

Cost-effectiveness of Diagnostic Strategies for Evaluation of Suspected Subarachnoid Hemorrhage in the Emergency Department

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背景

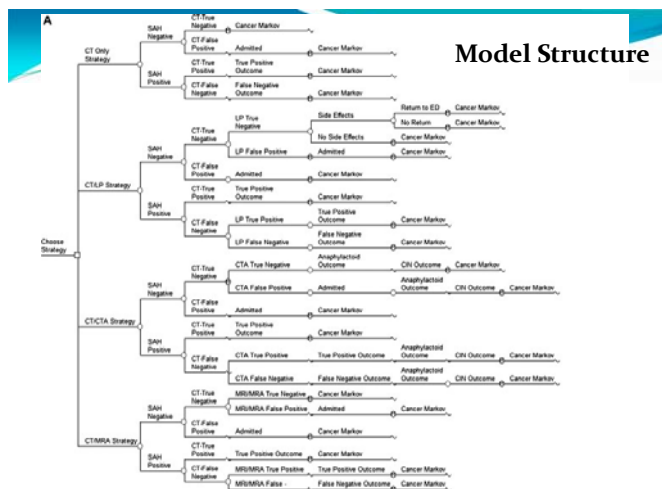
- 在急診室診斷SAH是一項挑戰
 - 若沒有診斷出來，病人的mortality and morbidity rate會上升
 - 在台灣可能還會被病人告到脫褲
- 目前診斷方法：
 - CT only
 - CT / lumbar puncture (LP) -> 目前許多guideline推薦的診斷方法
 - CT / MRI
 - CT / CTA

研究目的

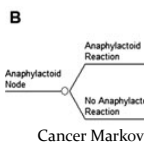
- 從 cost-effectiveness 的角度來探討 "CT-only", "CT / LP", "CT / MRI", "CT / CTA" 這四個診斷SDH的策略的選擇。

方法

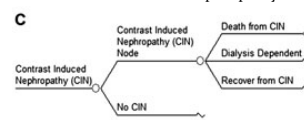
- 研究設計: A decision tree study
 - 情境: a 45-year-old neurologically normal patient who presents to the ED after the acute onset of severe headache (arrived 12 hours after the onset of headache)



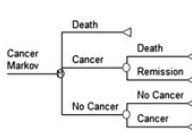
Anaphylactoid Node



Contrast Induced Nephropathy



Cancer Markov



- Model Parameters/Input Parameters
 - Clinical Probabilities
 - Diagnostic Test Assumptions
 - Costs
 - Life Expectancy and Disutilities
- Cost-effectiveness analysis : 比較"CT-only", "CT / LP", "CT / MRA", "CT / CTA"
 - Costs (both short- and long-term)
 - QALYs (quality-adjusted life years)
 - ICERs (incremental cost-effectiveness ratio) compared to the willingness to pay (WTP) threshold (\$50,000 per QALY)
- Sensitivity Analyses
 - 利用 ICER 以 one-way sensitivity analyses 來評估模型中的變數對決策的影響
 - 用 two-way sensitivity 來評估變數間的潛在的交互作用
 - 利用 probabilistic sensitivity analyses and Monte Carlo simulation 來評估 uncertainty surrounding specific parameter assumptions

Clinical Probabilities. 機率從已發表的研究中取得

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Table 1
Base-case Estimates of Probabilities and Range of Values Used in Sensitivity Analyses

Variable	Base-case Estimate	Range	Reference
Anaphylactoid reaction	0.0073	0-0.1	25, 26
Cancer from noncontrast head CT	0.00009	0.00001-0.0002	29, 30
Cancer from CT angiogram of the brain	0.0003	0.0001-0.00059	29, 30
CIN	0.116	0-0.2	22-24
Death from anaphylactoid reaction	0.002	0-0.01	25, 26
Death from CIN	0	0-0.5	Assumption
Death from SAH (delayed diagnosis)	0.14	0-0.2	2
Death from SAH (no delay)	0.05	0-0.2	2
Mild disability from SAH (no delay)	0.38	0-0.5	2
Mild disability from late diagnosis of SAH	0.65	0.5-1	2
Severe disability from SAH (no delay)	0.534	0-0.1	2
Severe disability from late diagnosis of SAH	0.097	0-0.2	2
Renal failure from CIN	0.086	0-0.15	22, 24
Return to ED from POPH	0.04	0-0.2	Institutional data
Sensitivity of noncontrast head CT for aneurysmal blood	0.96	0.8-1	9, 14, 19, 32
Sensitivity of CTA for aneurysm	0.97	0.8-1	40
Sensitivity of LP for aneurysmal blood	1.00	0.5-1	9, 13, 14
Sensitivity of MRA for aneurysm	0.86	0.75-1	38, 41, 42
Side effects from LP	0.21	0-0.4	9, 21
Specificity of noncontrast head CT for SAH	1.00	0.8-1	9
Specificity of CTA for aneurysm	0.98	0.8-1	9, 40
Specificity of LP for SAH	0.85	0.6-1	9, 15
Specificity of MRI/MRA for aneurysm	0.85	0.7-1	38, 42
SAH probability	0.12	0-0.3	7, 9, 11, 12, 15, 19, 20
Survival from head/neck cancer	0.37	0.3-1	28

Data were obtained from published literature to establish the base-case values. Clinically plausible ranges were used in the sensitivity analyses to evaluate their influence on the decision strategy.
CIN = contrast-induced nephropathy; CT = computed tomography; CTA = CT angiogram; LP = lumbar puncture; MRA = magnetic resonance angiography; PDPH = postdural puncture headache; SAH = subarachnoid hemorrhage.

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Table 2
Cost Estimates Used in the Decision Model

Variable	Base-case Estimate (\$)	Range (\$)	Reference
Anaphylactoid reaction	23,516	10,000-50,000	44, 45
Anaphylactoid reaction—death	80,489	50,000-100,000	44, 45
Annual cost of severe disability	37,435	20,000-50,000	48
Any disability (one-time)	39,022	20,000-50,000	48
Cancer			
Initial phase	87,956	76,000-100,000	18, 49
Continuing phase	6,418	3,000-9,000	18, 49
Terminal phase	102,112	95,000-110,000	18, 49
CIN	14,384	10,000-30,000	23, 44, 45
CIN—death	88,384	50,000-118,000	44, 45
CT head noncontrast (CPT 70450)	216	100-300	45
CT head angiogram (CPT 70496)	696	100-2000	45
ED visit (CPT 92285)	170	50-300	45
LP (CPT 62270)	74	25-125	45
MRI brain (CPT 70551)	592	100-1000	45
MRI/MRA brain, no dye (CPT 70544 and 70551)	1,226	100-2400	45
SAH hospitalization	37,975	10,000-70,000	46
SAH hospitalization (severe disability)	69,059	30,000-200,000	44, 45

CIN = contrast-induced nephropathy; CPT = current procedural terminology; LP = lumbar puncture; MRI = magnetic resonance imaging; MRA = magnetic resonance angiography; SAH = subarachnoid hemorrhage.

Table 3
Assumptions for QALY Calculations

Variable	Base-case Estimate	Reference
Age (yr)	45	11-13, 15
Life expectancy for 45-year-old (yr; both sexes, all races)	37	50
Discount rate	3%	10
Short-term disutility		
For hospital admission	0.01	Assumption
For anaphylactoid reaction	0.00082	51
Disutility for LP	0.01	Assumption
Disutility for post dural headache	0.02	Assumption
Utility of any disability	0.85	52
Utility of cancer	0.7	52
Utility of CIN	0.7	52
Utility of dialysis	0.84	52
Utility of severe disability	0.26	52

CIN = contrast-induced nephropathy; LP = lumbar puncture; QALY = quality-adjusted life-year.

結果

Main result

Base-case Results of a 45-year-old Patient Presenting to the ED With Severe, Sudden Headache and Normal Neurologic Exam

Strategy	Total Cost (\$)	Total Effectiveness (QALYs)	Incremental Cost (\$)	Incremental Effectiveness (QALYs)	Incremental C/E Ratio, ICER (\$/QALY)	Dominance
CT-only	10,339	20,250				
CT/CTA	12,840	20,238	2,501	-0.012	-206,758	(Dominated)
CT/LP	15,120	20,366	4,781	0.116	41,239	(Dominated)
CT/MRA	16,207	20,265	1,087	-0.100	-10,769	(Dominated)

C/E = cost-effectiveness; CT = computed tomography; CTA = CT angiogram; ICER = incremental cost-effectiveness ratio; LP = lumbar puncture; QALY = quality-adjusted life year; MRA = magnetic resonance angiography.

<WTP threshold

結果

Sensitivity analyses

- One-way sensitivity analyses 顯示主要的影響因素為:
 - probability of severe disability from SAH
 - sensitivity of noncontrast CT
 - specificity of LP and MRA
- Two-way sensitivity analyses
- Results of a 10,000 replication Monte Carlo simulation

	95% CI of cost	95% CI of effectiveness
CT-only	\$9,051 to \$11,684	20.21 to 20.29 QALYs
CT/LP	\$13,964 to \$16,329	20.34 to 20.39 QALYs
CT/CTA	\$11,617 to \$14,133	20.19 to 20.28 QALYs
CT/MRA	\$15,059 to \$17,406	20.22 to 20.31 QALYs

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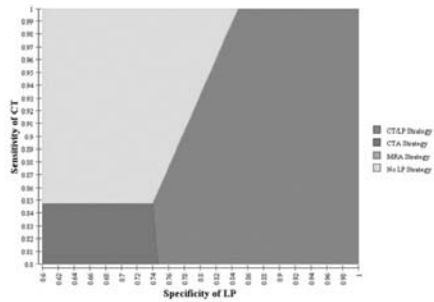


Figure 2. Results of a two-way sensitivity analysis comparing sensitivity of CT to specificity of LP. CT = computed tomography; CTA = CT angiography; LP = lumbar puncture; MRA = magnetic resonance angiogram.

討論

- CT-only and CT/LP 是比較 cost-effective 的診斷策略
- CT-only strategy
 - 花費最少
 - 不進行 LP 可能使醫師面臨誤診的風險
- The CT/LP strategy
 - 花費比CT-only strategy多
 - 但對診斷SDH更有效用，因為減少誤診的機率與誤診帶來的傷害
- Probabilistic sensitivity analysis 顯示這四個診斷策略的cost and effectiveness 的95%信賴區間有重疊，因此並未偏向哪一個診斷策略，除非其他策略得花費明顯降低或是診斷率明顯提高，不然應以CT/LP strategy為優先考量。
- 目前仍不建議使用 CT/CTA，因為沒有證據顯示可以降低與SAH相關的花費與併發症。

結論

- 在base-case scenario, CT-only 比起 CT/CTA 和 CT/MRA strategies 是較好的診斷策略。
- CT/LP strategy 與其他診斷策略相比，並沒有很明顯的 cost-effectiveness 的差異，但考量sensitivity analyses 的結果與現今醫療法律環境，目前還是建議採用 CT/LP strategy。
- 本論文的限制：
 - 沒有關於radiation-induced malignancies良好的統計數據。
 - 可能與實際的醫療花費不符。
 - 未考量某些費用，例如長期復健費用、住院後後續安排檢查的費用、機會成本...等。
 - 國情不符