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Original Contribution

A risk stratification model of acute pyelonephritis to indicate hospital admission from the ED☆

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102.07.24

Journal reading

PGY張哲誠/F林俊龍

Introduction

- **Acute pyelonephritis (APN) is a common infection**
  - young healthy women
  - 15 to 17 cases per 10 000 women (USA)
- **Acute pyelonephritis**
  - Uncomplicated
    - Typical pathogens in an immunocompetent
    - Without conditions predisposing to the anatomical
  - Complicated
    - Anatomical or functional abnormalities (PKD)
    - pregnancy
    - catheter
    - diabetes and immunosuppression

Purpose

- Decision of hospitalization 很重要
  - reduce mortality, complication, recurrence, and cost.
- However, there are no predictive criteria(guideline) or grading systems for APN
- Finding scoring system to evaluate risk factors indicating hospital admission for patients with APN on visiting our ER

Method- study design

- retrospective analysis of a prospective database
  - assess the effectiveness protocol
  - scoring system
- A retrospective database between 2006.01 and 2012.06

Setting

- APN female patients > 15 years
- APN Dx
  - (1) BT higher than 38°C,
  - (2) pyuria
  - (3) costovertebral angle tenderness.
- exclusion criteria
  - obstructive APN
  - transfer to other hospital
  - death
- Records between 2009.01 and 2009.12 were collected → **external validation**
- **From other hospital**
- **Use the same criateria**

Protocol and measurement

- IV hydrated
- antiemetic agents.
- Antipyretic agents
- IV antibiotics was not used at first
  - 留觀六小時 再度評估
- (1) capable of oral Tx
- (2) BT lower than 39°C
- (3) No shock
- Collect several data
- Primary outcome
  - Admssion to ward
  - Subsequent admission after revisit in 7 days

RESULT

Table 1
Baseline characteristics of all cohort groups

	Derivation (n = 809)	Internal validation (n = 808)	External validation (n = 192)	P: Derivation vs internal validation	P: Derivation vs external validation
Admissions, n (%)	191 (23.6)	194 (24.0)	67 (34.9)	.850	.001
Age (y)	50.9 ± 18.8	51.5 ± 19.2	56.0 ± 18.5	.562	.001
Initial symptoms, n (%)					
Fever	666 (82.3)	652 (80.7)	164 (85.4)	.398	.306
Chill	556 (68.7)	561 (69.4)	124 (64.6)	.759	.269
Vomiting	183 (22.6)	180 (22.3)	54 (28.1)	.869	.107
Dysuria	238 (29.4)	224 (27.7)	54 (28.1)	.450	.723
Comorbid diseases, n (%)					
Diabetes	136 (16.8)	120 (14.9)	44 (22.9)	.280	.059
Hypertension	210 (26.0)	213 (26.4)	71 (37.0)	.854	.002
Chronic liver disease	12 (1.5)	16 (2.0)	5 (2.6)	.444	.280
Chron					0
Stroke					8
Cancer					1
Initial					
SBP (					0
DBP (					1
HR (b					9
RR (b					1
BTs (°					1
Laborat					
WBC (					0
Segme					1
Hemo					8
Platel					9
BUN (					1
Serum					0
CRP (mg/dL)[a]	8.7 ± 8.9	9.9 ± 8.9	11.2 ± 9.7	.638	.061
Serum albumin (g/dL)	4.0 ± 0.5	4.0 ± 0.5	3.8 ± 0.6	.630	<.001
Urine WBC >50 (/HPF), n (%)	303 (37.5)	313 (38.7)	99 (51.6)	.589	<.001
Positive urine nitrite, n (%)	334 (41.3)	357 (44.2)	80 (41.9)	.239	.880

Data were presented as means with SDs or number with percentage. DBP, diastolic blood pressure; BUN, blood urea nitrogen.
[a] CRP not performed in 45 cases in prospective cohorts.

1717 cases were screened, with 100 being excluded
32 →obstructive APN,
66 →hospital transfers
2 →died

809 (50%) were randomly assigned to the derivation set and 808 (50%) to the internal validation set

than 3.3 g/dL, urine WBC more than 50/HPF, and positive urine nitrite vomiting, whereas patients with complicated pyelonephritis should

Table 2
Univariate predictors of hospital admission in the derivation cohort (n = 809)

	No admission (n = 618)	Admission (n = 191)	P
Age ≥ 65 y	151 (24.4)	95 (49.7)	<.001
Initial symptoms, n (%)			
Fever	496 (80.3)	170 (89.0)	.006
Chill	404 (65.4)	152 (79.6)	<.001
Vomiting	119 (19.3)	64 (33.5)	<.001
Dysuria	178 (28.8)	60 (31.4)	.489
Comorbid diseases, n (%)			
Diabetes	81 (13.1)	55 (28.8)	<.001
Hypertension	127 (20.6)	83 (43.5)	<.001
Chronic liver disease	7 (1.1)	5 (2.6)	.138
Chronic kidney disease	10 (1.6)	11 (5.8)	.002
Stroke	21 (3.4)	12 (6.3)	.078
Cancer	31 (5.0)	22 (11.5)	.002
Initial vital signs			
SBP <90 mm Hg	5 (0.8)	7 (3.7)	.010
HR >120 (beats/min)	51 (8.3)	26 (13.6)	.027
RR >20 (breaths/min)	84 (13.6)	33 (17.3)	.206
BTs >39 (°C)	106 (17.2)	41 (21.5)	.177
Laboratory findings			
WBC < 4, > 12 ($\times 10^3$/mm^3)	259 (41.9)	116 (60.7)	<.001
Segmented neutrophils >90%	79 (12.8)	58 (30.4)	<.001
Hemoglobin <12 (mg/dL)	169 (27.4)	91 (47.6)	<.001
Platelet <150 ($\times 10^3$/mm^3)	74 (12.0)	43 (22.5)	<.001
Serum creatinine >1.5 (mg/dL)	31 (5.0)	45 (23.6)	<.001
CRP >10 (mg/dL)[a]	196 (31.7)	119 (62.3)	<.001
Serum albumin <3.3 (g/dL)	15 (2.4)	38 (19.9)	<.001
Urine WBC >50 (/HPF), n (%)	216 (35.0)	87 (45.6)	.008
Positive urine nitrite, n (%)	240 (38.8)	94 (49.2)	.011

Data were presented as number with percentage. BUN, blood urea nitrogen.
[a] CRP not performed in 20 cases.

Multivariable logistic regression

Table 3
Risk score model with best fit for predicting hospital admission

Variables	β Coefficient	OR (95% CI)	P	Score
Age ≥ 65 y	0.96	2.62 (1.79-3.85)	<.001	1
Chill	0.88	2.40 (1.54-3.74)	<.001	1
Segmented neutrophils >90%	0.69	2.00 (1.28-3.13)	.002	1
Serum creatinine >1.5 mg/dL	0.88	2.41 (1.35-4.30)	.003	1
CRP >10 mg/dL	0.86	2.37 (1.62-3.42)	<.001	1
Serum albumin <3.3 g/dL	2.00	7.36 (3.69-14.68)	<.001	2

OR, odds ratio.

邏輯斯迴歸分析適用於依變數為二元類別資料的情形，若自變數只有一個，則稱為單變數邏輯斯迴歸分析(univariate logistic regression)，若自變數超過一個以上，則稱為多邏輯斯迴歸分析(multivariate logistic regression)，又可稱為多元或複邏輯斯迴歸分析。

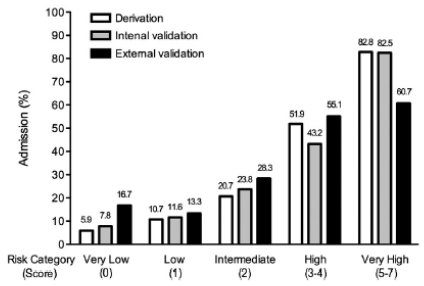


Fig. 2. Admission rates of patients in each risk group and cohort.

Result

- Derivation group
  - very low (5.9%), low (10.7%), intermediate (20.7%), high (51.9%), and very high (82.8%)
  - An ROC curve and (AUC) was 0.770 (95% confidence interval [CI], 0.730-0.809)
- internal validation cohort
  - very low (7.8%), low (11.6%), intermediate(23.8%), high (43.2%), and very high (82.5%) risk,
  - AUC of the stratification model was 0.743 (95% CI, 0.701-0.784)
- external validation cohort consisted of
  - very low (16.7%), low (13.3%), intermediate (28.3%), high (55.1%), and very high (60.7%)
  - AUC of the model was 0.725 (95% CI, 0.649-0.801).

ROC curve

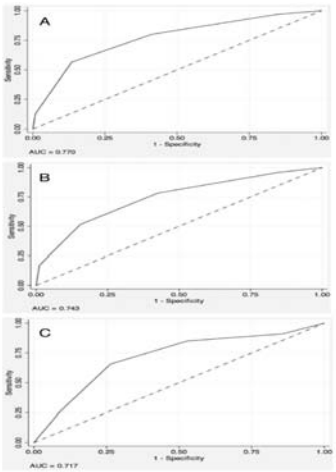


Fig. 1. Area under the ROC curves of the risk stratification model for predicting admission in the derivation (A), internal validation (B), and external validation (C) cohorts.

Discussion

- Oral antibiotics on OPD for uncomplicated pyelonephritis with mild symptoms
  - low-grade fever
  - normal or slightly elevated peripheral leukocyte count
  - without nausea or vomiting
- Admitted with complicated pyelonephritis
  - broad-spectrum empirical antimicrobials
- However, patients with severe uncomplicated pyelonephritis should also be hospitalized.
  - hemodynamic instability
  - intolerance to oral antimicrobials

Discussion

- Hospital admission rates of 28% to 60% have been reported
  - varied decision policies
- APN management protocol since 2006 to reduce the admission rates for APN in our ED (與以前的比較)
  - The initial admission rate lower than before group (15.1% vs 47.7%, P b .001).
  - ED revisit rates after initial discharge between the before (11.8%) and after (15.3%) groups were no different (P = .38).
  - subsequent admission after revisit was also similar(8.4% vs 5.9%, P =.42).
  - The ultimate admission, initial admission plus subsequent admissions after revisit, was significantly decreased from 52.1% to 20.1%

Discussion

- FIRST to predictive variables for the hospitalization of patients with APN using a risk stratification model.
- A previous study reported as this study
  - not include a scoring system
- Our model can be used to decide the admission of patients with APN in the ED
  - verylow- risk (5.9%) / low-risk (10.7%) →discharged
  - high-risk (51.9%) / very-high-risk (82.8%)→ admission
  - Intermitent → 自行決定或觀察

FACTOR selective reason

- Age
  - Independent criteria
- Chilling
  - Subjective
  - associated with bacteremia
- A higher percentage of segmented neutrophils
  - predicting bacteremia
- creatinine level higher than 1.5 mg/dL
  - prolonged fever
  - Predictor of outcome
- CRP level
  - pneumonia severity index

FACTOR selective reason

- Low serum albumin level.
  - important prognostic factor for infectious diseases.
  - related to mortality (CAP)
  - low concentration was identified as the most reliable risk factor
    - from nutritional deficiencies
    - infectious processes
    - underlying diseases

Finally of study

- hospital admission in APN cases was initially developed
  - Derivation cohort → AUC was 0.770
  - Stratification → 0.743
  - External validation →0.725
- Indicating a good overall discriminating power of the model.
  - predictive ability of the risk stratification model was also reasonable in all cohorts.

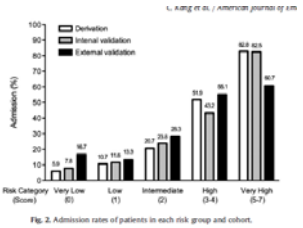
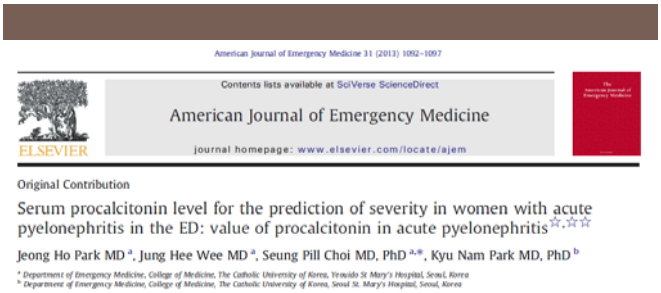


Fig. 2. Admission rates of patients in each risk group and cohort.

Conclusion

- significant predictors of hospital admission in patients with APN include
  - 65 years or greater
  - chills
  - Levels of segmented neutrophils greater than 90%
  - serum creatinine greater than 1.5 mg/dL
  - CRP greater than 10 mg/dL
  - serum albumin less than 3.3 g/dL
- Provides estimates of admission risk that may guide clinical decisions.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Original Contribution

Serum procalcitonin level for the prediction of severity in women with acute pyelonephritis in the ED: value of procalcitonin in acute pyelonephritis☆,☆☆

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Journal reading

PGY張哲誠/F林俊龍

Introduction

- Acute pyelonephritis (APN) is one of the most common infections occurring in women.
  - 50% of women contract APN at least once during their lifetimes.
  - more than 1 million visit ED
  - more than 100 000 are admitted to hospital
- Most patients with APN have minor symptoms and low mortalities
  - progress rapidly to life-threatening states such as septic shock, multiorgan failure, and death

Introduction

- Safely treated at OPD
  - Young, healthy women without complications
- Admission is recommended for
  - children, elderly individuals, and pregnant women
    - Sepsis risk ↑
- Difficult to predict the progression to poor outcomes
- Methods of staging the severity of sepsis caused by APN are lacking.

Purpose

- Recent research has suggested that procalcitonin (PCT) is a unique marker of inflammation in response to infection
  - distinguish between mild-to-moderate sepsis and severe sepsis
- **Evaluate serum PCT** values determined in the ED can differentiating the stages of sepsis in APN.

Study design

- Prospective observational study
- Female patients with APN presenting to an ED between 2009.05 and 2011.04

Inclusion Cr

- The eligibility criteria were as follows:
  - 女性
  - age >18 years,
  - BT > 38°C ／fever and chills 24 hours
  - Acute onset with at least 1 sign and symptom of a UTI
    - (dysuria, urgency, frequency, suprapubic pain, flank pain, or CVA, tenderness on physical examination)
  - Positive nitrite or leukocyte esterase dipstick test result
    - Urinalysis with more than 10^5 (WBCs) per milliliter.
- Confirmed with a diagnosis → positive urine culture

exclusion Criteria

- The exclusion criteria were as follows:
  - pregnant or breastfeeding
  - functional or structural urinary tract abnormalities
  - recent urolithiasis or hydronephrosis
  - indwelling catheters
  - nephrostomy
  - hemodialysis or peritoneal dialysis
  - kidney transplantation
  - cancer, immunodeficiency, HIV
  - history of recent manual or instrumental urologic examination.

Baseline data collection and ED management with 統計學

- basic information data collection
- laboratory and radiographic investigations,
  - PCT
  - hs-CRP
  - WBC counts
  - ESRs

RESULT

380 patient → 105 exclusion→ 43 poor data → 10 loss follow up

Table 1
Baseline characteristics of 240 female patients presenting with APN

	All patients (n = 240)	Infection, no SIRS (n = 54)	Sepsis with SIRS (n = 107)	Severe sepsis (n = 53)	Septic shock (n = 26)
Age (y)*	45.76 ± 15.86	41.11 ± 14.27	46.52 ± 17.30	59.43 ± 12.42	63.23 ± 16.32
Comorbidities, n (%)					
Diabetes mellitus*	81 (33.75)	13 (24.07)	26 (24.30)	29 (54.72)	13 (50.00)
Hypertension	103 (42.92)	16 (29.63)	36 (33.64)	35 (66.04)	16 (61.54)
Urologic disease	18 (7.50)	4 (7.41)	5 (4.67)	5 (9.43)	4 (15.38)
Clinical sign					
Temperature (°C)*	38.08 ± 1.03	38.04 ± 0.82	38.14 ± 0.93	38.07 ± 0.91	38.12 ± 0.83
HR (beats/min)*	97.13 ± 20.69	85.67 ± 16.49	102.50 ± 16.24	96.58 ± 18.57	99.96 ± 35.56
MAP (mm Hg)*	89.25 ± 16.91	92.15 ± 15.46	91.91 ± 14.84	90.41 ± 16.54	69.88 ± 16.89
Clinical symptom, n (%)					
Dysuria	69 (28.25)	13 (24.07)	38 (35.51)	13 (24.53)	5 (19.23)
Frequency	62 (25.83)	12 (22.22)	36 (33.64)	11 (20.75)	3 (11.54)
Urgency	19 (7.92)	3 (5.56)	9 (8.41)	6 (11.32)	1 (3.85)
Suprapubic pain	19 (7.92)	2 (3.70)	11 (10.28)	4 (7.55)	2 (7.69)
CVA tenderness*	115 (47.92)	25 (46.30)	63 (58.88)	23 (43.40)	4 (15.38)
Laboratory value					
PCT (ng/mL)*	0.50 (0.13-4.06)	0.13 (0.07-0.47)	0.45 (0.13-2.22)	1.51 (0.26-11.50)	14.72 (0.65-70.60)
hs-CRP (mg/L)	88.03 (33.57-167.85)	39.70 (16.74-103.83)	84.98 (35.87-159.11)	96.18 (39.10-216.35)	139.43 (89.80-209.83)
ESR (mm/h)	54.00 (33.50-79.50)	46.00 (23.00-76.00)	55.00 (39.00-77.50)	56.50 (34.50-97.00)	55.00 (21.00-82.00)
WBC count (10^3/mm^3)*	11.48 (8.49-14.68)	9.32 (6.98-11.14)	12.65 (10.02-14.95)	11.48 (8.37-15.92)	15.49 (7.30-25.95)
Urea nitrogen (mg/dL)*	17.00 (11.20-28.50)	13.15 (9.80-19.30)	14.00 (9.95-21.35)	27.20 (17.40-52.40)	44.25 (26.10-82.50)
Creatinine (mg/dL)*	0.99 (0.84-1.49)	0.90 (0.80-0.99)	0.95 (0.85-1.18)	1.60 (0.99-2.73)	2.02 (1.13-2.80)
e-GFR (mL/min/1.73m^2)*	61.15 (37.30-77.74)	71.83 (50.76-83.41)	65.33 (50.04-79.21)	34.04 (19.24-62.31)	26.51 (17.55-48.95)
Previous antibiotics, n (%)	58 (24.17)	14 (25.93)	28 (26.17)	9 (16.98)	7 (26.92)

Data are shown as number (percentage) for dichotomous variables and median (IQR) or mean ± SD for continuous variables.
* Value of statistical significance.

Table 2
Comparison between the mild and severe sepsis groups in APN

	Mild sepsis group (n = 161)	Severe sepsis group (n = 79)	P
PCT (ng/mL)	0.28 (0.92-1.57)	3.61 (0.38-26.24)	<.05
hs-CRP (mg/L)	66.34 (28.56-146.62)	107.94 (38.94-213.73)	<.05
ESR (mm/h)	52.57 (33.25-76.83)	56.25 (33.25-93.50)	.27
WBC count (10^3/mm^3)	11.27 (8.69-13.75)	12.05 (8.11-18.27)	.20
Urea nitrogen (mg/dL)	13.50 (9.88-20.45)	32.70 (18.70-57.53)	<.05
Creatinine (mg/dL)	0.93 (0.82-1.10)	1.72 (1.00-2.75)	<.05
e-GFR (mL/min per 1.73 m^2)	67.72 (52.60-79.73)	31.55 (16.74-58.89)	<.05
MEDS	2.70 (0.50-5.46)	7.49 (5.55-11.04)	<.05
SAPS II	19.33 (12.18-25.04)	34.63 (27.06-42.50)	<.05
SOFA	0.73 (0.05-1.73)	4.52 (2.93-7.36)	<.05
APACHI II	6.33 (3.42-9.31)	16.67 (11.29-20.95)	<.05
Mortality, n (%)	6 (3.73)	14 (17.72)	<.05

Data are shown as median (IQR), unless otherwise indicated.

overall mean length of stay was 4.6 (±3.2) days and was longer for the septic shock group compared with the other groups.

Table 3
Medical outcomes and severity of disease classification system in APN

	All patients (n = 240)	Infection, no SIRS (n = 54)	Sepsis with SIRS (n = 107)	Severe sepsis (n = 53)	Septic shock (n = 26)
Admission, n (%)	204 (85.00)	36 (66.67)	92 (85.98)	51 (96.23)	25 (96.15)
ICU admission, n (%)	39 (16.25)	2 (3.70)	2 (1.87)	14 (26.42)	21 (80.77)
Length of stay (d)	4.6 ± 3.2	2.2 ± 2.1	4.3 ± 2.6	7.5 ± 3.8	9.1 ± 3.3
MEDS	4.67 (1.39-7.31)	2.34 (0.37-4.71)	2.91 (0.59-5.72)	6.24 (5.20-7.85)	11.64 (9.50-13.50)
SAPS II	23.52 (14.83-32.00)	18.86 (12.91-24.40)	19.60 (9.31-25.50)	32.00 (24.50-37.93)	41.25 (35.50-56.33)
SOFA	1.52 (0.36-3.64)	0.56 (0.00-1.35)	0.84 (0.11-1.90)	3.70 (2.48 -5.19)	7.67 (6.00-10.50)
APACHI II	8.71 (4.92-13.95)	5.29 (2.27-8.30)	6.75 (4.28-8.96)	15.00 (11.56-19.50)	19.33 (15.20-26.00)
Mortality, n (%)	20 (8.33)	2 (3.70)	4 (3.74)	3 (5.66)	11 (42.31)

Data are shown as number (percentage) for dichotomous variables and median (IQR) or mean ± SD for continuous variables.

Result

- The inflammatory markers were analyzed for their ability to predict sepsis, severe sepsis, and septic shock in the patients with APN

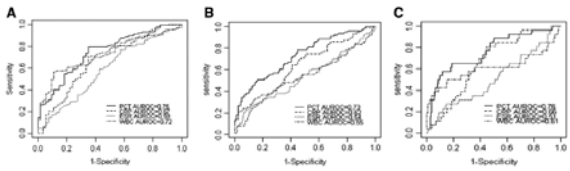

Fig. 1. The ROC curves of PCT, hs-CRP, ESR, and WBC count for the prediction of sepsis (A), severe sepsis (B), and septic shock (C) in women with APN.

There were 20 deaths during the study period, with 14 (17.72%) of 79 patients in the severe sepsis and septic shock groups, as well as 6 (3.73%) patients belonging to the other groups

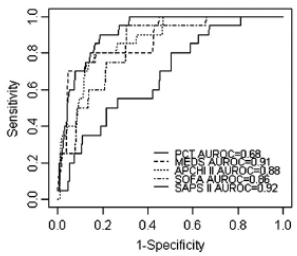

Fig. 2. The ROC curve for the prognostic value of PCT and disease classification systems to predict mortality of APN.

Biomarker with the score
Pearson correlation coefficients

- inflammatory biomarkers VS 4 scoring systems.
  - PCT with the SOFA, SAPS II, APACHI II, and MEDS were 0.55, 0.46, 0.39, and 0.32
- The hs-CRP with the SOFA score (0.34) 最高
- WBC count with SAPS II score (0.39) 最高.
- ESR did not demonstrate a meaningful correlation with any of the 4 scoring systems.

Result of blood culture

Table 4
Blood culture and laboratory values of APN

	Positive (n = 40)	Negative (n = 200)	P
PCT (ng/mL)	3.61 (0.34-14.47)	0.30 (0.10-1.68)	<.05
hs-CRP (mg/L)	121.60 (57.67-223.07)	69.89 (25.20-139.62)	<.05
ESR (mm/h)	57.00 (40.00-80.00)	51.33 (28.17-79.25)	.21
WBC count (10^3/mm^3)	12.88 (9.24-17.81)	11.15 (8.15-13.53)	<.05
Urea nitrogen (mg/dL)	23.00 (15.13-39.40)	14.95 (9.63-24.10)	<.05
Creatinine (mg/dL)	1.31 (0.97-1.84)	0.94 (0.82-1.19)	<.05
e-GFR (mL/min per 1.73 m^2)	42.98 (27.80-61.31)	67.54 (50.02-80.34)	<.05

Data are shown as median (IQR).

- The calculated AUCs of PCT, hs-CRP, ESR, and WBC count were 0.72, 0.64, 0.56, and 0.60

Disscussion

FACTOR	PCT
4 group study 決定severity	PCT good
Predict bacteremia	PCT good
scoring systems related : APACHE II, MEDS, SAPS II, and SOFA	PCT good
Motality	PCT not good SAPS II was best

PCT in child

- Procalcitonin → early diagnosis of UTI and prediction of UTI complications
  - more accurate than CRP and WBC.
- **(meta-analysis)** → young children with culture-positive UTI, a PCT value greater than 0.5 ng/mL
  → renal parenchymal involvement
  → APN from cystitis.
- PCT can be used to stage the severity of disease in children with UTI

Discussion

- Other studies have determined that PCT, CRP, and pro BNP are not useful in selecting **the site** for treating adult patients with pyelonephritis

Discussion

- The present study did not analyze the role of PCT in diagnosing APN
  - 0.50 ng/mL, like previous study(0.46 ng/mL)
  - CRP 88.03 mg/L, lower reported value 220 mg/L
- CRP can supplement currently used clinical and laboratory parameters
  - guiding appropriate treatmentsas
  - was not useful in distinguishing the severity of sepsis.
  - 與本實驗一致 (大group 分不出來)

limitation

- Analyzed at a single tertiary university hospital, and thus, the number of cases was limited.
- Use of antibiotics before presentation at the ED or before the onset
- Targeted patients presenting to an ED without considering patients visiting the outpatient clinic

Conclusion

- Previous research → PCT as a prognostic factor for patients with pyelonephritis is limited
- Relative to other classic markers of inflammation
  - distinguishing the severity of sepsis related to APN,
- PCT levels can provide additional aid to clinicians in disease severity classification and their decision of treatment at ED.

THANKS FOR YOUR ATTENTION

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