台大醫院藥事照護分享

臺大醫院藥劑部

吳建志組長

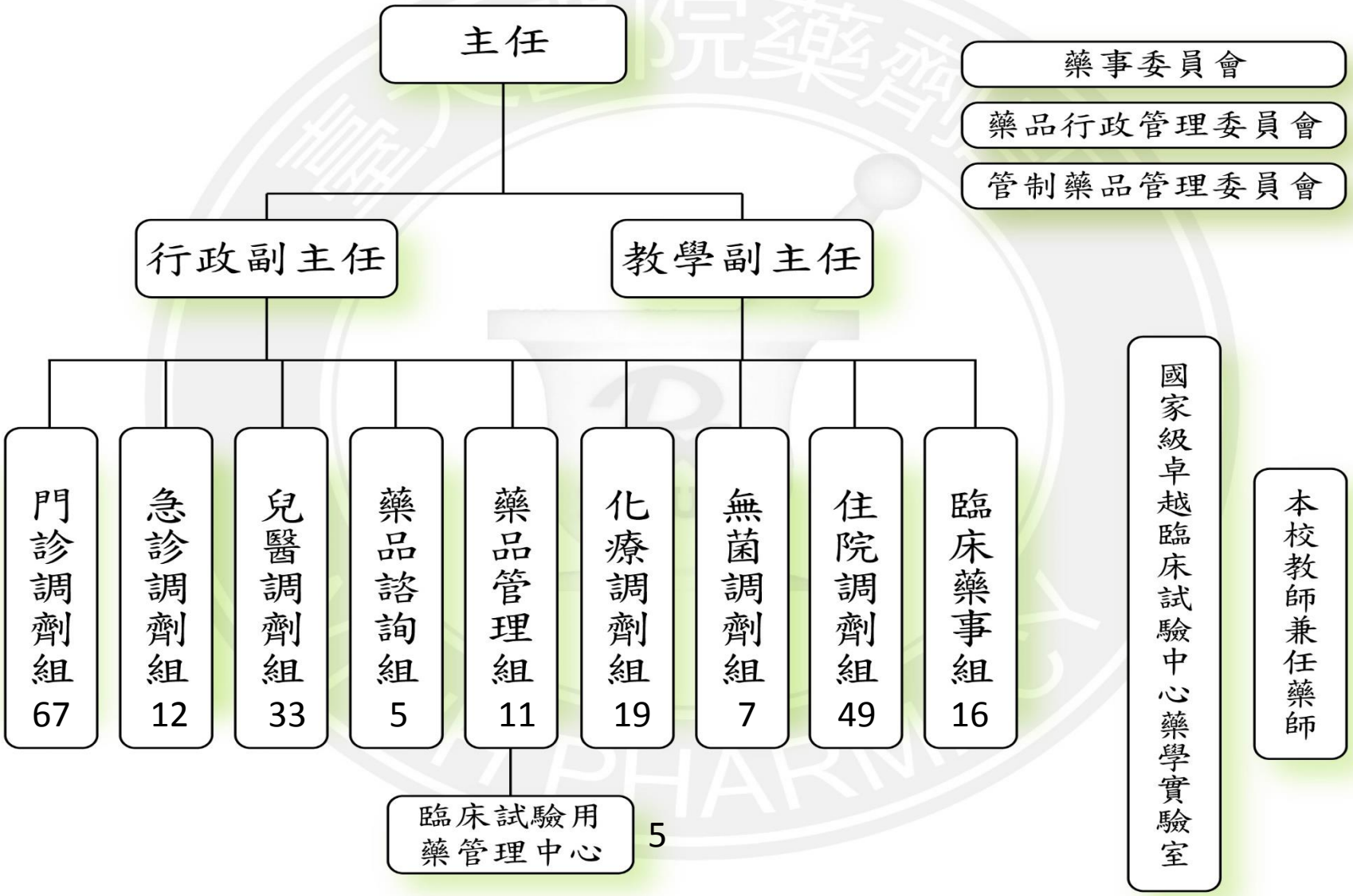
20190726

大綱

- 台大醫院臨床藥事照護簡介
- 用藥指引及臨床決策系統成效
- 住院臨床藥事照護成效
- 門診臨床藥事照護成效

國立臺灣大學醫學院附設醫院

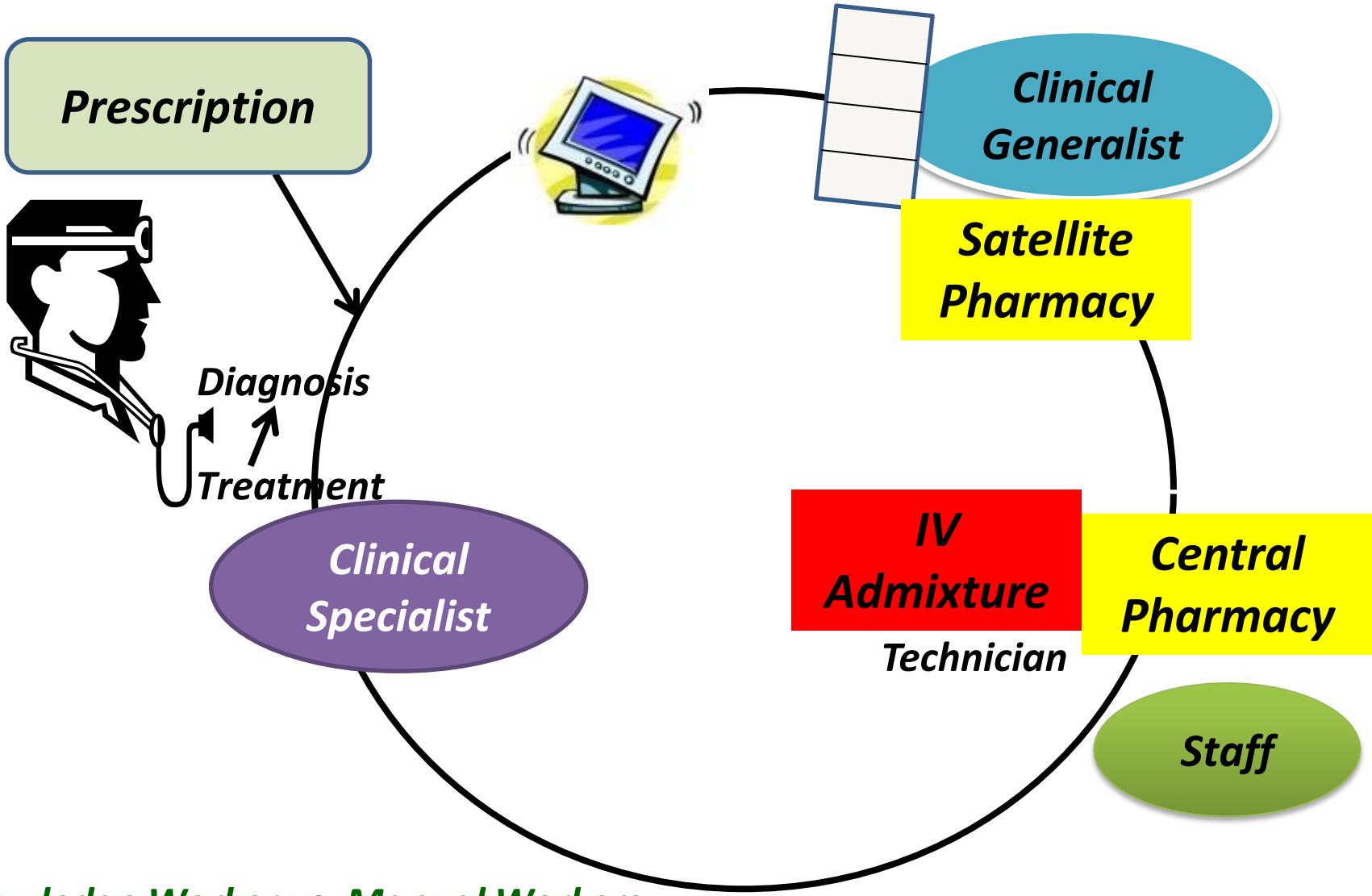
藥劑部組織架構



業務量

- 門診處方張數：~8000張/日
- 住院病房處方比數：~20000筆/日
- 住院病人衛教數：~1100件/月
- 化療處方：355筆/日 + 輔藥255筆/日
- TPN處方 ：~100張/日

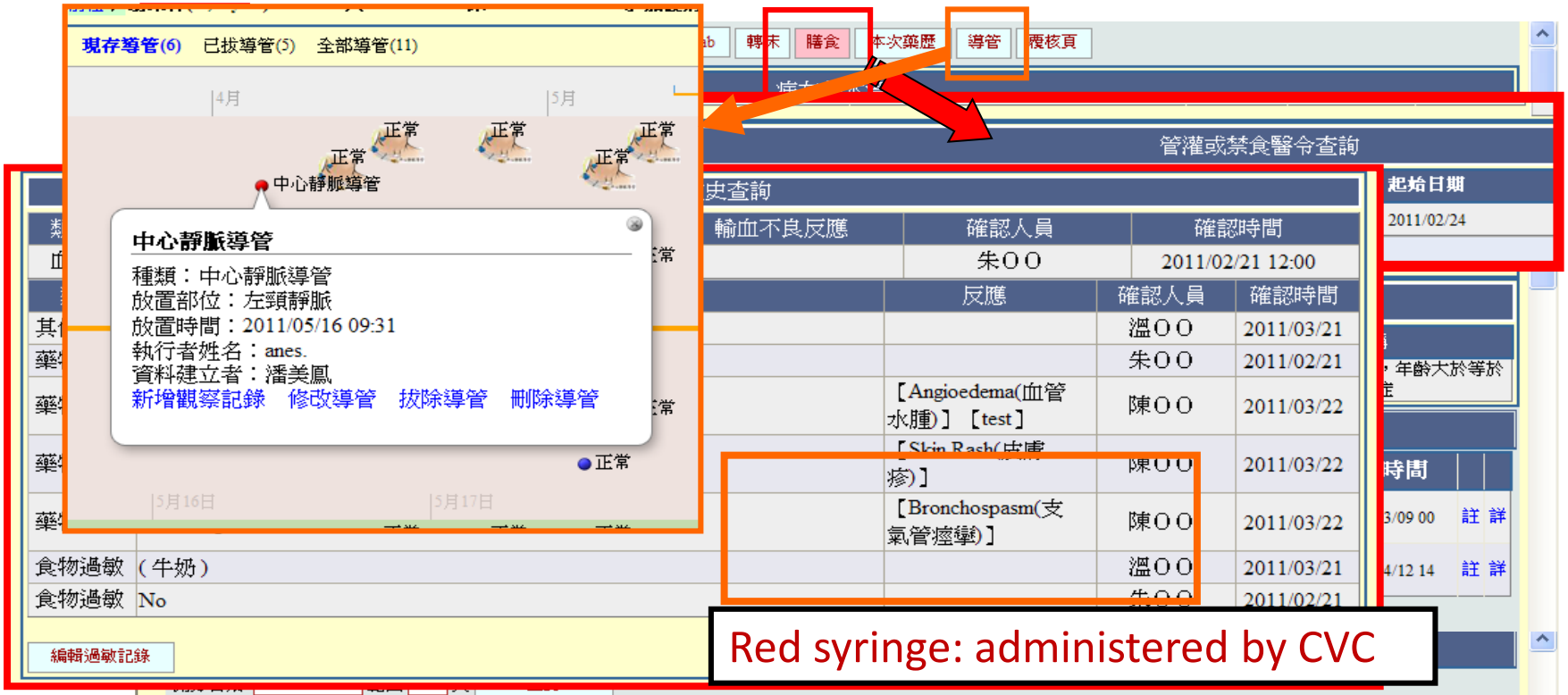
Our Vision — Role of Pharmacist at NTUH



Knowledge Worker vs. *Manual Workers*

Health Professional vs. *Educator* vs. *Scientist*

Pharmacists online verification



Computer software to check drugs for

- Allergy,
- Therapeutic duplication,
- Maximum dose,
- Drug interactions

Click to show drug-food interaction, renal dose, hepatic dose, etc.

Nurses cannot administer drugs before verification by pharmacists

西元 2013 年 2 月 19 日 簽收 查詢/重整 前日 次日 治療處置 未處理 已給藥 未給藥，含原因 處理中 給藥前複核 頻率表 途徑表

一般藥物(8) 化療藥物(0) 癌症計劃書 執行給藥 給藥後複核 給藥前複核 給藥確認 列印標籤

2013年2月19日

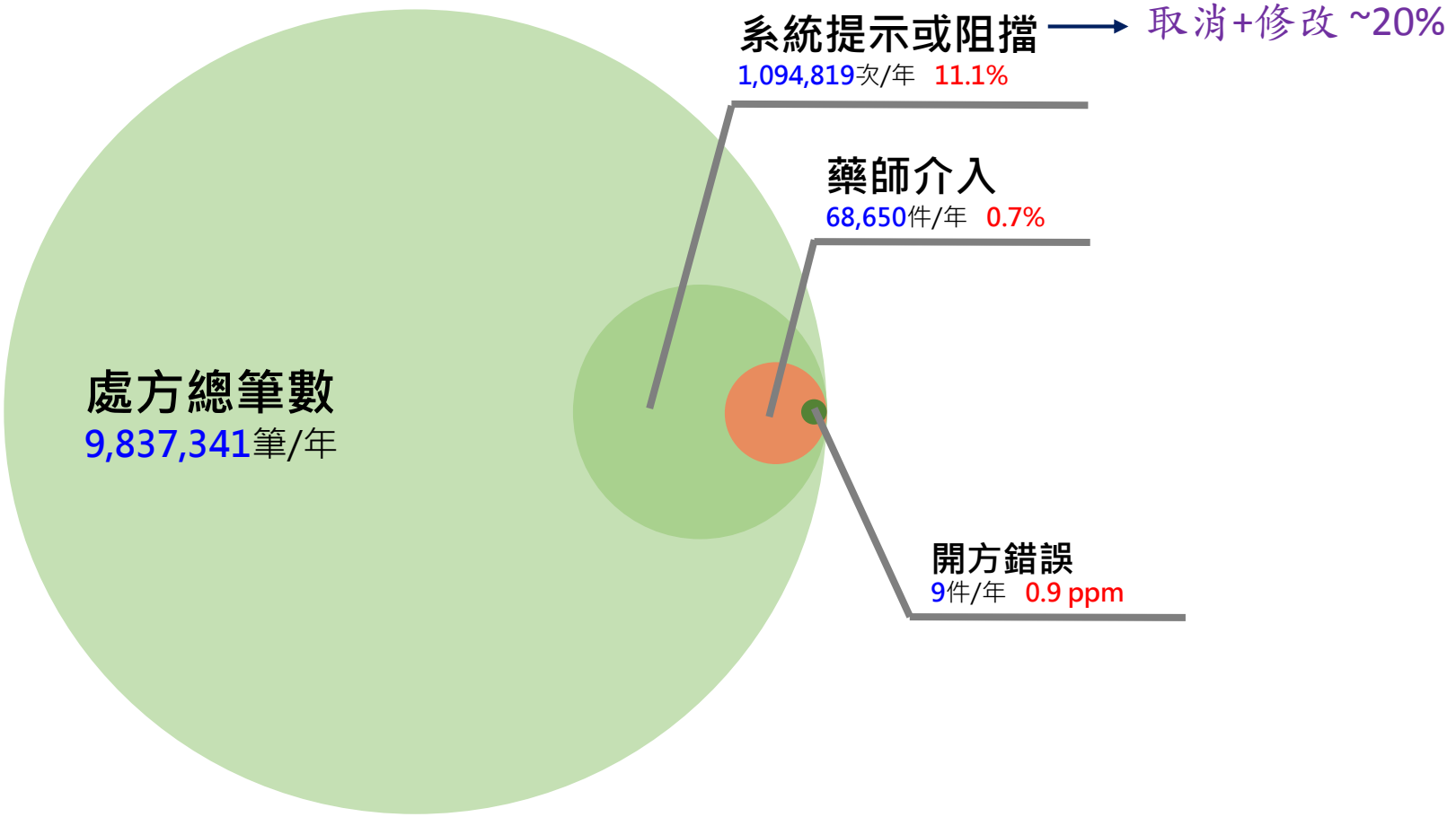
備	學名/商品名	劑量	途徑	頻率	給藥記錄
	Dopamine HCl 警 Dopmin 200 mg/5 mL /amp	500 mg(2.5 amp)	cIF	QD	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
in: NS 250 mL (濃度: 2 mg/mL) keep 流速: 5 mL/時 (速度: 0.1667 mg/分) 起: 2013/02/19 14					
	(急救補登)Atropine Sulfate Atropine 1 mg/1 mL /amp	1 mg(1 amp)	IV	STAT	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
起: 2013/02/19 13 迄: 2013/02/19 13					
	(急救補登)Calcium Gluconate Calglon 4.65 mEq/10 mL /amp	4.65 mEq(1 amp)	IV	STAT	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
起: 2013/02/19 13 迄: 2013/02/19 13					
	Atropine Sulfate Atropine 1 mg/1 mL /amp	0.5 mg(0.5 amp)	IV	STAT	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
起: 2013/02/19 14 迄: 2013/02/19 14					
	自備藥 Crotamiton (外 Ulex Cream 10 g/tube)	1 tube	D	PRN	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
起: 2013/02/19 14					

Clinical decision supporting system (CDSS)

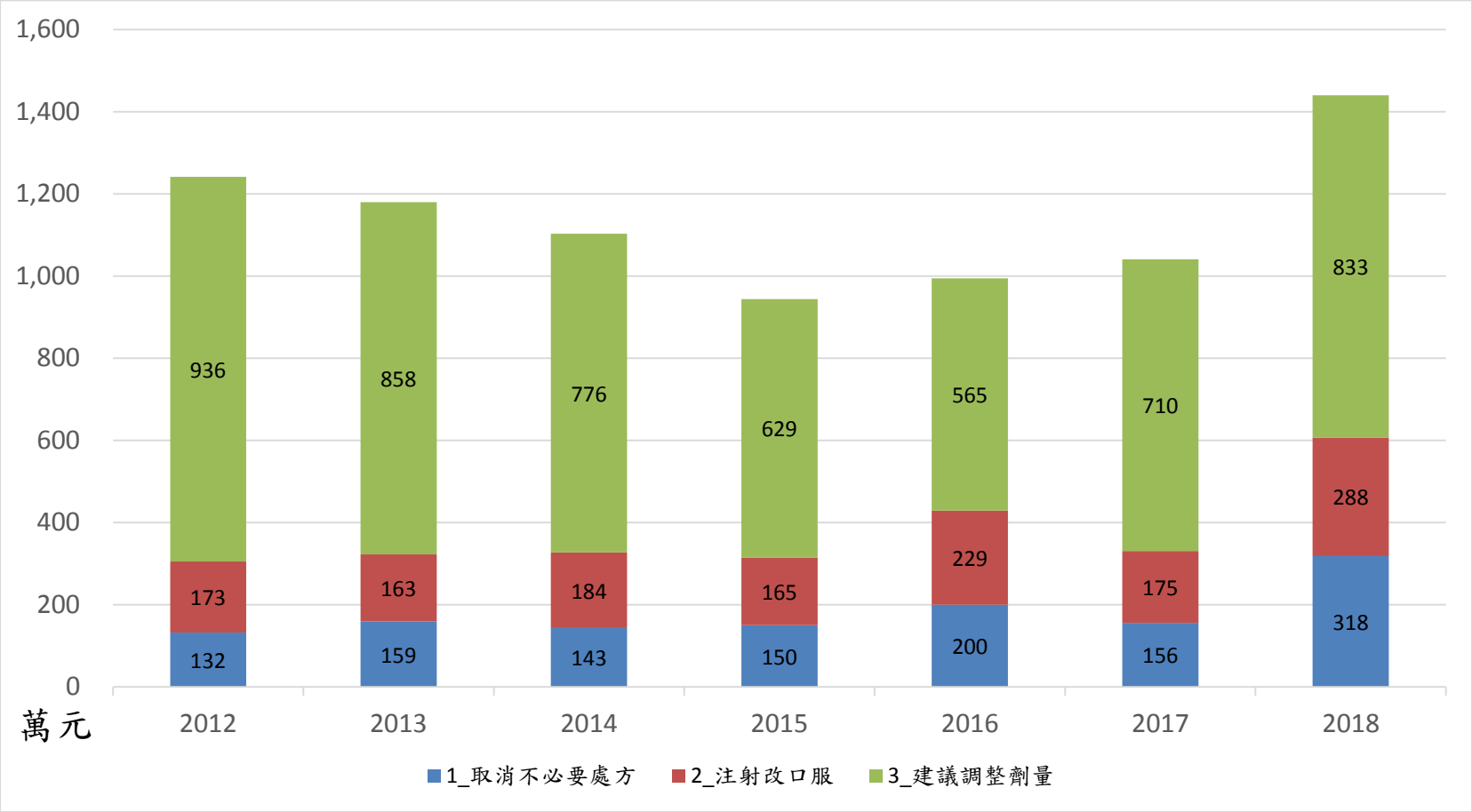
36 databases built by pharmacists

- Antibiotics、Controlled medications
- Pregnancy category X (OPD only): 2007
- Adverse drug reaction/Allergy alert: 2008.6~
- Therapeutic duplication alert: 2008.11~
- Pharmacist online verification: 2009.4~(UDD), 2012.12 (OPD), 2013.3 (ER)
  - Renal and hepatic dose adjustment reminder: 2009.6~
- Maximum dose alert: 2009.6~
- Drug-drug interactions alert: 2009.6~
- Drug-food interactions reminder: 2009.9~
- Oral dosage form to be divided or crushed: 2010.11~
- Drugs to be administered via central line: 2011.1~
- Choosing drugs based on pharmacological categories: 2011.4~
- Drug-disease interactions alert: 2012.4~
- Protocol-based chemotherapy prescribing: 2012.12~ (2015.9, 100%)
- Infusion set compatibility reminder: 2015.2
- Cloud medication records application: 2015~
- Renal dose alert: 2018~

2018年統計資料


系統提示或阻擋
1,094,819次/年 11.1%
取消+修改 ~20%
藥師介入
68,650件/年 0.7%
處方總筆數
9,837,341筆/年
開方錯誤
9件/年 0.9 ppm

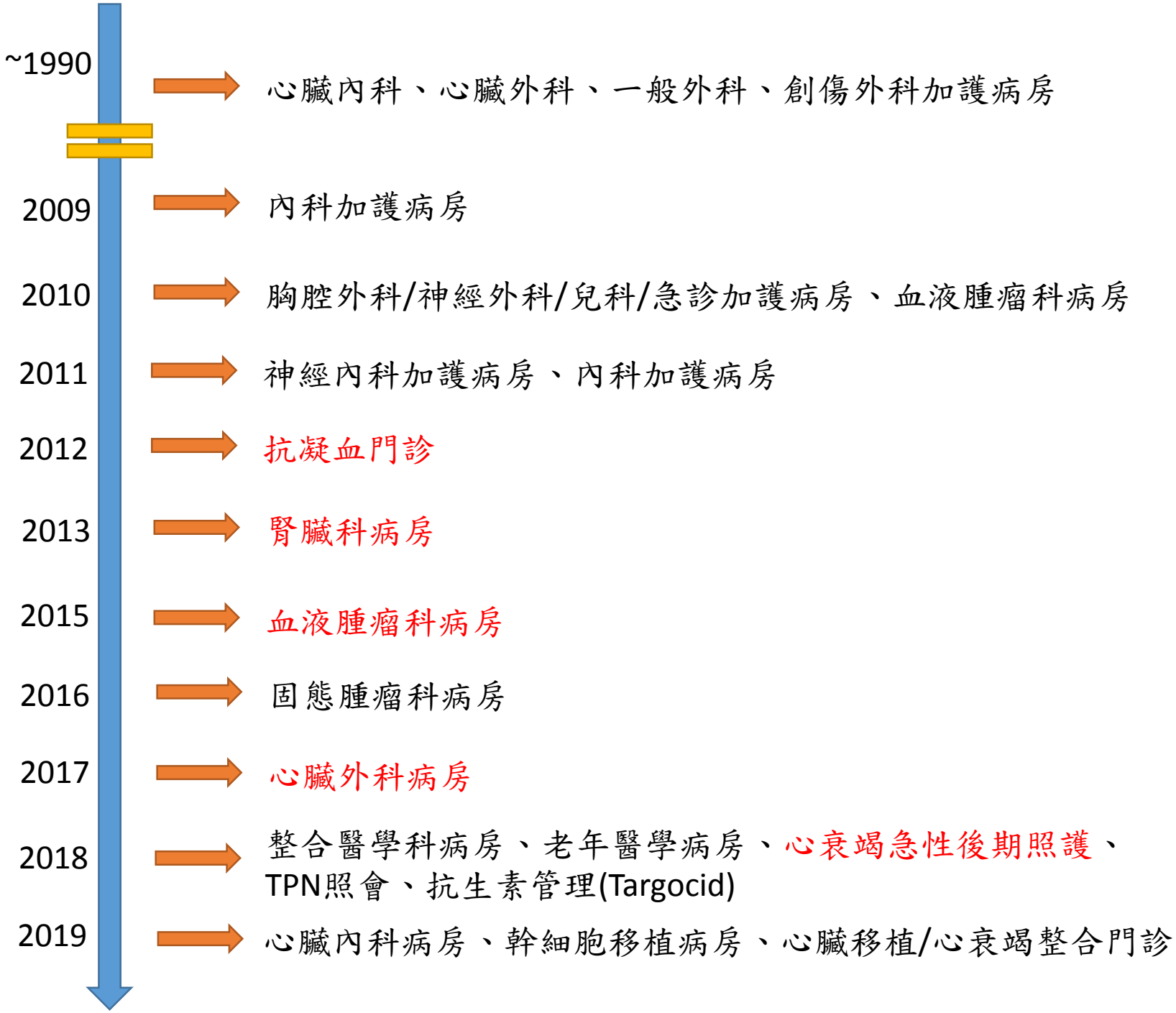
藥師建議節省藥品支出 (cost-avoidance)



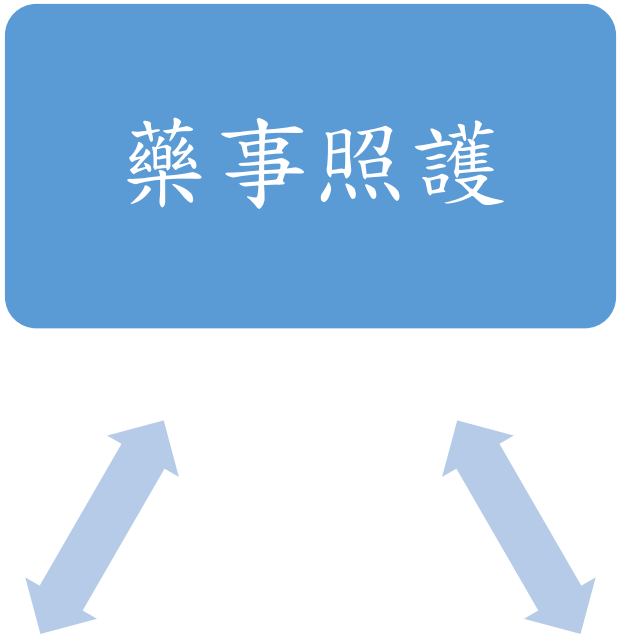
住院臨床藥事照護

半年期進階臨床訓練計畫

- 訓練對象
  - 工作滿兩年具臨床藥學相關碩士學位（M.S. in clinical pharmacy）或Pharm.D. (需完成至少36週之臨床藥學實習時數)者；藥學學士學位於教學醫院年資滿四年以上且具P3資格者(如附件一)。
  - 參加筆試及口試通過
- 訓練內容
  - 視未來服務專科而定, ex. 心臟內科臨床服務
    - 心臟內/外科加護病房、一般內科加護病房、腦中風加護病房、心臟外科一般病房
- 訓練要求
  - 至少一次專題演講
  - 完成專案一件或文章發表一篇


~1990
心臟內科、心臟外科、一般外科、創傷外科加護病房
2009
內科加護病房
2010
胸腔外科/神經外科/兒科/急診加護病房、血液腫瘤科病房
2011
神經內科加護病房、內科加護病房
2012
抗凝血門診
2013
腎臟科病房
2015
血液腫瘤科病房
2016
固態腫瘤科病房
2017
心臟外科病房
2018
整合醫學科病房、老年醫學病房、心衰竭急性後期照護、
TPN照會、抗生素管理(Targocid)
2019
心臟內科病房、幹細胞移植病房、心臟移植/心衰竭整合門診

臨床專責藥師



協助P&P制定及Protocol設立
臨床輔助系統改善
跨團隊藥事照護

新進藥師訓練
六年制
臨床藥學研究所
國外PharmD
外院藥師

臨床問題
改善臨床照護

文件名稱	連續性腎臟替代療法之抗微生物製劑劑量建議	權責單位		藥劑部	頁碼/總頁數	1/8
文件編號	15600-3-000003	版次	1	修制訂日期		2018/7/26
				檢視日期		2018/7/26

107 年 7 月 26 日第 240 次藥事委員會審查

一、 目的：

國立臺灣大學醫學院附設醫院（以下簡稱本院）為提升抗微生物製劑使用於接受連續性腎臟替代療法(continuous renal replacement therapy，簡稱CRRT)病人之療效，同時減少因不適當的劑量所造成的副作用發生，特制定連續性腎臟替代療法抗微生物製劑劑量建議（以下簡稱本建議）。

二、 範圍：

本院各成人加護病房病人。

三、 內容：

(一)抗微生物製劑治療成功的重要因素包括因應病人狀況選擇適當的抗微生物製劑以及給予適當的劑量等。當病人腎臟功能惡化接受 CRRT 時，若未及時調整劑量，可能造成劑量過高或過低。

(二)使用 CRRT 時，影響藥品濃度的因素主要可分為機器設定、藥品特性及殘餘腎功能：

1. 機器設定：影響藥品排除的主要因素包括超過濾或透析速率(effluent rate)、透析膜的材質及表面積。
   i. Effluent rate：為影響藥品移除的最重要因素，一般藥品清除率和 effluent rate 成正比。接受 CRRT 時藥品的建議劑量主要是根據 effluent rate 為 1-2 L/hr 的情況。因此，若 effluent rate 超過 2L/hr，可考慮增加劑量。無 CRRT 相關建議劑量，建議以 effluent rate 作為肌酐酸廓清率(creatinine clearance、CL_{Cr})的替代，再根據該藥品於不同 CL_{Cr} 時之建議劑量來給予。
   ii. 透析膜材質及表面積：透析膜的表面積越大，藥品的排除越多。目前的劑量建議多根據表面積較小的透析膜(<1 m^2)。本院目前的 CRRT 透析膜表面積主要為 1.4 m^2。
2. 藥品特性：如高分子量(>50000 Daltons)、分佈體積大(>1 L/kg)、高蛋白質結合率(>80 %)及低腎臟排除比例(<30 %)的藥品，一般較不

藥品		建議劑量	
Lipopeptides	Vancomycin[8,a,e]	20 mg/kg	7.5 mg/kg q12h
	Daptomycin[9]	-	8 mg/kg qd
Oxazolidinones	Linezolid	-	600 mg q12h
Polymyxins	Colistin[10]	4 mg/kg, max. 300 mg	217.1 mg q12h
Glycylcyclines	Tigecycline	100 mg	50 mg q12h
Miscellaneous	Clindamycin	-	900 mg q8h
	Fosfomycin[f]	-	8 g q8h
	Metronidazole	1 g	500 mg q8h
	Sulfamethoxazole/trimethoprim	-	7.5 mg/kg q12h[g]

- Dose suggestion was based on effluent rate of 1-2 L/hr. If higher effluent rate was applied, higher dose of antibiotics could be considered.
- Dose suggestion was based on minimal residual renal function (daily urine output < 500 mL/day). If residual renal function preserved, higher dose of antibiotic could be considered.

* Dose was expressed as the component of ampicillin and piperacillin.

a. Serum concentration should be monitored for dose adjustment.
b. Extended infusion (4 hrs) should be used for penicillin, cephalosporin and carbapenem antibiotics in patients with residual renal function
c. Use effluent rate as CL_{Cr}, then adjust dose accordingly. Ex. Effluent rate = 2L/hr = 33.3 mL/min, adjust dose by CL_{Cr} = 33.3 mL/min
d. Because of the discrepancy of CRRT removal of two components, dose suggestion is not available currently.
e. Based on NTUH data, over 80% of serum concentration could achieve trough of 10-20 mg/L.
f. Because fosfomycin was highly eliminated by CRRT (~77%), usual dose for severe infection was suggested.
g. Based on trimethoprim dose

Effect of Extracorporeal Membrane Oxygenation on the New Vancomycin Dosing Regimen in Critically Ill Patients Receiving Continuous Venovenous Hemofiltration

Chi-Ju Yang, MSCP, Chia-Wei Wu, MSCP,* and Chien-Chih Wu, MSCP*†*

Characteristic	Mean ± SD or No. (%)
Age (yrs)	59.6 ± 14.8
Male sex	31 (82%)
Weight (kg)	68.8 ± 13.7
APACHE II score*	29.5 ± 7.2
ECMO use	21 (55%)
Ultrafiltration rate ($mL \cdot kg^{-1} \cdot h^{-1}$)	30.6 ± 5.5
<20	1 (2.6%)
20–25	4 (10.5%)
25–30	13 (34.2%)
30–35	10 (26.3%)
35–40	8 (21.1%)
>40	2 (5.3%)
Loading dose (mg/kg)†	16.0 ± 3.3
Maintenance dose (mg/kg)	7.2 ± 1.0
Sampling time after administered vancomycin (d)	3.6 ± 1.6
Serum vancomycin concentration (mcg/mL)	14.7 ± 3.5
<10	3 (8%)
10–15	17 (45%)
15–20	16 (42%)
>20	2 (5%)

C_{trough} was within the target range in 87% of patients.

Wu CC et al. *Ther Drug Monit*. 2018;40(3):310-4

臨床輔助系統改善

2011-02-20 28 M, no PMH. 175 cm/80 kg. Scr: 0.8 mg/dL.

- Send to ER: Generalized tonic-clonic seizure. Fever up to 39oC
- **Depakine (sodium valproate): LD 800 mg, MD: 400 mg q8h as maintenance.**
- Vancomycin 1 g q8h, Rocephin (ceftriaxone) 2 g q12h, Zovirax (acyclovir) 750 mg q8h for CNS infection

2011-02-22 VPA level: 63. Continue VPA 400 mg q8h.

- 2011-02-25: Persistent fever. Shift Rocephin to Mepem 2 g q8h.
- 2011-02-27: Myoclonus seizure observed. Recheck VPA level: 40. → titrate VPA to 600 mg q8h.

2011-03-02 GTC occurred. VPA level: 7. Give re-LD: 800 mg.

- Titrate MD to 800 mg q6h.
- 2011-03-04: VPA level: 11. Stop Mepem. Add Maxipime (cefepime) 2 g q8h.
- 2011-03-07: VPA level: 92. → taper MD to 400 mg q6h. 2011-03-04: VPA: 52.

No interaction alert for this combination

臨床輔助系統改善

2011-02-20 28 M, no PMH. 175 cm/80 kg. Scr: 0.8 mg/dL.

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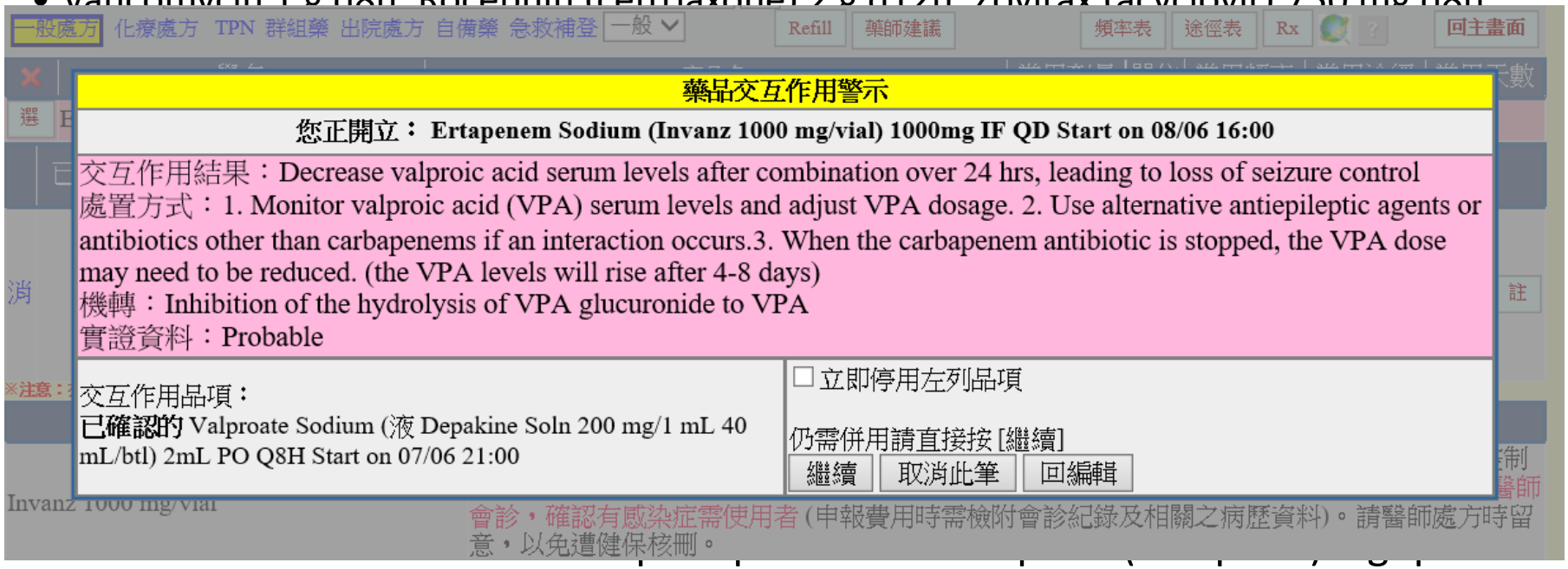

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No interaction alert for this combination

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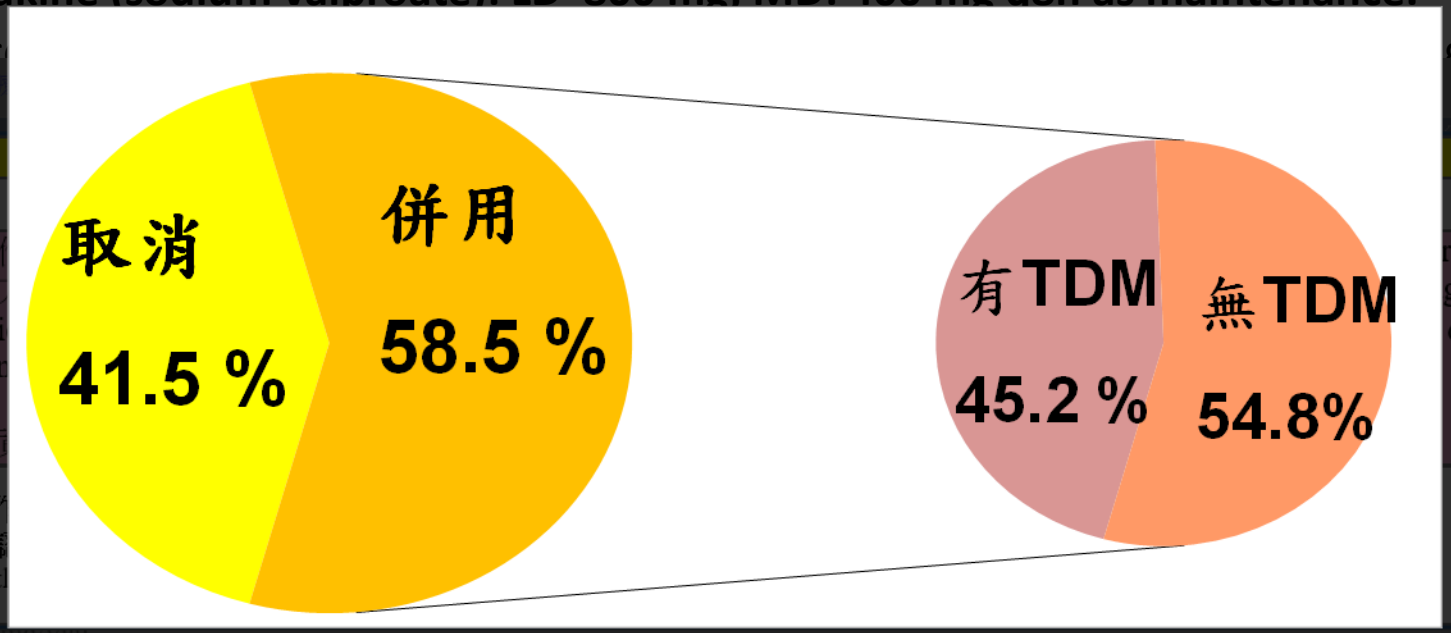
- Vanc

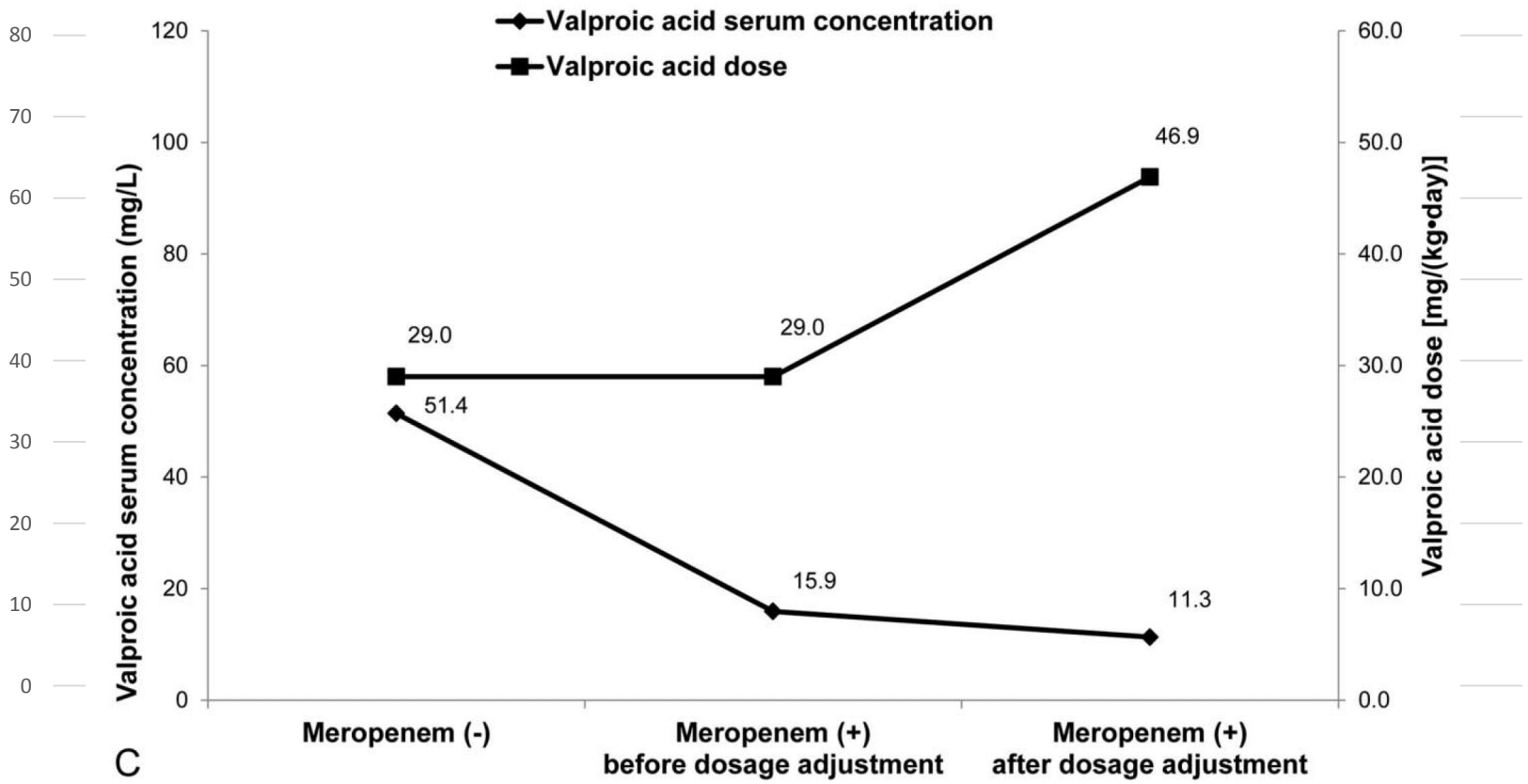


- 2011-03-07: VPA level: 92. → taper MD to 400 mg q6h. 2011-03-04: VPA: 52.

No interaction alert for this combination

The Effect of Different Carbapenem Antibiotics (Ertapenem, Imipenem/Cilastatin, and Meropenem) on Serum Valproic Acid Concentrations

Chien-Chih Wu, MSCP,† Tsung-Yu Pai, PharmD,* Fei-Yuan Hsiao, PhD,*†‡ Li-Jiuan Shen, PhD,*†‡ and Fe-Lin Lin Wu, PhD*†‡§*



- Increase valproic acid dose could not overcome this interaction

Therapeutic drug monitoring 2016;38:587-92.

臨床專責藥師成效

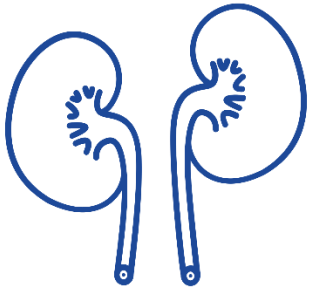
- 臨床成果
  - 減少medication error，可能發生的ADR，住院天數等等
- 節省花費
  - 直接的藥費節省 (Cost savings)
    - 用藥期間/數量問題、適應症問題及藥品併用問題，計算一天節省相關藥品花費。
    - 用藥劑量/頻次問題、用藥途徑或劑型問題，計算一天節省相關藥品花費乘上後續使用總天數
  - 間接的醫療費用節省 (Cost avoidance)
    - 減少ADR導致的住院所衍生的花費

Intensive Care Med 2003;29:691–698

Cost avoidance

- 每個ADR可延長住院天數2天
- 腎臟科病房費約5000元/天
- 根據不同藥事介入，若未介入發生ADR的機率(P)為0/0.01/0.1/0.4/0.6
- 預防ADR的件數 = P*N (介入件數)
- 醫療費用節省 = 2*5000*P*N

Medicine 2017;96(34):e7883



總住院人次：813
總處方數：39256 筆
藥師介入修改處方件數：824
主動建議數：37
直接藥費節省：52,072
間接藥費節省：3,383,700
平均住院天數：13.22
Benefit/cost ratio: 4.29

總住院人次：937
總處方數：40580 筆
藥師介入修改處方件數：1977
主動建議數：253
直接藥費節省：144,138
間接藥費節省：7,342,200
平均住院天數：11.10
Benefit/cost ratio: 9.36

Quality Improvement Study

Medicine®

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The cost-saving effect and prevention of medication errors by clinical pharmacist intervention in a nephrology unit

Chia-Chi Chen, MSCP[a], Fei-Yuan Hsiao, PhD[a,b,c], Li-Jiuan Shen, PhD[a,b,c], Chien-Chih Wu, MSCP[a,c,*]

Abstract

Medication errors may lead to adverse drug events (ADEs), which endangers patient safety and increases healthcare-related costs. The on-ward deployment of clinical pharmacists has been shown to reduce preventable ADEs, and save costs. The purpose of this study was to evaluate the ADEs prevention and cost-saving effects by clinical pharmacist deployment in a nephrology ward.

This was a retrospective study, which compared the number of pharmacist interventions 1 year before and after a clinical pharmacist was deployed in a nephrology ward. The clinical pharmacist attended ward rounds, reviewed and revised all medication orders, and gave active recommendations of medication use. For intervention analysis, the numbers and types of the pharmacist's interventions in medication orders and the active recommendations were compared. For cost analysis, both estimated cost saving and avoidance were calculated and compared.

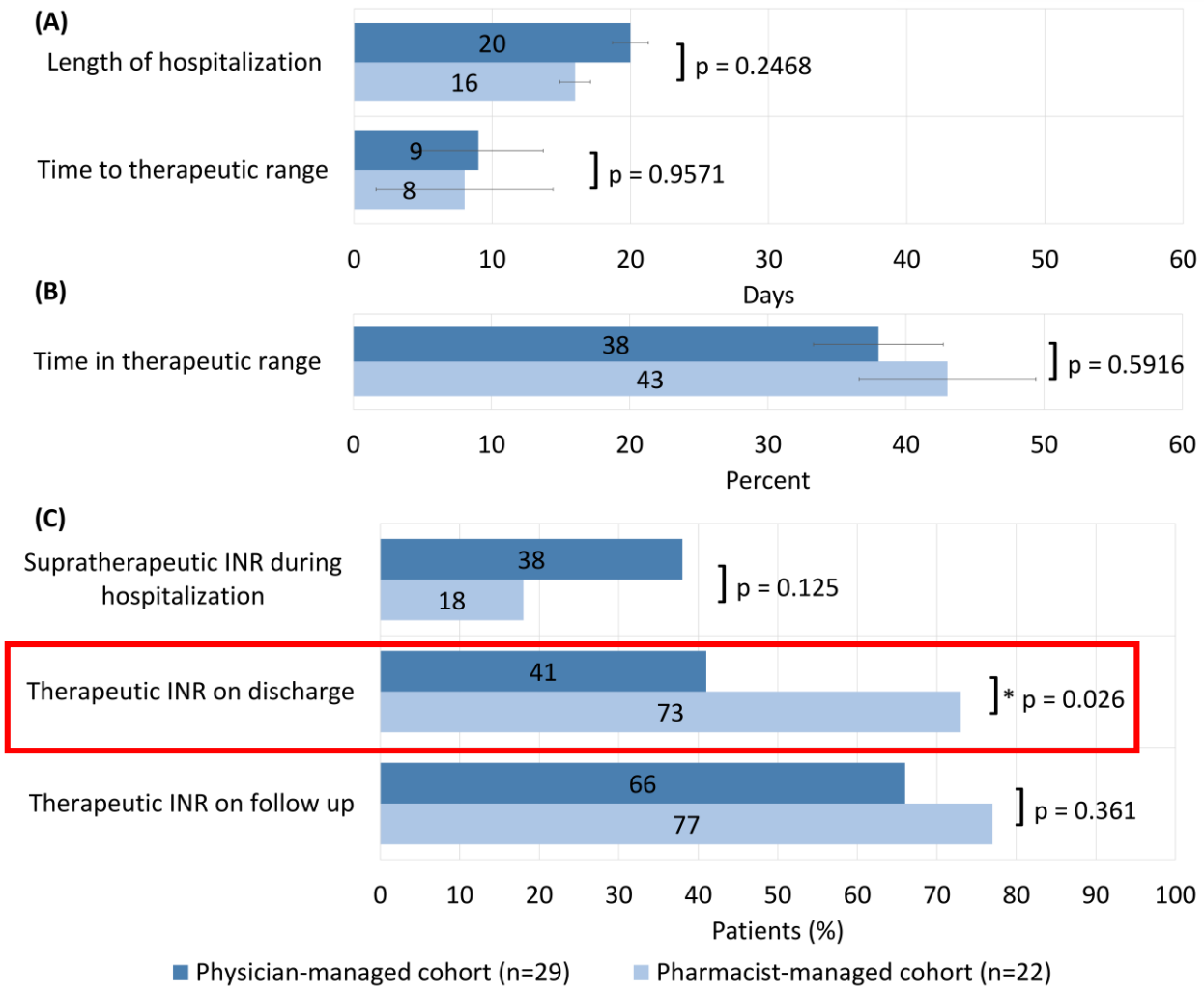
The total numbers of pharmacist interventions in medication orders were 824 in 2012 (preintervention), and 1977 in 2013 (postintervention). The numbers of active recommendation were 40 in 2012, and 253 in 2013. The estimated cost savings in 2012 and 2013 were NT$52,072 and NT$144,138, respectively. The estimated cost avoidances of preventable ADEs in 2012 and 2013 were NT$3,383,700 and NT$7,342,200, respectively. The benefit/cost ratio increased from 4.29 to 9.36, and average admission days decreased by 2 days after the on-ward deployment of a clinical pharmacist.

The number of pharmacist's interventions increased dramatically after her on-ward deployment. This service could reduce medication errors, preventable ADEs, and costs of both medications and potential ADEs.

Abbreviations: ADE = adverse drug events, NHI = National Health Insurance, NTUH = National Taiwan University Hospital.

Keywords: clinical pharmacist, cost saving, medication error, nephrology, preventable adverse drug event

The impact of clinical pharmacist intervention on inpatient warfarin therapy after mechanical heart valve replacement



Best poster award in 2019 NTU pharmacy school Research Day

心衰竭急性後期整合照護

全民健康保險急性後期整合照護計畫

106 年 06 月 26 日健保醫字第 1060007890 號公告修正
106 年 09 月 30 日健保醫字第 1060033976 號公告修正

壹、 前言

因應人口老化，愈來愈多的病患在急性醫療後可能出現失能情形，將大幅造成對醫療體系、家庭及社會照顧之負擔或依賴，故需儘早規劃急性後期之醫療整合照護模式(Post-acute Care，以下稱 PAC)。雖然目前全民健保給付治療疾病所需之相關醫療費用，但國內急性後期照護模式尚未建立，跨醫療院所照護急性後期病人轉銜系統尚待整合，急性期穩定之病人憂心返家後的照護而滯留醫院，因此以再住院及超長住院方式因應急性後期照護需要，或造成照護強度不足，或為復健入住大型醫院之情形，對於醫療服務品質與資源使用效率亦有待改善。故透過支付改革，建構急性後期照護模式與病人垂直整合轉銜系統，依個別病人失能程度，在治療黃金期內立即給予積極性之整合性照護，使其恢復功能，將可減少後續再住院醫療費用、減輕家庭及社會照顧之負擔。亦可強化急性醫療資源配置效率，與長期照護服務無縫接軌，達到多贏的目標。

心衰竭整合照護-藥師的角色及重要性

ORIGINAL ARTICLE

Drug-related problems vary with medication category and treatment duration in Taiwanese heart failure outpatients receiving case management

Wan-Tseng Hsu [a], Li-Jiuan Shen [b,c,d], Chii-Ming Lee [e,*]

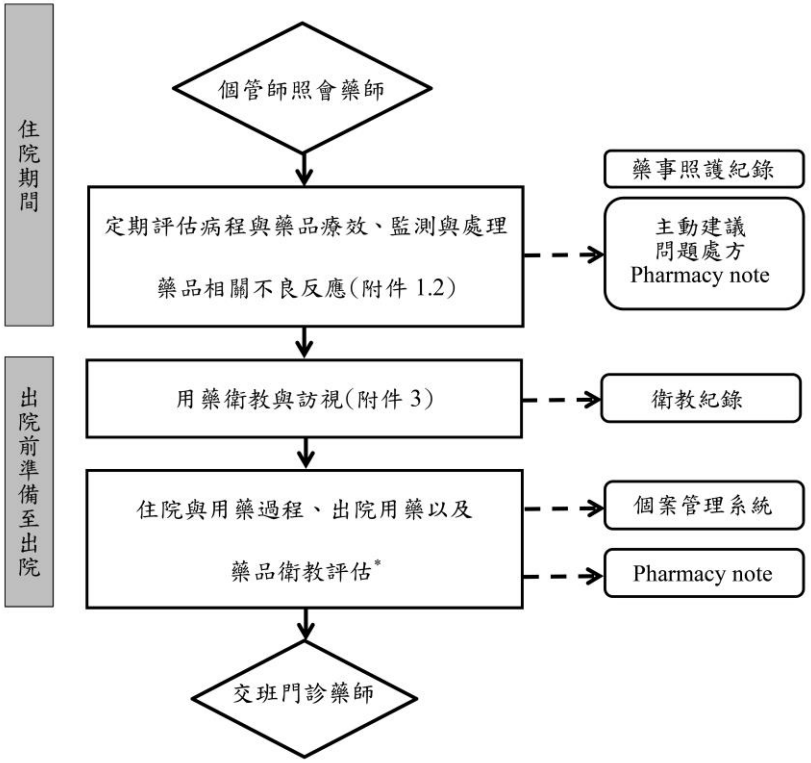
Table 3 Drug-related problem code distribution among study participants.

Primary Domain	Code	Description	*n* (%)
1. Adverse reactions	1.1	Nonallergic side effects suffered	106 (13.3)
	1.2	Allergic side effects suffered	0 (0)
2. Drug choice problem	2.1	Contraindication	0 (0)
	2.2	No clear indication for drug use	0 (0)
	2.3	No drug prescribed but clearly indicated	56 (7.0)
	2.4	Inappropriate duplication of therapeutic group or active ingredient	6 (0.8)
3. Dosing problem	3.1	Drug dosage too low or dosage regimen not frequent enough	33 (4.1)
	3.2	Drug dosage too high or dosage regimen too frequent	12 (1.5)
4. Interactions	4.1	Potential interaction	236 (29.6)
	4.2	Manifest interaction	11 (1.4)
5. Others	5.1	Insufficient awareness of health and disease (possibly leading to future problems)	76 (9.5)
	5.2	Therapy failure	0 (0)
	5.3	Need for laboratory tests (e.g., therapeutic drug monitoring, laboratory value, electrocardiography)	260 (32.7)
Total			796 (100)

Journal of the Formosan Medical Association 2016;115:335-342

NTUH心衰竭急性後期整合照護-藥事照護流程

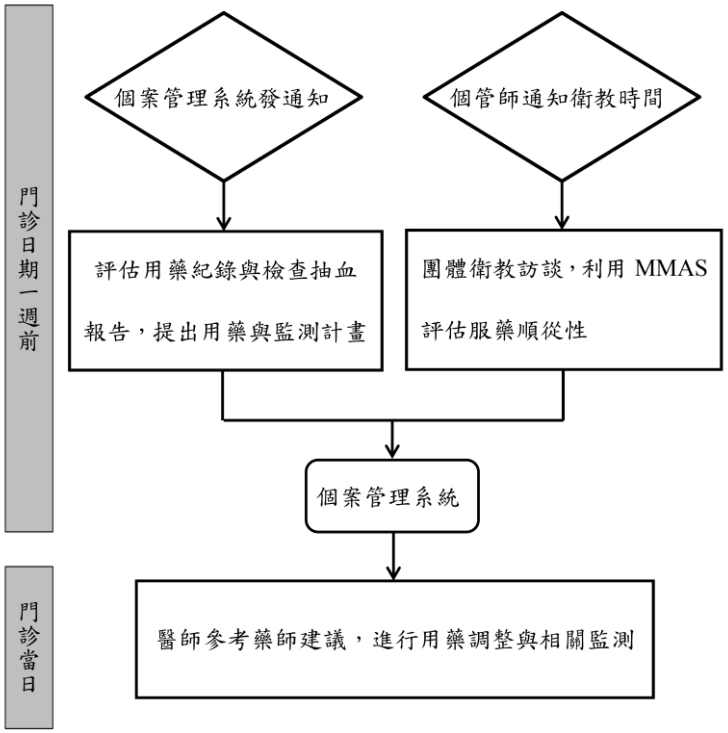
圖一　急性期住院期間藥事照護流程圖



*若預定出院日為假日，藥師可於一週後病人回門診時進行衛教

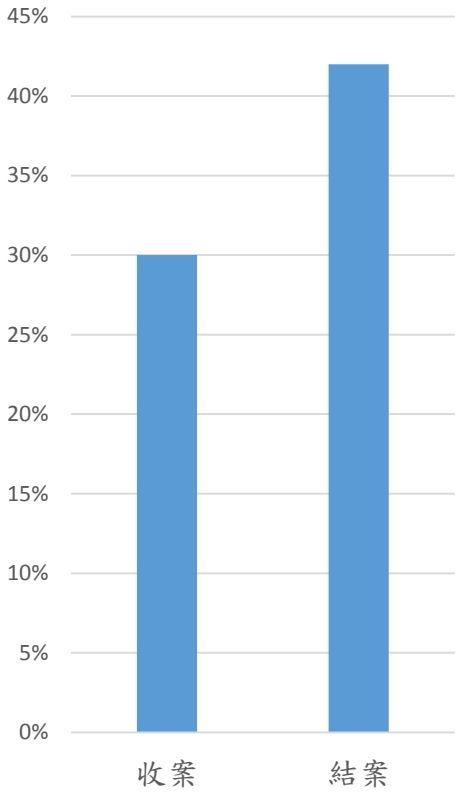
圖二　急性後期門診期間藥事照護流程圖

(出院後第三個月與第六個月門診)

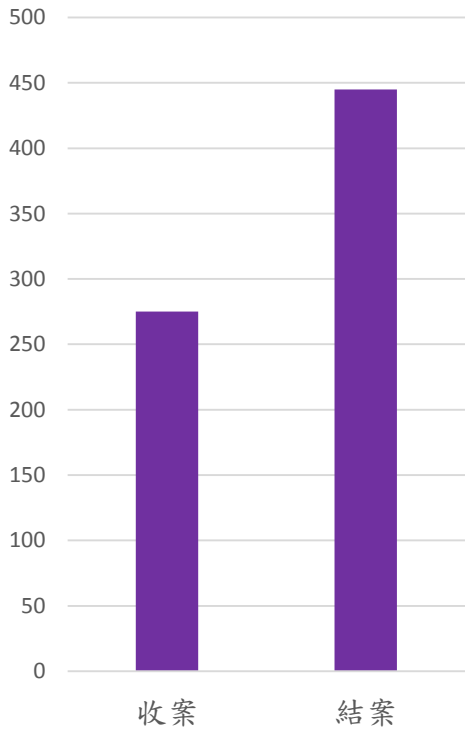


NTUH心衰竭急性後期整合照護成效

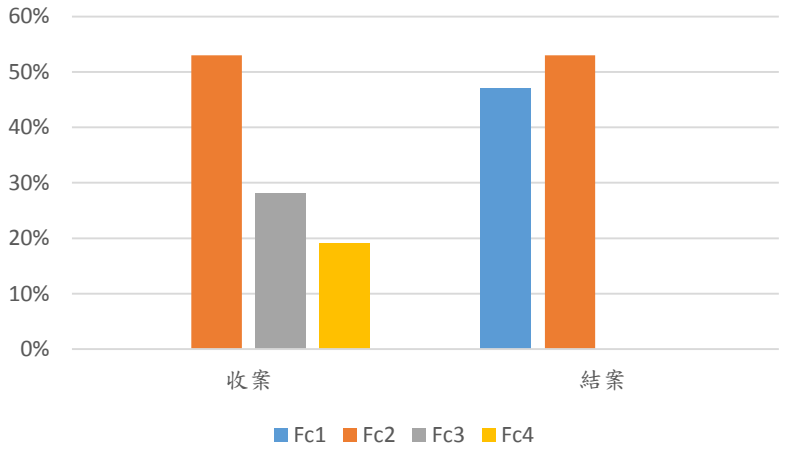
LVEF



6MWD

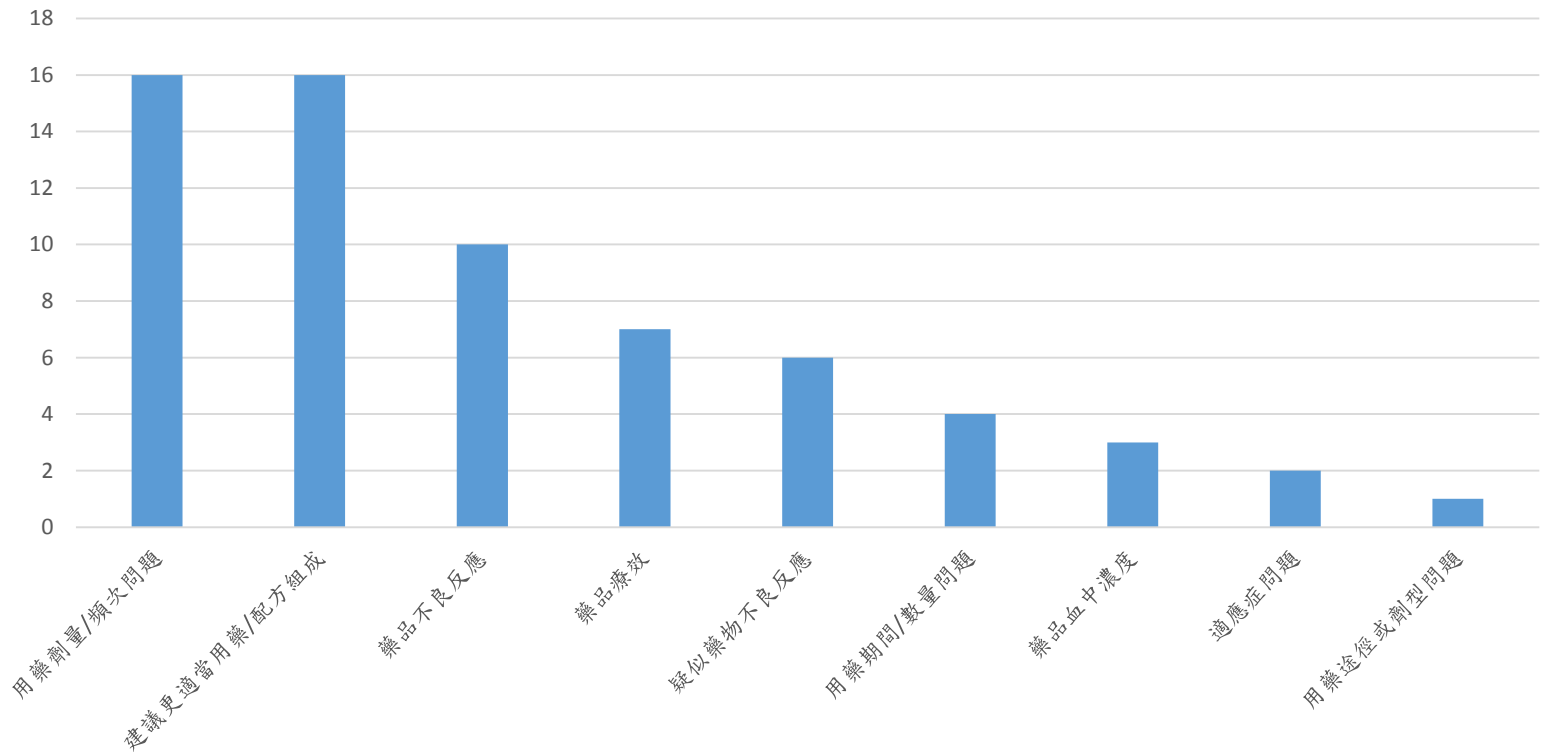


NYHA



NTUH心衰竭急性後期整合照護-藥師介入

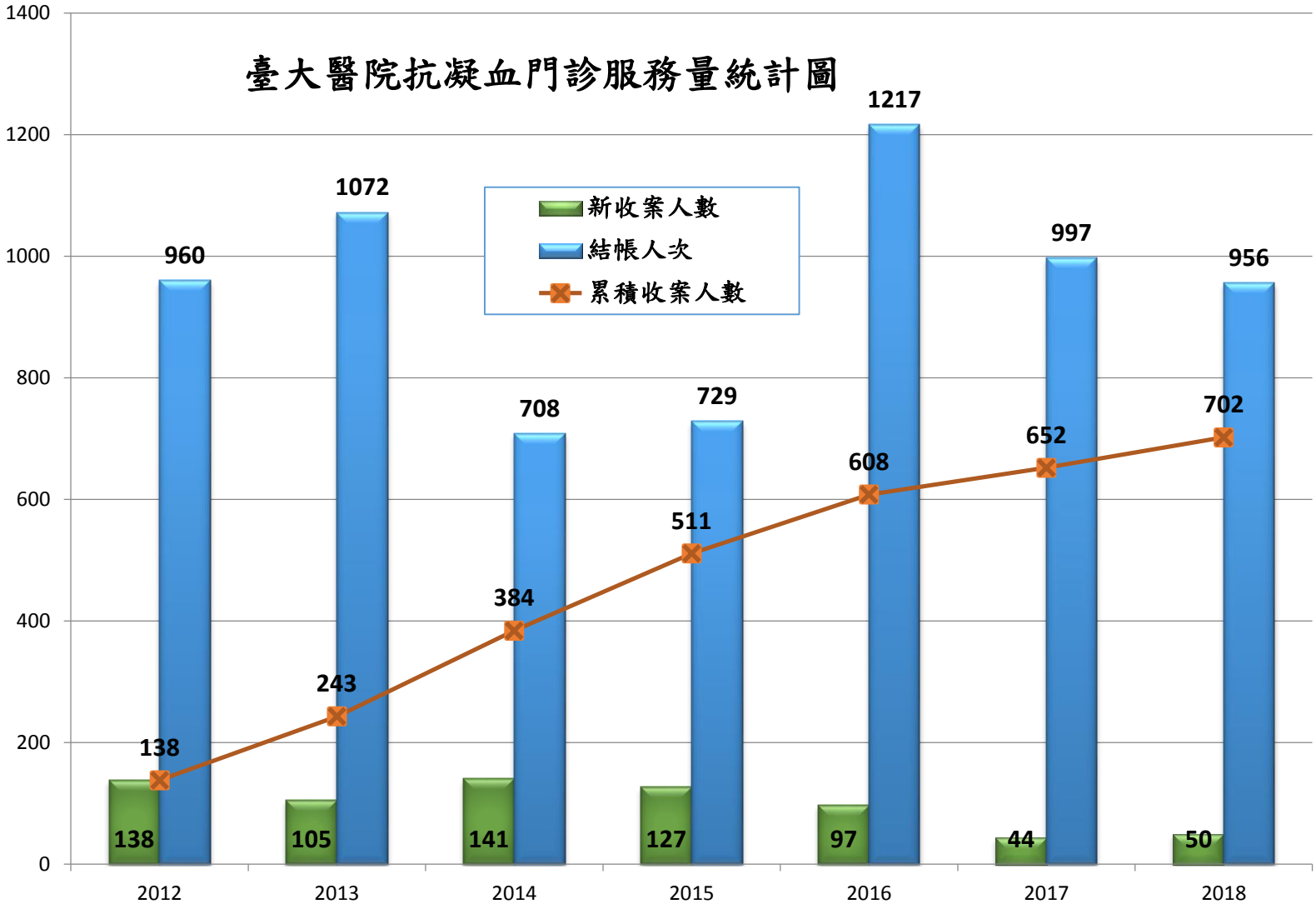
- 衛教次數: 176次
- 處方介入修改: 71件

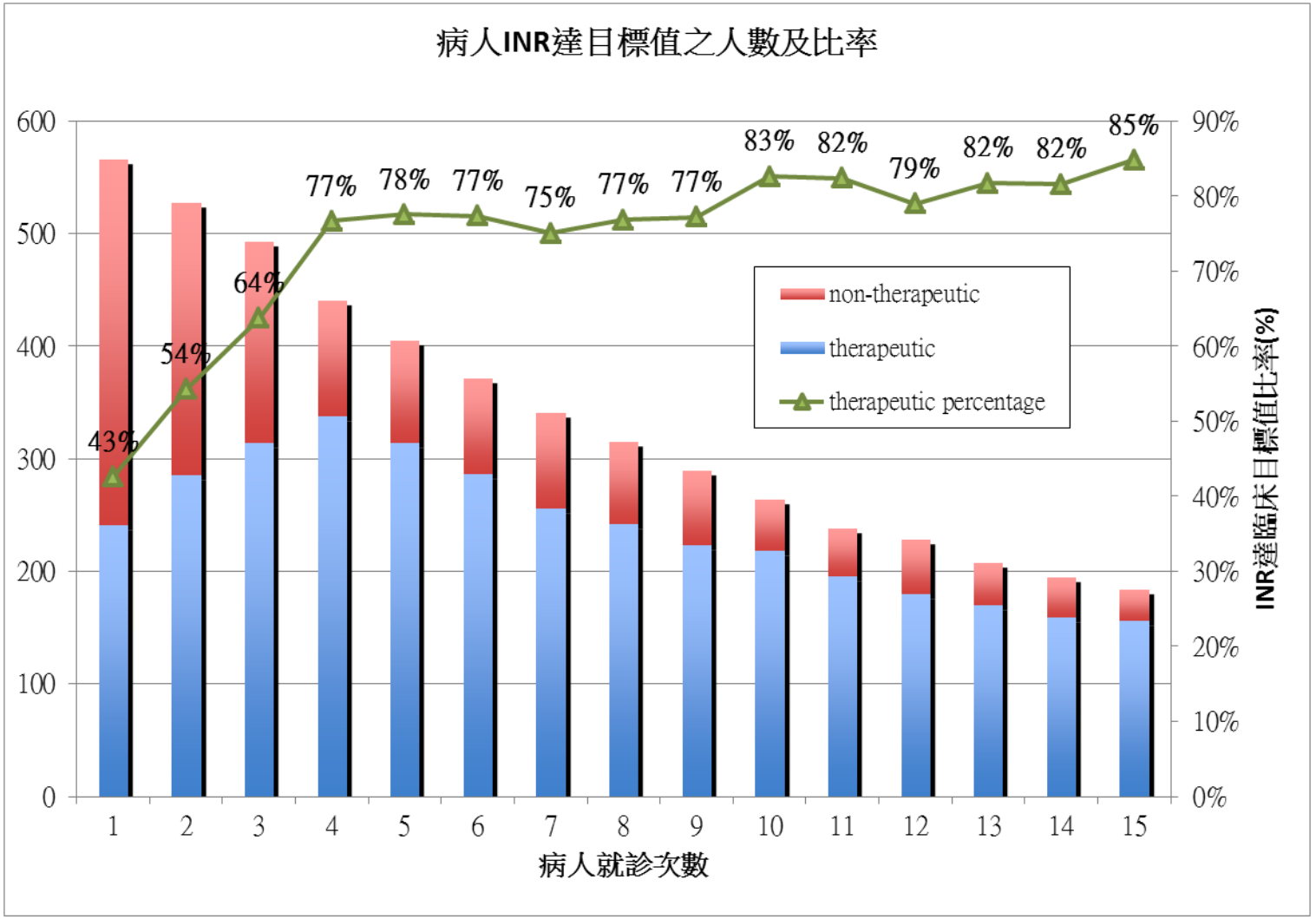


First Pharmacy Clinic Patients Pay for Services

藥師抗凝血門診

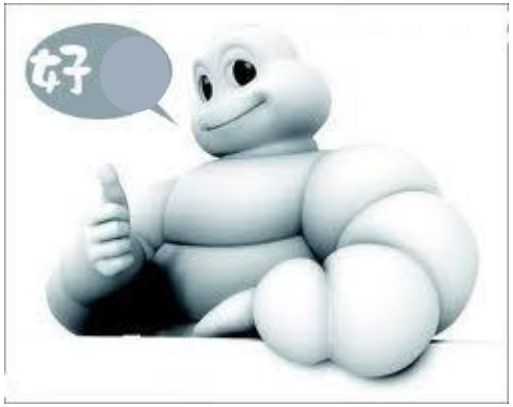
University of Illinois at Chicago Antithrombotic Clinic


臺大醫院抗凝血門診服務量統計圖
新收案人數
結帳人次
累積收案人數
1400
1200
1000
800
600
400
200
0
960
1072
708
729
1217
997
956
138
243
384
511
608
652
702
138
105
141
127
97
44
50
2012
2013
2014
2015
2016
2017
2018


病人INR達目標值之人數及比率
600
500
400
300
200
100
0
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
43%
54%
64%
77%
78%
77%
75%
77%
77%
83%
82%
79%
82%
82%
85%
non-therapeutic
therapeutic
therapeutic percentage
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
病人就診次數
INR達臨床目標值比率(%)

高滿意度

病人對本院創新之抗凝血藥品共同照護模式感到非常滿意。得分為 4.57± 0.50 (滿分為5分), N=49。



病人對疾病及warfarin的認知程度顯著進步

病人對warfarin的認知程度及格率，從 19.1% 增加為 74.5% (p<0.0001)，N=47。進步率為290%。

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Article

OXFORD

Article

Cost-effectiveness of the pharmacist-assisted warfarin monitoring program at a Medical Center in Taiwan

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Editorial Decision 27 July 2017; Accepted 31 July 2017

Abstract

Objective: To investigate the cost-effectiveness of the first patient self-paying pharmacist-assisted warfarin monitoring (PAWM) program in Taiwan.

Design: A Markov model with a 1-month cycle length and a 20-year time horizon was employed in this study. The model is composed of the following eight states: three no-event states (i.e. 'sub-therapeutic,' 'within therapeutic' and 'supratherapeutic' states), two serious adverse events (AEs) (i.e. bleeding and thromboembolism), two sequelae states and death. The likelihood of events, costs and utilities were derived from local databases and literature, if applicable. This study was conducted with a payer's perspective and all costs were discounted with a rate of 3%.

Setting: A pharmacist-led clinic.

Participants: A hypothetical cohort of 10 000 participants.

Intervention(s): PAWM versus usual care.

Main outcome measure(s): Average quality-adjusted life-years (QALYs) gained and cost increments per patient, and incremental cost-effectiveness ratios (ICERs).

Results: The PAWM program resulted in an average of 0.13 QALYs gained and a cost increment of NT$53 850 (US$1683) per patient. As the ICER (NT$410 749 [US$12 836]) was less than the gross domestic product per capita (NT$631 142 [US$19 723]), the PAWM was considered to be very cost-effective. The sensitivity analyses suggested that our result was robust and that the PAWM program had an 86% probability of being very cost-effective.

Conclusions: Even if the costs saved from avoiding AEs were thought to be minimal due to the low-medical expenditures in Taiwan, the PAWM program was demonstrated to be economical. According to our findings, the policymakers should consider reimbursing such a service.

Key words: warfarin, pharmacist-assisted warfarin monitoring (PAWM), cost-effectiveness, Markov model, incremental cost-effectiveness ratio (ICER)

藥師提供藥事照護

- 改善疾病治療。
- 減少用藥疏失及藥品不良反應。
- 減少醫療花費。