THE USE OF THE CRB-65 SEVERITY OF ILLNESS SCORE TO DETERMINE THE NEED FOR ADMISSION OF PATIENTS WITH COMMUNITY-ACQUIRED PNEUMONIA PRESENTING TO AN EMERGENCY DEPARTMENT

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DECLARATION

I, Dalton Mulombe Kabundji, declare that this research report is my own work. It is being submitted for the degree of Master of Sciences in Medicine (Emergency Medicine) in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

DM Kabundji

Signature: Date: 24 /11/ 2011

DEDICATION

To God Almighty because all glory is yours.

To my late father Daniel Kabundji Munkindji and my mother Marie Lofo Bonyoma.

To my wife Jenny Maviluka Mayala and my son Eli Munkindji Kabundji for their love, patience and support.

To my brother Jean Paul Kitenge Kabundji and Tharcisse Munkindji Kabundji for all your support.

To my sisters and other brothers, Nganze Tshilungu, Ngoyi Kabundji, Astride Kitoto Kabundji, Gege Muabi Kabundji, Ebambi Kabundji Ndongala, JP Mumba Kabundji, Papy Kabundji Mulombe, Julienne Lofo Lifaefi, Justin Nickiver Bonyoma, Elysee Mpemba Kabundji, and Erick Kibonge Kabundji.

To my late sister Esther Nkusu Kabundji.

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ABSTRACT

Introduction: The decision as to the most appropriate site of care of a patient with community-acquired pneumonia (CAP), especially whether hospitalisation is warranted or not, is one of the most important decisions in the overall emergency department management of such patients. It has consequences both with regard to the level of treatment received by the patient as well as the overall costs of treatment. Several tools have been developed to predict mortality and/or determine which patients could be sent home and treated safely with good clinical outcomes. The CRB-65 score is one of the validated severity of illness scoring tools recommended. This scoring system may be of particular benefit in resource-constrained areas, as it is easier to use.

Study's aim: To determine whether it would be useful to introduce the CRB-65 severity of illness score in the routine evaluation of patients with CAP in the Helen Joseph Hospital Emergency Department (HJH ED).

Study's objectives: To determine what criteria HJH ED doctors use in their decision to admit or discharge CAP patients; to determine the frequency with which the CRB-65 severity of illness score is used in current practice by the HJH ED doctors for admitting or discharging CAP patients; and to determine the potential performance of the CRB-65 severity of illness score in the management of patients with CAP in the HJH ED.

Design: Prospective, observational, hospital-based study.

Setting: Emergency Department of the Helen Joseph Hospital.

Patients and methods: All patients 18 years of age and older with the diagnosis of CAP constituted our study population. Data from 152 patients seen between February 2011 and April 2011 was collected and analysed. Outcome measures included hospital admission or discharge, time to clinical stability, length of hospital stay, and mortality.

Results: Overall, 152 patients (79 females and 73 males) were included in the analysis. The median age was 36.5 years, with a range from 20 to 87 years. The chest radiograph was the commonest criterion (41%) used by the HJH ED doctors to determine the need for admission of the patients with CAP, while the haemodynamic parameters were the commonest criteria used (25.9%) for discharge decisions. On only three occasions was the CRB-65 score utilised out of the 193 criteria documented (1.55%).

There was a significantly shorter time to clinical stability ($p = 0.0069$), but no tendency to a shorter length of hospital stay in patients with a lower CRB-65 score ($p = 0.5694$). Patients with a higher CRB-65 score were at significantly higher risk of death compared to patients with a lower CRB-65 score ($p < 0.001$). There were no deaths from outpatients, but there were a total of five deaths observed from the in-hospital patients of which 3/5 patients (60%) would potentially have been classified as intermediate mortality risk and the remaining 2/5 patients (40%) as high mortality risk if the CRB-65 score had been the only criterion used as the standard for site of care decisions by the HJH ED doctors.

Conclusion: The chest radiograph was the commonest criterion used by the HJH ED doctors to determine the need for admission of the patients with CAP, while the haemodynamic parameters were the commonest criteria used for discharge

decision. The CRB-65 score is not frequently being used in current practice by the HJH ED doctors for admitting or discharging CAP patients.

This study demonstrates the ability of the CRB-65 severity of illness score to accurately predict both the time to clinical stability for patients hospitalised with CAP and the risk of death associated. In addition, this study documents that the CRB-65 severity of illness score performed well in its ability to determine the initial site of care for patients with CAP.

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LIST OF ABBREVIATIONS

AMTMSAC: Abbreviated Mental Test Modified for South African Conditions

ATS: American Thoracic Society

BP: Blood pressure

CAP: Community-acquired pneumonia

COPD: Chronic obstructive pulmonary disease

CRP: C-reactive protein

CRB-65: Severity of illness score using the following parameters, confusion, respiratory rate, blood pressure, and age

CURB-65: Severity of illness score using the following parameters, confusion, urea, respiratory rate, blood pressure and age

CXR: Chest-x ray

DBP: Diastolic blood pressure

ED: Emergency department

EGDT: Early-goal directed therapy

FBC: Full blood count

GCS: Glasgow coma score (as method of defining a patient's level of consciousness and neurologic status by assessing the following parameters, eye opening, verbal response, and motor response).

HIV: Human immunodeficiency virus

HJH: Helen Joseph Hospital

ICU: Intensive care unit

IDSA: Infectious Diseases Society of America

Ig A: Immunoglobulin A

Ig G: Immunoglobulin G

Ig M: Immunoglobulin M

INR: International normalized ratio

IV: Intravenous

LFT: Liver function test

PEEP: Positive end-expiratory pressure

PIN: Patient identification number

PMNs: Polymorphonuclear leucocytes

PT: Prothrombin time

PTT: Partial thromboplastin time

PSI: Pneumonia severity index

RR: Respiratory rate

RSA: Republic of South Africa

RSI: Rapid sequence intubation

SBP: Systolic blood pressure

SD: Standard deviation

SvO2: Mixed venous oxygen saturation

U&E: Urea and electrolytes

USA: United States of America

WBC: White blood cell

CHAP 1. COMMUNITY-ACQUIRED PNEUMONIA: LITERATURE REVIEW

1.1. Background information

Despite recent advances in the management of the disease, community-acquired pneumonia (CAP) is still a common and potentially lethal infectious disease. In the USA, it is estimated that 4 to 5 million cases occur annually, accounting for approximately 10 million physician visits, 500 000 hospitalisations, 45 000 deaths (the sixth leading cause of death), and an annual cost of $23 billion.[1]

In the RSA, 20% of all deaths in children under five years of age are due to acute lower respiratory infections, and 90% of these deaths are due to pneumonia.[2] It became the fifth-largest cause of mortality in the country in 2000, accounting for 3.9% of all deaths.[3] A recent South African study reported a 20% mortality rate for adult patients hospitalised with CAP.[4]

CAP mortality is variable, depending on the site of care: it is less than 1% in the outpatient setting,[5,6] around 5–15% in inpatients not requiring ICU care, up to 25% in intubated patients, and nearly 50% in ICU patients requiring vasopressors.[5,7,8] In the assessment and management of patients with CAP, determination of disease severity is crucial, since it guides various therapeutic options such as the site of care (i.e. need for hospital or ICU admission or suitability for home care), the extent of the microbiological investigation, and the choice and route of empiric antimicrobial chemotherapy. Inpatient treatment of pneumonia is approximately 25 times more expensive per patient than outpatient treatment.[7]

The decision as to the most appropriate site of care of a patient with CAP, especially whether hospitalisation is warranted or not, is one of the most important decisions in the overall emergency department (ED) management of such patients. It has consequences both with regard to the level of treatment received by the patient as well as the overall costs of treatment. Such decisions are best informed by an accurate assessment of the severity of illness of the patient at the time of presentation.

Several tools have been developed to predict mortality and/or assist in determining which patients could be sent home and treated safely with good clinical outcomes. The CURB-65 score (Figure 1.1) is one of the two most extensively studied and validated severity of illness scoring tools. It was derived from the British Thoracic Society rule, is simple to use, and its accuracy is similar to that of the more complicated scoring systems, such as the Pneumonia Severity Index (Table 1.1).[5,9] Five risk classes are derived from the CURB-65 score, with different predicted mortalities. Class 0 has a predicted mortality of approximately 0.7%, class 1, 2.1%, class 2, 9.2%, class 3, 14.5%, and class 4, 40-57%. Patients in classes 0 and 1 are at low risk of mortality and may be suitable for outpatient treatment. Patients in class 2 are at intermediate risk of mortality and should be considered for inpatient treatment. Patients in classes 3 and 5 are at higher risk of mortality and correspond to those who may need high care or ICU admission.[5,10] For the PSI, five risk classes are derived with class I to III considered as low risk of mortality (0.1 to 2.8%), class IV as intermediate risk of mortality (8.2%), and class V as higher risk of mortality (29.2%). It is suggested that patients in classes I to III may be managed as hospital outpatients, patients in class IV need inpatient treatment, and patients in class V may need ICU care (Appendix A).[5,10]

A more simplified tool, the CRB-65 score was subsequently reported and studied (Table 1.1), in which the measurement of the only laboratory value of the CURB-65 score, namely the blood urea nitrogen, was not required.[9] This scoring system may be of particular benefit in resource-constrained areas, since it obviates the need to measure the blood urea level.

Table 1.1: PSI score, CURB-65 score and CRB-65 hospital admission risk class stratification scores.[5]

PSI score	Risk class	I	II	III	IV	V
	Points	(A)	< 70	71-90	91-130	> 130
	Mortality	0.10%	0.60%	2.80%	8.20%	29.20%
	Site of care recommended	Out	Out	Out/b.I	Inpatient	Inpatient
CURB-65 Score	Risk class	0	1	2	3	4
	Mortality	0.70%	2.10%	9.20%	14.50%	40-57%
	Site of care recommended	Out	Out	Inpatient	Inpatient	Inpatient
CRB-65 Score	Risk class	0	1	2	3 to 4	
	Mortality	1.20%	5.30%	12%	33%	
	Site of care recommended	Out	Inpatient	Inpatient	Inpatient	

(A) risk class I: age < 50 years, no comorbidities, and absence of vital sign abnormalities. Out: outpatient. Out/b.I: outpatient or brief inpatient

1.2. Severity of illness assessment of patients with CAP presenting to an emergency department (ED)

Severity of illness assessment of patients with CAP presenting to an ED impacts on decisions regarding the site of care, the extensiveness of the microbiological and laboratory evaluation, the type, route, and duration of antibiotic therapy, the intensity of clinical observation and the overall medical resource use for this condition. Accurate prognostication helps to predict the expected outcomes and the probability of serious adverse events in the initial management decisions.

However, clinicians tend to overestimate the risk of death associated with CAP patients. This leads to unnecessary admissions to hospitals, as demonstrated in one of the biggest studies, in which 65.1% of low mortality risk patients were treated as inpatients.[10,11]

1.3. Definition

The term community-acquired pneumonia refers to pneumonia acquired within the general community and is defined as an acute infection (of less than 14 days duration) associated with inflammation of the lung parenchyma distal to the terminal bronchioles, most commonly bacterial in nature, and associated with clinical and/or radiological evidence of consolidation of part or parts of one or both lungs.[9,12]

1.4. Aetiology

The microbial aetiology of CAP varies widely according to the different reviews published. It is influenced by the geographic area, the population studied, and the diagnostic methods used.[13] The causative pathogen remains unknown in some 30% to 60% of cases, despite vigorous clinical and laboratory investigations.[1]

The organisms commonly associated with CAP include so-called “typical pathogens”, including *Streptococcus pneumoniae, Haemophilus influenzae, Staphylococcus aureus,* and *Klebsiella pneumoniae*, respiratory viruses including Influenza virus, respiratory syncitial virus, adenovirus, and parainfluenza virus and so-called "atypical pathogens" including *Mycoplasma pneumoniae, Chlamydia pneumoniae,* and *Legionella species*.[1,9,13] This has led some to classify CAP as "CAP", "viral CAP" and "atypical CAP" respectively.[1]

The frequency of detection of the different pathogens, as causes of CAP, ranges between 20% to 60% for *Streptococcus pneumoniae*, 3% to 10% for *Haemophilus influenzae*, 1% to 6% for *Mycoplasma pneumoniae*, 3% to 5% for gram-negative bacilli and around 4% for *Chlamydia pneumoniae*, 2% to 8% for *Legionella species*, 3% for *Staphylococcus aureus*, and 2% for viruses.[1] Aspiration and other identified causes account for 6% to 10% and 10% to 40% respectively.[1]

1.5. Pathophysiology of CAP[14]

The lung offers a large epithelial surface (70 m^2) that is exposed to the environment. This surface is constantly exposed to a multitude of potential pathogens. Pathogens can reach the lung by one of several routes, including haematogenous spread from distant foci, by inhalation of airborne pathogens, or most commonly by micro-aspiration of microorganisms harboured in the nasopharynx.

The organisms that more commonly reach the lungs through blood circulation are *Staphylococcus* spp; and gram-negative bacilli. The viruses reach the lungs through airborne droplets inhaled through the mouth and nose. Fungal pneumonia is rarely seen in the immune-competent host, and the mechanism of invasion is very similar to that of bacterial pneumonia.

1.5.1. Host defence mechanisms[15]

The respiratory tract has a multilayered defence mechanism to contain and eliminate these bacteria. A breach of these defences at any level will make an individual more prone to infection of the respiratory tract, including CAP.

Mechanisms of host defence may be non-immunological or immunological. Immunological mechanisms may be natural (innate) or specific (humoral).

1.5.1.1. Non-immunological mechanisms

Non-immunological mechanisms that protect against CAP include filtration of air as it passes through the nasopharynx, the glottal reflex, laryngeal closure, the cough reflex, clearance of organisms from the lower airways by ciliated cells and the mucociliary escalator, and ingestion of small bacterial inoculates that manage to reach alveolar spaces by pulmonary macrophages and PMNs.

1.5.1.2. Immunological mechanisms

1.5.1.2.1. Innate immunity

Innate immune mechanisms participate in clearance of pneumococci from the nasopharynx, as well in phagocytosis by PMNs and macrophages via the microbial pattern recognition receptor, Toll-like receptor 2.

1.5.1.2.2. Humoral immunity

Immunologically specific humoral mechanisms provide the best protection against host invasion by microorganisms. These include activation and production of cytokines, toxin neutralisation, complement activation, and opsonin promotion. The antibody response to infection, typically involving the development of Ig M during the initial acute infection followed by Ig G, is one of the most important pathogen-specific responses and plays an important role in diagnostic evaluation.

1.5.2. Pathogenesis

Once the microorganism is able to evade or overcome all of these defences, it can flourish in the alveolus, start to multiply and to release damaging toxins that cause inflammation and oedema of the lung parenchyma, leading to accumulation of cellular debris and exudates within the lungs.[14,16]

Exudation of protein fluid in alveolar spaces is associated with ventilation-perfusion impairment, and decrease in lung compliance, contributing to increased work of breathing and hypoxia. The inflammatory process is orchestrated by pro-inflammatory cytokines such as tumour necrosis factors and the interleukin (IL) series (IL-1, IL-2, IL-6, and IL-8), and is balanced by anti-inflammatory mediators. Cytokines are largely responsible for the clinical and laboratory manifestations of bacterial CAP.[17]

In most acute bacterial pneumonias, the major mechanism for arterial hypoxaemia is intrapulmonary shunt caused by maintenance of pulmonary arterial blood flow to the consolidated lung, leading to a ventilation–perfusion mismatch.[17] There is also evidence that metabolically active inflammatory cells within the consolidated lung consume oxygen, thus further decreasing pulmonary venous oxygen content and arterial oxygenation.[17]

1.6. Complications of CAP[18,19]

Complications of CAP include pleural effusion, empyema or pyothorax, lung abscess, secondary bacterial lung infection after a viral infection, sepsis, respiratory failure, acute respiratory distress syndrome, haemoptysis, atelectasis, bronchospasm, and death.

1.7. Diagnosis of CAP

1.7.1. Clinical presentation

CAP can vary from indolent to fulminant in presentation and from mild to fatal in severity. The various signs and symptoms, which depend on the progression and severity of the infection, include both constitutional effects and manifestations limited to the lung and its associated structures. In the light of the pathophysiology of the disease, many of the findings are to be expected.

The patient is frequently febrile, with a tachycardia, and may have chills and/or sweats and cough, either non-productive or productive of mucoid, purulent, or blood-tinged sputum, pleuritic chest pain or chest discomfort, palpitations, and shortness of breath. Up to 20% of patients may have gastrointestinal symptoms such as nausea, vomiting, and/or diarrhoea and abdominal pain. Other symptoms may include headaches, fatigue or malaise, anorexia, myalgias, and arthralgias.[16]

Findings on physical examination vary with the degree of pulmonary consolidation and the presence or absence of a significant pleural effusion. An increase in respiratory rate and use of accessory muscles of respiration are common. Palpation may reveal increased or decreased tactile fremitus, and the percussion note can vary from dull to stony dull, reflecting underlying consolidated lung and pleural fluid, respectively. Crackles, bronchial breath sounds, and possibly a pleural friction rub and signs of bronchial secretions (rhonchi and wheezing) may be heard on auscultation.[16] The clinical presentation may not be as obvious in the elderly, who may display new-onset or worsening confusion and few other manifestations.[16] Symptoms and signs of conditions complicating CAP may be present as well.

Unfortunately, the sensitivity and specificity of the findings on physical examination are less than ideal, averaging 58% and 67%, respectively.[17] Furthermore, the overall prevalence of CAP among unselected patients presenting with respiratory complaints ranges from about 3% to 10%, depending on the setting. There are no individual (or combination of) findings on the history, physical examination, or laboratory examination that can rule in or out the diagnosis of CAP with adequate accuracy.[19] Therefore, the diagnosis of CAP relies both on the presence of symptoms and signs of acute pulmonary infection and on evidence of a new radiographic infiltrate.[19]

1.7.2. Risk factors for CAP

Risk factors associated with any type of CAP are race (black), alcoholism, drug abuse, tobacco smoking, prior antibiotic use, steroid therapy, advanced age, recent travel history, associated comorbidities such as immunosuppression, asthma, COPD, stroke, diabetes, heart failure, seizures, renal failure, liver failure and dementia.[17]

1.7.3. Chest radiograph

With a sensitivity of 65%-85% and specificity of 85%-95%, a chest radiograph (CXR) is usually regarded as the reference standard for the diagnosis of CAP.[13,19] In the appropriate setting, a new area of consolidation on CXR makes the diagnosis.[9,20] Occasionally, the CXR initially appears normal, particularly in immunocompromised and in severely dehydrated patients.[19,20]

The CXR may show lobar consolidation, involving single or, less commonly, multiple lobes with air-bronchograms, as the most common pattern of presentation of

pneumococcal CAP, reticular or reticulonodular in pattern associated with interstitial CAP resulting from atypical pathogen and viral infections, or bronchopneumonic changes with peribronchial thickening and poorly defined air-space opacities with no, or inhomogeneous, patchy areas of consolidation that usually involve several lobes.[13] The radiological pattern is unhelpful in suggesting likely aetiology, because the changes are not specific enough with the different microorganisms to be of diagnostic value.

A CXR is advisable in all patients who are likely to have pneumonia, because it helps to confirm the diagnosis, delineate the extent of the consolidation, indicate the presence of underlying disorders, and denote the presence of complications.[9,21]

1.7.4. Laboratory studies

1.7.4.1. Sputum microscopy and culture

There is debate about the value of sputum samples in the diagnosis of CAP. Oral flora rather than the offending pathogen may dominate a sputum Gram's stain and culture. The guidelines provided by the IDSA recommend pathogen-directed therapy assisted by Gram's stain (and culture) even though acknowledging that the yield of positive results is low (30% to 40%).[22] The guidelines of the ATS are less supportive of the Gram's stain, stating that due to the low yield and low specificity, empiric therapy to cover all likely organisms is preferred.[22] Nevertheless, most experts believe that an attempt should be made to obtain a sputum sample before commencing antibiotic therapy, as this is sometimes the best opportunity to identify pathogens that may need special attention.[23]

Unfortunately the routine use of sputum Gram's stain as a basis for empiric therapy in the ED can be problematic for several reasons. Firstly, many patients are not able to provide adequate sputum specimens. Secondly, induction of sputum without adequate isolation facilities can put patients and staff at risk of being infected with microorganism such as tuberculosis. Thirdly, correlation between pneumococcus identification on Gram's stain and sputum culture and the presence or absence of pneumococcal infection is poor. Fourthly, sputum specimens are even less likely to demonstrate gram-negative pathogens, such as *Haemophilus influenzae.* Lastly, empiric antimicrobial agents are usually highly clinically effective, if chosen on the basis of clinical information, and they do not require sputum analysis.[6]

1.7.4.2. Blood culture

Blood cultures are the most specific diagnostic test for the causative organism, but are positive in only around 10% of patients admitted to hospital with CAP; the more severe the pneumonia, the more likely blood cultures are to be positive.[23]

Most experts recommend that blood be cultured from all patients, except those well enough to be managed at home with oral antibiotics, and should be obtained before initiation of antimicrobial therapy.[22,23]

1.7.4.3. Blood chemistry and haematology[24]

A number of investigations are recommended. On a white blood cell and differential count, leukocytosis or left shift may be seen and leucopoenia has been linked to a poor prognosis. Abnormal renal or liver function tests have been associated with CAP, and have implications for medication. C-reactive protein (CRP) as a septic marker is usually elevated. Serum glucose is recommended to exclude any hypo- or

hyperglycaemia, and lactate to exclude any tissue hypoperfusion. Prothrombin time (PT), partial thromboplastin time (PTT) and international normalised ratio (INR) are requested when appropriate. Arterial blood gas (ABG) analysis is recommended, as it provides prognostic information and may identify patients with respiratory failure and the need for early ventilatory support. Serum bicarbonate will be low in metabolic acidosis. HIV testing may be indicated. Thoracentesis should be done in patients with pleural effusion, which should include white cell and differential count and measurement of the pH, protein, glucose and lactate dehydrogenase and adenosine deaminase, Gram's staining and culture, and Ziehl-Neelsen stain.[9]

1.7.4.4. Other studies

These include serological testing for atypical pathogens, tests for microbial antigens and/or antibodies, invasive diagnostic testing including bronchoscopy, and investigative tools such as polymerase chain reaction.[9] Most experts recommend that they should not be performed routinely, especially in ED, because results are not available in time to affect therapy decisions, and the cost of care is increased unnecessarily.[25]

1.8. Emergency department management of CAP

Emergency department management involves resuscitation with rapid-focus clinical assessment if needed, medical history, physical examination, urgent relevant blood tests and investigations, and early appropriate administration of empiric antimicrobial therapy.

1.8.1. Patient who does need resuscitation

Because of multiple potential complications associated with CAP the ABC (Airway, Breathing, Circulation) approach to resuscitation should be assessed and addressed first.[10]

Clinical situations in which CAP patients might require urgent resuscitation include profound hypotension and septic shock complicating sepsis in the setting of pneumonia, terminal respiratory distress and respiratory failure with the immediate need for ventilatory support, cardiac arrest complicating pneumonia with multiple organ dysfunction, massive pleural effusion with cardiovascular collapse complicating CAP, and severe pneumonia in the setting of comorbities such as asthma, COPD, cardiac failure and end-stage AIDS.

Measurement of blood pressure (BP), pulse (P), temperature (T), Glasgow coma score (GCS), capillary refill time (CRT), pulse oximetry, urine output if indicated, and assessment of the arterial blood gas (ABG) are essential, and a more detailed examination of the patient follows as the situation permits.[10]

1.8.1.1. Establishing an airway

Administration of oxygen after basic airway opening manoeuvres (head tilt chin lift, and jaw thrust in cervical spine precaution in the case of trauma, extreme age, and in medical conditions such as rheumatoid disease, ankylosing spondylitis and Down's syndrome[26]) should be considered. Adjunctive airways such as oro-pharyngeal and nasopharyngeal airways may be needed.

Endotracheal intubation may be considered to secure the airway should the patient be in need of ventilatory support. If rapid sequence intubation (RSI) is indicated, a

prudent approach to avoid the use of etomidate as much as possible in the setting of septic shock is recommended by most experts so as to prevent adrenal insufficiency and other associated risks.[27] However, if this agent has been used for induction, hydrocortisone 50 mg IV 6 hourly is recommended until the baseline serum cortisol level has been assessed.[27]

1.8.1.2. Controlling the work of breathing

Control of breathing is required when tachypnoea accompanies shock and mechanical ventilation and sedation decrease the work of breathing and have been shown to improve survival.[10]

Arterial oxygen saturation should be restored to greater than 92% and ventilation controlled to maintain a partial pressure of carbon dioxide between 35 mmHg to 40 mmHg.[10]

1.8.1.3. Optimising the circulation

Placing the patient supine, with legs raised above the level of the heart, does improve cardiopulmonary performance compared to Trendelenburg positioning.[10] For patients in shock, haemodynamic stabilisation begins with IV access through a large-bore peripheral line, and a central line should be inserted and measured. In cases of septic shock, correction or stabilisation of hypotension and inadequate perfusion with rapid, aggressive fluid administration as per EGDT protocol (Appendix B) is recommended (unless cardiogenic shock or extreme age is associated).[10,28]

Fluid resuscitation begins with isotonic crystalloid: 1-2 litres (20 mg/kg) of Ringer's lactate (first choice) or normal saline solutions (second choice) are preferred.[10] The colloid-versus-crystalloid resuscitation controversy remains despite evidence that

there is a slight increase in mortality when colloids are used for volume replacement in critically ill patients.[29] Some studies have found a lower incidence of pulmonary oedema, and possible greater benefits in elderly patients with colloid resuscitation, although survival is not significantly improved.[10] In the acute situation with severe shock, colloids may be considered to achieve rapid plasma expansion, and use less volume than crystalloids.[10]

Vasopressor agents are used when there has been an inadequate response to volume resuscitation or when a patient has a contraindication to volume infusion.[30] In relation to septic shock, unfortunately, no large, prospective, randomised, and well-conducted studies to guide pharmacological management are available so far.[31]

The conventional recommendation of either norepinephrine or dopamine as first-line therapy to correct septic hypotension and epinephrine limited to patients in whom volume resuscitation (3 to 4 litres) and first-line drugs have failed to restore sufficient BP has recently been challenged.[31] Furthermore, while dobutamine was also previously considered the preferred drug to increase cardiac output in critically ill patients and recommended as the agent of choice in septic shock patients, this has also been questioned.[32,33]

1.8.1.4. Other considerations

A focused physical examination from head to toes should be performed and special attention should be paid to the respiratory system by looking for use of accessory muscles of respiration, palpation for increased or decreased tactile fremitus, and percussion for dullness or stony dullness, reflecting underlying consolidated lung and pleural fluid, respectively. The auscultation may reveal crackles, bronchial breath

sounds, and possibly a pleural friction rub and signs of bronchial secretions (rhonchi and wheezing).[16]

A chest radiograph is a valuable initial examination with further testing dictated by clinical suspicion. If indicated complex imaging studies (computed tomography) should wait until the patient is resuscitated.[10]

Urgent blood tests should be done, including full blood count with differential, urea and electrolytes, liver function test, and C-reactive protein, coagulation studies, lactate, glucose, and blood cultures. Care should be taken to obtain urinalysis in all patients and perform pregnancy testing in all women of child-bearing age.

It is also important to identify and correct metabolic derangement (hypoglycaemia, hypocalcaemia) and consider the need of early mechanical ventilation with PEEP, when indicated. Early administration of antibiotics and anticipation of possible need for vasopressors and stress-dose hydrocortisone should be done.[34] Severe fever, treatment with oral or IV paracetamol should be considered, and care should be taken to avoid hypothermia. If appropriate, chest decompression with therapeutic thoracentesis or sometimes with tube thoracostomy, in the presence of a pleural effusion, should be considered.[10]

1.8.1.5. Corticosteroid therapy

Studies in early and late septic shock have shown that low-dose corticosteroids reduce the duration of vasopressor requirements and should be considered for use in patients who remain hypotensive despite adequate fluid, vasopressor and oxygen delivery strategies, or in patients who are not tolerating vasopressor agents.[35] In this

regard hydrocortisone 50 mg IV 6 hourly is the recommended dose.[35] Corticosteroid therapy is also used in suspected deficiency states.

1.8.1.6. Achieving end points of resuscitation[10,22]

The goal of resuscitation is to restore and maintain adequate tissue perfusion as indicated by normalisation of BP, and pulse rate, increased urine output, improved mentation, skin perfusion, decreased lactate, and resolving metabolic acidosis.

A goal-directed approach at achieving urine output above 0, 5-1 mL/kg/h, central venous pressure (CVP) 8 to 12 mm Hg, mean arterial pressure MAP 65 to 90 mm Hg, central venous oxygen saturation (Scvo2) above 70% during ED resuscitation of the shock patient significantly decreases mortality.

1.8.2. Patient who does not need resuscitation

1.8.2.1. Medical history

The clinical diagnosis will be directed at looking for any of the symptoms of CAP as well as any of the risk factors associated.

1.8.2.2. Physical examination

Measurement of blood pressure, pulse, temperature, Glasgow coma scale, capillary refill time, and pulse oximetry should be done. Because of multiple potential complications associated with CAP a full physical examination, from head to toes, should be performed. Examination of the head, ears, eyes, nose, throat, and lymph nodes should be documented. Cardiovascular status should be assessed by auscultating for normal and abnormal heart sounds, the regularity of the cardiac beat, and the presence/absence of murmurs. Pulmonary examination for the use of

accessory muscles of respiration, palpation for increased or decreased tactile fremitus, and percussion for dullness or stony dullness, reflecting underlying consolidated lung and pleural fluid, respectively, should be undertaken. Auscultation for crackles, bronchial breath sounds, and possibly a pleural friction rub and signs of bronchial secretions (rhonchi and wheezing) should also be undertaken.[16] The status of the abdomen should be assessed for possible distension, tenderness, and organomegaly. Hydration status and skin examination should be documented.

1.8.2.3. Other considerations

A chest radiograph should be requested and the site of care should be decided. If indicated, urgent blood tests should be done, including full blood count with differential, urea and electrolytes, liver function test, and C-reactive protein, lactate, glucose, and blood cultures. Pregnancy tests should be performed in all women of child-bearing age. Early administration of antibiotics is recommended and consideration should be given to fever and pain treatment with paracetamol and/or non-steroidal anti-inflammatory drugs.

1.8.3. Empiric antimicrobial therapy

The first dose of the antimicrobial should be given as soon as possible, within the golden hour (as soon as 4 hours after disease presentation, if possible), and has been shown to improve survival and reduce length of stay of hospitalised CAP patients.[36]

Although an aetiological agent is frequently not identified, the distribution of organisms remains approximately 70% to 80% typical bacterial respiratory pathogens, and about 20% to 25% atypical microorganisms. Co-infection with both

typical and atypical bacteria has been reported and may increase mortality and length of hospitalisation.[37] Mortality reduction has been described when treatment covers both typical and atypical pathogens and clinically it is not possible to reliably differentiate between the two types of bacterial infection. For these reasons all guidelines recommend empiric antimicrobial agents to be started in ED for both typical and atypical pathogens coverage.[37]

Different options for empiric antibiotic therapy are offered and individual choice of treatment is guided by thorough knowledge of commonly encountered pathogens in the region or practice environment and a full appreciation of their usual susceptibility patterns. Significant differences in microbial susceptibilities have been noted, not only within the different geographical areas of South Africa, but also between the public and private sector.[9] A further recommendation is that since recent exposure to an antibiotic (in the past 3 months) is a risk factors for antibiotic resistance, particularly to that class of antibiotics, patients presenting with pneumonia should be asked about recent antibiotic exposure. If they have recently been exposed to a particular class of antibiotics, continued or repeated use of that class of antibiotics is not recommended, or, in the case of a beta-lactam, an agent in that same class with a broader spectrum should be used.[9] The South African guideline for patients with CAP is described as follows (Appendix C).[9] Few of the recommended treatment regimens have been validated in prospective studies.

1.8.3.1. Patients treated at home

1.8.3.1.1. Young patients < 65 years of age, without comorbid illness

In young patients, below the age of 65 years and without comorbid illness, the treatment of choice is high-dose oral amoxicillin (Appendix D).

1.8.3.1.2. Elderly patients ≥ 65 years and/or adults with comorbidity, including patients with HIV infection

Agents available for oral outpatient use, which are recommended for use in the elderly (≥ 65 years), for patients with co-morbid illness, and for sicker patients, are amoxicillin-clavulanate or selected oral cephalosporins (i.i: cefuroxime axetil or cefpodoxime).

1.8.3.1.3. Alternative antibiotics for both situations

1.8.3.1.3.1. Fluoroquinolones

Fluoroquinolones with extended Gram-positive cover (moxifloxacin and gemifloxacin) are the preferred agents because of their superior microbiological efficacy against *S. pneumoniae*. Levofloxacin, which is now recommended at the higher dose (750 mg daily or 500 mg 12-hourly), is also a suitable option. However, in order to limit the development of resistance, it is recommended that these agents are not used as routine first-line therapy, but rather are reserved for patients with severe allergy to standard beta-lactam agents, for known or suspected cases of infection with highly penicillin-resistant pneumococci or other resistant infections, and for patients in whom initial therapy with other antimicrobial agents has failed. These antibiotics also provide good cover, as monotherapy, for infections with the so-called "atypical pathogens".

1.8.3.1.3.2. Macrolides/Azalides

On the basis of current information on the mechanism, prevalence, and significance of macrolide/azalide resistance in *S. pneumoniae* in South Africa, these agents are not routinely recommended as monotherapy for the treatment of CAP in many

situations. The prevalence of resistance of these agents appears to be high in many areas, particularly in the private sector in South Africa. In areas known to have a low prevalence of macrolide resistance, such as in many of the public sectors, the continued use of macrolides/azalides as monotherapy in young, previously healthy adults, who have not recently been exposed to antibiotics, may still be acceptable. A thorough knowledge of common pathogens and their susceptibility pattern in one's own area of practice is therefore essential.

1.8.3.1.3.3. Telithromycin

Telithromycin has in vitro activity against macrolide/azalide-resistant S. *pneumoniae*. Like the fluoroquinolones, it is recommended that this agent is not used as routine first-line therapy, but reserved for patients with severe allergy to standard beta-lactam agents, for known or suspected cases of infection with highly penicillin-or macrolide resistant pneumococci, and for cases in which initial therapy with other antimicrobial agents has failed.

1.8.3.1.3.4. Tetracycline/Doxycycline

The considerable and increasing resistance of *S. pneumoniae* to tetracycline/doxycycline in South Africa, limits its general use as monotherapy for CAP.

1.8.3.2. Hospitalised patients

1.8.3.2.1. Young patients <65 years of age, with no comorbid illness

The treatment of choice is high doses of parenteral penicillin or ampicillin or amoxicillin (Appendix D). Alternative therapy may be an intravenous anti-pneumococcal fluoroquinolone, with the same considerations as described above.

1.8.3.2.2. Elderly patients ≥ 65 years and/or adults with comorbidity, including patients with HIV infection

The treatment of choice is either amoxicillin-clavulanate or a selected second-generation cephalosporin (cefuroxime) or a selected third-generation cephalosporin (ceftriaxone or cefotaxime). It is further recommended that these agents be given parenterally initially, at least until the temperature settles.

1.8.3.3. Additional therapy for both non-hospitalised and hospitalised cases

A macrolide, azalide, tetracycline or telithromycin is recommended on its own or as additional therapy for any patient being treated with a beta-lactam antibiotic in the case of suspected or proven infection with the so-called atypical pathogens. While clinical features often do not allow for an accurate differentiation of atypical infections from the more common bacterial causes, it may be appropriate to add one of these agents to standard therapy in cases with atypical or unusual features, or in cases not responding to initial antibiotic treatment. Also the guideline recommends that in the more severely ill, hospitalised patient with CAP, a macrolide/azalide should be added to the standard beta-lactam therapy, because of several studies showing improved outcomes in those cases treated with such therapy (see below).

1.8.3.4. Critically ill adults

The treatment of choice is a combination of parenteral amoxicillin-clavulanate or a parenteral second-generation cephalosporin (cefuroxime), or a third-generation cephalosporin (ceftriaxone or cefotaxime), together with an aminoglycoside (gentamicin or amikacin or tobramycin) and a macrolide (erythromycin, clarithromycin or azithromycin). The aminoglycoside is added initially because of the

relative high prevalence of CAP associated with aerobic Gram-negative bacilli documented previously in various intensive care unit studies in South Africa. Alternative treatment may include an anti-pneumococcal fluoroquinolone, particularly in the setting of severe beta-lactam allergy. However, there is no data on whether these agents are adequately effective as monotherapy in critically ill cases, and therefore at present, in this setting, it is recommended that if they are used it should be together with another antibiotic, such as a beta-lactam agent or an aminoglycoside.

1.8.3.5. Combination therapy

There is emerging evidence that in patients with severe CAP, combination antibiotic therapy, most commonly the addition of a macrolide agent to standard beta-lactam therapy, may be associated with a better outcome than monotherapy. Although the studies have been retrospective or purely observational in design, the benefit in outcome has been shown, particularly in sicker, hospitalised patients with pneumonia, including the sub-set of patients with bacteraemic pneumococcal infections. The current guideline recommends combination antibiotic therapy in severely ill patients with CAP admitted to hospital for intravenous antibiotic therapy, in line with most international pneumonia guidelines.

1.9. CURB-65 and CRB-65 severity of illness scores

1.9.1. Overview

CAP presents to physicians as a wide spectrum of illness severity, varying from mild self-limiting infection to life-threatening and occasionally fatal disease.[38] This breadth of illness severity is reflected in the variable mortality rates reported by studies of

CAP in different clinical settings.[38] The decision regarding the most appropriate site of care of a patient with CAP is one of the most important decisions in the overall ED management of these patients. It has consequences both for the level of treatment received by the patient as well as the overall costs of treatment.[38] Such decisions are best informed by an accurate assessment of the severity of illness at presentation and therefore the likely prognosis. The recognition of patients at low risk of mortality and/or complications and therefore suitable for treatment out of hospital has the potential to reduce inappropriate hospitalisation and consequently inherent medical costs.[38] When hospital admission is required, further management is also influenced by illness severity.[38] This includes the extent of the microbiological investigation, the choice of initial empiric antimicrobial chemotherapy and its route of administration, the duration of hospital treatment and the level of nursing and medical care.[38]

Early identification of patients at high risk of death allows early initiation of appropriate antibiotic therapy and especially early admission to an ICU, factors that may significantly impact on outcome. Clinicians will often make these decisions based on their assessment of the severity of illness of their patient with CAP. A number of severity of illness assessment tools have been developed to assist in such decision making.

The CURB-65 severity of illness score is one of the two most extensively studied and validated clinical practice guideline tools that have been recognised and recommended by experts.[5,22,37] This severity assessment tool was proposed by the British Thoracic Society and later modified by Neill et al. [22,38] It was developed mainly as a means of identifying patients with more severe CAP at higher risk of mortality.[22]

The CURB-65 score firstly was validated in a study of over 1 000 prospectively studied patients with CAP from the United Kingdom, New Zealand and the Netherlands.[37] Since then the CURB-65 score has been studied in over 20 000 patients representing a mix of patients seen both in the community and in hospitals and all studies reported findings similar to the derivation studies.[37]

For the CURB-65 score, one point is assigned for each of the following parameters, if present, namely confusion, urea >7mmol/l, respiratory rate ≥ 30/min, blood pressure (systolic < 90 mmHg and/or diastolic ≤ 60 mmHg) and age ≥ 65 years, thus enabling patients to be stratified according to increasing risk of mortality (score 0, 0.7%, score 1, 2.1%, score 2, 9.2%, score 3-5, 15-40%) (Figure 1.1).[22,37]

It is suggested that patients with scores 0 and 1 are at low risk of mortality and may be suitable for management as hospital outpatients.[39,40] Patients with a score of 2 are at intermediate risk of mortality and should be considered for hospital-supervised treatment.[38] Patients with scores 3 to 5 are at higher risk of mortality and correspond to those who may need high care or ICU care.[22]

A more simplified tool, the CRB-65 score, was subsequently reported and studied, in which the only laboratory value of the CURB-65 score, namely the blood urea nitrogen, was not required (Figure 1.1).[22,37] For this scoring system, one point is assigned for each of the following parameters, if present: confusion, respiratory rate ≥ 30/min, blood pressure (systolic < 90 mm Hg and/or diastolic ≤ 60 mm Hg) and age ≥ 65 years.[22,37] For this scoring system, the risk of mortality for each of the scores is: score 0, 1.2%, score 1, 5.3%, score 2, 12.2%, score 3-4, up to 33%.[37]

It is suggested that patients with a score of 0 are at low risk of mortality and may be suitable for management as hospital outpatients.[39,40] Patients with a score of 1 or 2

are at intermediate risk of mortality and should be considered for hospital-supervised treatment.[22] Patients with scores 3 to 4 are at high risk of mortality and correspond to those who may need high care or ICU care.[22]

This modified tool was validated with results similar to those of the CURB-65 score (Table 1.1).[5,22,37] This more simplified score may be particularly valuable in developing countries, especially in poor resources settings, since it obviates the need to measure the blood urea level.

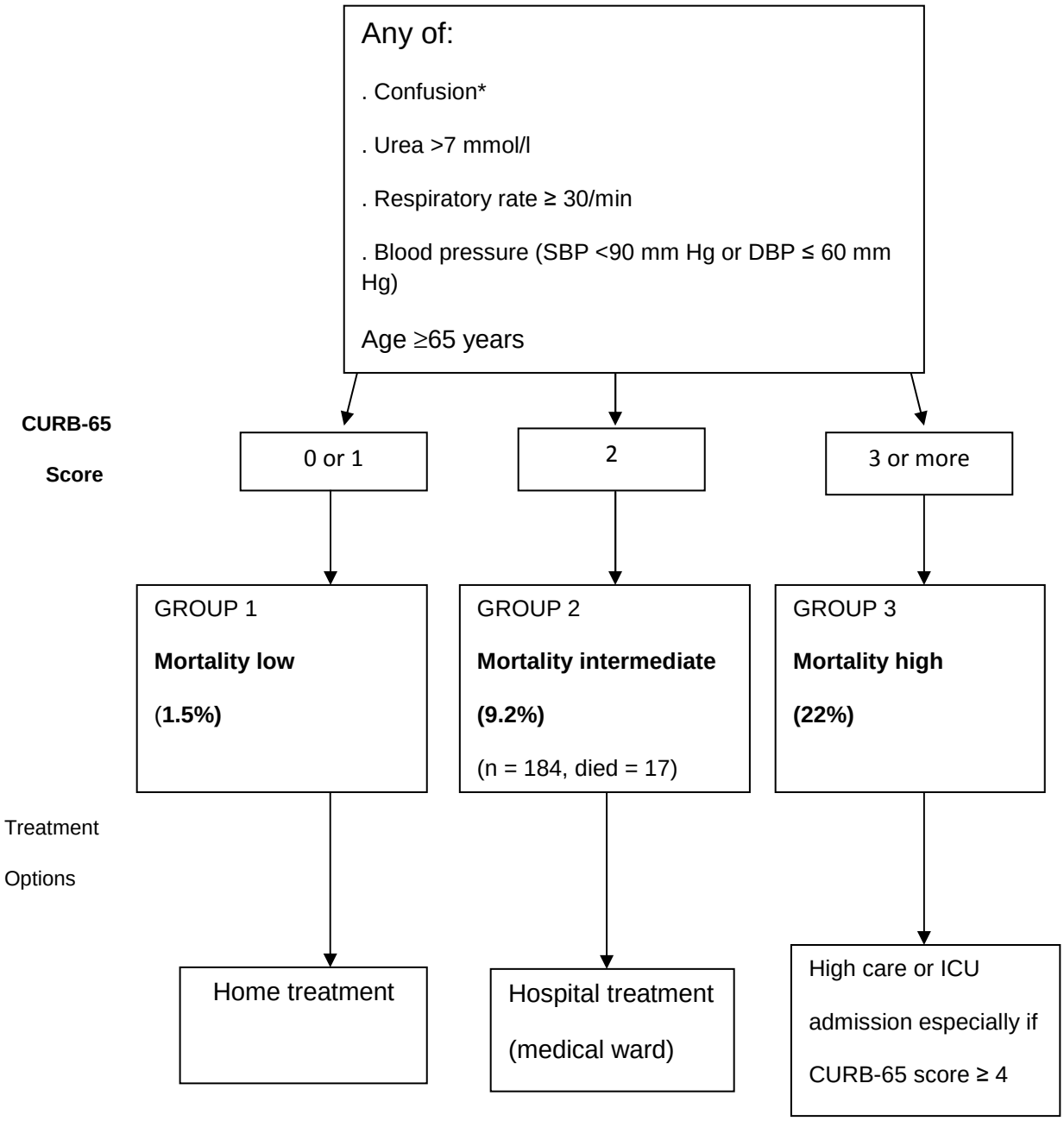
In order to better determine the presence or not of confusion, as used in the CRB-65 severity of illness score, one can do the abbreviated mental test, as described below.

1.9.2. The abbreviated mental test as used in the CRB-65 score

This quick screening test (Table 1.2) was first introduced by Hodkinson in 1972 to rapidly assess elderly patients for the possibility of dementia.[39] Its uses in medicine have become somewhat wider (i.e. to assess for confusion or other cognitive impairment)[40] and data recommends its use in ED as the generally accepted practice.[41]

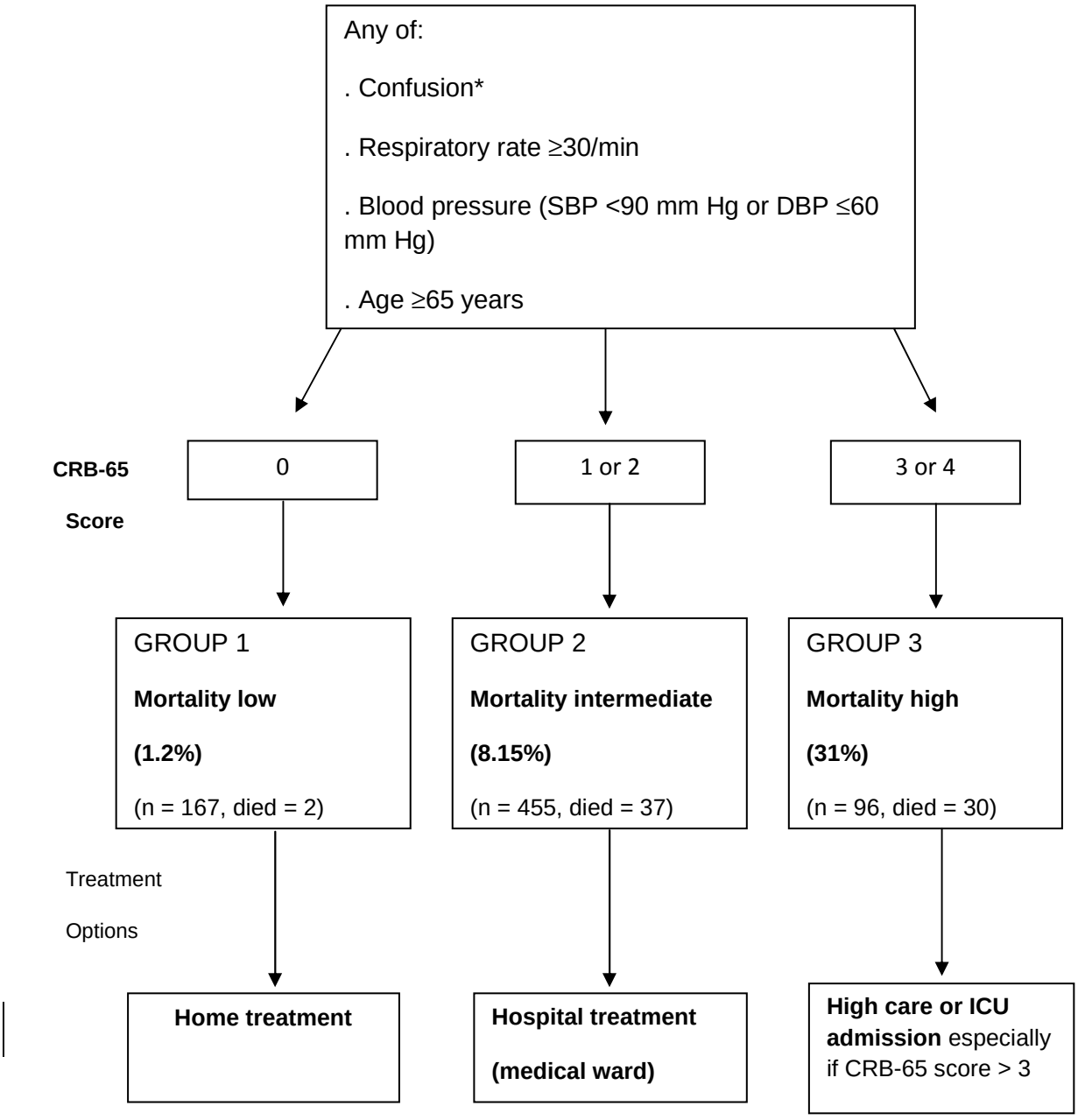
As modified for South African conditions (Table 1.3), a number of questions are put to the patient and each of them correctly answered scores one mark, for a total of 10 marks.[7,8] Confusion is defined as a mental test score of 8 or less or new disorientation in the patient, place or time as used in CURB-65 and CRB-65 severity of illness scores.[22]

Figure 1.1: Severity of illness assessment: the CURB-65 score[22]



*defined as a Mental Test Score of 8 or less, or new disorientation in person, place or time.

Figure 1.2: Severity of illness assessment: the CRB-65 score[22]



*defined as a Mental Test Score of 8 or less, or new disorientation in person, place or time.

Table 1.2: The abbreviated mental test[39,40]

- Patient's age
- Patient's date of birth
- Time (to nearest hour)
- Year
- Hospital name
- Recognition of two persons (e.g. doctor, nurse)
- Recall address
- Date of First World War
- Name of monarchs
- Count backwards 20 to 1

Table 1.3: The abbreviated mental test modified for South African conditions

- Patient's age
- Patient's date of birth
- Time (to nearest hour)
- Year
- Hospital name
- Recognition of two persons (e.g. doctor, nurse)
- Recall address (1)
- Date of the first democratic election in South Africa (2)
- Name of the current state president (3)
- Count backwards 20 to 1

1 = Ability of patient to recall his/her address checked with the home address given to the Clerks. 2 = 1994, and 3 = Jacob Zuma.

1.10. Study aim

To determine whether it would be useful to introduce the CRB-65 severity of illness score in the routine evaluation of patients with community-acquired pneumonia in the Helen Joseph Hospital Emergency Department.

1.11. Study objectives

1. To determine what criteria Helen Joseph Hospital Emergency Department doctors use in their decision of whether to admit or discharge CAP patients.
2. To determine the frequency with which the CRB-65 severity of illness score is used in current practice by the Helen Joseph Hospital Emergency Department doctors for admitting or discharging CAP patients.
3. To determine the potential performance of the CRB-65 severity of illness score in the management of patients with CAP in the Helen Joseph Hospital Emergency Department.

CHAP 2. MATERIALS AND METHODS

2.1. Ethics

The research was approved by the Human Research Ethics Committee of the University of the Witwatersrand (protocol approval number M10912 – see appendix E). The Helen Joseph Hospital Emergency Department doctors were informed about the study and requested to volunteer to participate (Appendix F). Using a subject information sheet, research participants were informed (in the language they were most comfortable with) about the study.

Written informed consent was obtained from the patients (Appendix G). When the patient was unable to give informed consent, this was requested from a spouse or partner, a parent, a grandparent, an adult child or a brother or sister of the patient (Appendix H). When the patient was unable to give consent and none of his/her relatives were present, the patient was automatically enrolled in the study and a retrospective consent (Appendix I) was obtained from the patient once his/her mentation was improved to acceptable baseline. Confidentiality was maintained by not using patient names but giving a unique PIN to each patient, starting from 001 (Appendix J).

2.2. Study design

This was a prospective, observational, hospital-based study of a convenience sample of 152 patients over a 12-week period between February 2011 and April 2011.

2.3. Study sample, study setting and population

The study was conducted in the Emergency Department at Helen Joseph Hospital in Auckland Park, Johannesburg.

2.3.1. Inclusion criteria

- Patient aged 18 years or above evaluated as having CAP in the ED of HJH.
- CAP was defined as the presence of two or more of the following:[2]
    - Altered breath sounds and/or signs of lung consolidation
    - Fever
    - Rigors
    - Sweats
    - Cough with or without sputum production
    - Pleuritic chest pain
    - Cyanosis
    - Shortness of breath
    - Tachypnoea
- All patients were required to have radiological confirmation of the diagnosis of pneumonia.

2.3.2. Exclusion criteria

- Patients with suspected or confirmed aspiration pneumonia.
- Patients with suspected or confirmed chemical pneumonitis.
- Patients with suspected or confirmed *Pneumonocystis jirovecii* pneumonia.
- Patients with suspected or confirmed pulmonary tuberculosis.

2.4. Data collection

The study proceeded as follows:

- Prior to the start the candidate explained to ED colleagues that he was conducting a study to determine what the criteria were that were used by the HJH ED for admitting or discharging CAP patients. He requested their participation in the study, following informed consent, and discussed this with them in general terms so as not to change their clinical practice (Appendix F).
- The candidate requested the ED doctors to call him every time they finished their evaluation/management of a CAP patient.
- The candidate interviewed the patient and requested his/her participation in the study, with informed consent. The candidate confirmed that the cases fitted the inclusion criteria and then filled in the case report form (Appendix K). In order to protect the confidentiality of the patients, each patient was given a unique PIN starting from 001, which was entered into the case report form.
- Following this, the candidate ascertained from the ED doctor on what basis the doctor had elected to admit the patient to hospital or to discharge the patient home. The question was open ended. e.g. “On what basis did you decide to admit the patient to hospital or to discharge the patient home?” All reasons given were recorded (Appendix K).
- The candidate assessed the severity of illness of the patient using the CRB-65 score. This was also entered into the case report form.
- The candidate followed the progress of the patient’s illness. For those admitted to HJH, the candidate followed the cases until discharge, step-down or death. The clinical details were entered into the case report form. For those stepped down to Selby Hospital, the candidate followed the progress of the

patient's illness telephonically with an identified Selby Hospital permanent medical officer. The patients who were discharged home were asked to supply a contact number (kept confidential) in order to contact them or their family to determine the progression of their infection (Appendix J).

2.5. Outcome measures

Outcome criteria of CAP patients included:

- Discharge, step-down or death.
- For those admitted to hospital, resolution of clinical symptoms and signs – time to clinical stability. Time to clinical stability was determined according to a validated rule that defined clinical stability as the first day that most of the following criteria were simultaneously achieved: SBP ≥ 90 mmHg; RR ≤ 24 breaths/min; oxygen saturation ≥ 92%, temperature ≤ 37.2℃; ability to tolerate oral intake; and baseline mental status.[42] Time to clinical stability was calculated by subtracting the admission date from the first date that the patient was determined to be clinically stable.[42] Length of hospital stay was calculated by subtracting the hospital admission date from the hospital discharge date.[42]

2.6. Sample size estimation

It has previously been observed that the average proportion of patients diagnosed with CAP in the ED of the HJH is 7%. However, our experience showed that this proportion can rise to 15%. Using a significance level of 5%, the minimum sample size required to detect a difference from 7% to 15% with a power of 95% is 144 (Stata version 11 command). Study participants may withdraw for multiple reasons,

and the percentage of withdrawals can be estimated as 10%. The sample size was then increased by 15 to give a minimum sample size of n=159.

2.7. Data analysis

Collected data was captured on a personal computer using Excel software and analysed in Excel and Stata version 11, with the help of a statistician.

Descriptive statistics were done using frequencies, cross-tabulations, bar charts and histograms. Means and standard deviations for normally distributed continuous variables were also calculated and reported. For non-normally distributed continuous variables, medians and their associated ranges were calculated and reported. Associations between categorical outcomes were formally tested using the Chi-squared test and the Fisher's exact test (FET) when the expected numbers of subjects in the cells were less than five. The Chi-squared test assumes that each cell has an expected frequency of five or more, but the FET has no such assumption. Associations between non-normally distributed continuous variables were tested using the non-parametric Spearman's correlation. To test for agreement between two categorical variables, the kappa test statistic was used. Results were presented using p-values.

2.8. Significance level

Two-sided statistical tests at the 5% significance level were used throughout the analysis. A p-value of less than 0.05 was considered statistically significant.

2.9. Software

All data was entered and stored in a Microsoft Excel [R] (Microsoft office 2007, Microsoft Corporation) spreadsheet. All analysis was conducted using Stata version 11 and Excel.

CHAP 3. RESULTS

3.1. Baseline clinical characteristics

A total of 159 patients, representing a diverse spectrum of ethnic groups, were enrolled in the study over the three-month period between February 2011 and April 2011. Seven patients were later excluded because they were subsequently confirmed to have pulmonary tuberculosis, and therefore 152 patients were included in the final analysis. The baseline clinical characteristics (age, gender, abbreviated mental test modified for South African conditions (AMTMSAC), systolic and diastolic blood pressure (BP), heart rate, respiratory rate, and body temperature) are summarised in Table 3.1 and Table 3.2.

Table 3.1: Baseline clinical characteristics of the study patients

Variable	Mean ± SD	Median (Range)
Age (years)	39.7 ± 13.6	36.5 (20 to 87)
Systolic BP (mmHg)	118.8 ± 17.6	114 (86 to 172)
Diastolic BP (mmHg)	71.4 ± 12.2	72 (35 to 100)
Heart rate (beats/min)	100.1 ± 20.3	103 (58 to 158)
Respiratory rate (breaths/min)	23.9 ± 5.1	23.5 (14 to 38)
Temperature (ºC)	37.7 ± 0.9	37.8 (36 to 41)

SD: standard deviation, BP: blood pressure

Table 3.2: Other baseline clinical characteristics of the study patients

Variables		N (%)
Gender	Female	79 (52%)
	Male	73 (48%)
AMTMSAC	10/10	149 (98%)
	8/10	2 (1.3%)
	6/10	1 (0.7%)

AMTMSAC: Abbreviated Mental Test Modified for South African Conditions

3.1.1. Age

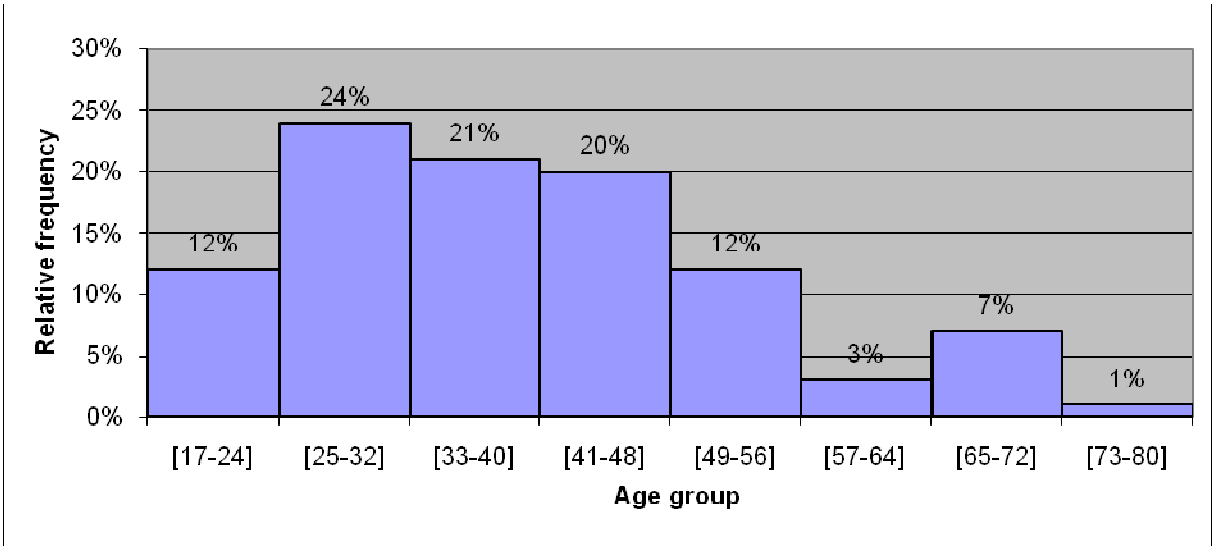
The median age was 36.5 years and the range was from 20 to 87 years, as shown in Table 3.1. The frequency distribution of the ages of the patients is shown in Table 3.3 and the corresponding frequency histogram is given in Figure 3.1. The majority of the patients 140/152 (92.1%) were less than 65 years of age and the remaining 12/152 (7.9%) were aged 65 years and above.

Table 3.3: Age frequency distribution

Age (observed value)			
Age interval	N	%	Cumulative %
[17-24]	18	11.84	11.84
[25-32]	37	24.34	36.18
[33-40]	32	21.05	57.24
[41-48]	30	19.74	76.97
[49-56]	18	11.84	88.82
[57-64]	5	3.29	92.11
[65-72]	10	6.58	98.68
[73-80]	2	1.32	100.00
	152	100.00	

Number in brackets represents range of ages (years)

Figure 3.1: Histogram for age distribution



3.1.2. Gender

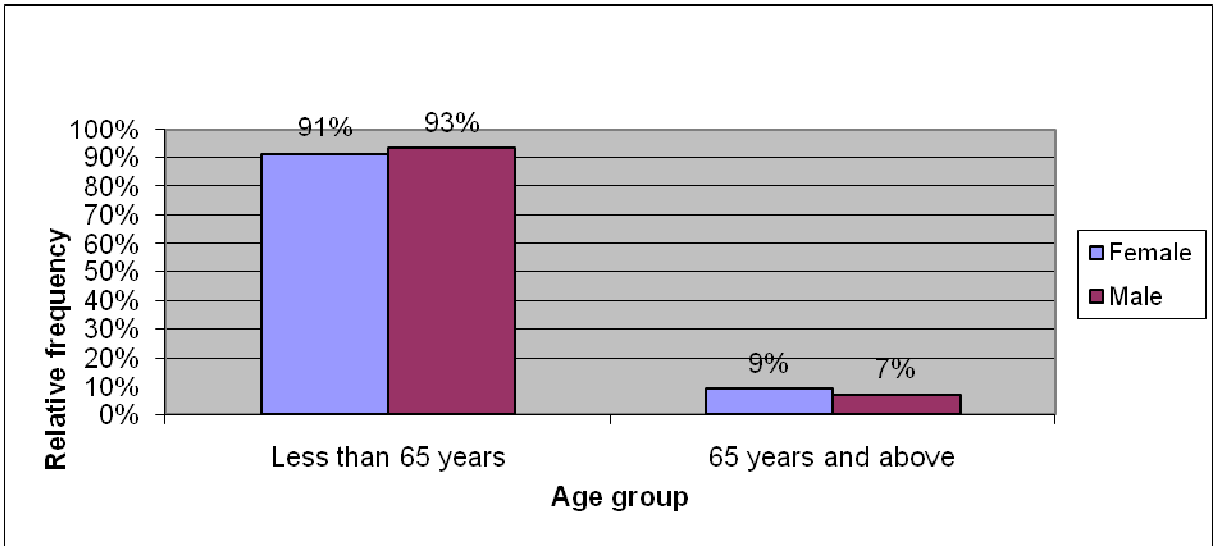
Almost half (79/152 (52%)) of all the enrolled patients were females, with males making up 73 of the 152 patients (48%), as shown in Table 3.2. Table 3.4 and Figure 3.2 show the gender distribution by age group (using a cut-off of 65 years). There was no statistically significant difference in gender distribution by age group (p = 0.646).

Table 3.4: Gender distribution by age group

Age interval	Female	Male	Total
Less than 65 years	72 (91.14%)	68 (93.15%)	140
65 years and above	7 (8.86%)	5 (6.85%)	12
Total	79 (100%)	73 (100%)	152

Note: column percentages in brackets

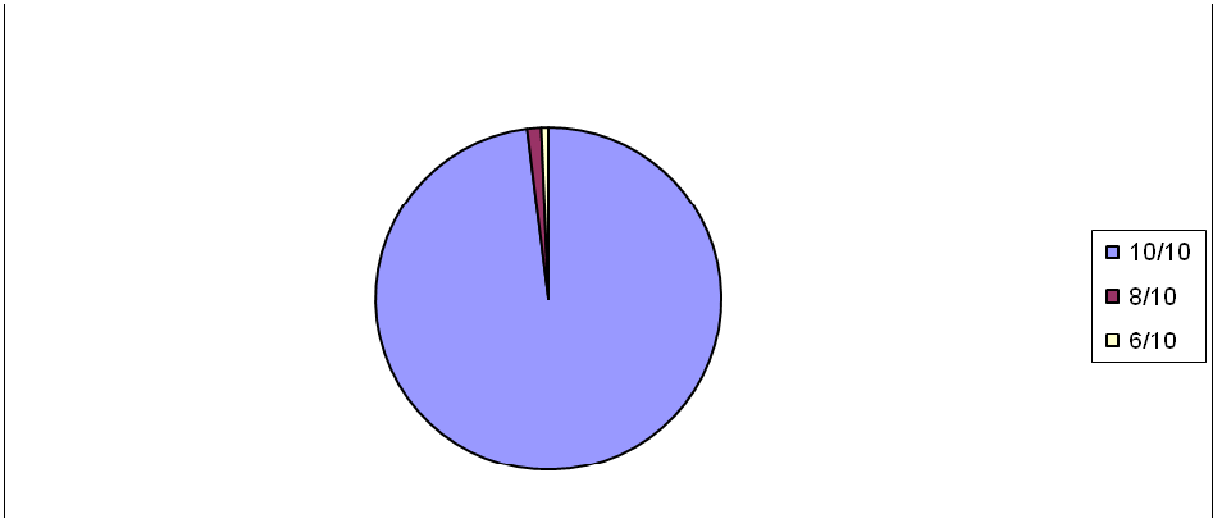
Figure 3.2: Age bar chart by gender



3.1.3. Abbreviated Mental Test Modified for South African Conditions (AMTMSAC)

The majority (149/152 (98%)) of the patients enrolled in the study had a normal AMTMSAC score of 10/10, a few (2/152 (1.3%)) had a score of 8/10 and only 1/152 (0.7%) had a score of 6/10. This is shown in Table 3.2 and Figure 3.3.

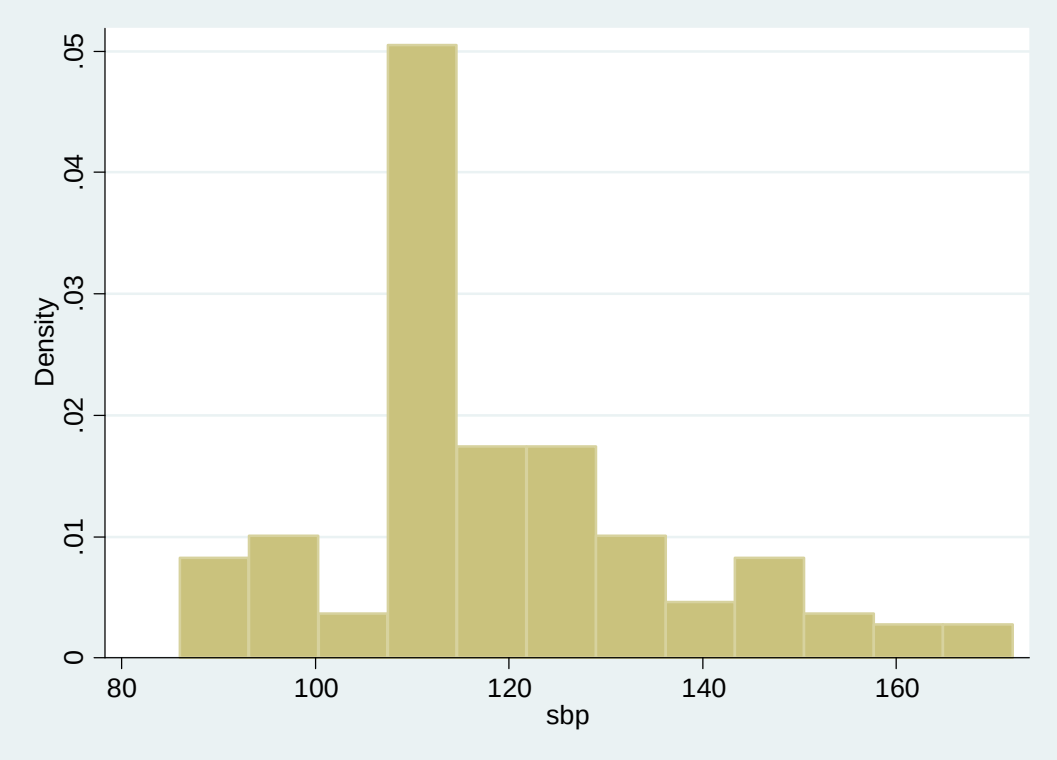
Figure 3.3: AMTMSAC pie-chart



3.1.4. Systolic blood pressure

As shown in Table 3.1, the median systolic BP for all the patients enrolled was 114 mmHg and ranged from 86 mmHg to 172 mmHg. The frequency histogram for systolic blood pressure is shown in Figure 3.4.

Figure 3.4: Systolic BP histogram

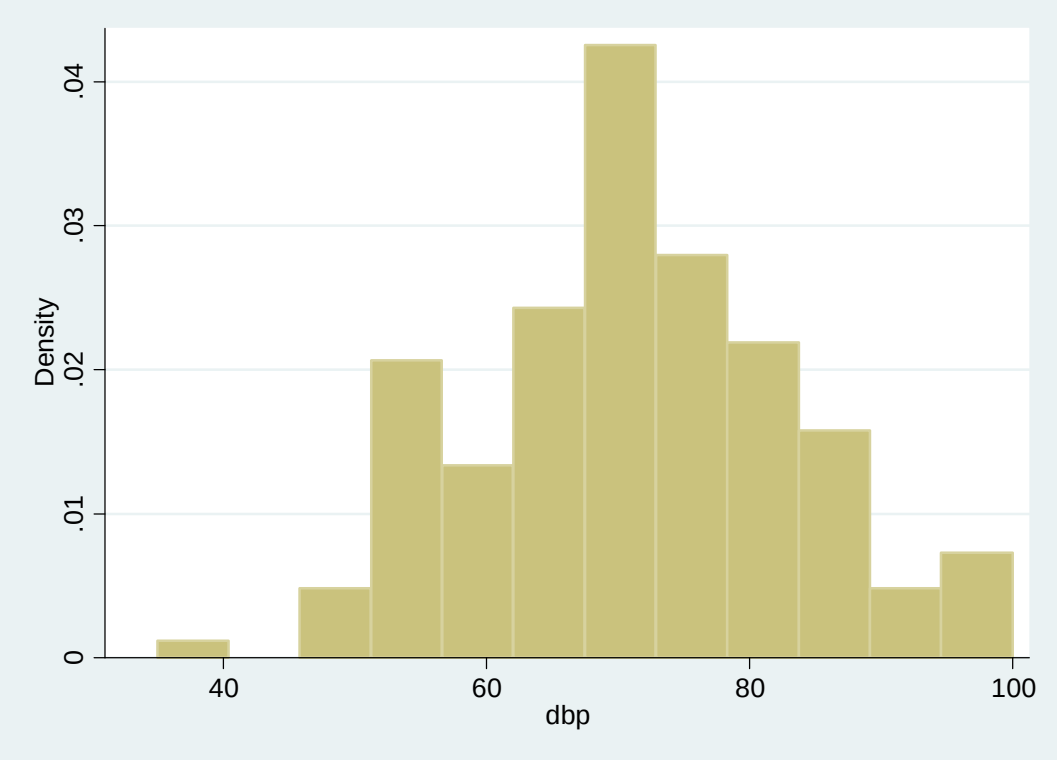


sbp: systolic blood pressure

3.1.5. Diastolic blood pressure

As shown in Table 3.1, the median diastolic BP for all the patients was 72 mmHg and ranged from 35 mmHg to 100 mmHg. The frequency distribution of diastolic BP is shown in Figure 3.5.

Figure 3.5: Diastolic BP histogram

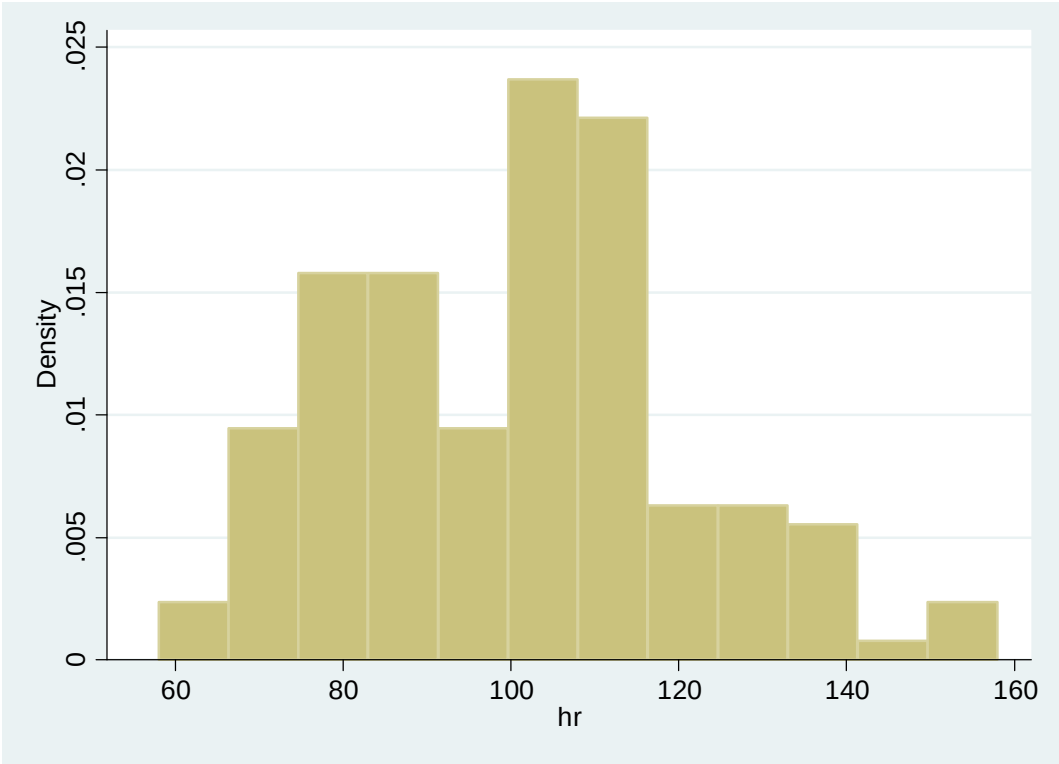


dbp: diastolic blood pressure

3.1.6. Heart rate

As shown in Table 3.1, the median heart rate for all the patients was 103 beats per minute and ranged from 58 beats per minute to 158 beats per minute. The frequency distribution of heart rate is shown in Figure 3.6.

Figure 3.6: Heart rate histogram

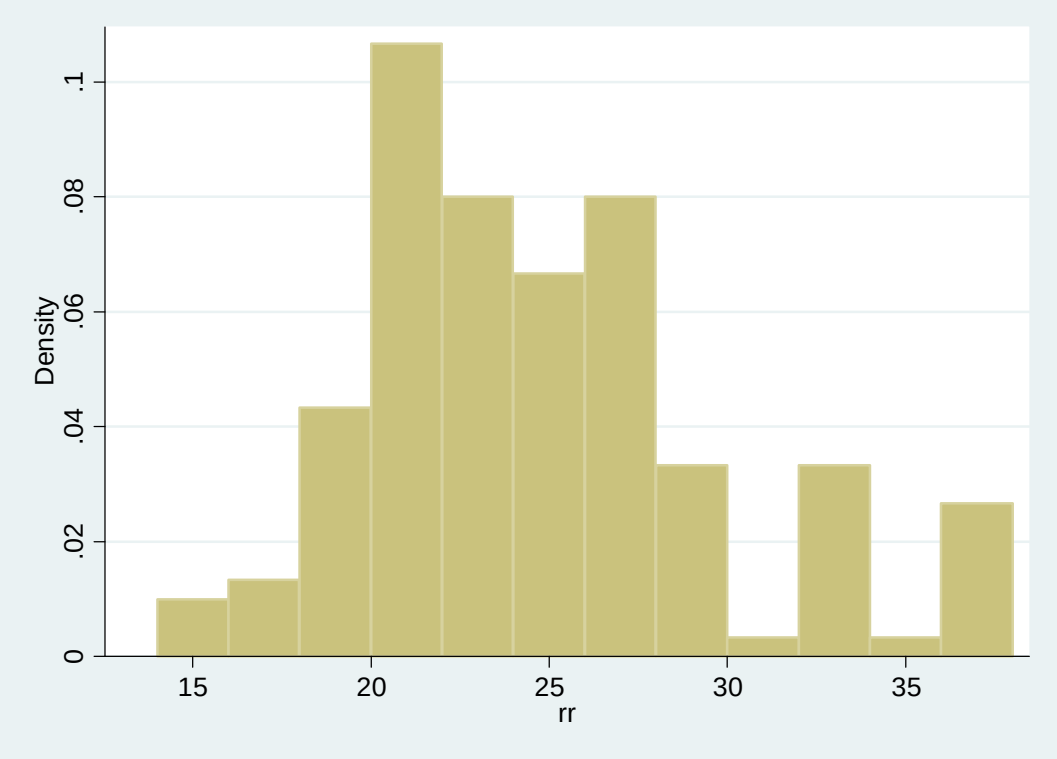


hr: heart rate

3.1.7. Respiratory rate

As shown in Table 3.1, the median respiratory rate for all the patients was 23.5 breaths per minute and ranged from 14 breaths per minute to 38 breaths per minute. The frequency distribution of respiratory rate is shown in Figure 3.7.

Figure 3.7: Respiratory rate histogram

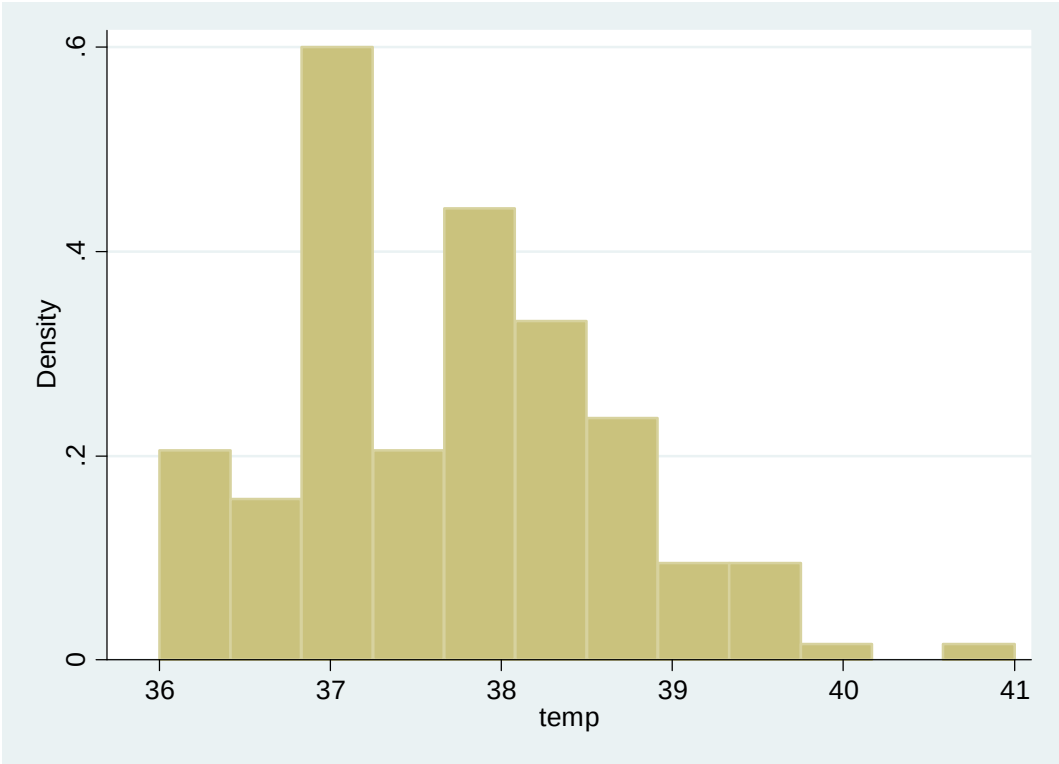


rr: respiratory rate

3.1.8. Body Temperature

As shown in Table 3.1, the median body temperature for all the patients was 37.8 ºC and ranged from 36 ºC to 41 ºC. The frequency distribution of temperature is shown in Figure 3.8.

Figure 3.8: Body temperature histogram

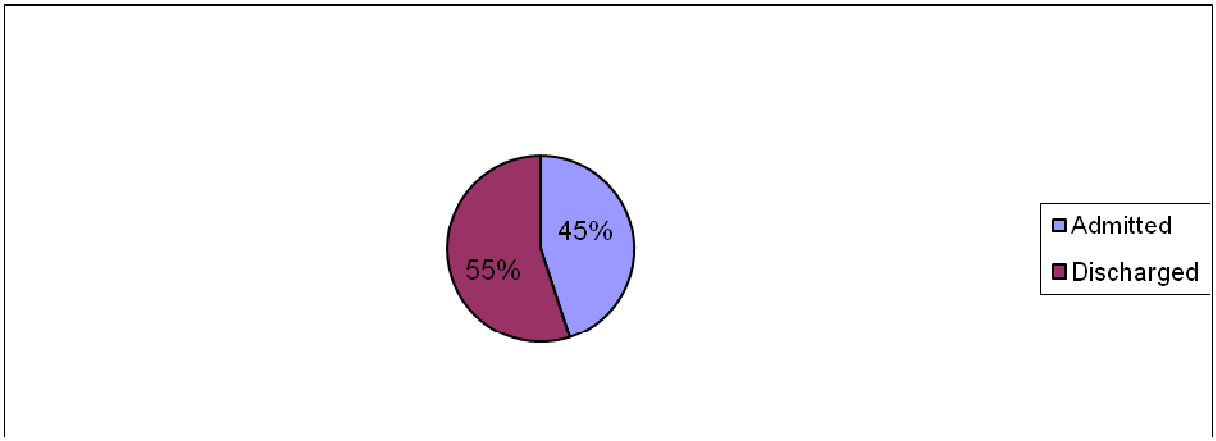


temp: temperature

3.2. Admission/discharge decision

Overall, 68/152 (45%) of all the enrolled patients were managed as in-hospital patients and the remaining 84/152 (55%) were treated as outpatients. This information is also shown in Figure 3.9.

Figure 3.9: Admission/discharge data



3.2.1. Admission/discharge data by gender group

The admission/discharge data per gender group is shown in Table 3.5. Overall 56/68 (82%) of the in-hospital patients were females and 12/68 (18%) were males. Of those treated as outpatients, 23/84 (27%) were females and 61/84 (73%) were males. Significantly more females were managed as in-hospital patients than males, and significantly more males were managed as outpatients than females ($p < 0.001$).

Table 3.5 Admission/discharge by gender group

Gender	Decision		Total
	Admitted	Discharged	
M	12 (18%)	61 (73%)	73 (52%)
F	56 (82%)	23 (27%)	79 (48%)
Total	68 (100%)	84 (100%)	152 (100%)

Note: column percentages are given in brackets

3.2.2. Admission/discharge by age group

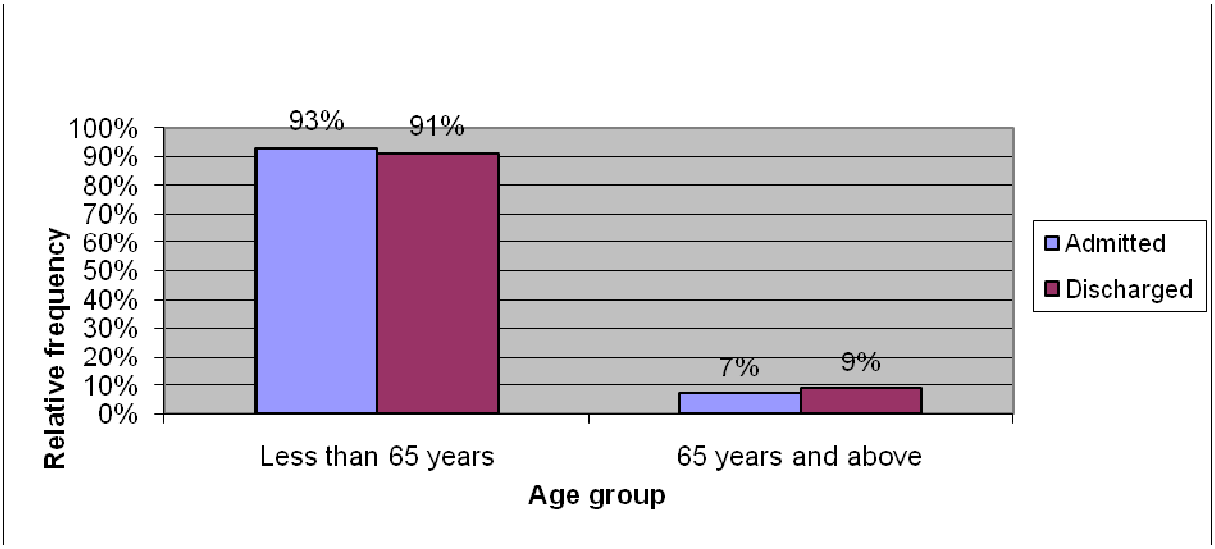
Table 3.6 shows the cross-tabulation of the decision on management of patients as either in-hospital patients or as outpatients by age group (using a cut-off of 65 years). Figure 3.10 gives the visual display. No significant differences were observed in the age distribution between the in-hospital patients and outpatients ($p = 0.702$).

Table 3.6: Admission/discharge decision by age group (cut-off of 65 years)

Age interval	Admitted	Discharged	Total
Less than 65 years	62 (91.18%)	78 (92.86%)	140 (92.11%)
65 years and above	6 (8.82%)	6 (7.14%)	12 (7.89%)
Total	68 (100%)	84 (100%)	152 (100%)

Note: column percentages are given in brackets

Figure 3.10: Admission/discharge data by age group



3.2.3. Admission/discharge criteria used by ED doctors for admission decisions

Table 3.7 shows the criteria used by HJH ED doctors in deciding site of care for patients, arranged in decreasing order of frequency. The corresponding relative frequencies are given in the table. The total of 193 exceeds our sample size of 152 because for some patients more than one criterion was used.

Table 3.7: Criteria used by the HJH ED doctors for site of care decisions

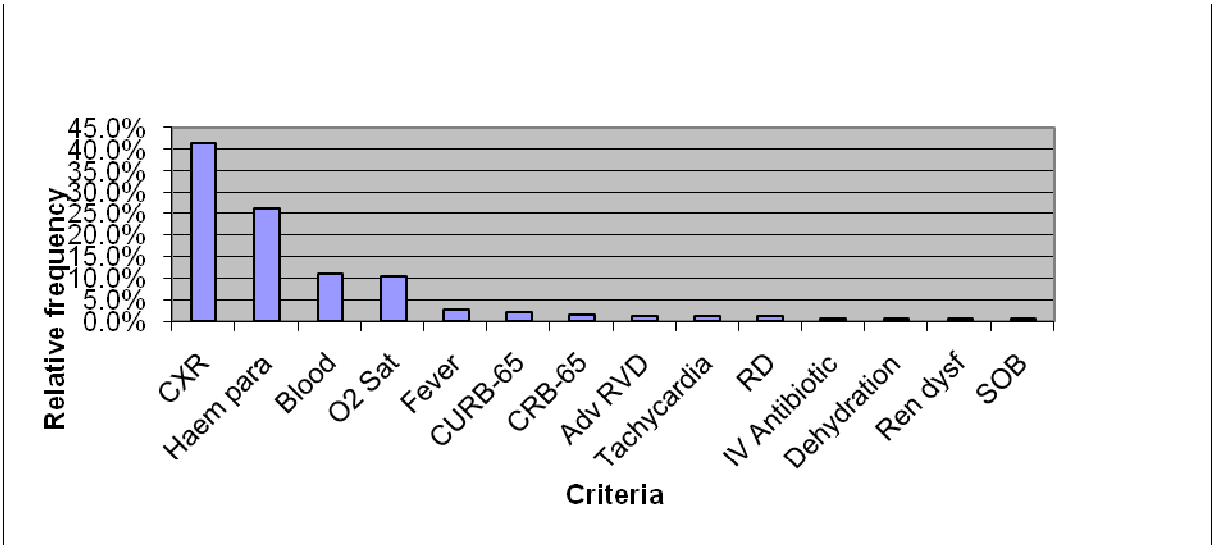
Criterion	N	%
CXR	80	41.50%
Haem para	50	25.90%
Blood	21	10.90%
O2 Sat	20	10.40%
Fever	5	2.60%
CURB-65	4	2.10%
CRB-65	3	1.60%
Adv RVD	2	1.00%
Tachycardia	2	1.00%
RD	2	1.00%
IV Antibiotic	1	0.50%
Dehydration	1	0.50%
Ren dysf	1	0.50%
SOB	1	0.50%
TOTAL	193	100

CXR: chest radiograph, Blood: blood test results of the patients, Adv RVD: advanced retroviral disease, O2 sat: saturation of oxygen on room air, Haem. para: haemodynamic parameters of the patients, Ren dysf: renal dysfunction, RD: respiratory distress, and SOB: shortness of breath, IV Antibiotic: patient's need for intravenous antibiotics.

As shown in Table 3.7, the criteria used by the Helen Joseph Hospital Emergency Department doctors, in decreasing order of frequency, were as follows. Firstly, the chest radiograph was the commonest criterion used (80/193 (41.5%)). Secondly, it was the haemodynamic parameters of the patient (50/193 (25.9%)). Thirdly, it was the blood test results (full blood count, urea and electrolyte, C-reactive protein, liver function test) of patients (21/193 (10.9%)). Fourthly, it was oxygen saturation of the patient on room air (20/193 (10.4%)). Fifthly, it was the presence of fever (5/193

(2.6%)). Sixthly, the CURB-65 score (4/193 (2.1%)) was used. Seventhly, the CRB-65 score (3/193 (1.6%)) was used. Eighthly, there were three criteria with the same relative frequency (2/193 (1%) each), namely advanced retroviral disease as associated co-morbidity, the presence of tachycardia, and the presence of respiratory distress. Lastly, there were four criteria with the same least percentage (1/193 (0.5%) each), namely the need for intravenous antibiotics, shortness of breath, the presence of renal dysfunction, and dehydration. This information is shown in Figure 3.11.

Figure 3.11: Criteria used by the ED doctors for site of care decisions



CXR: chest radiograph, Blood: blood test results of the patients, Adv RVD: advanced retroviral disease, O2 sat: saturation of oxygen on room air, Haem. para: haemodynamic parameters of the patients, Ren dysf: renal dysfunction, RD: respiratory distress, and SOB: shortness of breath, IV Antibiotic: patient's need for intravenous antibiotics.

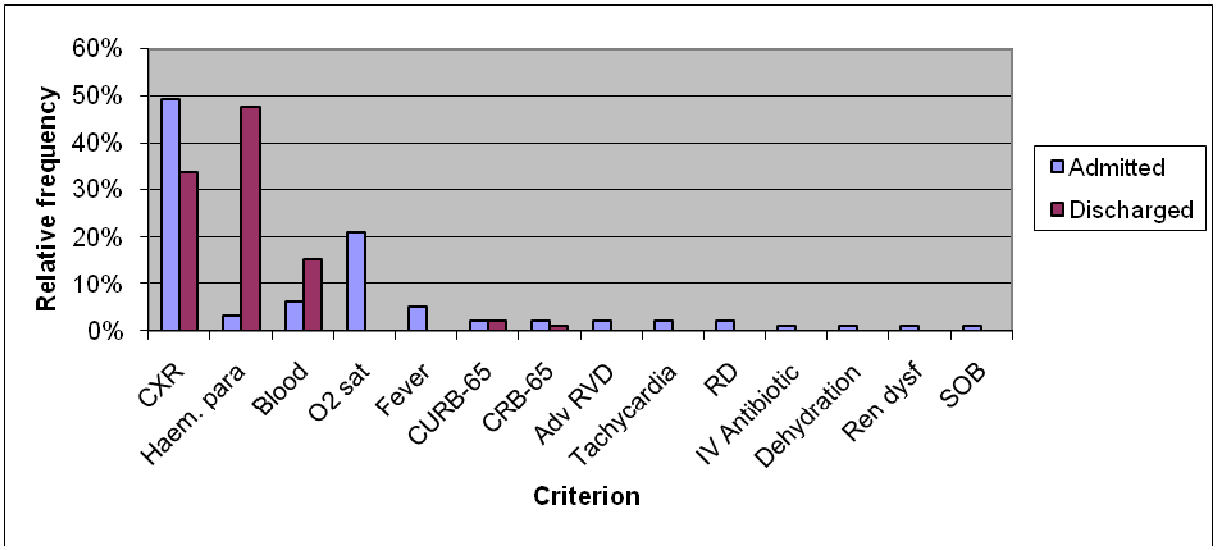
Table 3.8 shows the distribution of the criteria for the site of care decisions used by the HJH ED doctors. Figure 3.12 shows the clustered bar chart for this same distribution.

Table 3.8: Admission and discharge decisions according to criteria made

Criterion	Admitted		Discharged		Total	
	N	%	N	%	N	%
CXR	47	49	33	34	80	41.5
Haem. Para	3	3	47	48	50	25.9
Blood	6	6	15	15	21	10.9
O2 sat	20	21	_	_	20	10.4
Fever	5	5	_	_	5	2.6
CURB-65	2	2	2	2	4	2.1
CRB-65	2	2	1	1	3	1.6
Adv RVD	2	2	_	_	2	1.0
Tachycardia	2	2	_	_	2	1.0
RD	2	2	_	_	2	1.0
IV Antibiotic	1	1	_	_	1	0.5
Dehydration	1	1	_	_	1	0.5
Ren dysf	1	1	_	_	1	0.5
SOB	1	1	_	_	1	0.5
Total	95	100	98	100	193	100

CXR: chest radiograph, Blood: blood test results of the patients, Adv RVD: advanced retroviral disease, O2 sat: saturation of oxygen on room air, Haem. para: haemodynamic parameters of the patients, Ren dysf: renal dysfunction, RD: respiratory distress, and SOB: shortness of breath, IV Antibiotic: patient's need for intravenous antibiotics

Figure 3.12: Admission/discharge decisions by criteria



CXR: chest radiograph, Blood: blood test results of the patients, Adv RVD: advanced retroviral disease, O2 sat: saturation of oxygen on room air, Haem. para: haemodynamic parameters of the patients, Ren dysf: renal dysfunction, RD: respiratory distress, and SOB: shortness of breath, IV Antibiotic: patient's need for intravenous antibiotics

Significant differences were noted in the criteria used for admission and discharge decisions ($p < 0.001$) by the HJH ED doctors in that the chest radiograph was used more frequently in admitting patients compared to all other criteria, whereas haemodynamic parameters were used more frequently for discharging patients compared to all other criteria (Figure 4.12).

3.2.4. Admission/discharge decisions by CRB-65 score

Only on three occasions was the CRB-65 score utilised out of 193 criteria for admission decisions 3/193 (1.55%).

3.3. Outcomes

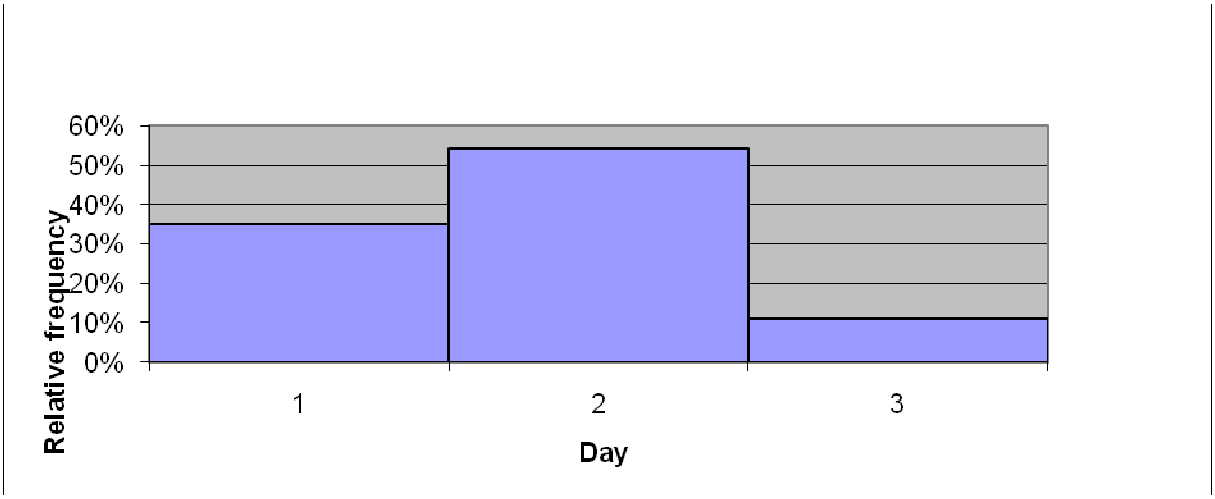
3.3.1. Time to clinical stability (in days)

The distribution of number of days to clinical stability is shown in Table 3.9 and Figure 3.13. The total of 63 in-hospital patients in the table excludes the five deaths that occurred from an overall total of 68 in-hospital patients.

Table 3.9: Time to clinical stability (in days)

Day of stability	N	%
1	22	35
2	34	54
3	7	11
Total	63	100

Figure 3.13: Time to clinical stability (days)



The median time to clinical stability (in days) for all in-hospital patients was two days and ranged from one to three days.

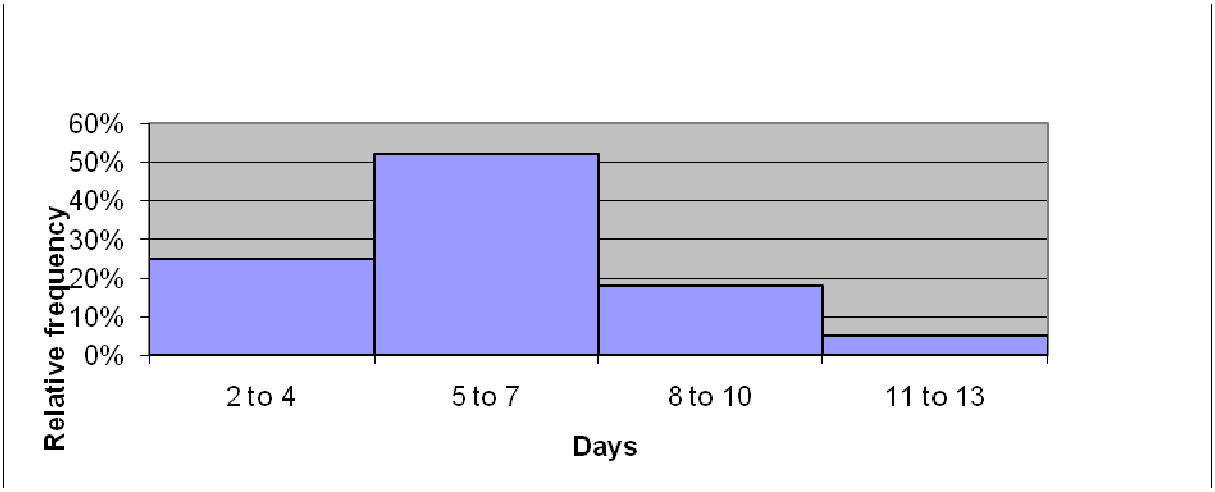
3.3.2. Length of hospital stay (in days)

The distribution of the length of hospital stay (in days) is shown in Table 3.10 and Figure 3.14. The total of 63 in-hospital patients in the table excludes the five deaths that occurred from an overall total of 68 in-hospital patients.

Table 3.10: Length of hospital stay (in days)

Days of hospital stay	N	%
2 to 4	16	25
5 to 7	33	52
8 to 10	11	18
11 to 13	3	5
Total	63	100

Figure 3.14: Length of hospital stay (in days)



The median number of days spent in hospital by all in-hospital patients was six days and ranged from two to 13 days.

3.3.3. Mortality

Since a total of five deaths were observed out of all the 152 enrolled patients, the total mortality rate was 5/152 (3.3%). All the deaths were in in-hospital patients and there were no deaths from outpatients; therefore the in-hospital patient mortality rate observed was 5/68 (7.4%).

3.4. CRB-65 performance

The CRB-65 severity of illness score was applied to all the patients enrolled in the study to determine what the decision regarding the site of care would have been if the CRB-65 score was the standard criterion used for hospital admission/discharge decisions at the Helen Joseph Hospital Emergency Department.

3.4.1. CRB-65 results

The results obtained from applying the CRB-65 score to all the 152 enrolled patients are given in Table 3.11.

Table 3.11: CRB-65 score recorded for all the patients in the study

CRB-65 score	Mortality risk	Frequency	%
0	Low (1.2%)	107	70%
1-2	Intermediate (8.15%)	42	28%
3-4	High (31%)	3	2%
Total		152	100%

Table 3.11 shows that if the CRB-65 score had been applied to all the patients as the only criterion for site of care decision by the HJH ED doctors, 107/152 (70.4%) would

have had a low mortality risk, implying that they could potentially have been managed as outpatients, while 42/152 (27.6%) would have been classified as intermediate mortality risk, and they could potentially have been managed as in-hospital patients together with the remaining 3/152 (2.0%) who would have been classified as high mortality risk, implying that they could potentially have been suitable for high care or ICU care.

Table 3.12 shows the cross-tabulation of CRB-65 score and the admission/discharge decisions that would have been made if the CRB-65 score was the only criterion used by the HJH ED doctors.

Table 3.12: CRB-65 score by admission/discharge decisions if the CRB-65 score was the standard used by the HJH ED doctors

CRB-65 score	Mortality risks	Admitted n (%)	Discharged n (%)	Total
0	Low (1.2%)	_	107 (100%)	107
1-2	Intermediate (8.15%)	42 (100%)	_	42
3-4	High (31%)	3 (100%)	_	3
Total		45 (30%)	107 (70%)	152

Note: row percentages are given in brackets except second column (mortality risks)

This indicates that if the CRB-65 score was applied as the only criterion for site of care decisions by the HJH ED doctors, 107/152 patients (70.4%) would potentially have been managed as outpatients, while 45/152 patients (29.6%) would potentially have been managed as in-hospital patients.

3.4.2. CRB-65 results versus site of care decisions by HJH ED doctors

Table 3.13 gives a cross-tabulation of the CRB-65 results that would have been obtained if the CRB-65 score was the only criterion applied by the HJH ED doctors and the actual site of care decisions used by the HJH ED doctors during the study.

Table 3.13: CRB-65 results and actual admission/discharge decisions by HJH ED doctors during the study

CRB-65 score	Mortality risks	Admitted n (%)	Discharged n (%)	Total
0	Low (1.2%)	34 (32%)	73 (68%)	107
1-2	Intermediate (8.15%)	31 (74%)	11 (26%)	42
3-4	High (31%)	3 (100%)	_	3
Total		68 (45%)	84 (55%)	152

Note: row percentages are given in brackets except second column (mortality risks)

Table 3.13 shows that of the low mortality risk patients, 73/107 (68.2%) were managed as outpatients in accordance with the CRB-65 score, but 34/107 (32%) were treated as in-hospital patients when they could potentially have been managed as outpatients. With regard to these low-risk patients admitted, 25/34 (73%) were admitted because of chest radiographic features, 5/34 (15%) were admitted because of low oxygen saturation on room air, 2/34 (6%) were admitted because of a CURB-65 score of 1, 1/34 (3%) was admitted because of a haemodynamic parameter, and 1/34 (3%) was admitted because of being incorrectly classified as having a CRB-65 of 1.

With regard to intermediate mortality risk, 11/42 patients (26.2%) were managed as outpatients in disagreement with the CRB-65 score and 31/42 (73.8%) were managed as in-hospital patients in accordance with the CRB-65 score.

Regarding the high mortality risk category, no patients were managed as outpatients in complete agreement with the CRB-65 score and 3/3 (100%) were managed as in-hospital patients. These three should have been managed as ICU patients, but none of them were actually admitted to the ICU. There was a significant difference observed between the site of care decisions by the Helen Joseph Hospital Emergency Department doctors and the site of care decisions that would have been made if the CRB-65 score was the only criterion applied ($p < 0.0001$).

3.4.3. CRB-65 results and time to clinical stability

Table 3.14 shows a cross-tabulation of the CRB-65 results and the actual time to clinical stability observed for the admitted patients. The total of 63 in-hospital patients in the table excludes the five deaths that occurred from an overall total of 68 in-hospital patients.

Table 3.14: Cross-tabulation of CRB-65 results and time to clinical stability observed

		Time to clinical stability (days)			
CRB-65 score	Mortality risks	1	2	3	Total
0	Low (1.2%)	16 (47%)	17 (50%)	1 (3%)	34
1-2	Intermediate (8.15%)	6 (21.5%)	16 (57%)	6 (21.5%)	28
3-4	High (31%)	_	1 (100%)	_	1
Total		22 (35%)	34 (54%)	7 (11%)	63

Note: row percentages are given in brackets except second column (mortality risks)

Significant association was observed (p = 0.0069) between time to clinical stability observed and the CRB-65 score results that would have been obtained if the CRB-65 score was used as the only criterion. This indicates that there was a significantly shorter time to clinical stability in patients with a lower CRB-65 score.

3.4.4. CRB-65 results and length of hospital stay

Table 3.15 shows cross-tabulation of the CRB-65 results and the actual length of hospital stay observed for the admitted patients. The total of 63 in-hospital patients in the table excludes the five deaths that occurred from an overall total of 68 in-hospital patients.

Table 3.15: Cross-tabulation of CRB-65 results and length of hospital stay observed

		Length of hospital stay (days)				
CRB-65 score	Mortality risks	2 to 4	5 to 7	8 to 10	11 to 13	Total
0	Low (1.2%)	11 (32%)	15 (44%)	5 (15%)	3 (9%)	34
1-2	Intermediate (8.15%)	5 (18%)	17 (61%)	6 (21%)	_	28
3-4	High (31%)	_	1 (100%)	_	_	1
Total		16 (25%)	33 (52%)	11 (18%)	3 (5%)	63

Note: row percentages are given in brackets except second column (mortality risks)

No association was observed (p = 0.5694) between length of hospital stay observed and the CRB-65 score results that would have been obtained if the CRB-65 score was used as the only criterion. This indicates that there was no tendency to a shorter length of hospital stay in patients with a lower CRB-65 score.

3.4.5. CRB-65 results and deaths

Table 3.16 shows a cross-tabulation of deaths observed and the CRB-65 results that would have been observed if CRB-65 score was the only criterion used by the HJH ED doctors for site of care decisions in relation to the patients.

Table 3.16: Cross-tabulation of CRB-65 results and deaths observed

CRB-65 score	Mortality risks	Alive	Dead	Total
0	Low (1.2%)	107 (100%)	_	107
1-2	Intermediate (8.15%)	39 (93%)	3 (7%)	42
3-4	High (31%)	1(33%)	2 (67%)	3
Total		147 (97%)	5 (3%)	152

Note: row percentages are given in brackets except second column (mortality risks)

There were a total of five deaths observed from the in-hospital patients, 3/5 patients (60%) would potentially have been classified as intermediate mortality risk and the remaining 2/5 patients (40%) as high mortality risk if the CRB-65 score had been the only criterion used as the standard for site of care decisions by the Helen Joseph Hospital Emergency Department doctors. Patients with a higher CRB-65 score were at a significantly higher risk of death compared to patients with a lower CRB-65 score ($p < 0.001$).

CHAP 4. DISCUSSION AND CONCLUSION

4.1. Discussion

This was a prospective, observational, hospital-based study of consecutive cases of CAP that presented at Helen Joseph Hospital Emergency Department during the period between February 2011 and April 2011. A total of 159 patients, representing a diverse spectrum of ethnic groups, were enrolled in the study over the three-month period. Seven patients were later excluded because they were subsequently confirmed to have pulmonary tuberculosis and therefore 152 patients were included in the final analysis.

4.1.1. Baseline clinical characteristics

The results have shown that patients were mostly young adults with no difference in the gender ratio. There was no difference in age between in-hospital patients and outpatients, but more females were managed as in-hospital patients while more males were managed as outpatients.

The overall median age was 36.5 years (Table 3.1), which was similar to the median age (42 years) reported by Van Rensburg et al in a previous South African study of patients with community-acquired pneumonia in Witbank,[43] but lower than the median age of 74 years reported by Diez et al, in a Spanish study of serum leptin levels in community-acquired pneumonia patients.[44] This significant difference in age might be explained by the higher prevalence of HIV infection in young adult South Africans compared to that in the Spanish population. The youngest patient was 20 years old and the oldest was 87 years old (Table 3.1). This was similar to the adult age range (18 years to 89 years) reported by Van Rensburg et al.[43] This also

corresponds to the adult age range (18 years to 101 years) reported by Halm et al, in a study from New York of time to clinical stability in patients hospitalised with community-acquired pneumonia.[45] The majority of the patients (92.1%) in the current study were less than 65 years of age (Table 3.3). This was higher than the overall adult gender distribution by age group (using a cut-off of 65 years) of 56% reported by Halm et al.[45]

There was no difference in the gender distribution in the patients, with 52% of the group being female and 48% male. The gender ratio was therefore 1/1 (Table 3.4). This corresponds with the overall adult gender distribution (51% female versus 49% male) reported by Halm et al.[45] There was no significant difference in gender distribution by age group using a cut-off of 65 years ($p = 0.646$).

Table 3.1 and Table 3.2 summarise the baseline clinical characteristics of the study patients. The majority of patients enrolled in the study had a normal AMTMSAC of 10/10 (98%). The median systolic BP was 114 mmHg and ranged from 86 mmHg to 172 mmHg. The overall median diastolic BP was 72 mmHg and ranged from 35 mmHg to 100 mmHg. The overall median heart rate was 103 beats per minute and ranged from 58 beats per minute to 158 beats per minute. The overall median respiratory rate was 23.5 breaths per minute and ranged from 14 breaths per minute to 38 breaths per minute and the overall median body temperature was 37.8 ^{o}C and ranged from 36 ^{o}C to 41 ^{o}C.

There was no difference ($p= 0.985$) in the proportion of patients managed as in-hospital patients (45%) versus outpatients (55%) (Figure 3.9). This was similar to the overall site of care distribution (53% outpatients versus 47% in-hospital patients) reported by Aujesky et al, in a Swiss study.[46] Significantly more females were

managed as in-hospital patients than males (82% versus 18%) (Table 3.5). This was in contrast to the percentages reported by Mortensen et al (79% male versus 21% female) in an American study of antibiotic therapy and 48-hour mortality in patients with pneumonia.[47] Conversely, of those treated as outpatients, significantly more were males (73%) than females (27%) (Table 3.5).

There were no significant differences observed in the age distribution (using a cut-off of 65 years) between the in-hospital patients and outpatients ($p = 0.702$).

4.1.2. Criteria used by the HJH ED doctors to determine the initial site of care decision of patients with CAP

Table 3.8 and Figure 3.12 summarise the criteria used by the HJH ED doctors to determine the initial site of care decision of the patients with CAP. There was a significant difference in criteria used for admission versus discharge decisions ($p < 0.001$) by the HJH ED doctors in that the chest radiograph was used more frequently in the decision to admit patients, compared to all other criteria, whereas haemodynamic parameters were used more frequently in the decision to discharge patients, compared to all other criteria. The specific CXR criteria that encouraged HJH ED doctors to admit the patients were not investigated in the current study. However the candidate reviewed the CXR of all these patients and noted that the most common radiographic features among these patients that were admitted were bilateral infiltration, multilobar consolidation and significant pleural effusion.

As shown in the table the CRB-65 severity of illness score was used infrequently by the HJH ED doctors. This study did not address the question why those doctors did not frequently use the scoring system. Many ED providers do not follow guideline recommendations for the assessment of severity of illness to determine the initial site

of treatment for patients with CAP. Consequently, many low mortality risk patients are commonly managed as in-hospital patients and higher mortality risk patients are most often managed as outpatients. The study by Aujesky et al found that the most commonly reported reasons for admitting low mortality risk patients were the presence of a comorbid illness (71%); a laboratory value, vital sign, or symptom that preclude ED discharge (29,3%); or a recommendation from a primary care or a consulting physician (19.3%). Higher mortality risk patients were most often treated as outpatients because of a recommendation by a primary care or consulting physician (40%).[46]

4.1.3. Outcomes: time to clinical stability, length of hospital stay, and mortality

The overall median time to clinical stability for all in-hospital patients was two days, with the range from one day to three days (Table 3.9). This was similar to the overall median time to clinical stability (three days for the most lenient definition of stability) reported by Halm et al.[45] The overall median number of days spent in hospital by all in-hospital patients was six days, and ranged from two days to 13 days (Table 3.10). This was similar to the overall median length of hospital stay of seven days reported by Meijvis et al, in a Dutch study investigating the length of hospital stay in patients with community-acquired pneumonia.[48] The length of hospital stay of the patients was often considerably longer that of the time to clinical stability. There may be many reasons for this, such as the need to treat underlying comorbid conditions; however the reasons among the patients in the current study were not investigated.

There was an overall mortality rate of 3.3% (Table 3.16), which was less than the overall mortality rate (20%) commonly reported in the literature.[4] This was also lower

than the overall mortality rate of 20% reported by Nyamande et al, which was a previous study from KwaZulu-Natal of adherence to South African CAP antibiotic guideline recommendations.[4] In that study, the authors demonstrated the poor adherence with the South African CAP antibiotic guidelines. Although adherence to the RSA guideline recommendations was not addressed in the current study, it is possible that greater adherence to the guideline recommendations in the current population versus that in the Nyamande study might explain the higher mortality rate observed in that area. There were no deaths among the outpatients in the current study and none of the higher-risk patients were admitted to ICU. Thus, the in-hospital patient mortality rate observed (7.4%) was similar to the in-hospital patients mortality rate (5–15%) reported in the literature.[5,7,8,45]

4.1.4. CRB-65 results

If the CRB-65 score had been applied to all the patients as the only criterion for site of care decision by the HJH ED doctors, 70% of the patients would have had a low mortality risk, implying that they could potentially have been managed as outpatients, while 28% would have been classified as intermediate mortality risk, indicating that they could potentially have been managed as in-hospital patients together with the remaining 2.0% who would have been classified as high mortality risk, implying that they could potentially have been suitable for high care or ICU care (Table 3.11). This distribution of patients was different from the overall patient percentages (52% low mortality risk, 34% intermediate mortality risk, and 14% high mortality risk) reported by Mortensen at al.[49] This was also different from the overall site of care percentage (53% outpatients versus 47% in-hospital patients) reported by Aujesky et al.[46]

This study shows that of the low mortality risk patients, 68.2% were managed as outpatients in accordance with the CRB-65 score, but 32% were treated as in-hospital patients when they could potentially have been managed as outpatients (Table 3.13). This was similar to the overall percentage (37.4%) of low-risk patients managed as in-hospital patients reported by Aujesky et al[46], but was considerably lower than the overall percentage (52%) reported by Mortensen et al.[47] With regard to intermediate mortality risk, 26% of these patients were managed as outpatients in disagreement with the CRB-65 score and 74% were managed as in-hospital patients in accordance with the CRB-65 score (Table 3.13). Regarding the high mortality risk category, no patients were managed as outpatients in complete agreement with the CRB-65 score, and all of them were managed as in-hospital patients (Table 3.13). This was different to the overall percentage (20%) of higher mortality risk patients treated as outpatients reported by Aujesky et al.[46] In that study the authors demonstrated that higher-risk patients were most often treated as outpatients because of a recommendation by a primary care or consulting physician (40%).[46]

There was thus a significant disagreement observed between the site of care decisions by the Helen Joseph Hospital Emergency Department doctors and the site of care decisions that would have been made if the CRB-65 score was the only criterion applied ($p < 0.0001$).

4.1.5. CRB-65 performance

4.1.5.1. CRB-65 score and time to clinical stability

There was a significantly shorter time to clinical stability in patients with a lower CRB-65 score ($p = 0.0069$) (Table 3.14). Thus, this study demonstrates the ability of the CRB-65 to accurately predict time to clinical stability for CAP hospitalised

patients. The study by Arnold et al also found that the CRB-65 score had a good accuracy for predicting time to clinical stability in hospitalised patients with CAP.[49] In addition to this, the authors demonstrated that the predictive accuracy of the CRB-65 score was equivalent to that of the PSI (0.647, 95%CI: 0.619-0.6700 versus 0.638, 95%CI: 0.613-0.660) for determining time to clinical stability.[49]

4.1.5.2. CRB-65 score and length of hospital stay

There was no tendency to a shorter length of hospital stay in patients with a lower CRB-65 score in the current study (p = 0.5694) (Table 3.15). The study by Zuberi et al, which was a prospective comparison of prediction rules of mortality risk for community-acquired pneumonia in a developing country, also found that the length of hospital stay did not increase with a higher CRB-65 score.[50] This was in contrast with the study by Ewig et al on new perspectives on community-acquired pneumonia in 388 406 patients, which concluded that the length of hospital stay was associated with the severity of the disease (mean (SD) length of hospital stay 9.45 (7.82) versus 12.39 (8.47) versus 14.5 (10.69), respectively for risk class 1-3, excluding death).[51]

4.1.5.3. CRB-65 score and death

There were a total of five deaths observed from the in-hospital patients of which three would have been classified as having intermediate mortality risk and the remaining two as having a high mortality risk if the CRB-65 score had been the only criterion used as the standard for site of care decisions by the Helen Joseph Hospital Emergency Department doctors (Table 3.16). This study shows that patients with a higher CRB-65 score are at a significantly higher risk of death than patients with a lower CRB-65 score (p < 0.001). The study by Ewig et al found that the CRB-65 score accurately predicted death in the three class pattern.[51] The study by Chalmers

et al also found that the CRB-65 score had a good accuracy for predicting mortality in hospitalised patients with CAP.[52] In addition to this finding, the authors of that study also demonstrated that all the three severity of illness scores, namely the PSI, the CURB-65 and the CRB-65, had an equivalent 30-day mortality predictive accuracy (p= 0.09) for patients hospitalised with CAP.[52]

4.1.5.4. CRB-65 score and initial site of care for patients with CAP

No deaths were observed among the outpatients and all the deaths occurred among patients that were admitted to Helen Joseph Hospital. There were a total of five deaths observed of which all would potentially have been managed as in-hospital patients (with even two admissions, at least, to ICU) if the CRB-65 score had been the only criterion used as the standard for site of care decisions by the HJH ED doctors (Table 3.16). The ability of the CRB-65 score to accurately predict both the time to clinical stability for CAP hospitalised patients (Table 3.14) and the risk of deaths associated (Table 3.16) demonstrate that the CRB-65 severity of illness score performed well in its ability to determine the initial site of care for patients with CAP.

4.1.6. Potential limitations of this study

The study does have a few potential limitations. The study was undertaken at one site, in one area of the country and in a public hospital setting only. As such the findings may not be generalisable to other geographical areas of South Africa or to other settings, such as the private sector.

Furthermore, the ethnic origin of the patients, their socio-economic status or home circumstances, and their habits (e.g. excessive alcohol consumption, drug use, or

cigarette smoking) were not recorded or used for any analysis, and it is possible that these factors may have impacted on the findings.

4.1.7. Potential strengths of this study

The study does have a number of strengths. In the first instance it was a prospective study and therefore there was the opportunity to collect all the information that was required for the study analysis. The study was powered, with the help of a statistician, prior to being conducted, to ensure that a sufficient number of patients was recruited in order to allow accurate statistical analysis. This study is also the first study attempting to validate the CRB-65 score, or in fact any severity of illness scoring system for CAP patients in the South African environment.

4.2. Conclusion

The study shows that chest radiograph was the commonest criterion used by the Helen Joseph Hospital Emergency Department doctors to determine the need for admission of the patients with CAP, while the haemodynamic parameters were the commonest criteria used for discharge decision. The CRB-65 score was infrequently used in current practice by the Helen Joseph Hospital Emergency Department doctors for admitting or discharging CAP patients. This study demonstrates the ability of the CRB-65 severity of illness score to accurately predict both the time to clinical stability for patients hospitalised with CAP and the risk of death associated. In addition, this study demonstrates that the CRB-65 severity of illness score performed well in its ability to determine the initial site of care for patients with CAP at the Helen Joseph Hospital. Thus, this scoring system may be a valuable tool to consider in

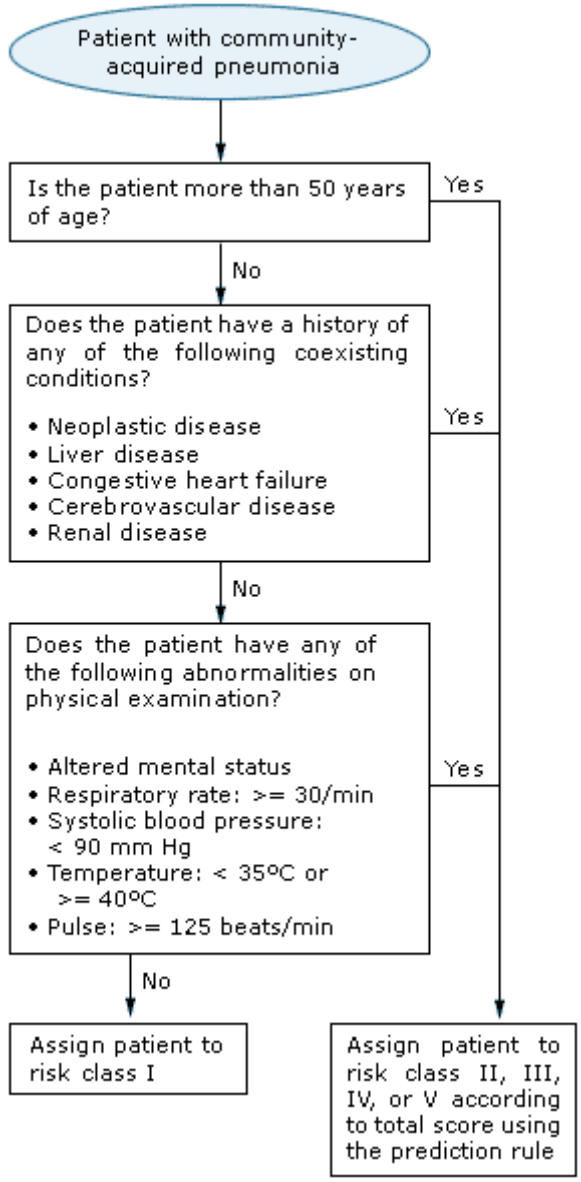
decision making regarding the initial site of care of patients with CAP presenting to an emergency department.

It remains important to remember that severity of illness assessment in CAP is an “Art of Medicine” decision. Severity of illness scores are useful to assist in the assessment of severity of illness, but they cannot be used alone for decisions regarding severity of illness or site of care. They need to be supplemented by the individual experience and/or expertise of the attending clinician. While many of the scoring systems have individual strengths they also have weaknesses and none of them take into account factors such as social circumstances, excessive use of alcohol, likely adherence to medication, presence of dementia, and various other factors that may impact negatively on the outcome of patients with CAP, irrespective of the potential severity of the infection.

4.3. Recommendations for further studies

It would seem, based on the current investigation, that further studies with the CRB-65 score would be useful, particularly in our setting in South Africa. For example, one may consider doing an interventional study, such as educating the ED staff about the CRB-65 severity of illness score and then instituting a program in which the CRB-65 score becomes part of the assessment of initial site of care for patients with CAP and evaluating its performance and potential benefits.

Appendix A: Pneumonia Severity Index[3]



Demographic factors

Age (in years)	
Men	
Women	-10
Nursing home resident	+10

Coexisting illnesses

Neoplastic disease	+30
Liver disease	+20
Congestive heart failure	+10
Cerebrovascular disease	+10
Renal disease	+10

Findings on physical examination

Altered mental status	+20
Respiratory rate ≥ 30/min	+20
SBP <90 mm Hg	+20
Temperature <35ºC or ≥ 40ºC	+15
Pulse ≥ 125 beats/min	+10

Laboratory and radiographic findings

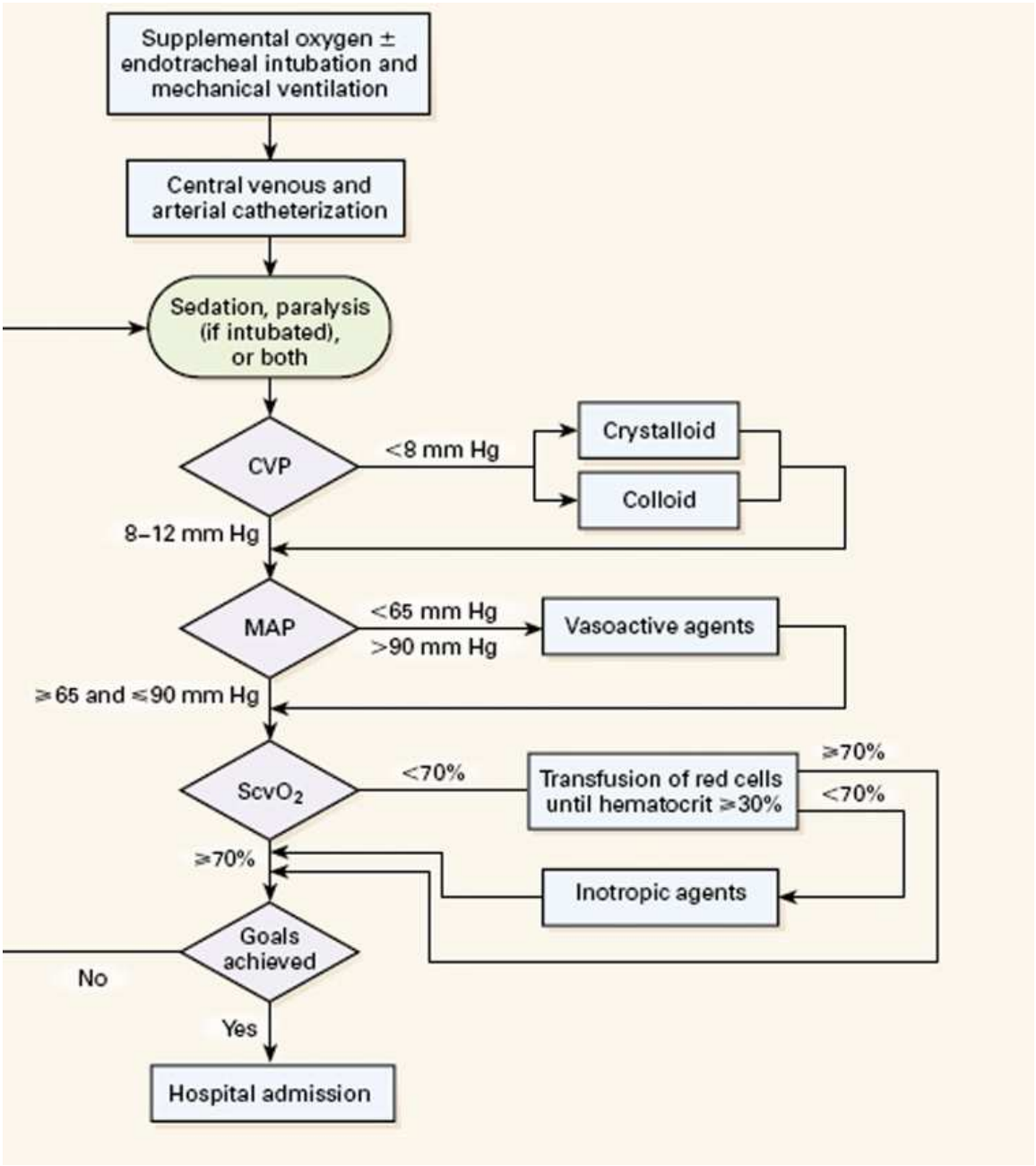
Arterial pH <7.35	+30
Urea ≥ 30/mg/dl (11 mmol/l)	+20
Sodium < 130 mmol/l	+20
Glucose ≥ 250 mg/dl (14 mmol/l)	+10
Hematocrit <30%	+10
PaO2 < 60 mm Hg or oxygen saturation < 90%	+10
Pleural effusion	+10

Stratification of risk score

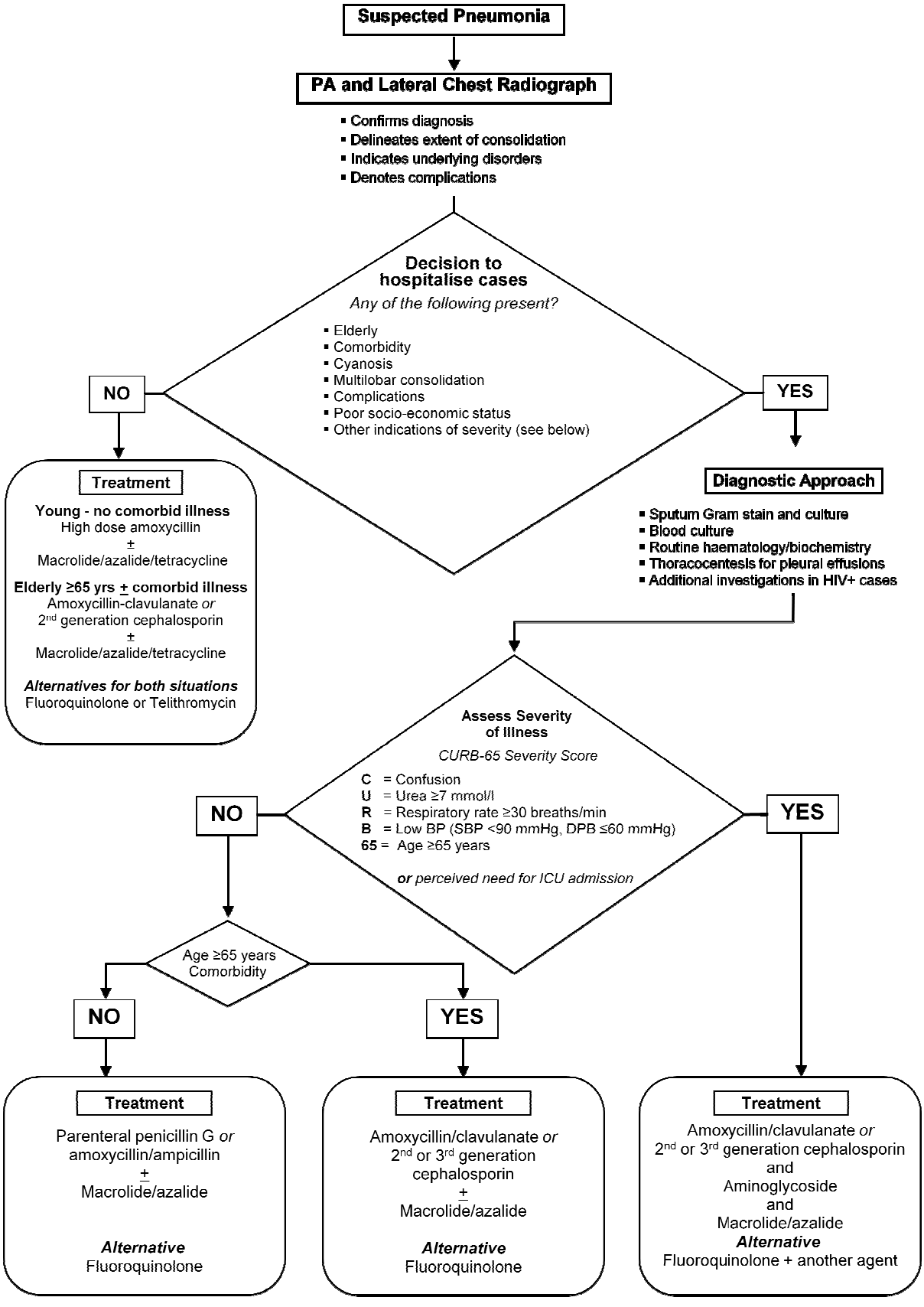
Risk	Risk Class	Score	Mortality	
Low	I	Based on algorithm	0.1%	Outpatient
Low	II	≤ 70	0.6%	treatment
Low	III	71-90	0.9%	
Moderate	IV	91-130	9.3%	Hospital
High	V	>130	27.0%	admission

* Interactive tool from the Assessment of the Variation and Outcomes of Pneumonia

Appendix B: Early Goal-Directed Therapy protocol for sepsis[28]



Appendix C: Algorithm for the management of CAP in adults in South Africa[9]



Appendix D: Recommended dosages of antibiotics for CAP[3]

<table>
<tr><th>Penicillins</th><th>Fluroquinolones</th></tr>
<tr><td>Oral
Amoxycillin: 1 g eight-hourly
Amoxycillin-clavulanate: minimum of 500 mg amoxicillin with 125 mg clavulanate eight-hourly. Sustained release preparations allow for 1 g 12-hourly dosing.
Parenteral
Penicillin G: 2-4 million units six-hourly
Ampicillin or Amoxycillin: 1-2 g six-hourly
Amoxycillin-clavulanate: 1,2 g eight-hourly</td><td>Oral
Gemifloxacin: 320 mg daily
Levofloxacin: 500 mg 12-hourly or 750 mg daily
Moxifloxacin: 400 mg daily

Parenteral
Levofloxacin: 500 mg 12-hourly or 750 mg daily
Moxifloxacin: 400 mg daily</td></tr>
<tr><th>Cephalosporins</th><th>Aminoglycosides</th></tr>
<tr><td>Oral
Second generation
Cefuroxime axetil: 750 mg – 1 gm 12-hourly
Cefpodoxime: 400 mg 12-hourly
Parenteral
Second generation
Cefuroxime: 1,5 g eight-hourly
Third generation
Ceftriaxone: 2 g daily (can increase to 2 g 12-hourly)
Cefotaxime: 3–4 g daily in two–four divided doses</td><td>Parenteral
Amikacin: 15 mg/kg/day (maximum 1,5 g daily)
gentamicin: 5–7 mg/kg/day (usual 320 mg daily)
Tobramycin: 5–7 mg/kg/day (usual 320 mg daily)</td></tr>
<tr><th>Macrolide/azalides</th><th>Tetracyclines</th></tr>
<tr><td>Oral
Erythromycin: 500 mg six-hourly
Clarithromycin: 500 mg 12-hourly
Clarithromycin XL: 1g daily
Azithromycin: 500 mg daily
Parenteral
Erythromycin: 4–5 mg/kg six-hourly given into a large vein
Clarithromycin: 500 mg 12-hourly
Azithromycin: 500 mg daily</td><td rowspan="3">Oral
Doxycycline: 200 mg stat followed by 100 mg 12-hourly</td></tr>
<tr><th>Ketolides</th></tr>
<tr><td>Oral
Telithromycin: 800 mg daily</td></tr>
</table>

Appendix E: Ethics clearance certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Dalton M Kabundji

CLEARANCE CERTIFICATE	**M10912**
PROJECT	The Use of CRB-65 Severity of Illness Score to Determine the Need fro Admission of Patients with Community-Acquired Pneumonia Presenting to An Emergency Department
INVESTIGATORS	Dr Dalton M Kabundji.
DEPARTMENT	Department of Medicine
DATE CONSIDERED	01/10/2010
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 15/11/2010 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Prof C Feldman

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix F: HJH ED doctor information sheet

Dear Staff

Good day! I am Doctor Kabundji Dalton – I am currently a student in the **MSc Med Emergency Medicine** at the Division of Emergency Medicine, Faculty of Heath Sciences, University of the Witwatersrand and I am doing a project for my research report.

This study is being conducted by me in partial fulfilment of the requirements for the MSc Med EM degree.

The aim of the study is to assess the severity of illness in patients with community-acquired pneumonia and for decisions regarding whether these patients need admission to hospital or could be safely discharged home.

I will also be determining what criteria are used by the Helen Joseph Hospital emergency department doctors for admitting or discharging community-acquired pneumonia patients.

I would like to invite you to help me with the study. Please would you call me when you have completed the evaluation of a patient with Community-Acquired Pneumonia? I will then proceed as follows:

- I will confirm that the patient fulfils the study's inclusion criteria by asking him/her questions about his/her conditions and details about his or her symptoms. I will also check his/her chest radiograph.

- Following this, I will ascertain from you on what basis you decided to either admit the patient to hospital or to discharge him/her home. All reasons given will be recorded.
- I will assess the severity of the patient‘s illness.
- In order to protect patient’s confidentiality, when recording details, patient will be given a unique patient identification number (PIN). The PIN will be known only to the researcher.
- I will follow the progress of the patient illness.
- Once I have collected all the data, I will analyse it to compare the outcomes of the patient based on the clinical decisions versus the severity score recommendations.

I will not record any of your details for this study.

Thanks

DM Kabundji

Date: CAP/CRB-65

Appendix G: Patient information sheet and consent form

Dear Sir/Madam

Good day! I am Doctor Kabundji Dalton – I am currently a student in the **MSc Med Emergency Medicine** at the Division of Emergency Medicine, Faculty of Heath Sciences, University of the Witwatersrand. I am inviting you to volunteer for a research study.

This study is being conducted by me in partial fulfilment of the requirements for the MSc Med EM degree.

The aim of the study is to determine the value of using the CRB-65 score in assessing the severity of illness in patients with pneumonia and for decisions regarding whether these patients need admission to hospital or could be safely discharged home.

The CRB-65 scoring system is a well-known scoring system used to assess patients with pneumonia. I will also be determining what criteria are used by the Helen Joseph Hospital emergency department doctors for admitting or discharging community-acquired pneumonia patients.

Please understand that your decision to participate in this research study is entirely voluntary and you are free to decline to join or withdraw your consent at any time, without consequence. If you agree I will proceed as follow:

- I will confirm that you fulfil the study's inclusion criteria by asking you questions about your condition and details about your symptoms. I will also check your chest x-ray.

- Following this, I will ascertain from my colleague (your doctor) on what basis they decided to either admit you to hospital or to discharge you home. All reasons given will be recorded.
- I will assess the severity of your illness using the CRB-65 score.
- In order to protect your confidentiality, when recording your details you will be given a unique patient identification number (PIN). The PIN will be known only to the researcher.
- I will follow the progress of your illness. If you are discharged home, would you please supply me with a contact number, which will be kept confidential, to contact you as to know how well you have done? If you are to be admitted to hospital, I will follow the course of your stay until you leave the hospital.
- Once I have collected all the data, I will analyse it to compare the CRB-65 severity of illness score and outcomes with the HJH ED doctors' criteria.
- I will need you to sign consent at the outset, and will retain a signed copy. Any personal information of yours that I collect during the course of this study will be kept strictly confidential.

I, (participant), fully understand the research study aim, that my participation is entirely voluntary and I may withdraw from the study at any time, without any consequences.

Patient's signature:

I, (the researcher), confirm that I have explained the research process to participant, and that I will adhere to the generally accepted ethical norms of research.

Researcher's signature: Witness's signature:

Date: / /2010.

PIN: _____ CAP/CRB-65

Appendix H: Family's information and consent form

Dear Sir/Madam

Good day! I am Doctor Kabundji Dalton – I am currently a student in the **MSc Med Emergency Medicine** at the Division of Emergency Medicine, Faculty of Heath Sciences, University of the Witwatersrand. I am inviting you to give permission for your relative to participate in a research study.

This study is being conducted by me in partial fulfilment of the requirements for the MSc Med EM degree.

The aim of the study is to determine the value of using the CRB-65 score in assessing the severity of illness in patients with pneumonia and for decisions regarding whether these patients need admission to hospital or could be safely discharged home.

The CRB-65 scoring system is a well-known scoring system used to assess patients with pneumonia. I will also be determining what criteria are used by the Helen Joseph Hospital emergency department doctors for admitting or discharging community-acquired pneumonia patients.

Please understand that the decision for you to allow your relative to participate in this research study is entirely voluntary and you are free to decline or to withdraw consent at any time, without consequences. If you agree I will proceed as follow:

- I will confirm that the case fits the study's inclusion criteria by asking questions about your relative's condition and details about symptoms and signs of his or her current illness. I will also check his or her chest x-ray.

- Following this, I will ascertain from my colleague (your relative's doctor) on what basis they decided to admit your relative to hospital or to discharge the patient home. All reasons given will be recorded.
- I will assess the severity of illness of your relative using the CRB-65 score. In order to protect the confidentiality of the patient, each patient will be given a unique patient identification number (PIN). The PIN will be known only to the researcher.
- I will follow the progress of the patients. If discharged home, with your permission I would please like to get a contact number, which will be kept confidential, in order to contact the patient in order to determine how well he or she did. For those admitted to hospital, I will follow the case until they leave the hospital.
- Once all the data is collected I will analyse it to compare the CRB-65 severity of illness score and outcomes with the HJH ED doctors' criteria.

I will need you to sign consent on his or her behalf at the outset, and will retain a signed copy. I will keep all personal information collected during the course of this study strictly confidential.

I (Family member), fully understand the research study aim, that my relative's participation is entirely voluntary and that I may withdraw my relative from the study at any time, without any consequences. I accept to sign this consent form on his or her behalf.

Patient's relative signature:

I, (the researcher), confirm that I have explained the research process to participant, and that I will adhere to the generally accepted ethical norms of research.

Researcher's signature: Witness's signature:

Date: / /2010.

Appendix I: Retrospective patient information and consent form

Dear Sir/Madam

Good day! I am Doctor Kabundji Dalton – I am currently a student in the **MSc Med Emergency Medicine** at the Division of Emergency Medicine, Faculty of Heath Sciences, University of the Witwatersrand.

I am doing a research study in partial fulfilment of the requirements for the MSc Med EM degree.

When you were very ill, with your relative's permission I included you in this study. I would now like to request your permission to include your information in my study.

The aim of the study is to determine the value of using the CRB-65 score in assessing the severity of illness in patients with pneumonia and for decisions regarding whether these patients need admission to hospital or could be safely discharged home.

The CRB-65 scoring system is a well-known scoring system used to assess patients with pneumonia. I will also be determining what criteria are used by the Helen Joseph Hospital emergency department doctors for admitting or discharging community-acquired pneumonia patients.

The procedures followed for this study are as follows:

- I confirm that the case fits the study's inclusion criteria and check the chest x-ray.
- I ascertain from my ED colleague doctor on what basis they decided to admit you to hospital. All reasons given are recorded.

- I then objectively assess the severity of illness using the CRB-65 score. In order to protect your confidentiality, I gave you a unique patient identification number (PIN). The PIN is known only to me.

Currently I would like to follow the progress of your illness until you are discharged from hospital. I will determine your length of your hospital/high-care/ICU stay, and the time it takes for your symptoms to stabilise.

Once the information from all the patients is collected I will then analyse the ability of the CRB-65 to accurately predict severity of illness and outcome.

If you agree, you will need to sign a consent form allowing me to continue collecting data from you and will retain a signed copy. I will keep all your information strictly confidential.

I (participant), fully understand the research study aim, that my participation is entirely voluntary and I may withdraw from the study at any time, without any consequences.

Patient's signature:

I, (the researcher), confirm that I have explained the research process to participant, and that I will adhere to the generally accepted ethical norms of research.

Researcher's signature: Witness's signature:

Date: / /2011.

Appendix J: Patient identification sheet

1. Surname and initials:
2. Sex:
3. Age:
4. Cell number or relative's cell number:
5. PIN:
6. Researcher:

Dalton Kabundji

Date: / /2011 Signature:

Appendix K: Study questionnaire and case report form

Question to ED doctor:

1. Where have you decided to treat the patient? (Tick if present)

Outpatient treatment	
Inpatient treatment	

2. On what basis have you decided to admit the patient to hospital or to discharge the patient home?

Reasons given *(*Tick if present)

1. Confusion
2. SBP < 90 or DBP ≤ 60 mmHg
3. RR ≥30/min
4. Blood urea >7mmol/l
5. CXR-confirmed pneumonia
6. Associated co-morbidity (specify)
7. Need for IV antibiotics
8. No need for IV antibiotics
9. Need for IV fluids
10. Presence of temperature ≥38^{0}C
11. Patient wasted
12. Patient unable to eat, drink or walk
13. Patient needs intubation and/or is mechanically ventilated
14. Patient need vasopressors support
15. Aged above 65 years
16. Aged below 65 years

17. Patient refused to be admitted

18. Poor socioeconomic status

19. Other reasons

Gender: M / F			Age:			
Date of evaluation						
	Day	Day	Day	Day	Day	Day
Altered breath sounds/consolidation						
Fever or hypothermia						
Rigors						
Sweats						
Cough						
Sputum production						
Pleuritic chest pain						
Cyanosis						
Shortness of breath						
Rapid respiratory rate						
Temperature						
Pulse rate						
Partial pressure of arterial O_2						
CRB-65						
Confusion						
Respiratory rate ≥ 30 breaths/min						
Blood pressure (SBP < 90 mmHg, DBP ≤ 60 mmHg)						
Age ≥ 65 years						
Total CRB-65 score						
Chest radiograph						
Confirmation of pneumonia						
Description						

Drawing of the CXR	
Patient Outcome	
Patient lived	
Patient died	
Date of death	
Medical ward management	
High care management	
ICU admission	
Date of discharge from hospital	
Outpatient management	
Date of resolution of symptoms/signs (time to clinical stability)	
Length of medical ward stay	
Length of ICU stay	
Date of patient step-down	
Length of hospitalisation prior to step-down	

Researcher' signature:

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