Why We Should be “P Sammy: The Problem with Peripherally Inserted Central Catheters

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Assistant Professor of Medicine
Conflicts of Interest

Grant Funding:
- Blue Cross Blue Shield Foundation of Michigan
- Agency of Healthcare Research and Quality
- National Institute of Aging
- VA Center for Clinical Management Research
Overview

• Introduction and Background
• Why We Should Be “Piccy”
• Improving PICC Use in Michigan Hospitals
• Engineering Solutions to Improve PICC Use
• Conclusions
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Trends in Hospital LOS By Region: 1965-1980

Average LOS in 1970s
7-10 days

SOURCE: Vital and Health Statistics, series 13, Nos 2, 10, 14, 17, 19, 23, 26, 31, 41, 46, 55, 60, 64 (Washington, D. C.’ National Center for Health Statistics, 1967-82)
Osteomyelitis
Endocarditis
Pancreatitis
Non-functional GI Tract
• UM trained surgeon (Class of 1964)
• Develop an “outpatient” catheter for total parenteral nutrition
• Key requirements:
  – Durable
  – Easy to insert
  – Self care compatible
“My goal was to shift patient care from the hospital to the home...”

Verne L. Hoshal, MD
(via telephone)
• Inserted 36 catheters using this method
• Mean dwell time: 20.4 days (4-36 days)
• 30 of 36 catheters lasted the entire duration
• 6 catheters developed infection and phlebitis
PICC Orders at UMHS: 2006-2012

- **2012**: 14900 PICC Kits (All Vendors), 7800 CVC Kits (Triple Lumen)
- **2011**: 13000 PICC Kits (All Vendors), 7400 CVC Kits (Triple Lumen)
- **2010**: 10200 PICC Kits (All Vendors), 6300 CVC Kits (Triple Lumen)
- **2009**: 7900 PICC Kits (All Vendors), 5900 CVC Kits (Triple Lumen)
- **2008**: 4800 PICC Kits (All Vendors), 4700 CVC Kits (Triple Lumen)
- **2007**: 2400 PICC Kits (All Vendors), 3200 CVC Kits (Triple Lumen)
- **2006**: 1200 PICC Kits (All Vendors), 1800 CVC Kits (Triple Lumen)

Data Courtesy Kristine Komives, Central Sterile Supply
Utilization of PICCs vs. other devices

Lobo et al, J Hosp Med 2011
Safer To Insert

Trauma

Pneumo thorax

Bleeding
PICCs Are **Economically** Attractive

- Enable early discharges
- Transitions of care
- No physician time for insertion of device

Umscheid CA, Anesthesia 2013
Patients love them...
Convenient Venous Access
So Why Be PICCy?
Venous Thromboembolism in Bloodstream Infection
PICC DVT Risk Versus CVCs

Pooled meta-analyses of 12 studies revealed that PICCCs were associated with 2.55x greater risk of Upper Extremity DVT compared to CVCs.
• N=23 studies (57,250 patients)
• 20 of the 23 studies compared PICCs to other devices
• No difference between the rate of infection in patients who got PICCs vs. those that got other devices

Current Systems **Concentrate** On ICUs
2/3 rds of CVCs are now in non-ICU patients

Variable Practices in non-ICU settings
Over 75% of PICCs multiple “idle days” of non use.

Patients with PICCs 5.4 days with a peripheral IV
PICCs were rarely removed prior to discharge

Sheri Chernetsky Tejedor, MD, SFHM; David Tong, MD, MPH; Jason Stein, MD, SFHM; Christina Payne, MD; Daniel Dressler, MD, MSc, SFHM; Wenqiong Xue, MS; James P. Steinberg, MD
Similar Findings in Michigan

- Web-based survey of 220 hospitalists in ten hospitals across the state
- 80% responded that they routinely kept PICCs in place till hospital discharge
- 70% had come across patients with both a PICC and a peripheral IV at the same time

Half of those surveyed admitted to, at least once, having forgotten their patient had a PICC

Chopra V et al., J Hosp Med 2013
“As of yesterday afternoon, did your patient have a urinary catheter?”

Providers were unaware 28% of the time

Attendings were most likely to be unaware (38%)

Do physicians know which of their patients have PICCs?
PICC Awareness Study

“As of this morning, does your patient have a PICC or a CVC in place?”

• Directly examined patients in the AM
• Queried providers (interns, residents, and attendings) the same day after rounds
• Interviewed 990 patients and over 2000 medical providers over 1 year at three academic medical centers
Awareness by Providers

• Interns: not aware 15% of the time
• Senior residents: not aware 10% of the time

General Medicine Attendings and Hospitalists
Not aware of PICC presence: 20% of the time

PICCs were most likely to be associated with lack of awareness (OR 4.8, 3.2-6.9)
Do Clinicians Know Which of Their Patients Have Central Venous Catheters?
A Multicenter Observational Study

Vineet Chopra, MD, MSc; Sushant Govindan, MD; Latoya Kuhn, MPH; David Ratz, MS; Randy F. Sweis, MD; Natalie Melin, BA; Rachel Thompson, MD; Aaron Tolan, MD; James Barron, MD; and Sanjay Saint, MD, MPH

Background: Complications associated with central venous catheters (CVCs) increase over time. Although early removal of unnecessary CVCs is important to prevent complications, the extent to which clinicians are aware that their patients have a CVC is unknown.

A total of 209 patients were identified, of which 60.3% (126 of 209) were PICCs. A total of 21.2% (90 of 425) of clinicians interviewed were unaware of the presence of a CVC. Unawareness was greatest among patients with PICCs, where 25.1% (60 of 239) of clinicians were unaware of PICC presence. Teaching attendings and hospitalists were more frequently unaware of the presence of CVCs than interns and resi-

Whose Line Is It Anyway?

The show where everything is made up, and the points don’t matter.” That is how Drew Carey used to introduce the improvisational comedy television show Whose Line Is It Anyway? Players made everything up as they went along, and no one really kept score. If only medicine could be that way, but it is not.

Our notes are scripted, our actions increasingly regimented according to clinical protocols and evidence-based guidelines, and you bet that everyone is keeping score: payers, administrators, patients, and physicians. That medical practice is less the “art” it used to be has been com-

mine whether the CVCs were still indicated, and did not survey nurses, at face value the rate of unawareness is troubling.

Perhaps nothing is wrong here, as the most important limitation of this study is the lack of data on outcomes.

Did patients whose clinicians were unaware of their CVCs have more complications? However, because we know that reducing indwelling time by removing CVCs is one of the most effective means of reducing their complications (6, 8), I suspect that the unawareness identified by Chopra and coworkers does matter.
Out of sight - out of mind. True for urinary #catheters over a decade ago. Also now true for #PICCs. #patientsafety

Vineet Chopra retweeted

10/21/14, 3:46 AM

Philip Lederer
@philiplederer

@DrJudyStone @sanjaysaint @apc_md @eliowa
@TimLaheyMD EMR needs to have a big warning that the patient has a PICC/ central line/ foley

@ivteam ivteam

Ken Catchpole
@KenCatchpole

@MaryDixonWoods @sanjaysaint @vineet_chopra Great stuff...presumably the nurses knew? Docs can't do it all - distributed cognition essential

10/20/14, 10:03 PM
The Problem With Peripherally Inserted Central Catheters

Rapid growth in non-ICU settings
Substantial Variation in Use
Risk of important complications

Important Patient Safety Problem
PICCs Facilitate Lack of Decision Making
Patient Needs 3 More Days of IV Antibiotics Before Discharge

“Can I get the bloodwork done?”

“Do they really need that antibiotic?”

“Can I get by with a small peripheral IV in the leg/neck?”

“Paged by nurse, ‘Your patient has no IV access; consider a PICC?’

Cannot draw blood due to poor veins; consider PICC for this patient.”
Your patient has no IV access....

......consider a PICC?

What are you drawing blood for?

Is that for labs or to give me...

Can I get by without an IV for a...
Not Only True For PICCs

CT Scans
PCI
Medical Devices
Stress Tests
PICCs teach us how technology diffuses in healthcare
Evolution of technology: from inception to maturity

Mapping of the evolution of technology with the Gartner *Hype* Cycle

- PICCs
- Cardiac Stress Tests
- Cardiac Stents
- Imaging
“Iatrogenesis”
Hospital Culture
Patient Safety
Don't place peripherally inserted central catheters (PICC) in stage III–V CKD patients without consulting nephrology.

Venous preservation is critical for stage III–V CKD patients. Arteriovenous fistulas (AVF) are the best hemodialysis access, with fewer complications and lower patient mortality, versus grafts or catheters. Excessive venous puncture damages veins, destroying potential AVF sites. PICC lines and subclavian vein puncture can cause venous thrombosis and central vein stenosis. Early nephrology consultation increases AVF use at hemodialysis initiation and may avoid unnecessary PICC lines or central/peripheral vein puncture.

American Society of Nephrology

5. Don't place, or leave in place, peripherally inserted central catheters for patient or provider convenience.
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PICC Orders at UMHS: 2006-2012

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Lobo et al, J Hosp Med 2011
No Data Available
PICCs placed in hospitalized patients = “buried within DRG”

- Most are placed by nurses (so like urinary catheters), no charge codes are generated
- Only physician placed PICCs are tracked
- National datasets do not contain PICC data

You can’t improve what you can’t measure
Clinical “Laboratory”

- 48-hospital, Blue Cross Blue Shield of Michigan/Blue Care Network-funded quality initiative
- 10 Pilot Hospitals Focusing on PICCs:
  - Appropriateness
  - Predictors of Harm
  - Interventions
Robust Data Collection

- Trained abstractors at each hospital; EMR data
- Defined data collection protocol and template
- Operations Manual
- Auditing of Data Quality from a central coordinating center
- Real-time feedback – nurse coordinators assigned to hospitals and available to respond to questions and issues as they arise
knowledge
Early data from this collaborative
Volume of PICC Data Collected

2,396 completed cases as of Sept 30th 2014
Number of PICC Indications Selected

- 75.9%
- 19.5%
- 4.2%
- 0.3%
Placement Indication – 1 selection

- Multiple Incompatible Fluids: 11
- Unknown: 51
- Parenteral Nutrition: 62
- Chemotherapy: 119
- Medications Requiring Central Access: 141
- Other: 265
- Difficult Access/Blood Draws: 567
- Home Antibiotics: 602
PICC Dwell Times

- 0-7 Days: 35.3%
- 8-14 Days: 23.2%
- 15-30 Days: 17.6%
- 31-45 Days: 8.5%
- 46-60 Days: 4.1%
- Unk/Still in: 11.4%
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Statistically significant variation across hospitals for Double and triple lumen PICCs
## Major Complications

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVT Cath Thromb Overlap</td>
<td>0.8%</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1.0%</td>
</tr>
<tr>
<td>CLABSI</td>
<td>1.1%</td>
</tr>
<tr>
<td>DVT</td>
<td>4.2%</td>
</tr>
<tr>
<td>Cath thromb w/ lumen</td>
<td>10.7%</td>
</tr>
</tbody>
</table>

Catheter thrombosis: Increased use of t-PA and prolongation of hospitalization (p<0.001)
Follow Up – EMR Success Rate

<table>
<thead>
<tr>
<th>Time</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 day</td>
<td>96.7%</td>
</tr>
<tr>
<td>60 day</td>
<td>92.7%</td>
</tr>
</tbody>
</table>

*Of patients that coordinating center believes should have information at time-point*
next steps
Moving Forwards...

• Expansion to other sites across the CQI
  – April 2015 (over 50 hospitals)
• Reduce variation in use (under- and over-use)
• Design interventions to reduce PICC-related complications and promote appropriate use
• Reduce cost, morbidity and mortality in patients who receive these devices
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Reminders of PICC Presence

- Up to 50% of providers at least once “forgotten” their patient has a PICC
- Many providers do not remove PICCs when therapy completed in hospital settings
- Providers may often be unaware that their patients have a PICC in place!

Why does awareness matter?

Each day with a PICC: ↑Risk of Complications
Early Removal of CVCs

A Cornerstone To Prevention of Complications

Contingent on Awareness
How may providers forget?

Which of these patients has a PICC?
Did you guess right?
It’s **NOT** Hard To Forget….

- **Lack of PICC or CVC Awareness**
  - Lines covered by gown
  - Lack of discussion of lines on daily rounds
  - Lack of awareness of risks associated with retention
  - No place in EMR identifying active lines
  - Lack of MD-RN communication about central venous catheters
  - No signs in room/signs not visible/ignored
  - Inherited care of patient from prior team or transfer

- **Patient comfort/dignity**
  - Multiple patients on a team
  - More clinically pressing issues to discuss about patient care

- **Sign ignored due to being in a hurry, seeing multiple patients**
  - No policy in place for documentation
  - No clear responsibility for sign being placed (RN versus VAST)

- Cluttered next to other signs (e.g. critical airway, hard of hearing)
  - Phlebotomy techs may not be aware they need to ask if pt has side that cannot be drawn from
  - Not always signed out in transition of care/handoffs
What we need is a system...
Catheter Detection and Reminder System

Activated when device (e.g., PICC or urinary catheter) inserted by nurse

Sends signal to light panel above bed

Colors change to reflect duration of catheter

Ultimately – integrate into the electronic medical record, auto-populate progress notes
Read range equation where $r$ is the read range in meters, $\lambda$ is the wavelength, $P_t$ is the power into the transmitting antenna, $G_r$ is the gain of the transmitting antenna, $G_t$ is the gain of the tag antenna, $P_{th}$ is minimum threshold power to operate the tag, and $\tau$ is a factor describing how well the tag’s chip and antenna are impedance matched.

The values inputted were:

$\lambda=0.328$ m, $G_t=3.55$, $G_r=1.41$, $P_{th}=100\mu$W, $\tau = 0.7$. 
“Heart” of the Technology

Arduino Uno with ATmega328

Interface Board

M9

Antenna

LED array

6VDC

Rx

Tx

Gnd

DC Power Jack (6V)

Reset Button

10K

1.00uF

2N2222A

3 AA (4.5 V) Backup Batteries
A: Design assembly contains the covered alarm light scheme front piece that attaches to the RFID technology and Arduino casing. B: Placement of the device above the bed permits communication with the RFID tag on the patient. C: The flexible RFID tag will be placed in between the dressing by a nurse for a PICC and attached to the bag of a urinary catheter. Tegaderm will be used as the adhesive for the RFID tag to its respective location based on the catheter type.
Field Testing Results
(20 UMHS ICU and Floor Nurses)

“Compared to your current workflow, does this system improve your recognition of the presence and duration of catheters?”

- Improved: 19
- Same: 1
- Not Improved: 0
Field Testing Results

Percentage of Tests Passed
Per Alert Stage Per Design Scheme

Low Risk: 86% (White) 100% (Color Changing)
Moderate Risk: 36% (White) 71% (Color Changing)
High Risk: 93% (White) 100% (Color Changing)
Field Testing: User Preferences

Preference for Design Scheme

- Color Changing LEDs: 15%
- White LEDs: 85%

Preference for Moderate Risk LED Color

- Yellow: 95%
- Blue: 5%
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“It may seem a strange principle to enunciate as the very first requirement in a hospital to do the sick no harm.”

Florence Nightingale
Peripherally Inserted Central Catheters

Plateau of Productivity
The Future
NEXT EXIT
THANK YOU

GRACIAS

ARIGATO

SHUKURIA

MERHABAN

JUSPAVAR

GAZAIMASHITA

EFCHARISTO

TASHAKKUR ATU

SUUKSAMA

KOMAPSUNIDNA

GRAZIE

MEHRBANI

PALDIES

TINGKI

SHUKRIA

BIYAN

BOLZIN

MERCY

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