Empiric management of community-acquired pneumonia in Australian emergency departments

David J Maxwell, Kylie A McIntosh, Lisa K Pulver, Kylie L Easton for the CAPTION Study Group*

ABSTRACT

Objective: To describe empiric community-acquired pneumonia (CAP) management in Australian hospital emergency departments (EDs) and evaluate this against national guidelines, including use of the pneumonia severity index and antibiotic selection.

Design: A multicentre, cross-sectional, retrospective audit, April 2003 to February 2005.

Setting: 37 Australian hospitals: 22 principal referral hospitals, six large major city hospitals, four large regional hospitals, four medium hospitals and one private hospital.

Participants: Adult patients with a diagnosis of CAP made in the ED. Data on 20 consecutive CAP ED presentations were collected in participating hospitals.

Outcome measures: Documented use of the pneumonia severity index, initial antibiotic therapy prescribed in the ED, average length of stay, inpatient mortality, and concordance with national guidelines.

Results: 691 CAP presentations were included. Pneumonia severity index use was documented in 5% of cases. Antibiotic therapy covering common bacterial causes of CAP was prescribed in 67% of presentations, although overall concordance with national guidelines was 18%. Antibiotic prescribing was discordant due to inadequate empiric antimicrobial cover, allergy status (including contraindication to penicillin), inappropriate route of administration and/or inappropriate antibiotic choice according to recommendations. There was no significant difference between concordant and discordant antibiotic prescribing episodes in average length of stay (5.0 v 5.7 days; $P = 0.22$) or inpatient mortality (1.6% v 4.1%; $\chi^2 = 1.82$; $P = 0.18$).

Conclusions: Antibiotic therapy for CAP prescribed in Australian EDs varied. Concordance with national CAP guidelines was generally low. Targeted interventions are required to improve concordance.

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Community-acquired pneumonia (CAP) produces significant worldwide morbidity and mortality.[1] Use of antibiotics for management of respiratory tract infections, including CAP, has been estimated to represent 75% of global antibiotic consumption,[2] so judicious antibiotic prescribing for respiratory conditions is essential. Australian data on the incidence and management of CAP are lacking,[3] although it has been estimated that CAP occurs in two per 1000 of the adult population per year and represents 2% of all overnight hospital admissions.[4]

Initial antibiotic management of CAP in hospital emergency departments (EDs) is mostly empiric. Causative organisms are typically unknown at presentation and are not always detected despite extensive diagnostic testing.[5] Therefore, it is important to ensure that initial antibiotic choice covers the key bacterial pathogens likely to be responsible for the disease: *Streptococcus pneumoniae*, *Mycoplasma pneumoniae*, *Chlamydophila pneumoniae* and *Legionella* species.[1,3,6] Patients with severe disease may require broad-spectrum antibiotic therapy to cover *Legionella pneumophila*, *Staphylococcus aureus* and enteric gram-negative bacilli.[6] The readily available and widely accepted national guidelines, *Therapeutic guidelines: antibiotic* (Guidelines)[6] advocate use of the pneumonia severity index (PSI),[7] and empiric antibiotic therapy based on the most likely bacterial pathogens and disease severity.

CAPTION (Community-Acquired Pneumonia: Towards Improving Outcomes Nationally) is a multicentre quality improvement study funded and supported by the National Prescribing Service.[8] The project aims to promote and implement the CAP recommendations of the Guidelines in Australian EDs. The first stage of the project involved collecting data on CAP management of adult patients in participating hospital EDs before the commencement of targeted education or interventions. This article evaluates current CAP management practices against the Guidelines.

METHODS

Participating hospitals were recruited on a voluntary basis through state-based quality use of medicines organisations. Endorsement by institutional ethics committees in each participating hospital was required,[9] with some hospitals requiring a full ethics committee review before any study-related activities could begin.

A retrospective medical record review was conducted on 20 consecutive adult patients presenting to the ED with a presumptive diagnosis of pneumonia documented by the attending ED doctor. Patients were identified by medical record coding using the

* CAPTION Study Group: NSW Therapeutic Advisory Group: Ms Karen Kaye (study lead), Mr David Maxwell (project officer); University of Queensland and Queensland Health: Professor Susan Tett, Mrs Judith Coombes, Mr Andrew Petrie (study leads), Ms Lisa Pulver (project officer); Victorian Drug Usage Evaluation Group: Ms Marion Robertson (study lead), Dr Kylie McIntosh (project officer), Dr Nazila Jamshidi (project officer); South Australian Department of Health: Mr William Dollman (project lead), Ms Anita Marwood (project officer), Dr Peter O'Connor (project officer); University of Tasmania: Professor Greg Peterson (project lead), Ms Lisa Stanton (project officer); National Prescribing Service: Ms Angela Wai, Dr Kylie Easton, Ms Judith Mackson and Dr Lynn Weekes.

NSW Therapeutic Advisory Group Inc, Sydney, NSW.
David J Maxwell, BPharm, DipHospPharm, Project Officer.
Victorian Drug Usage Evaluation Group, Melbourne, VIC.
Kylie A McIntosh, BPharm(Hons), PhD, Project Officer.
School of Pharmacy, University of Queensland, Brisbane, QLD.
Lisa K Pulver, BPharm, DipHospPharm, Project Officer.
National Prescribing Service, Sydney, NSW.
Kylie L Easton, BPharm, BPharmSci(Hons), PhD, Education and Quality Assurance Program Officer.
Reprints will not be available from the authors. Correspondence: Mr D J Maxwell, NSW Therapeutic Advisory Group Inc, PO Box 766, Darlinghurst, NSW 2010. tagproject@stvincents.com.au

1 Patient exclusion criteria

- < 18 years old
- Immunosuppressed (HIV positive or concurrent chemotherapy or immunosuppressant therapy)
- Cystic fibrosis
- Bronchiectasis
- Suspected or confirmed tuberculosis
- Aspiration or hospital-acquired pneumonia
- Discharged from hospital within the previous 14 days
- Transferred from another hospital (unless transferred within 4 hours of presentation at original institution) ◆

International Classification of Diseases, 10th revision, Australian Modification (ICD-10-AM) or through ED electronic information systems. Medical records were reviewed according to predefined exclusion criteria (Box 1). Patients not prescribed antibiotics in the ED were excluded.

Data collected included:

- patient demographics;
- documented use of the PSI;
- placement after ED;
- length of stay;
- inpatient mortality;
- prior antibiotic use;
- antibiotics initiated in the ED;
- medical team initiating antibiotic therapy; and
- penicillin allergy (nil documented, immediate [urticaria, angioedema, bronchospasm or anaphylaxis within 1 hour of drug administration] or non-immediate hypersensitivity).

Data required to calculate a PSI score were also collected (Box 2). Electronic pathology and radiology reporting systems were consulted if data were not located in the medical records. Undocumented data were considered normal. If insufficient information was provided to determine the nature of a documented penicillin allergy, the reaction was assumed to be non-immediate.

A data collection form was developed by quality use of medicines groups in collaboration with the National Prescribing Service, and was piloted in two hospitals. De-identified data were entered into an electronic database, Auditmaker. The database was designed to automatically calculate the PSI and assess concordance of initial management (PSI and antibiotic therapy prescribed) based on the presumptive diagnosis. An automated feedback report for each hospital described all data collected and concordance with the Guidelines. The automated PSI calculation and feedback report functionality were validated during the pilot phase.

Data analysis

Antibiotic therapy was classified as monotherapy, dual therapy or "other". If two antibiotics of the same class were prescribed concurrently (eg, two β-lactams), these were treated as a single drug.

The PSI score calculated by Auditmaker was used to classify patients into one of five classes of mortality (Box 3). Concordance with Guidelines was defined as the prescription of specific antibiotics, according to the calculated PSI score, as recommended by the Guidelines (Box 3). Dosage and duration of therapy were not included in the assessment of concordance.

Four key points about antibiotic choice were used to categorise reasons for discordance: choice of antibiotic and route of administration compared with the Guidelines (Box 3), adequate antimicrobial cover for common bacterial causes of CAP, and drug choice in the presence of documented penicillin allergy.

Average length of stay (ALOS) and inpatient mortality of concordant and discordant antibiotic prescribing episodes were compared using a *t* test and the χ^2 test, respectively.

RESULTS

Thirty-seven hospitals participated: 22 principal referral hospitals, six large major city hospitals, four large regional hospitals, four medium hospitals and one private hospital.[10] No hospitals from tropical regions of Australia were included.

We identified 740 CAP ED presentations. Thirteen were excluded because antibiotics were not prescribed in the ED, and another 36 were excluded because the presentation occurred before publication of the Guidelines (April 2003). In total, 691 CAP presentations (April 2003 to February 2005) were included in the baseline cohort. The mean age was 63 years (range, 18–103), 55% were older than 65 years, and 54% were men.

Disease severity

A PSI score was documented in the medical notes of 34 patients (5%). No other tools were identified as being used in assessing disease severity.

Box 4 shows the distribution of patients according to disease severity, based on the automated PSI calculation in Auditmaker. Most patients (76%) were admitted to a "ward" for further management (Box 4). The ALOS was 6 days (range, 0–92), and inpatient mortality was 4%.

Antibiotic therapy

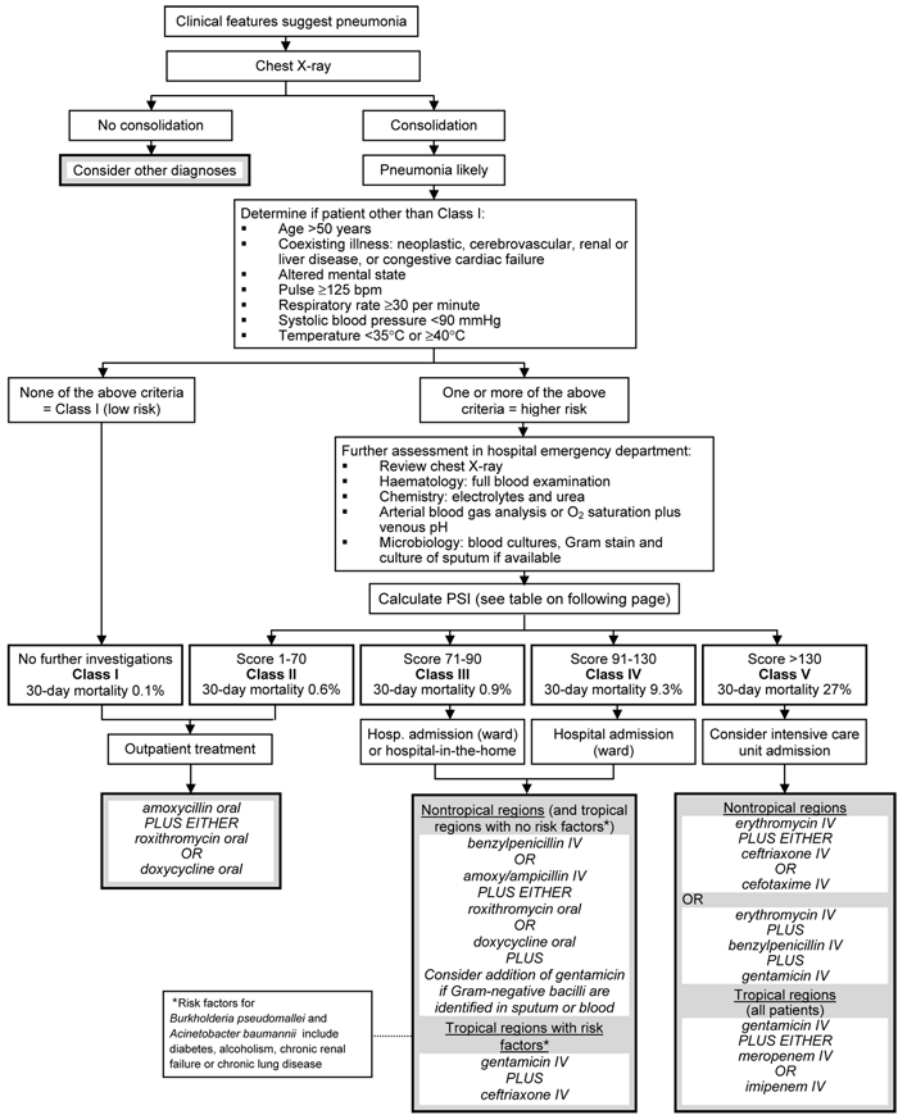
Antibiotics were initiated by ED staff in 80% of presentations, and by the admitting team in 13%. In the remainder, antibiotics were initiated during a consultation that occurred in the ED or at a time which could not be determined from the medical notes. Prior antibiotic therapy was documented in 191 presentations (28%).

2 Calculating the pneumonia severity index*

Characteristic	Points assigned
Demographic factor	
Age	
Men	Age (years)
Women	Age (years –10)
Nursing home resident	+ 10
Coexisting illness	
Neoplastic disease	+ 30
Liver disease	+ 20
Congestive heart failure	+ 10
Cerebrovascular disease	+ 10
Chronic renal disease	+ 10
Physical examination findings	
Altered mental status	+ 20
Respiratory rate ⩾ 30/min	+ 20
Systolic blood pressure < 90 mmHg	+ 20
Temperature < 35° C or ⩾ 40° C	+ 15
Pulse ⩾ 125/min	+ 10
Laboratory and radiographic findings	
Arterial pH < 7.35	+ 30
Urea ⩾ 11 mmol/L	+ 20
Sodium < 130 mmol/L	+ 20
Glucose ⩾ 14 mmol/L	+ 10
Haematocrit < 30%	+ 10
PaO_2 < 60 mmHg or O_2 ⩾ 90% saturation	+ 10
Pleural effusion on chest x-ray	+ 10

*Table adapted with permission from Fine et al (1997).[7] Scores are calculated for pneumonia severity classes II–V: class II, 1–70; class III, 71–90; class IV, 91–130; class V, > 130. ◆

3 Management of community-acquired pneumonia in adults using the pneumonia severity index from *Therapeutic guidelines: antibiotic*. Version 12[6]



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4 Patient placement after emergency department and concordance with Guidelines according to pneumonia severity index (PSI) class

		Placement after emergency department				Number (%) given antibiotics concordant with Guidelines
PSI class	Total (%)	Home (%)	Ward (%)	ICU (%)	Other (%)	
I	152 (22%)	60 (39%)	89 (59%)	3 (2%)	0	13 (9%)
II	143 (21%)	40 (28%)	99 (69%)	4 (3%)	0	11 (8%)
III	120 (17%)	18 (15%)	102 (85%)	0	0	44 (37%)
IV	197 (29%)	17 (8%)	171 (87%)	8 (4%)	1 (1%)*	54 (27%)
V	79 (11%)	5 (6%)	64 (81%)	8 (10%)	2 (3%)*	4 (5%)
Total	691 (100%)	140 (20%)	525 (76%)	23 (3%)	3 (1%)	126 (18%)

Home = home, hostel or nursing home. Ward = ward, hospital-in-the-home or other hospital.
ICU = Intensive care unit. * Died in the emergency department. ◆

Of the 691 presentations, 461 (67%) were prescribed antibiotic therapy that covered common bacterial causes of CAP. Overall, 21% of patients were prescribed monotherapy (PSI class I, 28 patients; class II, 43; class III, 26; class IV, 36; class V, 16); 70% received dual therapy and 9% "other" (Box 5). Three-quarters of the patients were prescribed a macrolide (roxithromycin, erythromycin, azithromycin or clarithromycin) or doxycycline. Intravenous (IV) third-generation cephalosporins (ceftriaxone or cefotaxime) were prescribed in 304 presentations (44%). Moxifloxacin was prescribed in six presentations (Box 5).

Penicillin allergy

Seventy-nine patients (11%) had documented penicillin allergy. Of these, 17 were documented to have immediate hypersensitivity, 55 had documented non-immediate hypersensitivity, and seven patients had assumed non-immediate hypersensitivity due to nonspecific allergy documentation.

Concordance with the Guidelines

Concordance with Guideline recommendations was 18% overall, and varied across the PSI classes (Box 4). Of the 567 patients for whom antibiotic prescribing did not follow the Guidelines, 54% were prescribed antibiotics by a route not recommended according to PSI class and 88% were prescribed therapy outside of recommendations according to PSI class (Box 6). In about 40% of discordant episodes (33% of the total patient cohort), empiric therapy that did not cover the common bacterial causes of CAP was prescribed. Some patients (4%) were prescribed antibiotic therapy that was contraindicated according to documented penicillin allergy status: 15 patients with immediate penicillin hypersensitivity were prescribed a β-lactam antibiotic and six patients with non-immediate penicillin hypersensitivity were prescribed a penicillin.

Of the 34 patients with a documented PSI score, 12 patients (35%) were prescribed antibiotic therapy that was concordant with the Guidelines.

There was no significant difference in ALOS (5.0 and 5.7 days; $P = 0.22$) or inpatient mortality (1.6% and 4.1%; $P = 0.18$) between concordant and discordant antibiotic prescribing episodes.

DISCUSSION

There are few published audits on current management of lower respiratory infections in Australian hospitals.[11,12] CAPTION pro-

5 Empiric antibiotic therapy prescribed in 37 Australian hospital emergency departments for patients with community-acquired pneumonia

Antibiotics prescribed	Number of patients
Monotherapy ($n = 149$)	
β-Lactam*	121
Macrolide† or doxycycline	24
Moxifloxacin	4
Dual therapy ($n = 482$)	
β-Lactam +	
macrolide or doxycycline	443
gentamicin	33
metronidazole	5
moxifloxacin	1
Other ($n = 60$)	
β-Lactam +	
gentamicin + macrolide or doxycycline	45
metronidazole + macrolide or doxycycline	6
gentamicin + metronidazole	6
gentamicin + trimethoprim	1
vancomycin + macrolide or doxycycline	1
moxifloxacin + macrolide or doxycycline	1

*β-Lactams identified: ampicillin, amoxycillin, amoxycillin/clavulanate, benzylpenicillin, ticarcillin/clavulanate, cefaclor, cefuroxime, cephalexin, cephalothin, cephazolin, cefotaxime and ceftriaxone. †Macrolides identified: erythromycin, roxithromycin, clarithromycin and azithromycin. ◆

vides cross-sectional data from 37 hospitals of varying types across Australia. This audit has demonstrated that documented use of the PSI is low (5%) and that initial empiric antibiotic therapy is, in general, not concordant with national guidelines (18% concordance).

Certain limitations of the study must be considered, including the retrospective patient identification and data collection and the number of personnel collecting the data. In addition, the sample size of 20 patients per hospital may not be representative of the broader prescribing habits. The use of ICD-10-AM codes restricts identification of patients to those with a documented respiratory illness at the time of discharge. Patients who presented to the ED with CAP but were documented to have a different diagnosis at discharge may have been excluded. It is also acknowledged that relying on documentation in medical notes/progress notes may be thought to weaken the PSI tool. However, the PSI was derived and validated retrospectively in separate cohorts of 38 039 inpatients and 2287 inpatients and outpatients, with the assumption that any missing values were normal.[7]

The low documented use of the PSI may reflect a lack of awareness or perceived usefulness of the tool. Alternatively, it may reflect lack of documentation by those using the PSI. Doubts have been raised regarding the suitability of the PSI beyond its originally intended purpose of identifying low-risk CAP patients amenable to outpatient therapy. The strong influence of age and comorbidities on the PSI score has been cited as a major problem likely to result in severely unwell younger CAP patients being "missed".[13] We argue firstly that the Guidelines recommendations are qualified by advising caution on the application of the PSI: "choice of management options using the PSI is a guide only and should always take into account the patient's clinical and social context". Secondly, data emerging from the ongoing Australian Community-Acquired Pneumonia Study indicate that the PSI is superior to both the British Thoracic Society's CURB-65 and the modified American Thoracic Society criteria in predicting CAP severity.[14] However, all three tools underestimate severity in selected patients requiring admission to an intensive care unit.[14] Finally, the Victorian Coroner recently recommended use of a pneumonia severity assessment tool at a Victorian hospital; the hospital subsequently adopted the PSI.[15]

Recommendations for empiric antibiotic therapy vary around the world,[1,16] with ongoing debate surrounding the most appropriate IV β-lactam antibiotic. Debate is fuelled by the fact that various broad- and narrow-spectrum antibiotics are effective; hence, it is not surprising that we found no difference in ALOS or mortality when non-concordant antibiotics were used. However, local and international opinion leaders have expressed concern over the frequent use of third-generation cephalosporins as empiric treatment for CAP and potential "collateral damage" associated with their use.[17-19] The Guidelines recommend these agents for patients with severe disease (class V) or patients with a non-immediate penicillin allergy requiring intravenous therapy. In this study, 114 patients (16%) satisfied these criteria; however, 44% of patients were prescribed ceftriaxone or cefotaxime. This result is consistent with previous Australian studies, which also demonstrated a high level of third-generation cephalosporin use outside Guidelines recommendations.[12,20]

The issue of antibiotic monotherapy with a β-lactam antibiotic or "atypical" cover versus combination therapy of a β-lactam and "atypical" cover in empiric management of CAP continues to be vigorously debated.[1,21-23] The Guidelines recommend that all CAP patients receive combination therapy[6] with two exceptions: moxifloxacin/gatifloxacin is recommended for patients with immediate hypersensitivity to penicillin, and the addition of gentamicin is recommended for all class V patients prescribed IV benzylpenicillin and IV erythromycin. In this audit, 21% of patients were prescribed monotherapy (excluding moxifloxacin monotherapy) in the ED. More than half of these patients (54%) had moderate to severe disease (class III–V).

In this cohort, 28% of patients had been prescribed antibiotic therapy before present-

6 Reasons for discordant antibiotic therapy for community-acquired pneumonia, according to pneumonia severity index class

Key points of discordance*	Pneumonia severity index class		
	I and II ($n = 271$)	III and IV ($n = 221$)	V ($n = 75$)
Antibiotics not recommended by Guidelines	252	188	58
Incorrect route of administration according to Guidelines	226†	35‡	44§
Inadequate empiric cover	78	95	57¶
Incorrect alternative for penicillin allergy	9	9	3

*Each presentation may have more than one reason. †Intravenous antibiotics were prescribed. ‡An oral β-lactam and/or an intravenous macrolide or fluoroquinolone was prescribed. §Oral antibiotics were prescribed. ¶Use of roxithromycin and clarithromycin in Class V patients was classified as inadequate for empiric treatment of *Legionella* spp. ◆

ing to the ED. Perceptions of failed oral antibiotic therapy in the community, or oral intolerance, may have influenced prescribers to initiate IV antibiotic therapy in the ED, irrespective of disease severity.

The CAP management algorithm in the Guidelines recommends alternative antibiotic choices for patients with a penicillin allergy. To ensure the most appropriate alternative is prescribed, a detailed history of penicillin reaction is needed. At least seven patients in this audit were documented to have a non-specific penicillin allergy, with antibiotic choice therefore likely to have been based on an assumption as to the type of previous reaction to penicillin. Additionally, 15 patients with documented immediate hypersensitivity were prescribed a cephalosporin and six patients with non-immediate hypersensitivity were prescribed penicillin. Although no adverse effects were reported, prescribing was inappropriate in these patients given the documented allergies, demonstrating the need to improve both knowledge about penicillin allergy and documentation of previous adverse drug reactions.

Therapeutic guidelines: antibiotic has been typically accepted as the best practice standard for antimicrobial prescribing in Australian hospitals and general practice. However, clinical judgement remains paramount and individual patients' clinical and social needs should always be considered. As such, attaining 100% concordance with the Guidelines is not necessary or appropriate. Nevertheless, it is important that clinicians be aware of current guidelines to ensure that clinical judgement is complemented by the most up-to-date knowledge and best standard of care.

Dissemination of guidelines alone is not effective in influencing prescribing practice.[24,25] A suite of tailored interventions, including academic detailing, audit and feedback, posters, stickers, PSI calculators and electronic point-of-prescribing prompts will be made available through CAPTION to assist in implementing Guideline recommendations. Further audits will be conducted to evaluate the effect of these interventions and to inform future intervention activities.

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COMPETING INTERESTS

None identified.

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