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Central Line Associated Bloodstream Infections:
Is achieving zero possible?

How much is infection prevention worth?

1. **Insertion bundle for zero risk for CLABSI**
   How large is the CLABSI problem ?
   How did we introduce bundle intervention ?

2. **Dwell time associated with increased risk of CLABSI**
   Is every patient with a CVC at risk of CLABSI?

3. **Surveillance analysis to assist CLABSI prevention**
   Is there a better surveillance method to identify dwell time for targeting infection control efforts?

4. **Other CLABSI prevention methods**
   Some are expensive so which patients should have additional prevention resources?

CDC DEFINITION OF A *CENTRAL LINE*

Insertion site or device type ARE NOT used to determine line as central line

Central line:

intravascular catheter that terminates at or close to the heart or in one of the great vessels which is used for infusion, withdrawal of blood, or hemodynamic monitoring

Great vessels:

Aorta, pulmonary artery, superior vena cava, inferior vena cava, brachiocephalic veins, internal jugular veins, subclavian veins, external iliac veins, common femoral veins [& in neonates: the umbilical artery/vein]

CVL MUST terminate in a great vessels or in/near the heart

National Healthcare Safety Network 2006/2010

Number patients with ≥1 central lines in situ = ∑ central-line days

Laboratory Diagnosis

Criterion 1. *recognised pathogen from ≥ B/C*

And

organism cultured from B/C is not related to infection at other site

Criterion 2. *patient has at least 1: fever (>38˚C) or chills or hypotension*

And

common skin contaminants

(Corynebacterium spp, Bacillus spp, Proprionibacterium spp, coag neg staph, strep viridians, Aerococcus spp, Micrococcus spp) is cultured from ≥2 B/C drawn on separate occasions.

Rate = ***Lab diagnosis CVL related BSI***

number of patients with ≥1 central lines

How large is the CLABSI problem ?

World Health Organization. Report on the Burden of Endemic Health Care-Associated Infection Worldwide: A Systematic Review of the Literature. Geneva, Switzerland: World Health Organization, 2011. Available at: http://whqlibdoc.who.int/publications/2011/9789241501507_eng.pdf.

12.2 infections per 1,000 central line-days

How large is the CLABSI problem in adult ICUs?

/1000 line days

Australia

32 NSW

3.7 (95%CI 2.5-5.3)

McLaws ML, Taylor P *J Hosp Infect* **2003**; 53 (4): 260-268.

13 VIC

2.3 (95%CI 1.5-3.3)

Russo PL, Bull A, Bennett N, et al.. *Am J Infect Control* **200**6;34: 430-6.

USA 5266

Average 2.0 range across 10 ICUs 1.0 to 5.6

Edwards JR, Peterson KD, Andrus M et al. *Am J Infect Control* **2008**; 36:609-26.

Germany 248

2.0 (95%CI 1.8-2.1)

Gastermeier P et al. JHI **2006**; 64:16-22.

What does this mean in terms of infected patients per year?

Germany

920 from 248 ICU ≈ 4 each ICU / year

USA

5266 from 1045 ICU ≈ 5 each ICU / year

AUSTRALIA (NSW + Victoria)

106 from 45 ICUs ≈ 2 each ICU / year

What does this mean in terms of death per year ?

attributable mortality 12% -25%

CDC. Vital Signs: Central line – associated blood stream infections – United States, 2001, 2008, and 2009. MMWR 2011; 60(8): 243-8.

≈1 death each ICU / year

15 years of Evidence

CLABSI is preventable

Early highlights on *prevention*

- **Prevention of central venous catheter-related infections by using maximal sterile barrier precautions during insertion.** Raad II et al. *Infect Control Hosp Epidemiol* 1994; 15:231-8.

- **Eliminating catheter-related bloodstream infections in the intensive care unit.** Berenholtz et al. *Crit Care Med* 2004; 32 (10): 2014-2020.

- **Prevention of intravascular catheter infection.** Eggimann P. *Curr Opin Infect Dis* 2007; 20:360-369

Major collaborative studies

- **CLABSI rate ⬇ by 68% to 1.36/1000 line days** over a 4 year period 69 ICUs in South Western Pennsylvania

  *MMWR. 2005;54:*1013-1016. *& JAMA* 2006; 269-270.

- **Comparable results were obtained in 46 ICUs in New York State & a group of Veterans Affairs hospitals**

  Koll BS et al. *Jt Comm J Qual Patient Saf* 2008;34:713-723.

  Bonello RS et al*. Jt Comm J Qual Patient Saf* 2008;34:639-645.

- **A regional collaborative study 44 ICUs underway in Tuscany**

  Rodell S et al.*Qual Saf Health Care* 2008;17:20-21.

- **Low resourced setting**

  Marra AR, Cal RG, Durao MS et al. *Am J Infect Control* 2010;38:434-439.

Keystone ICU Project

Pronovost P, Needham D, Berenholtz S, et al. An intervention to decrease catheter-related bloodstream infections in the ICU. N Engl J Med 2006;355:2725-2732

Pronovost et al ***NEJM* 2006**;355(26): 2725-32.

Pronovost et al ***BMJ* 2010**;340:c309.

55 then 108 ICU Michigan

0 months	**median 2.7 (IQR 0.6 - 4.8) /1000 line-days**
3 months	**median 0.0 (IQR 0.0 - 2.4) /1000 line-days**
16-18 months	**median 0.0 (IQR 0.0 - 3.0) /1000 line-days**
34-36 months	**median 0.0 (IQR 0.0 - 1.2) /1000 line-days**

How did NSW introduce bundle intervention ?

Aim: all 37 public ICUs in NSW

How did NSW introduce bundle intervention ?

Multidisciplinary support

Clinical Excellence Commission

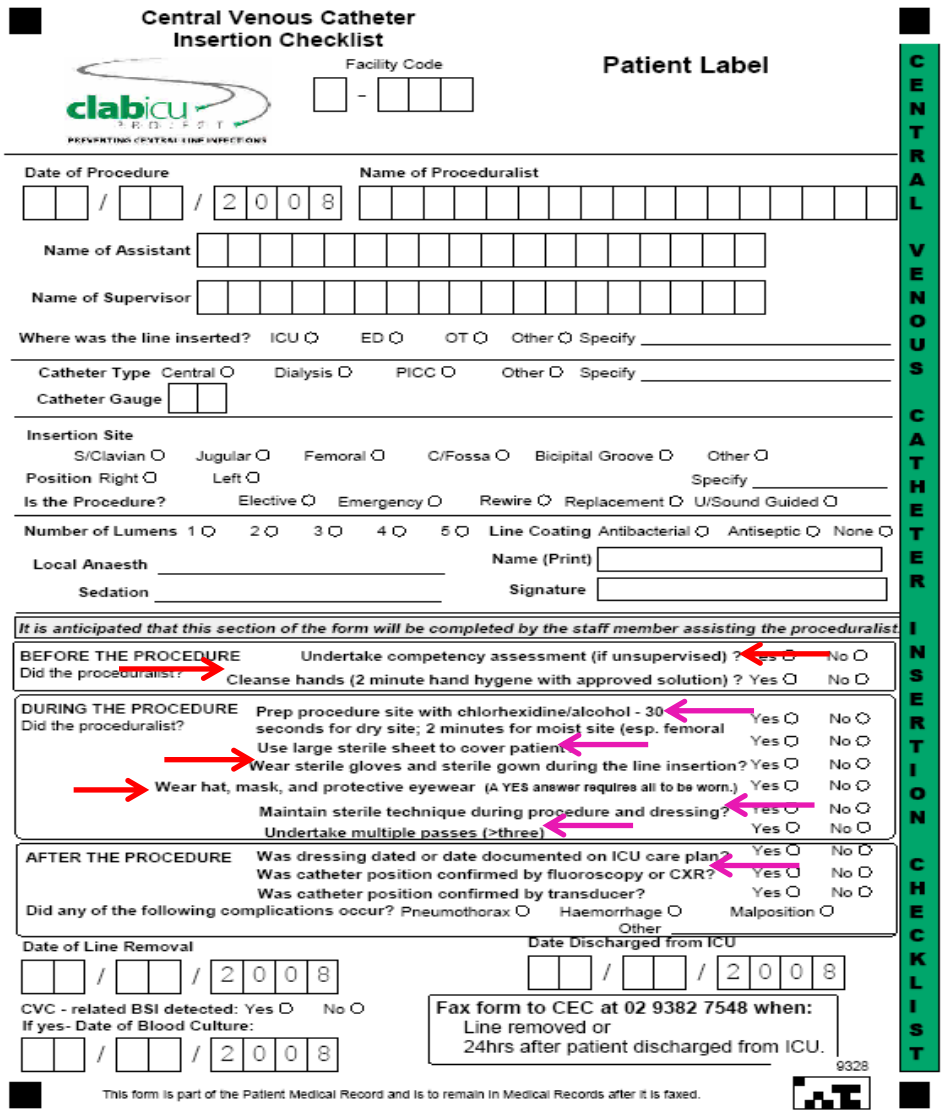
Intensive Care Centre Monitoring Unit

NSW Ministry of Health

Physician and Nurse from every ICU

Burrell A, McLaws ML, Herkes R, Mungo M, Pantle A. Aseptic insertion of central lines reduces bacteraemia: The NSW Central Line Associated Bacteraemia Collaborative (CLAB-ICU). *Med J Aust* 2011; 194: 583-587.

Checklist produced



Central Venous Catheter Insertion Checklist

clabicu PROJECT — PREVENTING CENTRAL LINE INFECTIONS

Facility Code

Patient Label

CENTRAL VENOUS CATHETER INSERTION CHECKLIST

Date of Procedure / / 2008

Name of Proceduralist

Name of Assistant

Name of Supervisor

Where was the line inserted? ICU ○ ED ○ OT ○ Other ○ Specify

Catheter Type Central ○ Dialysis ○ PICC ○ Other ○ Specify

Catheter Gauge

Insertion Site
S/Clavian ○ Jugular ○ Femoral ○ C/Fossa ○ Bicipital Groove ○ Other ○

Position Right ○ Left ○ Specify

Is the Procedure? Elective ○ Emergency ○ Rewire ○ Replacement ○ U/Sound Guided ○

Number of Lumens 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ Line Coating Antibacterial ○ Antiseptic ○ None ○

Local Anaesth Name (Print)

Sedation Signature

It is anticipated that this section of the form will be completed by the staff member assisting the proceduralist

BEFORE THE PROCEDURE
Did the proceduralist?
- Undertake competency assessment (if unsupervised) ? Yes ○ No ○
- Cleanse hands (2 minute hand hygene with approved solution) ? Yes ○ No ○

DURING THE PROCEDURE
Did the proceduralist?
- Prep procedure site with chlorhexidine/alcohol - 30 seconds for dry site; 2 minutes for moist site (esp. femoral — Yes ○ No ○
- Use large sterile sheet to cover patient — Yes ○ No ○
- Wear sterile gloves and sterile gown during the line insertion? Yes ○ No ○
- Wear hat, mask, and protective eyewear (A YES answer requires all to be worn.) Yes ○ No ○
- Maintain sterile technique during procedure and dressing? Yes ○ No ○
- Undertake multiple passes (>three) Yes ○ No ○

AFTER THE PROCEDURE
- Was dressing dated or date documented on ICU care plan? Yes ○ No ○
- Was catheter position confirmed by fluoroscopy or CXR? Yes ○ No ○
- Was catheter position confirmed by transducer? Yes ○ No ○

Did any of the following complications occur? Pneumothorax ○ Haemorrhage ○ Malposition ○ Other

Date of Line Removal / / 2008

Date Discharged from ICU / / 2008

CVC - related BSI detected: Yes ○ No ○
If yes- Date of Blood Culture: / / 2008

Fax form to CEC at 02 9382 7548 when:
Line removed or
24hrs after patient discharged from ICU.

9328

This form is part of the Patient Medical Record and is to remain in Medical Records after it is faxed.

Clinician bundle

- Undertake competency assessment
- Clean hands
- Sterile gloves/gown
- Hat mask protective eyewear

Patient bundle

- Prep with 2% chlorhexidine & dry 2 mins
- Large sterile drape
- Maintain sterile technique
- No multiple passes
- Confirm catheter position

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What data did we collect and why ?

Q. Did the ICU staff co-operate with the bundle?

Patient Bundle: aseptic insertion of central line

patient fully draped & skin prep

Clinician Bundle: hat, mask, hand hygiene, glove, gowns

check inserted properly - transducer/x-ray

Q. Could anything else been responsible for change in CLABSI rate?

Potential confounder: type of central line, insertion site, coating

level of ICU

compliance with bundles

ALOS

accreditation for insertion

What issues effected co-operation?

☹ **Initial clinician resistance**

‘We don’t have CLABSIs’

‘I don’t believe the evidence’

4 ICUs would not wear hats

‘Where’s the money?’ (Data collection/reporting)

Apathy

☺ **Overcome these by…**

Increased involvement by senior intensive care physicians

Increased checking of data submitted to Commission

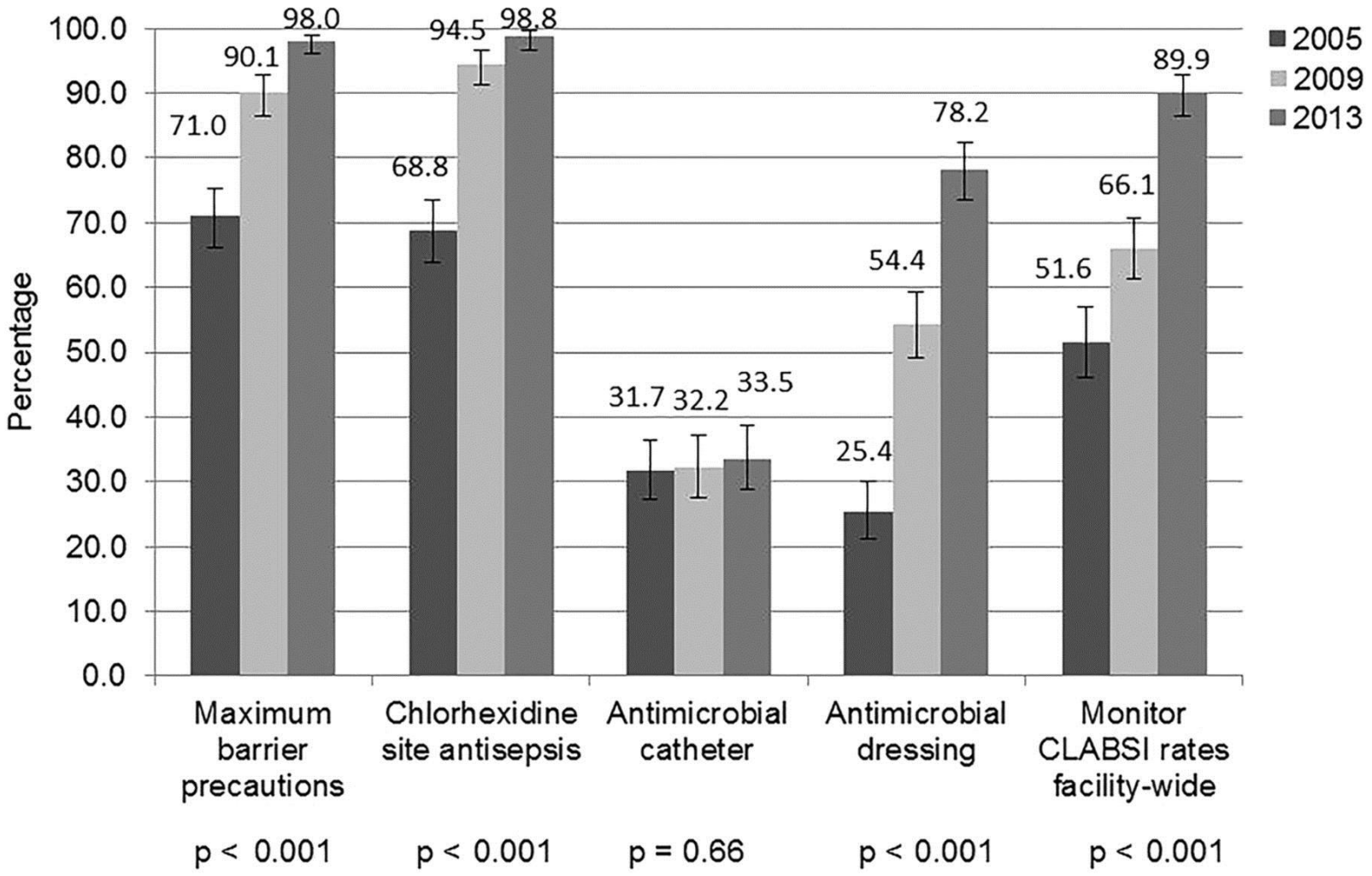
Increased feedback reports from us to participating units

Checklist Compliance rate for all units

After Safe Insertion

Entire patient draped	**93%**
Alcoholic chlorhexidine prep allowed to dry	**96%**
Sterile technique maintained	96%
Hat, mask, eyewear	80%
Hands washed 2 mins	92%
Sterile gown/gloves	96%
Competency assessed	48% (23% No; 29% missing)
No multiple passes	81%
Confirm position radiologically	74%
Other method to confirm placement	44% (45% No; 11% missing)

Per cent of hospitals that regularly use practice to prevent Central Line-Associated Bloodstream Infection (CLABSI).



Sarah L Krein et al. BMJ Qual Saf doi:10.1136/bmjqs-2014-003870

How successful was the intervention ?

☹ CLABSI rate higher - clinician who **<u>did not</u>** wear ***<u>hat</u>*** compared with clinicians who did

RR 1.6 (CI_{95} 1.1 - 2.4 p=0.0178)

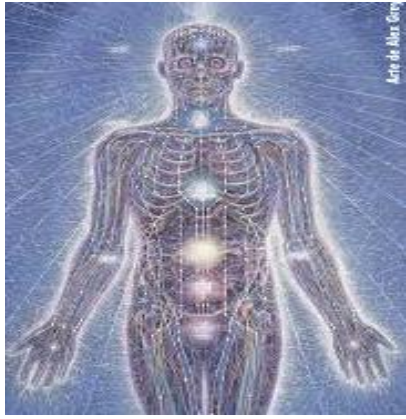
- Central RR 2.0 (CI_{95} 1.2 - 3.2 p=0.0037)
- PICC RR 5.1 (CI_{95} 1.03- 25.0 p=0.059)

Conclusion: Proxy for other poor IC related behaviours

☺ Compliers with *clinician* + *patient* bundles

RR CLAB **0.6** (CI_{95} 0.4-0.9, p=0.0103)

How successful was the intervention ?



10,575 centrally inserted lines

No confounding dwell time or catheter utilization

1-12 months 3.7 (95%CI 2.4-4.6)/1000 line-days **[37/10974]**

13-18 months 1.5 (95%CI 1.1-2.0)/1000 line-days **[40/26668]**

RR 0.44 (95%CI 0.28- 0.70) *p*=0.0003

McLaws ML, Burrell A. Zero risk for central line-associated bloodstream infection: Are we there yet? Critical Care Medicine 2012 Feb;40(2):388-93

Lessons

Collaboration worked

Feedback loop with local data

Expect difficulties at organisational and clinician level

Clinician network important – needs to be driven by clinicians

Need to identify local champions/opinion leaders and ensure they have time to drive clinical change – not project officers

Encourage local champions to be involved in running project

Need to consider burden of data collection – need infrastructure

Improvements were due to

- Increased awareness of need for scrupulous aseptic insertion
- Increasing compliance with clinician bundle (if non hat wearers their clinician bundle data were coded non complier)
- Not due to ↓femoral lines or ↓dwell time
- Significantly better communication between ICU & infection control
- Greater understanding of surveillance definition
- Increased ownership by ICU care clinicians following reporting of individual ICU CLABSI data

How did we compare with Keystone?

Pronovost et al ***NEJM* 2006**;355(26): 2725-32. **& *BMJ* 2010**;340:c309.

0 months **median 2.7 (IQR 0.6 - 4.8) /1000 line-days**

3 months **median 0.0 (IQR 0.0 - 2.4) /1000 line-days**

16-18 months **median 0.0 (IQR 0.0 - 3.0) /1000 line-days**

34-36 months **median 0.0 (IQR 0.0 - 1.2) /1000 line-days**

Who has reached zero?

CLABSI

The effect on rates of infection were mixed and the effect sizes were small, with the largest median effect for the change in level (interquartile range (IQR)) for the six CLABSI studies being observed at three months follow-up was a decrease of 0.6 (-2.74 to 0.28) cases per 1000 central line days (six studies and 36 sites). This change was not sustained over longer follow-up times. Flogen et al Cochrane Database Syst Rev 2013 doi: 10.1002/14651858.CD00655

Adult:

NNIS (8 studies)	mean rate	**5.8/ 1000 CVC-days**
Beathard 2003	-76%	7.0 → **1.7**/1000 CVC-days
Coopersmith 2002	-68%	11.6 → **3.7**/1000 CVC-days
Parra 2010	-31%	4.2 → **2.9**/1000CVC-days
Warren 2004	-41%	9.4 → **5.5**/1000 CVC-days

Paed/neonates:

Sannoh 2010	-43%	7.0 → **4.0**/1000 CVC-days
Miller 2010	-43%	5.4 → **3.1**/1000 CVC-days

Dubai

2.6 → **1.8** /1000 CVC-days

Latif et al ICHE April 2015 http://dx.doi.org/10.1017/ice.2015.70

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Why aren't we achieving zero infection ?

http://fedoraproject.org/wiki/File:Artwork_F10Themes_Binary_grid_animated.gif

How long after aseptic insertion can you expect The patient to remain free from infection ?

Is every patient with a CVC at risk of CLABSI?

First let's look at the calculation for CLABSI

NNIS in 2005 became *National Healthcare Safety Network*

Central line-associated BSI rate per 1,000 central line-days

$$= \frac{\text{Number of central line-associated BSI}}{\text{Number of central line-days}} \times 1{,}000$$

Represents days of exposure to at least 1 device (not total devices)

"

For device-associated HAI incidence density rates[9]: record daily the total number of patients and ***total number of ....central line-days****....in the patient care area(s) under surveillance; sum these daily counts at the end of the surveillance period for use as denominators" (CDC* ***April*** *2006)*

"*..the number of* ***patients with one or more central lines*** *of any type is collected daily, at the same time each day, during the month and recorded on the Denominators for Intensive Care Unit (ICU)/Other Locations" (CDC* ***May*** *2010)*

Incidence Density – *theory and why this rate is flawed*

$$\frac{\text{Total number of occupational injuries}}{\sum \textbf{Person years} \text{ at-risk of occupational injury}}$$

Allows persons at-risk to contribute their own sum of duration of risk

$$\frac{\text{Total number of CLABSI}}{\sum \text{central } \textbf{line-days} \text{ (for every line in situ is counted)}}$$

or

$$\frac{\text{Total number of CLABSI}}{\sum \text{central line-days (exposure to at least 1 line at time of observation)}}$$

History sophistication of disease frequency and distribution

1620-74 John Graunt quantified disease patterns in *The Nature of Political Observations Made Upon the Bills of Mortality (1664)*

1807- 83 William Farr vital statistics system (1837) for *surveillance* person-time

Statistics for a Fixed population

fixed

Mt (or Mb) in a fixed population is evaluated within successive 'same time' intervals so that time dependence of Mt can be elucidated.

Graunt's Life table

Fixed populations

Table 1. Graunt's Life Table

Age Interval	% Surviving during Interval	% Survived at start of Interval
0-6	36	100
7-16	24	64
17-26	15	40
27-36	9	25
37-46	6	16
47-56	4	10
57-66	3	6
67-76	2	3
77-86	1	1

*Statistics for a **dynamic** population*

dynamic

Persons enter (born, migrate, aging into a stratum) as observation time proceeds.
Some exit (emigrate, die, become diseased) but population is in a steady state

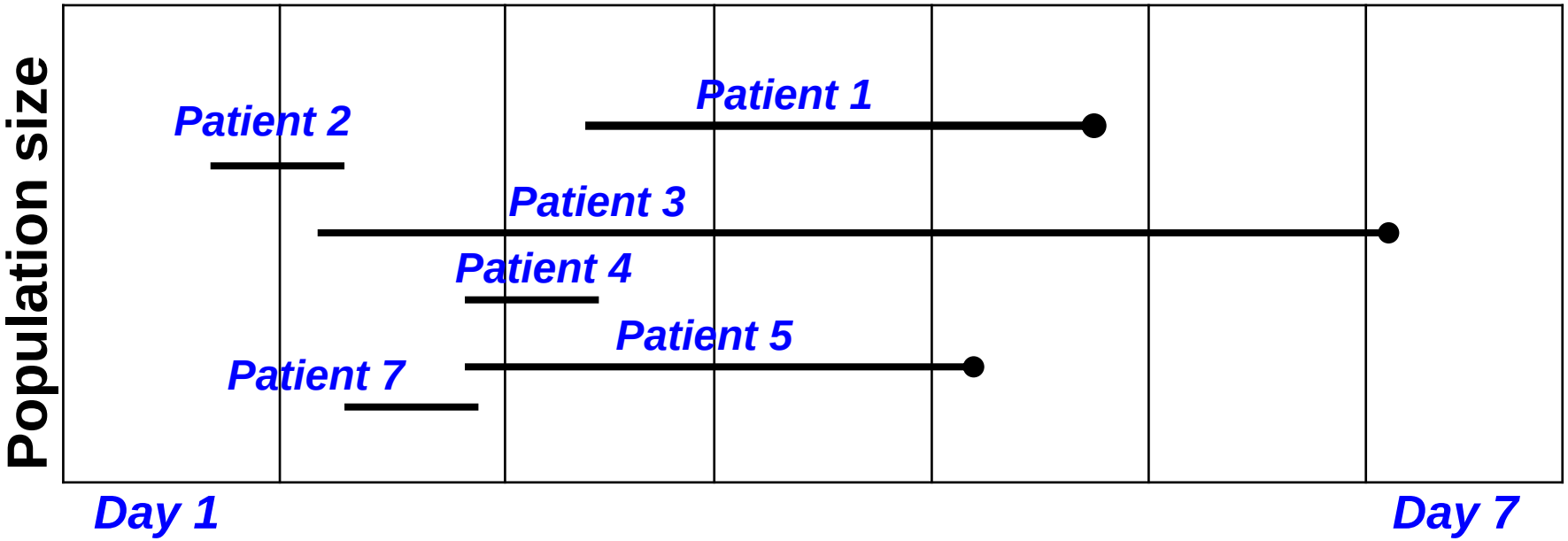
number entering must = number leaving the population to be in a *'steady state'*

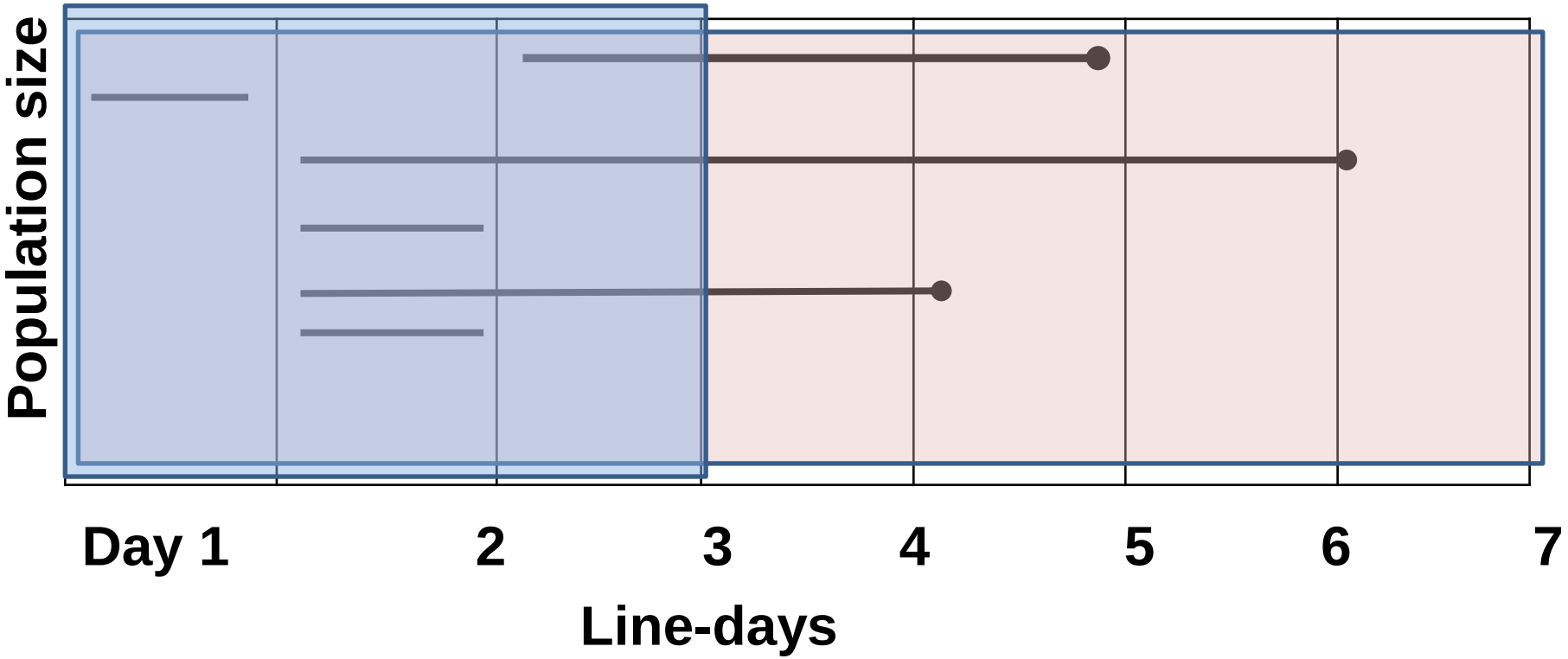
Farr's Person-time

Rules for **incidence density** for a *dyna*mic population:

constant *dwell time* over the audit period

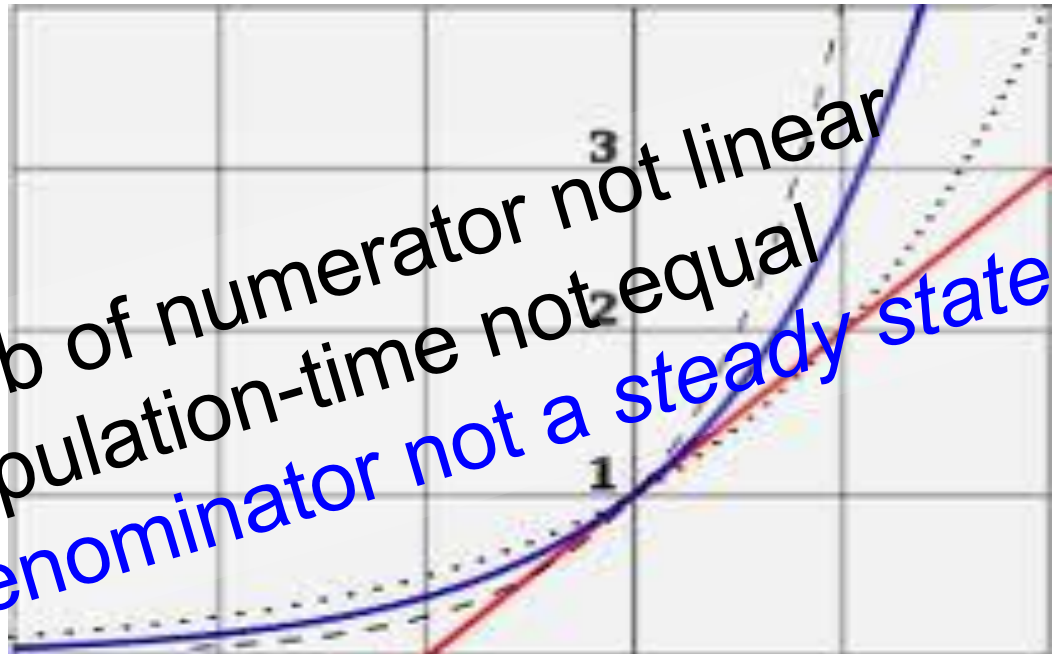
if you take a snap shot of the dwell-time experienced by *dynamic* population should be in a *steady state*





$$\frac{\text{0 CLABSI}}{\text{8 line days}} = \text{0 / 1000} \neq \frac{\text{3 CLABSI}}{\text{14 line days}} = \text{214 / 1000}$$

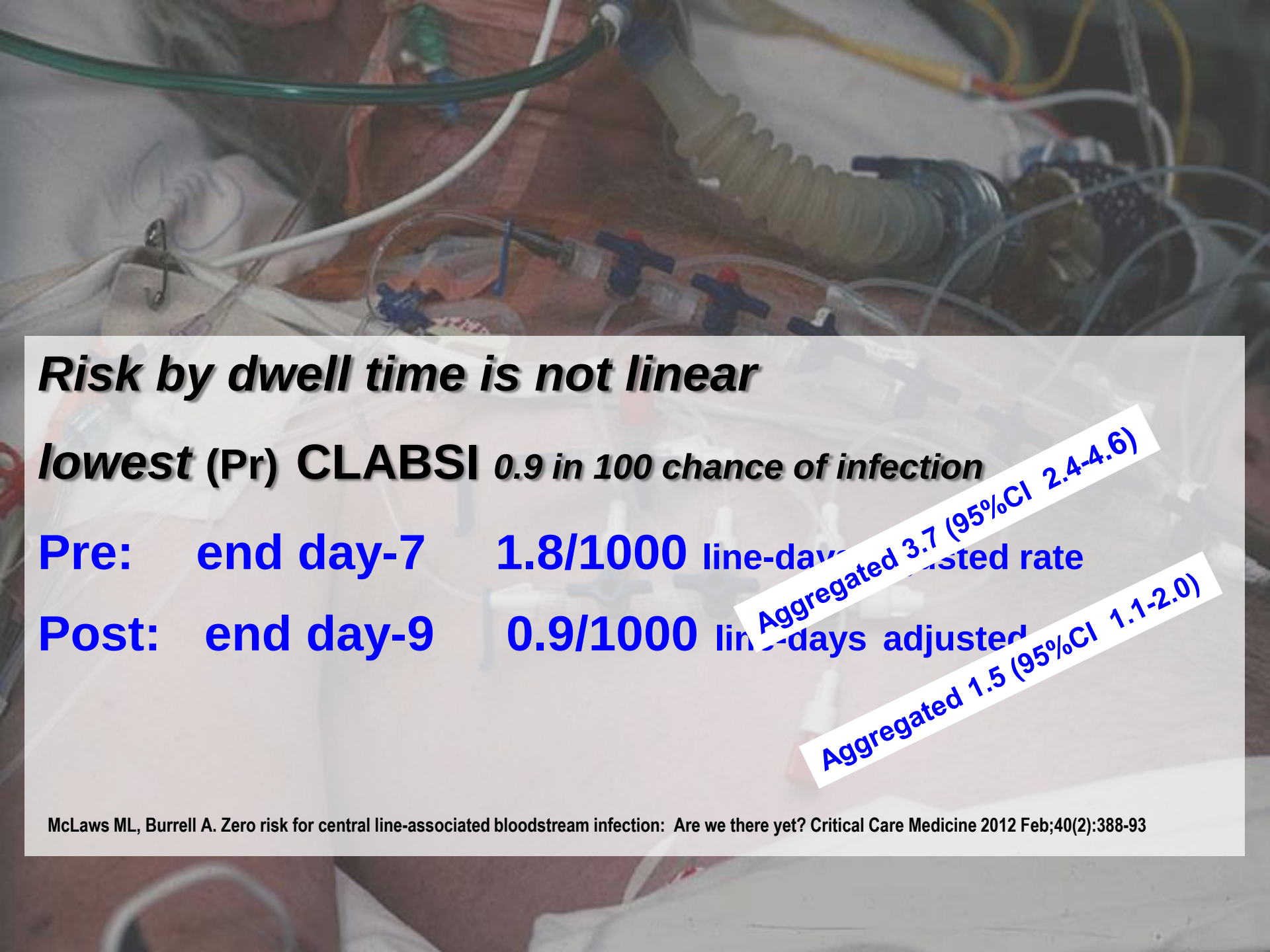
Population-time portion 1 ≠ Population-time portion 2



Current calculation assumes (Pr) CLABSI rate
(Pr)dwell time day1= (Pr)dwell time 2= (Pr)dwell time 3= etc

CDC calculation expects linear relationship and denominator in a steady state

What has this got to do with Zero risk?



Risk by dwell time is not linear

lowest* (Pr) CLABSI *0.9 in 100 chance of infection

Pre: end day-7 1.8/1000 line-day[illegible]sted rate

Post: end day-9 0.9/1000 lin[illegible]-days adjusted

Aggregated 3.7 (95%CI 2.4-4.6)

Aggregated 1.5 (95%CI 1.1-2.0)

McLaws ML, Burrell A. Zero risk for central line-associated bloodstream infection: Are we there yet? Critical Care Medicine 2012 Feb;40(2):388-93

Patients with CVC are dynamic

Patients with a longest dwell time have lowest risks for CLABSI

Analysis needs to assist our CLABSI prevention approach

Q. is there a better method of identifying patients at different risk?

Table 1. Graunt's Life Table (fixed populations)

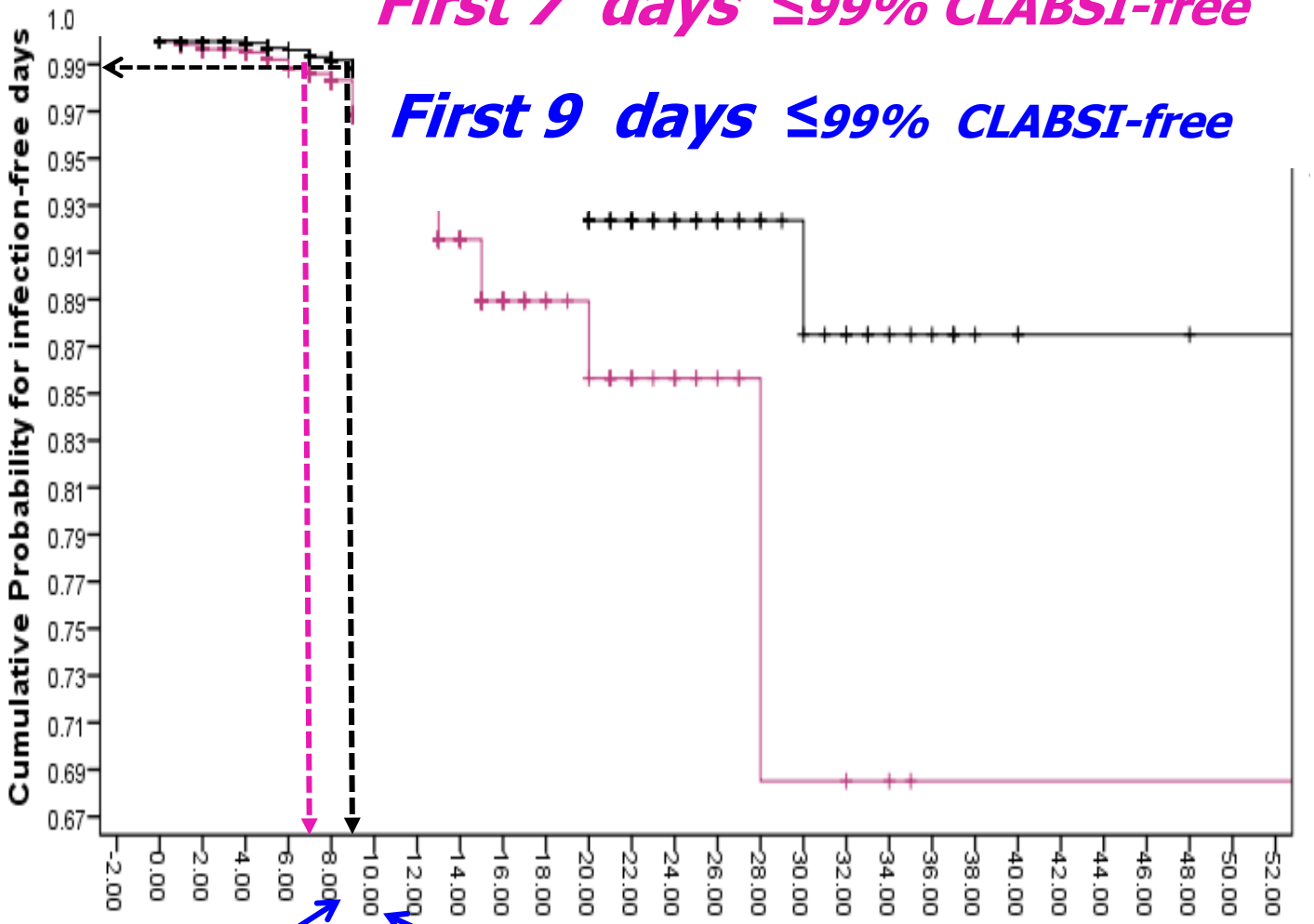
Age Interval	% Deaths in Interval	% Surviving at start of Interval
0-6	36	100
7-16	24	64
17-26	15	40
27-36	9	25
37-46	6	16
47-56	4	10
57-66	3	6
67-76	2	3
77-86	1	1

Dwell time	Total CLABSI	Total Dwell time
1-9 days		
≥10 days		

Level 6 ICUs Dwell time	Adjusted CLABSI /1000 line-days (CI_{95})	Probability CLABSI- *free* for dwell time
Pre-intervention **1-7 days**	**1.8 (0.9-3.3)**	**0.99**
Post-intervention **1-9 days**	**0.9 (0.5-1.5)**	**0.99**

CLABSI average rate for dwell time >9 days 5.5/1000 line-days

Probability CLABSI-free Dwell time



Probability CLABSI-free 1-12 months (+ CLABSI)

Probability CLABSI-free 13-18 months (+ CLABSI)

>Day 9 25% patients

≤Day 9 75% patients

Denominator of this dynamic population is <u>not</u> in a *steady state*

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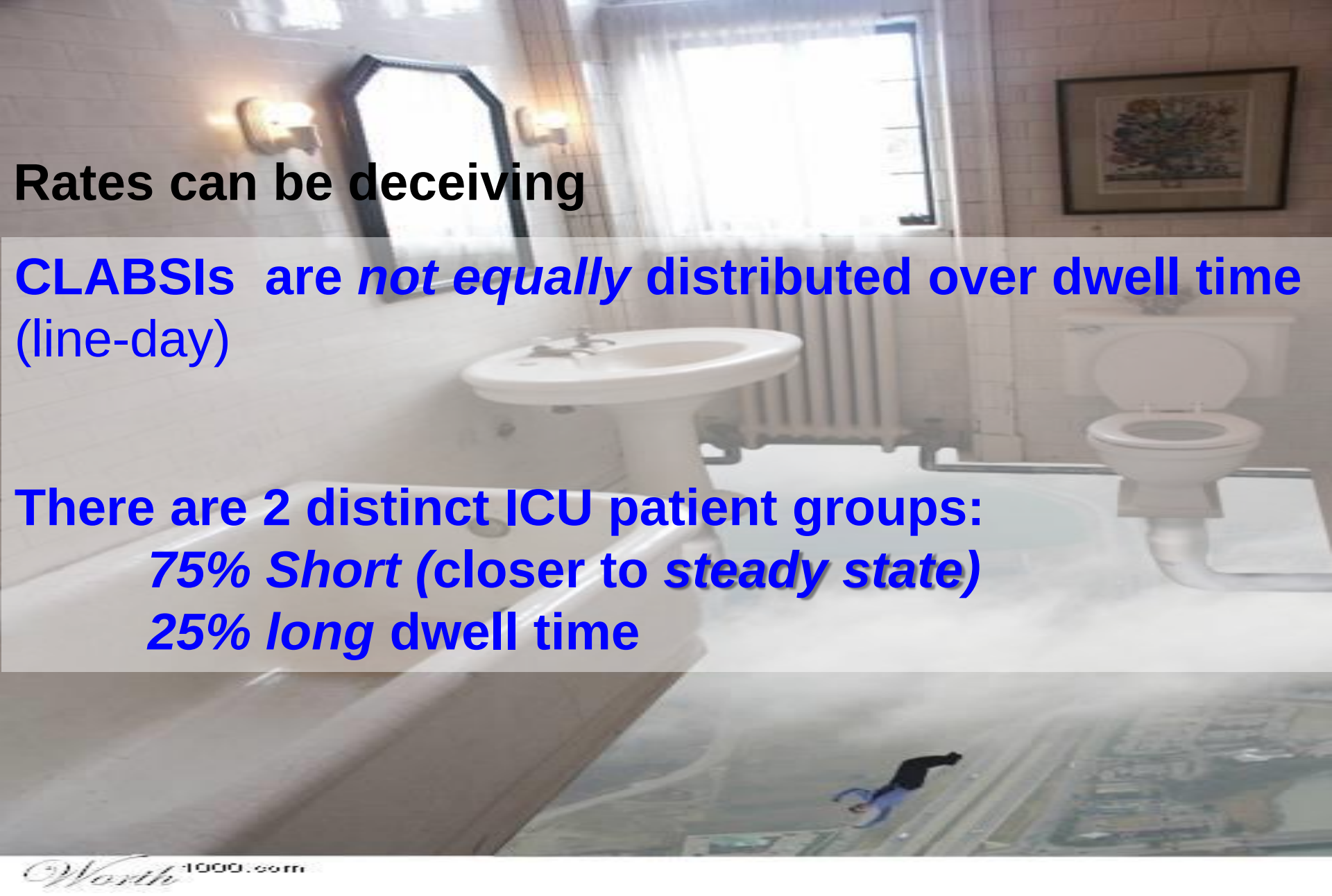

Rates can be deceiving

CLABSIs are *not equally* distributed over dwell time (line-day)

There are 2 distinct ICU patient groups:

- ***75% Short* (closer to *steady state*)**
- ***25% long* dwell time**

Most patients ALOS ICU ≈ 3 – 5 days

Start with dwell day-5 as target of *Zero* CLABSI risk

Work up to first 9-days

McLaws ML, Burrell A. **Zero risk for central line-associated bloodstream infection: Are we there yet?** *Critical Care Medicine* 2012:40(2):388-93

Hospital G

Central 1591

Line-days ranged ≤24 hours – 96 days

25th Day 7; 50th Day 11; 75th Day 17

Days 1-7

Pre-intervention = 1.8 (95%CI 0.9-3.3/1000 CVC-days)

Post intervention = 0.9 (95%CI 0.5-1.5) !!!

Hospital G

	% [lines inserted]
Central	73 [3389]
PICC	15 [700]
Dialysis	11 [533]
Other & not specified	1 [33]
TOTAL lines inserted	100 [**4655**]
lines **Singular**	74%
Concurrent	21%
Sequential	5%

Hospital G

Compliance with bundle items

Area for improvement

- **23% Competency training** (70% no; 7% missing)
- **100% Clean Hands**
- **100% Sterile gloves**

Area for improvement

- **84% Hat**

Area for improvement

- **100% Prep procedure site**
- **96% Sterile drape**
- **100% Sterile technique maintained**

Area for improvement

- **87% No multiple passes**
- **65% Position of line confirmed**
- **59% Used Transducer** (39.7% no; 1.6% missing)

Hospital G *Process Surveillance* for Anatomical insertion sites

Line type	% [lines]
Central:	
Subclavian	36% [80]
Jugular	35% [78]
Femoral	28% [63]
Not specified	-
	100 [257]
Dialysis:	
Femoral	81% [22]
Jugular	11% [3]
Subclavian	7% [2]
Not specified	-
	100 [27]

Area for improvement

Hospital G set *process targets*

1. Insertion site
2. Competency
3. Full sterile drape
4. No multiple passes/transducer

Set progressive targets for CLABSI with

1. dwell time for 50% ICU patients (Day 11)
2. dwell time for 75% ICU patients (Day 17)

CDC/NHSN

Surveillance ...in at least one inpatient location in the healthcare institution for at least one calendar month

simple analysis if numbers are large

CLABSI ≈10 per year Statistically rare

Distribution ***not normal***

Dwell time is not in a ***steady state***

Process surveillance report

- CVC dwell time (range, median, 75th)
- Daily audit: can you remove the CVC ?
- Compliance with *recommended insertion site*
- CLABSI rates: CLABSI in 75% patients (e.g. 1-8 line-day)

  1000 patient-days [95%CI]

  100 patients [95%CI]

- **Counts of prevention**

Hospital G non compliance

improvements pre- and post

83% Clinician Bundle **p=0.0003**

93% Patient Bundle **p=0.049**

Hospital G by length of participation	Counts of *non compliance* with Clinician Bundle [Patient Bundle]
1st 6 months post-intervention	15 [7]
2nd	5 [5]
3rd	8 [0]
4th	9 [4]
5th	4 [3]
6th	2 [0]

CVC inserted in ICU only

Hospital G by length of participation	Counts of CLABSI [Malposition + haem]
1st 6 months post-intervention	8 [4]
2nd	1 [4]
3rd	2 [1]
4th	0 [3]
5th	2 [0]
6th	1 [1]

Malposition+/-Haemorrhage *reduction*

Pneumothorax for 3 years *0.4%* [1 count]

CVC inserted in ICU only

CLABSI Rate (% of insertions)

Length of intervention participation	Hospital G CLABSI /100 insertions *p=0.037*	level 6 (teaching) ICUs CLABSI/ 100 insertions *p=0.0019*
1st 6 months	**13.8%** (95%CI 6.1-25.4)	2.4% (95%CI 1.5-3.6)
2nd	**2.3%** (95%CI 0.06-12.0)	1.4% (95%CI 0.7-2.4)
3rd	**5.3%** (95%CI 0.6-17.7)	0.9%(95%CI 0.4-1.6)
4th	**0.0%** (95%CI 0.0-7.2)	1.0% (95%CI 0.5-1.8)
5th	**5.4%** (95%CI 0.7-18.2)	0.7%(95%CI 0.2-1.5)
6th	**3.2%** (95%CI 0.08-16.7)	0.5%(95%CI 0.2-1.2)

CVC inserted in ICU only

Other CLABSI prevention methods

Some are expensive so which patients should have additional prevention resources?

>9 days average rate **5.5/1000 line-days**

Technologies for expected prolonged dwell time

- antiseptic/antibiotic impregnated lines & locks

Maki DG, et al. A novel antimicrobial and antithrombotic lock solution for hemodialysis catheters: A multi-center, controlled, randomized trial. *Crit Care Med* 2011; 39 (4): 613-620.

Hockenbull JC, et al. The clinical effectiveness of central venous catheters treated with antiinfective agents in preventing catheter-related bloodstream infections: a systematic review. Crit Care Med 2009; 37: 702-712.

CHG bath – requires nursing time

- **CHG**

Timsit JF et al. Chlorhexidine-impregnated sponges and less frequent dressing changes for prevention of catheter-related infections in critically ill adults: a randomized controlled trial. JAMA 2009;301:1231-41.

Post-insertion care

Inexpensive intervention for all dwell time

- early removal of catheters Mermel LA, et al. Clinical practice guidelines for the diagnosis and management of intravascular catheter-related infection: 2009 Update by the Infectious Diseases Society of America. Clin Infect Dis 2009; 49: 1-45.
- where possible removal of CVL on discharge from ICU

So where to from here

Counts of fewer CLABSI

(between last report and the current one)

75% patients should be at **zero risk**

– report for first x days (this cut point will differ by hospital)

Technology

- But for whom?.....

So who gets technology

- Everyone with CVC ?
- Just 25% of patients ***expected*** to have prolonged dwell time ?

Ask CEO

Q. What is your maximum willingness to free up an ICU bed at $4000 per day?

The psychedelic artist *http://en.wikipedia.org/wiki/Alex_Grey*