen Kaul at NorthShore University Health System

Novel Design Alternate Care Facility

…what is missing?



Kost GJ, et al. *Am J Disaster Med*. 2011;6:351-368.

Point-of-Care!

Test Clusters and Isolation

Disaster setting and bloodstream infections

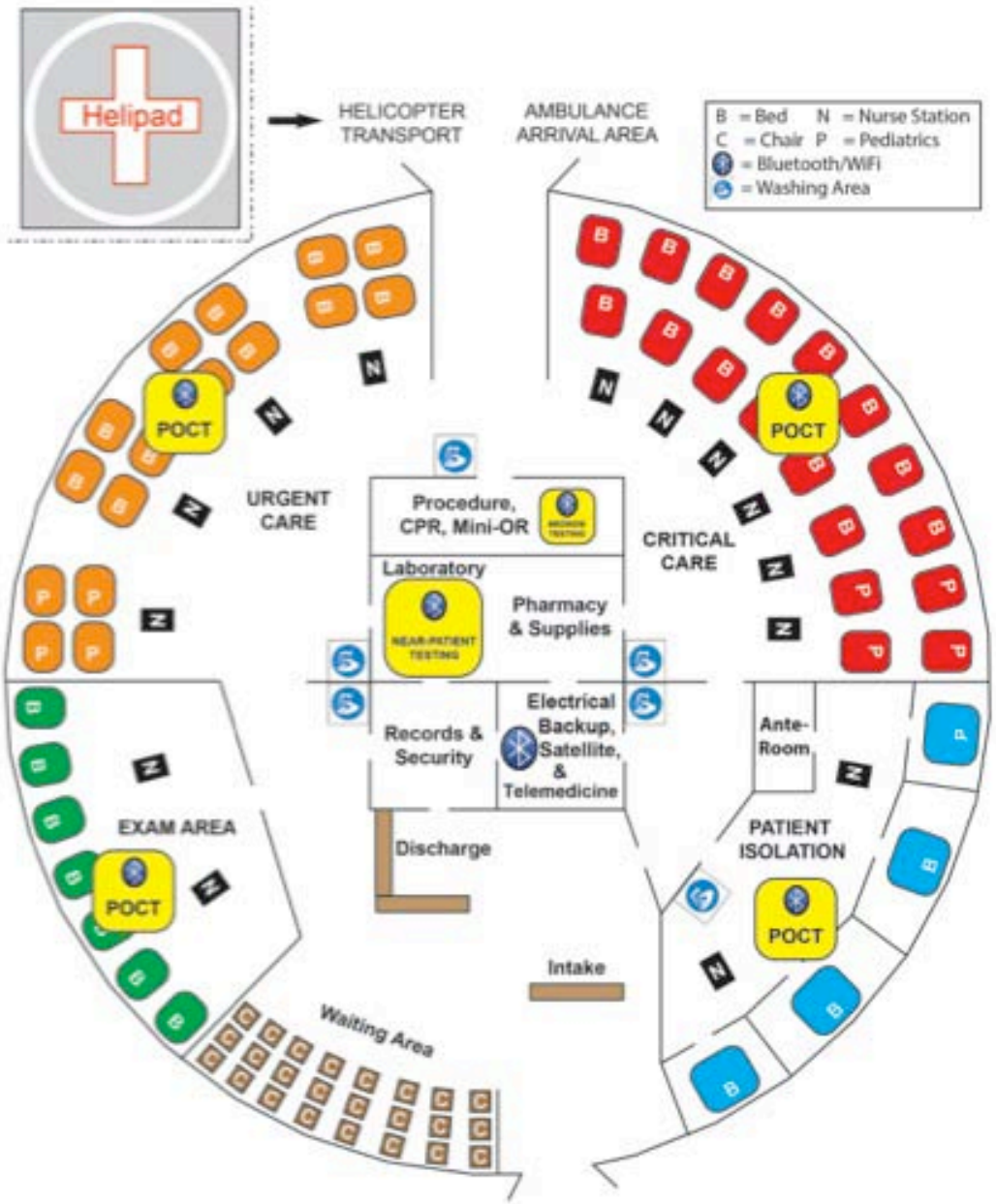
MRSA, *Salmonella typhi*, *Vibrio cholerae*, *E. coli*, *Staphylococcus aureus*, Pseudomonas aeruginosa, Streptococcus pneumoniae, and carbapenem-resistant enterobacteriaceae (*POC* 2012;11:119)

Whole-blood analysis

Electrolytes and blood gases (Cobas b123), viruses

Blood donor screening

HIV, Hepatitis B and C virus (*POC* 2012;11:119)



Kost GJ, et al. *Am J Disaster Med*. 2011;6:351-368.

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Guidelines (recent & in progress)
Clinical and Laboratory Standards Institute

- POCT10-A2. 31;24. Physician and Nonphysician Provider-Performed Microscopy Testing
- POCT11-A2. 31;9. Pulse Oximetry
- POCT12-A3. [in progress] Point-of-Care Blood Glucose Testing in Acute and Chronic Care Facilities
- POCT13-A3. [in progress] Glucose Monitoring in Settings Without Laboratory Support
- POCT14-P. [in progress] Point-of-Care Testing for Infectious Diseases
- GP36. [in progress] Planning for Laboratory Operations During a Disaster
- *POCT15. Emergency and Disaster Point-of-Care Testing. Kost GJ and Nichols J, Co-Chairs [in progress]*

AACC ANNUAL MEETING & CLINICAL LAB EXPO 2013

JULY 28 – AUGUST 1 | HOUSTON

Sarah Brown, PhD, Symposium Chair
"Clinical Chemistry in Disaster Response and Resource-Poor Environments"

Dr. Kost, Speaker
"The Use of Small-World Networks and Technological Advances in Point of Care for Disaster Preparedness, Response, and Resilience"

Two Other Speakers

Carla Orner, MBA, MT, of Heart-to-Heart International, will present her experience with mobile laboratories in the U.S. and with quality assurance initiatives in Haiti. Sarah Halcomb, MD, will speak about test utilization by emergency physicians in disaster response and low-resource settings, share examples of what was available after the Haiti earthquake, and contrast them to ideal laboratory support.

Session 32214, Monday, July 29, 2:30 - 5:00pm

George R. Brown Convention Center

Needs Assessment Research Papers

- Kost GJ, Hale KN, Brock TK, Louie RF, Gentile NL, Kitano TK, Tran NK. Point-of-care testing for disasters: needs assessment, strategic planning, and future design. *Clin Lab Med*. 2009;29:583-605.

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