醫療照護相關感染統計指標介紹

–感染率、感染密度、SIR

Chien-Hwa Chu

Taiwan Centers for Disease Control

大綱

- 為何要進行醫療照護相關感染監測?
- 如何進行醫療照護相關感染監測？
- 風險校正
- 什麼是標準化感染比（SIR）?
- 標準化感染比計算
- SIR數值的解讀意義
- 手術部位感染的指標

為何要進行
醫療照護相關感染監測?

- 偵測醫療照護相關感染的異常事件
- 建立醫療照護相關感染之基礎值及年代趨勢，以規劃院內感染管制措施，提供感染管制措施成效的評估
- 經由醫療照護相關感染的自我監控及院際間的同儕比較，提升感染管制品質
- 提供醫療照護相關感染事件對於經濟和健康衝擊的估計

如何進行醫療照護相關感染監測？

- 感染率
  - 公式：$\frac{\Sigma 感染人次數}{\Sigma 入(或出)院人次數} \times 100\%$
- 感染密度
  - 公式：$\frac{\Sigma 感染人次數}{\Sigma 住院人日數} \times 1000‰$
- 標準化感染比（SIR）
  - 公式：$\frac{實際感染人次}{預期感染人次}$

風險校正

- 感染率
  - 計算中未校正處於不同風險中的差異
- 感染密度
  - 以住院人日數為分母，相較感染率校正住院天數長短之差異
  - 但由於醫院層級和病房種類等結構差異，亦可能使感染密度在判讀上的誤差

什麼是SIR?

- 美國NHSN說
  - The standardized infection ratio (SIR) is a summary measure used to track healthcare-associated infections (HAIs) at a national, state, or local level over time. The SIR adjusts for patients of varying risk within each facility.
  - 換成中文來說：
    標準化感染比(SIR)是一項可以用於追踪國家、州或地方層級一段時間內醫療照護相關感染(HAI)發生情形的綜合性指標。
    SIR是依據每個機構內不同風險病人的組成進行調整。

還是聽不懂?

標準化感染密度

- 由於醫院的醫院層級和病房種類結構不同，可能導致醫療照護相關感染密度判讀上的誤差
  - 例如醫學中心可能因病人疾病嚴重度高，而有較高的院內感染密度
  - 例如以兒科為主的醫院，其院內感染密度較以內科為主的醫院低
- 藉由標準化調整醫院(或病房)間結構差異所造成的比較誤差，使指標更具比較性。
  - 直接標準法
  - 間接標準法

直接標準法vs.間接標準法

- 直接標準化
  - 以醫院本身的感染密度乘以參考族群之住院人日數，藉此求得期望數。
- 間接標準法
  - 以參考族群感染密度乘以本身之住院人日數，藉此求得期望數。
  - SIR採用間接標準法進行計算

標準化感染比計算

- 方法一(舊)
  - 由全國感染密度乘以醫院(或病房)的住院人日數，藉此求得預期感染人次，進一步估算標準化感染比。
- 方法二(新)
  - 將相關影響因子納入統計方法中，建構感染人次之預測模式；以醫院因子帶入模型後，求得預期感染人次，再進一步估算標準化感染比。

方法一範例：計算A醫院CLABSI的SIR

Predicted CLABSI (#) = $\frac{\text{NHSN CLABSI rate} \times \text{central line days}}{1000}$

A醫院數據　　全國數據

Location type	CLABSI (#) 觀察值	Central line days (#)	NHSN CLABSI rate	Predicted CLABSIs (#) 期望值
Medical cardiac	2	380	2.0	0.76
Medical	1	257	2.6	0.67
Med/Surg	3	627	1.5	0.94
Neurosurg	2	712	2.5	1.78
Total	8		------	4.15

Overall CLABSI SIR = $\frac{\text{observed}}{\text{predicted}} = \frac{8}{4.15} = 1.93$

方法二範例：計算B醫院某病房CLABSI的SIR-1

負二項迴歸模型

影響因子	參數	p-value
截距	4.687	<0.001
醫院層級別		
區域醫院	-0.409	<0.001
醫學中心	Reference	
醫院區域別		
台北區	0.435	<0.001
北區	0.412	<0.001
南區	0.334	<0.001
東區	0.517	0.001
高屏區	0.385	0.157
中區	Reference	
ICU科別		
外科	-0.137	0.047
心臟科	-0.325	0.004
兒科	-0.349	<0.001
綜合科	-0.203	0.003
內科	Reference	
導管使用率	-0.015	<0.001

預期感染人次=exp【4.687
–0.409(區域醫院)
+0(醫學中心)
+0.435(台北區)
+0.412(北區)
+ 0(中區)
+ 0.334 (南區)
+ 0.517(東區)
+ 0(高屏區)
– 0.137(外科)
–0.325(心臟科)
– 0.349(兒科)
– 0.203(綜合科)
+0(內科)
–0.015(導管使用率)】*(導管使用人日數/1000)

方法二範例：計算B醫院某病房CLABSI的SIR-2

例子：

- B醫院為區域醫院，位於高屏區，其某病房為心臟科，導管使用人日為1500人日，導管使用率為55%，2016年實際CLABSI為28人次。
- 帶入模型

  exp【4.687-0.409(1)+ 0(1)-0.325(1)-0.015(55)】*(1500/1000)=27.39(預期感染人次)
- B醫院某病房的SIR=28/27.39=1.022

SIR數值的解讀意義

- 基準值為1.0(全國/年度)
  - SIR >1.0

    表示實際發生的醫療照護相關感染個案數高於預期，亦指感染情況劣於基準。
  - SIR <1.0

    表示實際發生的醫療照護相關感染個案數低於預期，亦指感染情況優於基準。

National and State HAI Progress Report

http://www.cdc.gov/hai/progress-report/index.html

STATE	CLABSIs: CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS							
	2013 Reporting and Validation					2013 State CLABSI SIR		
	# Hospitals Reporting to NHSN	State Reporting Mandate	State HD* has Access to Data	Data Checked for Quality‡	Additional In-Depth Data Review ‡	vs. 2012 State SIR	vs. 2013 Nat'l SIR	vs. 2008 Nat'l Baseline
Alabama	75	✓	✓	✓		⇧	↑	↓
Alaska	10					↓	↓	↓
Arizona	56					⇧	↑	↓
Arkansas	48	✓	✓	✓	✓	⇩	⇧	↓
California	350	✓	✓	✓		⇩	↓	↓
Colorado	52	✓	✓	✓	✓	⇧	⇩	↓
Connecticut	30	✓	✓	✓		↓	⇧	↓
D.C.	8	✓	✓	✓		⇩	↑	↓
Delaware	8	✓	✓	✓		↑	↑	↓
Florida	191					⇧	↑	↓
Georgia	102	✓	✓			⇧	↑	↓
Hawaii	15	✓	✓	✓		⇧	↓	↓
Idaho	16					⇩	↓	↓
Illinois	148	✓	✓	✓		↓	↓	↓
Indiana	104	✓	✓	✓		⇧	↑	↓
Iowa	50		✓	✓		⇧	⇩	↓
Kansas	49		✓	✓		⇧	⇧	↓
Kentucky	72		✓			↓	↑	↓
Louisiana	79		✓	✓		⇩	↑	↓
Maine	21	✓	✓	✓		↓	⇧	↓
Maryland	47	✓	✓	✓		⇩	⇩	↓
Massachusetts	69	✓	✓	✓		⇩	⇩	↓
Michigan	97		✓	✓		⇧	↓	↓
Minnesota	47	✓				⇩	↓	↓
Mississippi	47		✓			↓	↑	↓
Missouri	74		✓			⇩	↓	↓

14

NATIONAL

HEALTHCARE ASSOCIATED INFECTIONS PROGRESS

Healthcare-associated infections (HAIs) are infections patients can get while receiving medical treatment in a healthcare facility. Working toward the elimination of HAIs is a CDC priority. The standardized infection ratio (SIR) is a summary statistic that can be used to track HAI prevention progress over time; lower SIRs are better. The infection data are collected through CDC's National Healthcare Safety Network (NHSN). HAI data for nearly all U.S. hospitals are published on the Hospital Compare website.

SSIs

HAI TYPE	# OF U.S. HOSPITALS THAT REPORTED DATA TO CDC'S NHSN, 2013+	2013 NAT'L SIR vs. 2012 Nat'l SIR‡	2013 NAT'L SIR vs. Nat'l Baseline‡	2013 NAT'L SIR
CLABSI Nat'l Baseline: 2008	3,578	↓ 4%	↓ 46%	0.54
CAUTI Nat'l Baseline: 2009	3,640	↑ 3%	↑ 6%	1.06
SSI, Abdominal Hysterectomy Nat'l Baseline: 2008	3,182	⇩ 4%	↓ 14%	0.86
SSI, Colon Surgery Nat'l Baseline: 2008	3,348	↑ 14%	↓ 8%	0.92
MRSA Bacteremia Nat'l Baseline: 2011	3,827	↓ 5%	↓ 8%	0.92
C. difficile Infections Nat'l Baseline: 2011	3,924	↓ 6%	↓ 10%	0.90

+The number of hospitals reporting for each HAI type may differ because some hospitals do not use central lines or urinary catheters, or do not perform colon or abdominal hysterectomy surgeries.
‡The 2012 Nat'l SIRs can be found in the data tables of this report.
‡Nat'l baseline time period varies by infection type. See first column of this table for specifics.

Methicillin-Resistant *Staphylococcus aureus* (MRSA) is bacteria usually spread by contaminated hands. In a healthcare setting, such as a hospital, MRSA can cause serious bloodstream infections.

- U.S. hospitals reported a significant decrease in MRSA Bacteremia between 2012 and 2013.
- 7% Among the 2,002 U.S. hospitals with enough data to calculate an SIR, 7% had an SIR significantly worse than the national SIR of 0.92.

* Statistically significant.

which can be spread in healthcare settings.

- U.S. hospitals reported a significant decrease in *C.difficile* infections between 2012 and 2013.
- 13% Among the 3,557 U.S. hospitals with enough data to calculate an SIR, 13% had an SIR significantly worse than the national SIR of 0.90.

THIS REPORT IS BASED ON 2013 DATA, PUBLISHED JANUARY 2015

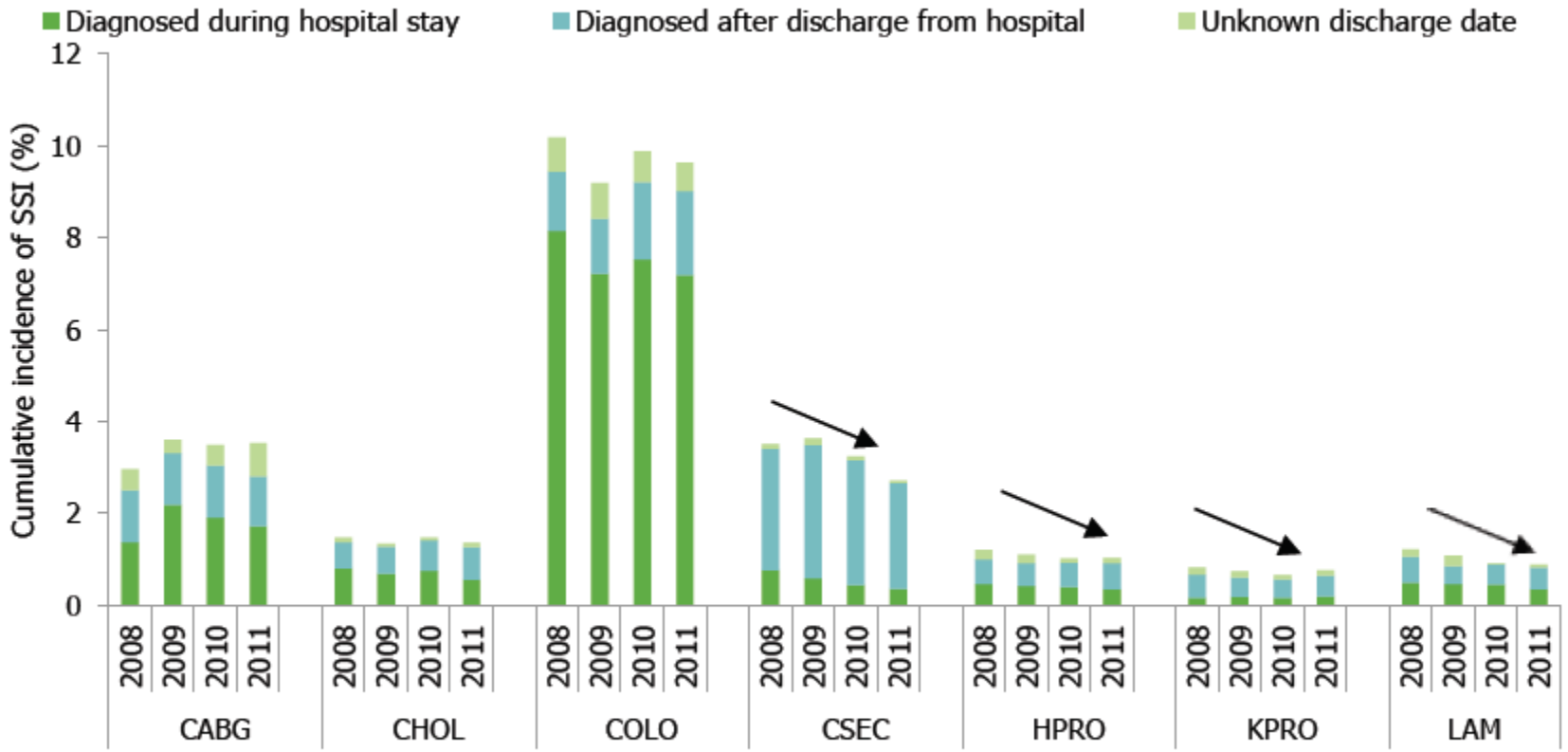
手術部位感染的指標

- 感染率
  - 公式：$\frac{\Sigma 感染人次數}{\Sigma 手術人次數} \times 100\%$
- 感染密度?
  - 公式：$\frac{\Sigma 感染人次數}{\Sigma 住院人日數} \times 1000\ \%$
- 標準化感染比（SIR）
  - 公式：$\frac{實際感染人次}{預期感染人次}$

使用住院人日數是否恰當？
1. 並非所有病人都接受手術 (分母應該是at risk的人日數)
2. 手術部位感染監測期間不限住院期間

手術部位感染率

Figure 3.3. Cumulative incidence for SSI by year and operation type, EU/EEA countries, 2008–2011

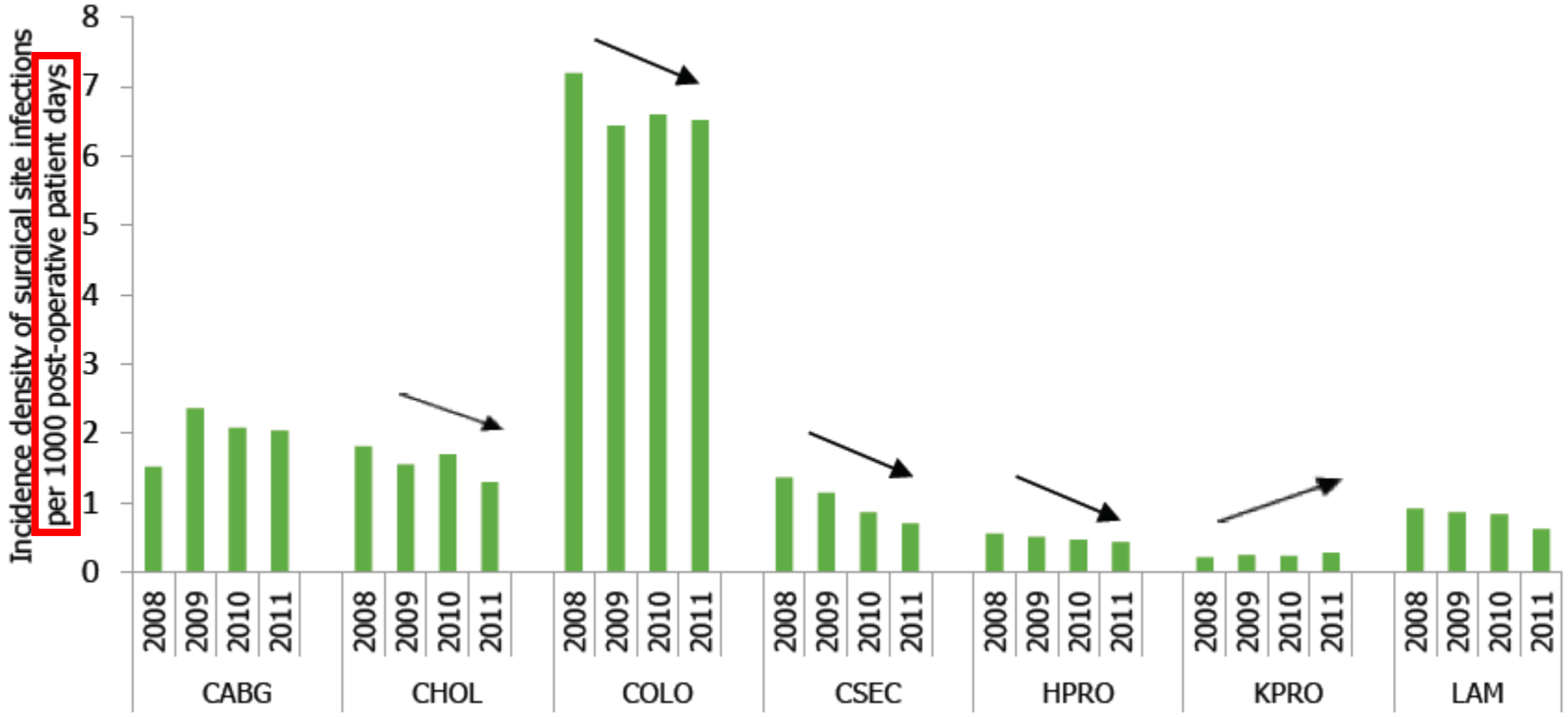


Data source: ECDC, HAI-Net SSI patient-based data 2008–2011.

Surveillance of surgical site infections in Europe 2010–2011

手術部位感染密度 (ECDC)

Figure 3.4. Incidence density of SSI (diagnosed in-hospital) by year and operation type, EU/EEA countries, 2008–2011



Data source: ECDC, HAI-Net SSI patient-based data 2008–2011.

Surveillance of surgical site infections in Europe 2010–2011

手術部位感染的SIR計算(1/2)

截距
糖尿病
美國麻醉醫師學會身體狀況分類等級
BMI
年齡
癌症醫院

Table 1. Risk Factors for SSI HYST; Complex 30-Day Model (2015 Baseline)			
Factor	Parameter Estimate	P-value	Variable Coding
Intercept	*-5.1801*	-	-
Diabetes	0.3247	<0.0001	Yes= 1 No= 0
ASA Score	0.4414	<0.0001	1= 1 2= 2 3= 3 4/5= 4
Body Mass Index (BMI)	0.1106	0.0090	≥ 30= 1 < 30= 0
Patient Age	-0.1501	<0.0001	Patient's age/10
Oncology Hospital	0.5474	0.0005	Oncology hospital= 1 Non-oncology hospital= 0

$$logit\ (\hat{p}) = -5.1801 + 0.3247(DIABETES) + 0.4414(ASA) + 0.1106(BMI) - 0.1501(AGE) + 0.5474(ONCOLOGY\ HOSPITAL)$$

手術部位感染的SIR計算(2/2)

Table 2. Risk Factors for 100 Patients Undergoing a HYST Procedure (Complex 30-Day model)

Patient	Diabetes	ASA score	BMI	Age	Oncology Hospital	SSI Identified?	Probability of SSI ($\hat{p}$)
1	Y	2	29	32	Y	1	0.020
2	N	3	35	49	Y	0	0.019
3	N	5	20	51	Y	1	0.026
.	.	.	.	.	.		.
.	.	.	.	.	.		.
100	N	4	27	27	Y	0	0.037
TOTAL						**8** (observed SSIs)	**6.750** (predicted SSIs)

$$SIR = \frac{Observed\ (O)\ HAIs}{Predicted\ (P)\ HAIs} = \frac{8}{6.750} = 1.190$$

不同手術類別，校正的危險因子不盡相同.....

Table 3c. Predictive Risk Factors from the All SSI Logistic Regression Model, Adults ≥ 18 years of age	
NHSN Operative Procedure	**Risk Factor(s)-All SSI Model, Adults**
AAA	procedure duration
AMP	anesthesia, wound class, hospital bed size*, age, procedure duration
APPY	gender, wound class, hospital bed size*, closure, procedure duration, BMI
AVSD	procedure duration
BILI	gender, emergency, trauma, wound class, hospital bed size*, scope, age, procedure duration
BRST	ASA score, age , procedure duration, BMI
CARD	emergency, medical school affiliation*, age, procedure duration , BMI
CABG	gender, diabetes, trauma, medical school affiliation*, hospital bed size*, age, procedure duration, BMI, age-gender interaction
CEA	anesthesia, diabetes, wound class
CHOL	diabetes, ASA score, wound class, scope, age, procedure duration
COLO	diabetes, trauma, anesthesia, ASA score, wound class, medical school affiliation*, hospital bed size*, scope, closure technique, age, procedure duration, BMI

Acknowledgements

Hospital infection control practitioners, and dedicated hospital staff who report surveillance data to TNISS

Chien-Hua Chu
olin@cdc.gov.tw