

流行病學方法論及實驗

The Methods of Epidemiology and Practices

授課教師：陳秀熙 教授

許辰陽 助理教授

台灣大學流行病學與預防醫學研究所

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週次	日期	單元名稱
1	02/22	牛頓與南丁格爾流行病學故事
2	03/01	辛普森矛盾故事與護理流行病學
3	03/08	解決辛普森矛盾之護理魔術
4	03/15	觸媒流行病學故事與護理照護
5	03/22	偏好選擇流行病學故事之護理觀
6	03/29	護理人如何校正偏好選擇之實例
7	04/05	清明節
8	04/12	柯南護理流行病學
9	04/19	貝氏柯南護理流行病學(1)
10	04/26	期中考
11	05/03	貝氏柯南護理流行病學(2)
12	05/10	賽先生護理流行病學 (1)
13	05/17	賽先生護理流行病學 (2)
14	05/24	信校度之護理流行病學
15	05/31	傳染病流行病學之護理觀
16	06/7	端午節
17	06/14	三段五級慢性病流行病學之護理觀
18	6/21	期末考

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學習宗旨

1. 南丁格爾故事及牛頓原理闡述社會物理科學之重要
2. 流行病學盛行率(prevalence)及 發生率(incidence)之應用

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「手持燈籠的女士」(The lady with a lamp)-護理鼻祖南丁格爾
(Florence Nightingale)



少女時期的南丁格爾

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護理學的先驅及著名的應用統計學家

- 弗羅倫斯應用[統計分析](#)於護理學專業。
- 以雞冠圖 (Coxcomb)剖析克里米亞戰爭中之死因
- 鑒於她在統計學方面的傑出成就，1858年被選為[英國皇家統計學會會員](#) 第一位女性會員，後來又獲選為[美國統計學會](#)榮譽會員。
- 社會影響遍及印度，澳大利亞等國。

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「南丁格爾—威廉法雷同盟」 社會物理-Newton

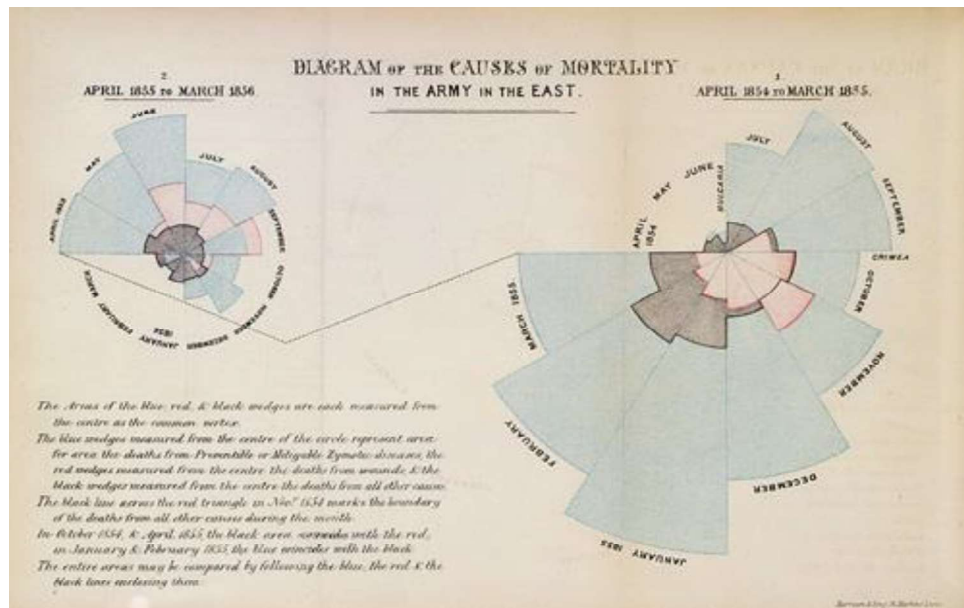
威廉法雷 (William Far) : 「現代流行病學之父」
(另一位是約翰斯諾 John Snow)

運用統計數字追查病源和改善國民健康，「國際疾病分類法」(International Classification of Disease) 便是以法雷的方法為基礎。

南丁格爾: 護士之母

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雞冠花圖 (coxcomb)



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The Wrong Denominator in Epidemiology

法雷計算英國醫院死亡率:

醫院一年死亡人數/醫院一天之內的住院人數

南丁格爾根據法雷的統計報告，宣稱英國二十四間醫院的死亡率高達百分之九十

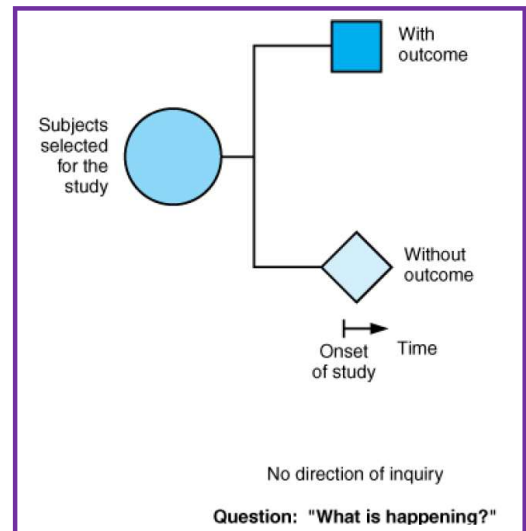
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盛行率與研究設計

Prevalence and Study Design

- 定義(Definition)

- This indicator is tailored for **measuring the constant and existing frequencies** of characteristics or disease among the number of population at a given time point (period). In our example, we are interested in Parkinson disease.



- 研究設計(Study Design)

- Cross-sectional survey.

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1. 盛行率

Prevalence

- 估算方法 (Estimate)

- It is a **proportion**.

- $Prevalence = \frac{m}{N}$

m number of Parkinson disease among the underlying population size equal to N .

- 應用 (Usefulness)

- Prevalence is used for **measuring disease burden** in community in order to elucidate health demand, health planning for clinical manpower, and resources allocation for Parkinson disease. All these aspects are related to **health administration**.

Prevalence, incidence, and mortality of PD

A door-to-door survey in Ilan County, Taiwan

R.C. Chen, MD; S.F. Chang, MD, MPH; C.L. Su, MD; T.H.H. Chen, DDS, PhD; M.F. Yen, MS;
H.M. Wu, BS; Z.Y. Chen, MD; and H.H. Liou, MD, PhD

[illegible]

prevalence of PD in the Chinese population was 3.38 (95% CI: 2.05–4.34). The 5-year survival rate was statistically lower than that in non-PD cases (92.84%). **Conclusion:** The prevalence of PD were much higher than those reported in China, but closer to those in Western countries. Environmental factors may be more important than racial factors in the

NEUROLOGY 2001;57:1679-1686

Original Research¹

Original Research

研究背景 (Background)

The reported prevalence and incidence rates of PD were significantly lower in China than those in Western countries. People in China and Taiwan have a similar ethnic background.

研究目標 (Objective)

To investigate the prevalence, incidence, and mortality rate of PD in Taiwan.

研究方法 (Methods)

population-based survey
(two-stage door-to-door approach)



patients with PD aged 40 years or older in Ilan, Taiwan

A map of the survey area in Ilan, Taiwan

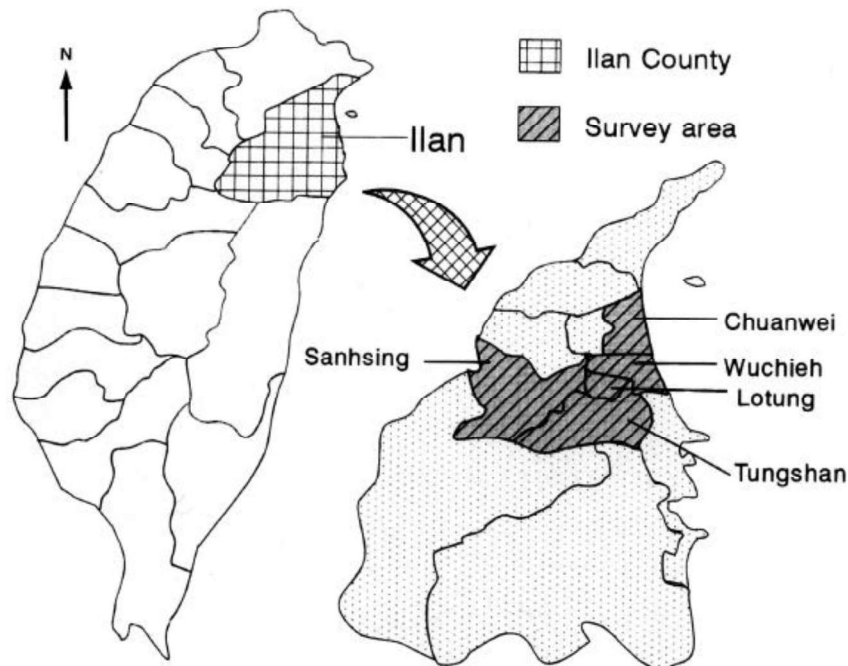


Figure 1. A map of the survey area in Ilan, Taiwan.

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Result

研究期間
宜蘭研究鄉鎮
人口分佈

Table 1 Age and sex distribution of the total population, targeted population, and participation rates in Ilan on January 1, 1993

Age group, y	Men	Women	Both sexes
No. of total population			
0–39	32,184	29,929	62,113
40–49	2096	1876	3972
50–59	2108	1957	4065
60–69	1738	1501	3239
70–79	812	821	1633
80+	218	339	557
Total	39,156	36,423	75,579
Total (40+)	6972	6494	13,466
No. of target population			
:			
No. of participants			
:			
Participation rate, %			
:			

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宜蘭巴金森氏症盛行率

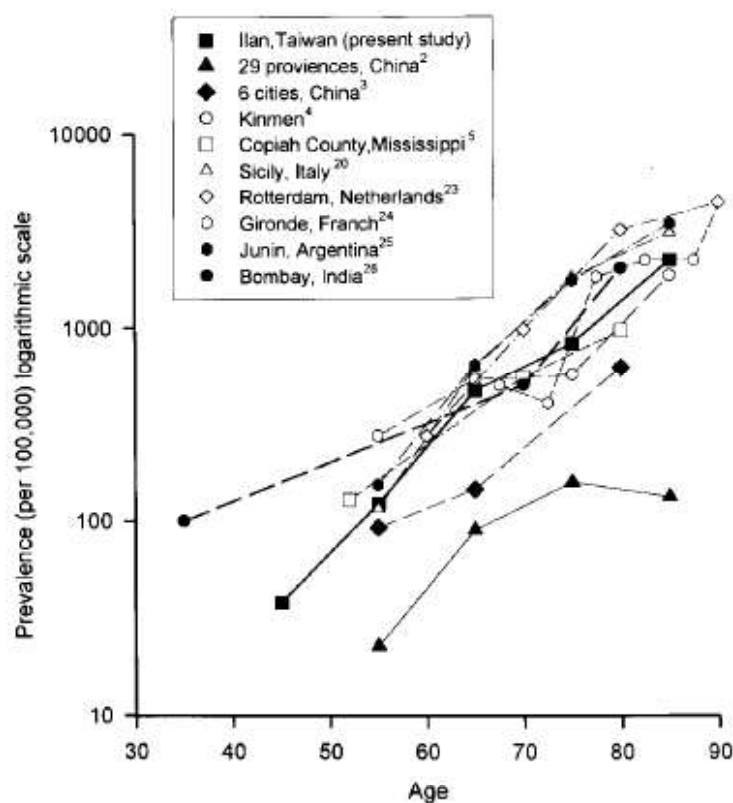
The prevalence of PD in Ilan (per 100,000)

Age, y	Men		Women		Both sexes	
	No. of cases	Prevalence per 100,000	No. of cases	Prevalence per 100,000	No. of cases	Prevalence per 100,000
40–49	1	78.3	0	0.0	1	37.8
50–59	4	252.5	0	0.0	4	122.5
60–69	3	224.9	11	896.5	14	546.7
70–79	4	645.2	6	1000.0	10	819.7
80+	3	2013.4	5	2325.6	8	2197.8
Total (40+)	15	302.2	22	431.9	37	367.9
Age-adjusted (40+)		299.2		423.7		357.9
Age-adjusted (for all age)		108.7		154.0		130.1

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巴金森氏症盛行率比較

Figure 3. Comparison of age-specific prevalence rates of PD obtained through door-to-door studies. The prevalence rates in Taiwan are much higher than those reported in mainland China but closer to those in Kinmen (金門) and Western countries.



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壓瘡盛行率

Prevalence of Pressure Ulcers

Point Prevalence: A measure of the number of cases of pressure ulcers at a specific time.

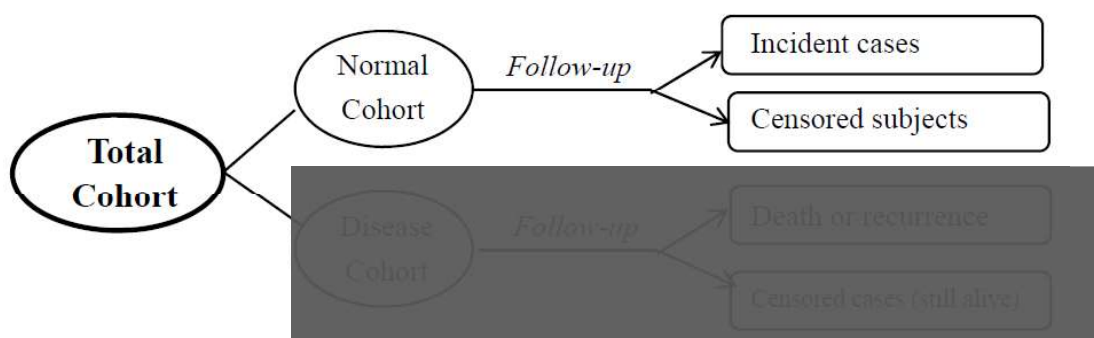
Period prevalence: A measure of the number of cases of pressure ulcers over a prolonged time period such as the entire hospitalization.

Reflecting **the total burden of the disease** and **providing insights into the magnitude of the pressure ulcer** problem for the planning for health resource needs but provide fewer insights into the quality of care being delivered.

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發生率之研究設計 Incidence and Study Design

- The concept of incidence is highly related **to relative instantaneous rate** (proposed since Newton in 17th Century)
- **Study Design:**
 - Follow-up study

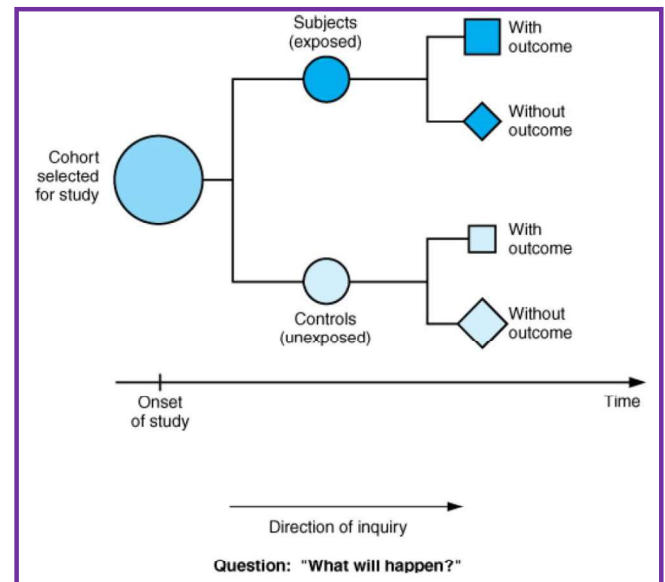


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2. Incidence

- Estimate:**

$$= \frac{\text{Total Events (i.e. Parkinson Dx)}}{\text{Total Person - time}}$$



- It represents relative instantaneous rate (force of morbidity) of yielding events (Parkinson disease) per unit time (years). The higher the incidence, the higher the risk for a specific population.
- Usefulness:**
 - The incidence is a measure for elucidating the etiological aspect of disease of interest.

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Original Research

Prevalence, incidence, and mortality of PD

A door-to-door survey in Ilan County, Taiwan

R.C. Chen, MD; S.F. Chang, MD, MPH; C.L. Su, MD; T.H.H. Chen, DDS, PhD; M.F. Yen, MS; H.M. Wu, BS; Z.Y. Chen, MD; and H.H. Liou, MD, PhD

巴金森氏症發生率

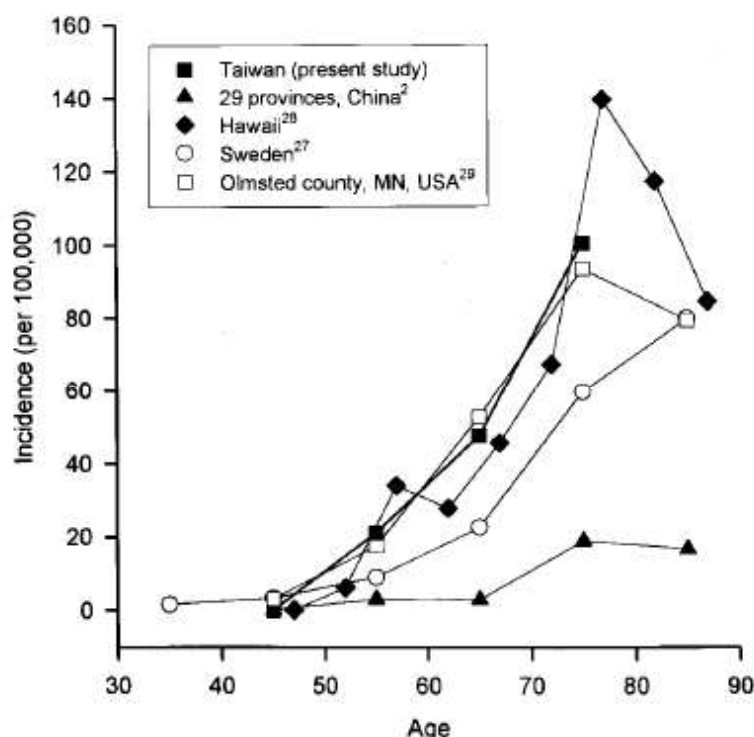
The incidence PD in Ilan (per 100,000)

Age, y	Men		Women		Both sexes	
	No. of cases	Incidence per 100,000	No. of cases	Incidence per 100,000	No. of cases	Incidence per 100,000
40-49	0	0.0	0	0.0	0	0.0
50-59	2	25.4	1	12.0	3	18.5
60-69	3	45.4	3	49.6	6	47.4
70-79	3	98.1	3	102.5	6	100.2
80+	0	0.0	0	0.0	0	0.0
Total (40+)	8	32.5	7	27.8	15	30.1
Age-adjusted (40+)		30.5		27.0		28.7
Age-adjusted (for all age)		11.1		9.8		10.4

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巴金森氏症發生率比較

Figure 4. Comparison of age-specific incidence rates of PD reported in China, Sweden, Hawaii, Olmsted County, Minnesota, and Taiwan. The incidence rates in Taiwan are much higher than those reported in mainland China but closer to those in Western countries.



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壓瘡之發生率

Incidence of Pressure Ulcers

The number of **new pressure ulcers** in people **without an ulcer at baseline**

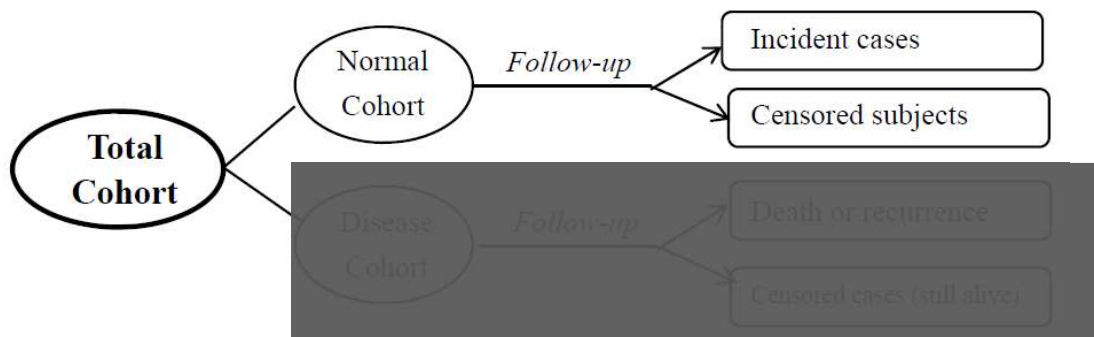
Direct measure of quality of care and the **identification of causative factors** for pressure ulcer development.

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發生率之研究設計

Incidence and Study Design

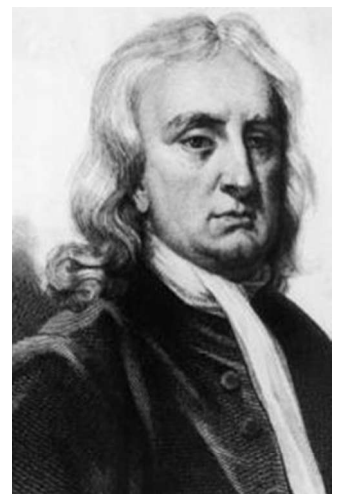
- The concept of incidence is highly related to “**relative instantaneous rate**” (proposed since Newton in 17th Century)
- **Study Design:**
 - Follow-up study



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Sir Isaac Newton

- 1669 -- Lucasian Professor of Mathematics at Cambridge (a position now held by Stephen Hawking)
- 1689 -- Member of Parliament representing Cambridge
- 1699 -- Master of the Mint
- 1701 to 1702 -- Member of Parliament for the second time
- 1703 -- President of the Royal Society of London, the United Kingdom's national academy of science
- 1705 -- Knighted



Trinity College University of Cambridge



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牛頓第二運動定律 與 罹病後存活狀況

Newton's Second Law and Survival of Disease

- Survival **vs** Distance
(存活) (距離)
- Hazard Rate (Incidence) **vs** Velocity
(風險率) (發生率) (速度)

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速度 (Velocity) 與 率 (Rate)

- 平均速度 Average Velocity

$$\bar{v} = \frac{x_j - x_i}{t_j - t_i} = \frac{\Delta x_{ij}}{\Delta t_{ij}} \quad \begin{array}{l} x: \text{位置} \\ t: \text{時間} \end{array}$$

- 瞬間速度 Instantaneous Velocity

$$\tilde{v} = \lim_{\Delta t \rightarrow 0} \frac{\Delta x_{ij}}{\Delta t_{ij}}$$

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發生率與存活

Incidence and survival (1)

- Concept of Rate:

- To measure rates of death or disease (such as Parkinson disease), we had better start from survival function.

$$\begin{aligned} S(t) &= P(\text{Surviving from time } = 0 \text{ to time } = t) \\ &= P(\text{Surviving during } [0, t]) \end{aligned}$$

- Equivalently,

$$\begin{aligned} S(t) &= P(\text{Surviving beyond time } t) \\ &= P(T \geq t) \quad 0 \leq S(t) \leq 1 \end{aligned}$$

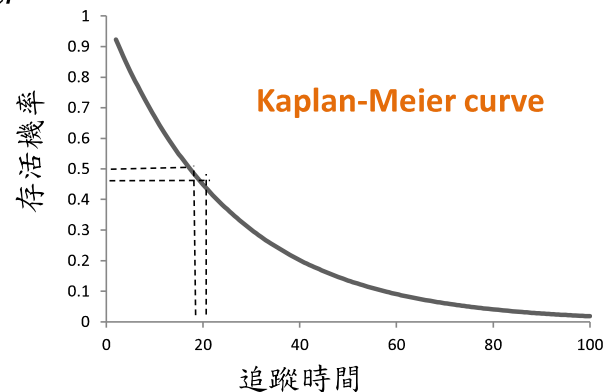
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Incidence (**Hazard Rate**) and survival (2)

- **Ex.** Suppose we have $S(t) = e^{-0.04t}$
 - The probability of surviving beyond t (age)=20 year is
$$S(20) = P(T \geq 20) = e^{-0.04 \cdot 20} = 0.45$$

- Median survival time (Half of life)

$$e^{-0.04 \cdot t_M} = 0.5, t_M = 17.33 \text{ year}$$



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Effect of Pressure Ulcers on the Survival of Long-Term Care Residents

- **Background.** Past studies have emphasized that **patients with pressure ulcers are at high risk of dying**. However, it remains unclear **whether this increased risk is related to the ulcer or to coexisting conditions**. In this study we **examined the independent effect of pressure ulcers on the survival of long-term care residents**.
- **Methods.** We evaluated all **19,981 long-term care residents** institutionalized in Department of Veterans Affairs (VA) long-term care facilities as of April 1, 1993. Baseline resident characteristics and survival status were obtained by merging data from five existing VA data bases. **Survival experience over a 6-month period** was described using a proportional hazards model.
- **Results.** Pressure ulcers were present in **1,539 (7.7%) long-term care residents**. **Residents with pressure ulcers had a relative risk of 2.37 (95% CI = 2.13, 2.64) for dying** as compared to those without ulcers. After **adjusting for 16 other measures of clinical and functional status**, the relative risk associated with pressure ulcers decreased to 1.45 (95% CI = 1.30, 1.65). No increased risk of death was noted for residents with deeper ulcers.
- **Conclusions.** Pressure ulcers are a significant marker for long-term care residents at risk of dying. After adjusting for clinical and functional status, however, the independent risk associated with pressure ulcers declines considerably. The fact that larger ulcers are not associated with greater risk suggests that other unmeasured clinical conditions may also be contributing to the increased mortality associated with pressure ulcers.

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壓瘡級別對長照住民存活之影響

Effect of Pressure on Survival of Patients in Long-term Care by Stage

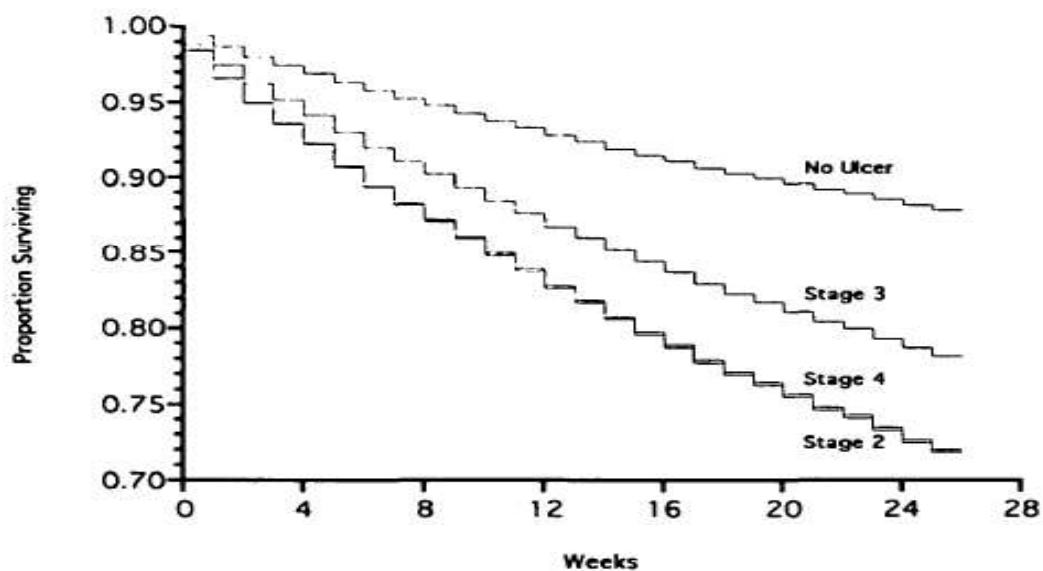


Figure 1. Proportional hazards estimates of the proportion of patients surviving, by weeks from baseline, for the no pressure ulcer and the ulcer stages 2, 3, and 4 subject groups, *without* adjustment for other factors.

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發生率與瞬時速率

Incidence and instantaneous rate

- Instantaneous rate:

- Newton defined an instantaneous rate as the **change in $S(t)$** as the **length of the time interval (Δt)** becomes infinitesimally **small**.

- The derivation of $S(t) = \frac{d}{dt} S(t)$

$$\frac{d}{dt} S(t) \approx \frac{S(t+\Delta t) - S(t)}{\Delta t}$$

= slope of a straight line between $S(t)$ and $S(t+\Delta t)$

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發生率與瞬時相對率

Incidence and instantaneous relative rate

- 瞬時相對率 (Instantaneous relative rate)

- Newton's **instantaneous rate** is rarely used to describe mortality or disease data, because it does not reflect risk.
- A rate of 10 deaths per month in a community of 1,000 individuals indicates an entirely different risk than the same rate in a community of 100,000.
- To measure risk, a **relative rate** is created, where

$$\text{Instantaneous relative rate} = h(t) = \frac{-\frac{d}{dt}S(t)}{S(t)}$$

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Applications with Incidence

- An instantaneous relative rate is called a **hazard rate** in human populations, sometimes called **the force of mortality** (an instantaneous rate of death) or relative velocity from the viewpoint of physics.
- To estimate the instantaneous rate of $h(t)$, we must know the exact form of the survival function $S(t)$.

$$\text{Instantaneous relative rate(瞬時相對率)} = h(t) = \frac{-\frac{d}{dt}S(t)}{S(t)}$$

$$\text{Incidence rate (發生率)} = I_t = \frac{\text{癌症人數}_t}{\text{年中人口數}_t}$$



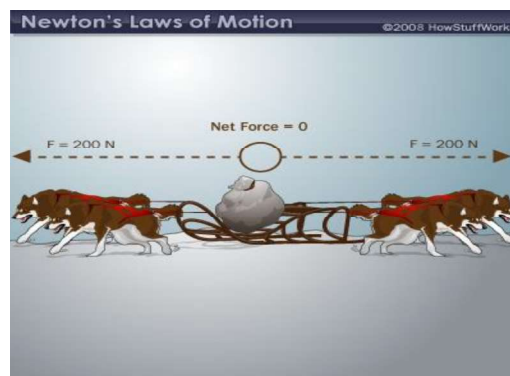
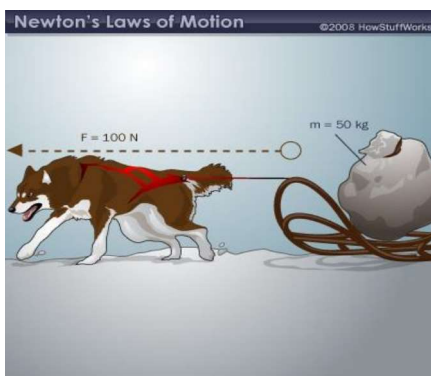
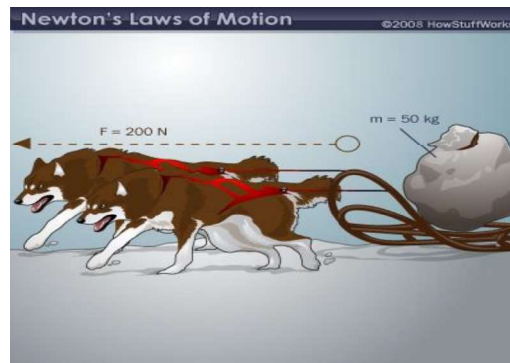
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發生率與事件風險之運用

Incidence-Hazard in Nursing Research (Newton's Second Law)

$$F=ma$$

$$=m (\Delta v/\Delta t)$$

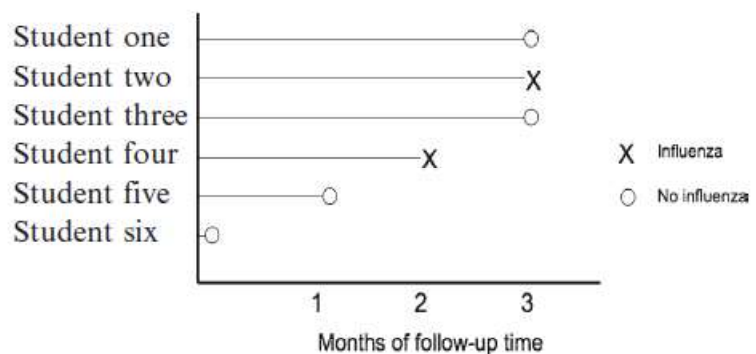


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人年之估算

Total Person – time

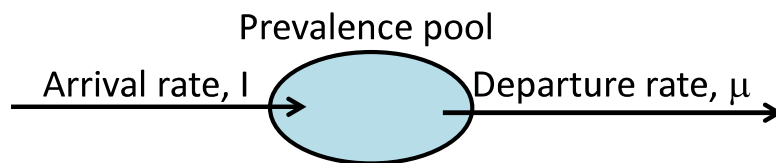
Fig. 1.1 Diagram of individual risk time and disease status



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3. P/I (Prevalence/Incidence) ratio

- Prevalence Pool:



- Suppose a population with size N consists of m prevalent Parkinson disease cases. In a cross-sectional survey, prevalence (P) is estimate as $P = \frac{m}{N}$
- In a steady population (i.e. inflow = outflow), we have the following balance equation in a small time inter (Δt)

$$I \times (N - m) \times \Delta t = \mu \times m \times \Delta t \rightarrow \frac{m}{N-m} = \frac{I}{\mu}$$

If $N \gg m$, $N - m \cong N$

$$P(\text{Prevalence}) = \frac{I(\text{Incidence})}{\mu} \rightarrow \frac{P}{I} = \frac{1}{\mu} = \bar{D} \text{ (Average Duration)}$$

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3. P/I (Prevalence/Incidence) ratio

Usefulness:

This indicator is used to denote the average duration of disease.

It has several applications. In our example of Parkinson disease, the P/I is used to reflect the quality of treatments or therapies.

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巴金森氏症 P/I 比較

Table 4 Prevalence, incidence, and ratio of PD in community-based studies

Location	Prevalence per 100,000	Incidence per 100,000	Prevalence/ incidence
Rochester, MN ³⁴	187.0	20.0	9.4
Carlisle, England ³⁵	113.0	12.0	9.4
Iceland ³⁶	162.0	16.0	10.1
Turku, Finland ³⁷	120.1	15.0	8.0
Yonago, Japan ³⁸	80.6	10.0	8.6
Sardinia, Italy ³⁹	65.6	4.9	13.4
Benghazi, Libya ⁴⁰	31.4	4.5	7.0
Ferrara, Italy ⁴¹	164.7	10.0	16.5
China ²	18.0	1.9	9.5
Östergötland, Sweden ²⁷	115.0	11	10.5
Ilan, Taiwan (current study)	130.1	10.4	12.5

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The Relationships Among Incidence, Prevalence, and Duration of Disease: Asthma

Age	Annual Incidence	Prevalence	Duration= Prevalence/ Annual Incidence
0-5	6/1,000	29/1,000	4.8 years
6-16	3/1,000	32/1,000	10.7 years
17-44	2/1,000	26/1,000	13.0 years
45-64	1/1,000	33/1,000	33.0 years
65+	1/1,000	36/1,000	33.0 years
Total	3/1,000	30/1,000	10.0 years

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