Abstract

TOTAL DIRECT COST OF MANAGING MAXILLOFACIAL TRAUMA AND RELATED INJURIES CAUSED BY MOTOR VEHICLE ACCIDENTS IN HOSPITAL UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN, KELANTAN

Mary Chok Chiew Fong

MSc Medical Statistics

Biostatistics and Research Methodology Unit

School of Medical Sciences, Universiti Sains Malaysia

Health Campus, 16150 Kelantan, Malaysia

Introduction: Maxillofacial trauma due to motor vehicle accidents had increased the clinical burden of health care institutions. Economic evaluation on the management of maxillofacial trauma had been studied in many countries. Information related to the factors associated with the cost of managing maxillofacial trauma is worth explored.

Objectives: The objectives of this study were to determine the total direct medical cost of managing maxillofacial trauma caused by motor vehicle accidents and the associated factors.

Patients and Methods: This was a cross-sectional study of 73 participants treated for maxillofacial trauma due to motor vehicle accidents at Hospital Universiti Sains Malaysia from 1st January 2010 to 31st December 2010. The outcome variable was total direct medical cost consisted of the sum of macro-cost and micro-cost. The association between total direct medical cost and study factors (socio-demographic factors, mode of injury and clinical characteristics) were analyzed using general linear regression. Box-Cox transformation was used to transform total direct medical cost in the regression analysis.

Results: The median total direct medical cost was RM5,899.51 and ranged from RM82 to RM1.5 million. The average cost per-person was RM58,398.20. The cost consisted 97.3 and 2.7 percent of macro-cost and micro-cost respectively. Factors significantly associated with the transformed total direct medical cost were the length of stay in hospital (regression coefficient 0.08, 95% confidence interval 0.03, 0.12; *P*=0.001), number of facial soft tissue injury (regression coefficient -1.08, 95% confidence interval -1.78, -0.38; *P*=0.003) and number of maxillofacial fracture (regression coefficient 1.64, 95% confidence interval 0.44, 2.84; *P*=0.008). Length of stay was found interacted with other significant factors. The cost associated with length of stay was different in each number of maxillofacial fracture and soft tissue injury.

Conclusion: In conclusion, length of stay in hospital, number of maxillofacial fracture and number of facial soft tissue injury were significantly associated with total direct medical cost of managing maxillofacial trauma caused by motor vehicle accident.

Dr. Aniza Abd. Aziz: Supervisor

Assoc. Prof. Dr. Norsa'adah Bachok: Co-Supervisor

Dr. Mohd. Ismail Ibrahim: Co-Supervisor

TOTAL DIRECT COST OF MANAGING MAXILLOFACIAL TRAUMA AND RELATED INJURIES CAUSED BY MOTOR VEHICLE ACCIDENTS IN HOSPITAL UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN, KELANTAN

MARY CHOK CHIEW FONG

UNIVERSITI SAINS MALAYSIA
2011

TOTAL DIRECT COST OF MANAGING MAXILLOFACIAL TRAUMA AND RELATED INJURIES CAUSED BY MOTOR VEHICLE ACCIDENTS IN HOSPITAL UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN, KELANTAN

by

MARY CHOK CHIEW FONG

Thesis submitted in partial fulfilment of the requirements for the degree of Master of Sciences (Medical Statistics)

UNIVERSITI SAINS MALAYSIA
March 2011

ACKNOWLEDGEMENTS

I forward my great gratitude to my beloved parents and family for the support given to me in pursuing my master degree course. I am also grateful to have Ministry of Health Malaysia sponsored my master degree course in Universiti Sains Malaysia (USM).

I would like to thank academic and clinical professionals and also personnel in USM and Hospital Universiti Sains Malaysia (HUSM) for the valuable consultation, guidance, advice, and assistance given to me during the course of this research project. List of acknowledgements is as follows;

1. Dr. Aniza Abd. Aziz, my supervisor whom continuously given me consultation, guidance and advice on various topics in this research and the thesis write-up.

2. Assoc. Prof. Dr. Norsa'adah Bachok, my co-supervisor whom had continuously guided me in the research and thesis write-up.

3. Dr. Mohd. Ismail Ibrahim, my co-supervisor in supervising and guiding me on the topic of health economy, cost analysis and thesis write-up.

4. Prof. Dr. Syed Hatim Noor, the co-ordinator of Biostatistics and Research Methodology Unit, whom I had consulted on the topic of general linear regression.

5. Dr. Wan Norlida Ibrahim whom I had consulted regarding the formula to calculate total direct medical cost and macro-cost.

6. Dato' Dr. Zaidun Kamari, HUSM Director, Dr. Nik Amin Ahmad, *Timbalan Pengarah Kanan* (*Klinikal*) and En. Wan Mohd. Suyuti Wan Ismail, *Timbalan Pengarah Kanan* (*Pentadbiran*) whom had approved the permission to collect data in HUSM.

7. Assistance from all the departments and units in HUSM also were appreciated. These departments and units are;

   i. Management Unit: Pn. Noor Hayati Mohammad (Head of unit), En. Mohd. Nur Hafiz Mohamad Alwi, Pn. Saudah Omar, Tuan Haji Mohd. Adnan C. Yusof and En. Mohd. Jimy Mat II
   ii. Finance Unit: Tuan Haji Syed Ahmad Kamil Syed Zakaria (Head of unit), Pn. Nur Azimah Ariffin and Pn. Zulaila Razali
   iii. Human Resoure Unit: Tuan Haji Anislan Yusof (Head of unit) and En. Mohd. Sabri Mohamad
   iv. Medical Record Unit: Pn. Zaini Mohd. Nor, Pn. Aminah @ Kamilah Beran, Pn. Salwani Mohd. Sapawi, Pn. Norslina Ibrahim and En. Alias Hj. Abas,
   v. Nursing Unit: Pn. Norhimah Mahmood (Head of unit), all nursing sisters and nurses
   vi. Medical Assistant and Attendant Unit: Dr. Mohammad Rosdi Abdul Rahman (Head of unit) and En. Abdullah Man

vii. Engineering and Maintenance Unit: En. Wan Mohd. Nasir Wan Mustapha (Head of unit), En. Mohamad Sazali Mansor, Pn. Rashidah Abdullah, En. Mat Hassan Ali, En. Che Sahari Che Abdullah, Pn. Tuan Kamsiah Raja Dollah, Pn. Nor Fadhilah Jaafar and En. Engku Nazli Engku Mohd. Ariffin

viii. Pharmacy Department: Tuan Haji Zainol Abidin Hamid (Head of department), Pn. Noryati Mohammad Nur and Cik Tarmawati Mohd. Razali

ix. Public Relationship Unit: En. Wan Azahar Wan Ahmad (Head of unit), and

x. All clinical disciplines and clinical supportive departments in HUSM.

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION

CHAPTER TWO: LITERATURE REVIEW

CHAPTER THREE: OBJECTIVES

CHAPTER FOUR: METHODOLOGY

CHAPTER FIVE: RESULTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ABC	Airway, breathing, circulation
A&E	Accident and emergency unit
ALOS	Average length of stay
AUD	Australian Dollar
bcTDMC	Box-Cox transformation of total direct medical cost (TDMC)
CBA	Cost-benefit analysis
CEA	Cost-effectiveness analysis
CI	Confidence interval
CUA	Cost-utility analysis
GCS	Glasgow Coma Scale
HUSM	Hospital Universiti Sains Malaysia
IQR	Inter-quartile range
ith	***i***th participant
LOS	Length of stay
LOS*MFF	Length of stay and number of maxillofacial fracture (interaction term)
LOS*STI	Length of stay and number of soft tissue injury (interaction term)
MFF	Number of maxillofacial fracture
MFT	Maxillofacial trauma
MVA	Motor vehicle accident
OMF	Oral and maxillofacial
OMFT	Oral and maxillofacial trauma
ORIF	Open reduction internal fixation
P-value	Probability value

RM	Malaysian Ringgit/Ringgit Malaysia
RTA	Road traffic accident
sd	Standard deviation
SD	Standard deviation
Stata/SE 11	Stata/SE 11 for Windows (StataCorp. LP)
STI	Number of soft tissue injury
STI*MFF	Number of soft tissue injury and number of maxillofacial fracture (interaction term)
TDMC	Total direct medical cost
USD	United States Dollar
USM	Universiti Sains Malaysia
VIF	Variance inflation factor

LIST OF SYMBOLS

α	Level of significance
β	Type II error
b	Regression coefficient
b_0	Constant
h	Leverage value
i	***i***th participant
K	Number of coefficient, includes constant
m^2	Metre square
n	Sample size
P	Probability value, P-value
r	Correlation coefficient
r^2	Coefficient of determination
W	Ward participant admitted
X	Independent variable
y	Dependent variable
Y	Dependent variable

JUMLAH KOS LANGSUNG PENGURUSAN KECEDERAAN MAKSILOFASIAL DAN YANG BERKAITAN AKIBAT KEMALANGAN KENDERAAN DI HOSPITAL UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN, KELANTAN

ABSTRAK

Kecederaan maksilofasial yang disebabkan oleh kemalangan kenderaan telah meningkatkan beban klinikal di institusi-institusi kesihatan. Penilaian ekonomi tentang pengurusan kecederaan maksilofasial telah dijalankan di banyak negara. Maklumat yang berkaitan dengan faktor yang mempengaruhi kos pengurusan kecederaan maksilofasial mempunyai nilai untuk diselidik. Objektif kajian ini adalah untuk menentukan jumlah kos perubatan langsung dalam pengurusan kecederaan maksilofasial yang disebabkan oleh kemalangan kenderaan dan faktor-faktor yang mempengaruhi kos ini. Kajian keratan lintang ini melibatkan 73 peserta yang mengalami kecederaan maksilofasial akibat kemalangan kenderaan yang dirawat di Hospital Universiti Sains Malaysia dari 1 Januari 2010 hingga 31 Disember 2010. Jumlah kos perubatan langsung merupakan pemboleh ubah hasil kajian yang terdiri daripada jumlah kos makro dan kos mikro. Perhubungan antara jumlah kos perubatan langsung dan faktor-faktor kajian (faktor sosio-demografi, keadaan dan mekanisme kecederaan dan ciri-ciri klinikal) dianalisis menggunakan regresi linear am. Transformasi *Box-Cox* digunakan untuk menukar jumlah kos perubatan langsung semasa analisis regresi tersebut. Median jumlah kos perubatan langsung ialah RM5,899.51 dan julat adalah antara RM82 hingga RM1.5 juta. Purata kos perseorangan ialah RM58,398.20. Kos tersebut terdiri daripada 97.3 peratus kos makro dan 2.7 peratus kos mikro. Faktor-faktor yang bererti secara statistik mempengaruhi jumlah kos perubatan langsung yang ditransformasi ialah jangka masa

menginap di hospital (pekali regresi 0.08, 95% selang keyakinan 0.03, 0.12; *P*=0.001), bilangan kecederaan tisu lembut muka (pekali regresi -1.08, 95% selang keyakinan -1.78, -0.38; *P*=0.003) dan bilangan tulang maksilofasial yang patah (pekali regresi 1.64, 95% selang keyakinan 0.44, 2.84; *P*=0.008). Jangka masa menginap turut didapati berinteraksi dengan faktor-faktor bererti yang lain. Kos berdasarkan jangka masa menginap adalah bergantung pada bilangan tulang maksilofasial yang patah dan bilangan kecederaan tisu lembut. Kesimpulannya, jangka masa menginap di hospital, bilangan tulang maksilofasial yang patah dan bilangan kecederaan tisu lembut muka mempunyai hubungan yang bererti dengan jumlah kos perubatan langsung dalam pengurusan kecederaan maksilofasial yang disebabkan oleh kemalangan kenderaan.

Kata kunci: kecederaan maksilofasial, kecederaan muka, kemalangan kenderaan, kemalangan jalan raya, kos pengurusan, analisis kos

ABSTRACT

Maxillofacial trauma due to motor vehicle accidents had increased the clinical burden of health care institutions. Economic evaluation on the management of maxillofacial trauma had been studied in many countries. Information related to the factors associated with the cost of managing maxillofacial trauma is worth explored. The objectives of this study were to determine the total direct medical cost of managing maxillofacial trauma caused by motor vehicle accidents and the associated factors. This was a cross-sectional study of 73 participants treated for maxillofacial trauma due to motor vehicle accidents at Hospital Universiti Sains Malaysia from 1st January 2010 to 31st December 2010. The outcome variable was total direct medical cost consisted of the sum of macro-cost and micro-cost. The association between total direct medical cost and study factors (socio-demographic factors, mode of injury and clinical characteristics) were analyzed using general linear regression. Box-Cox transformation was used to transform total direct medical cost in the regression analysis. The median total direct medical cost was RM5,899.51 and ranged from RM82 to RM1.5 million. The average cost per-person was RM58,398.20. The cost consisted 97.3 and 2.7 percent of macro-cost and micro-cost respectively. Factors significantly associated with the transformed total direct medical cost were the length of stay in hospital (regression coefficient 0.08, 95% confidence interval 0.03, 0.12; *P*=0.001), number of facial soft tissue injury (regression coefficient -1.08, 95% confidence interval -1.78, -0.38; *P*=0.003) and number of maxillofacial fracture (regression coefficient 1.64, 95% confidence interval 0.44, 2.84; *P*=0.008). Length of stay was found interacted with other significant factors. The cost associated with length of stay was different in each number of maxillofacial fracture and soft tissue

injury. In conclusion, length of stay in hospital, number of maxillofacial fracture and number of facial soft tissue injury were significantly associated with total direct medical cost of managing maxillofacial trauma caused by motor vehicle accident.

Keywords: maxillofacial trauma, facial trauma, motor vehicle accident, road traffic accident, cost of management, cost analysis

CHAPTER ONE

INTRODUCTION

1.1 Trauma

Trauma is a worldwide epidemic which had resulted an increase in clinical burden every year (Greaves *et al.*, 2009). Trauma and injury have been used interchangeably to describe the effect of harm on human body. The definite differences between these two terms are slight. Trauma refers to serious injury or shock to the body or any physical damage caused by violence or accident or fracture. It also describes a behavioural disorder resulted from mental or emotional stress or physical injury. Injury is defined as a damage or harm done to or suffered by a person. Fracture is a specific form of trauma which describes the breaking of a hard tissue in human body such as bone (Dorland, 2007).

1.1.1 Epidemiology of Trauma

The incidence of trauma is expected to escalate globally in the next few decades. About five million of people are killed due to trauma each year. This figure is equal to nine percent of total world population. In 2000, it was reported that 12 percent of the clinical burden of all diseases in the world was due to trauma (Peden *et al.*, 2002).

In Malaysia, motor vehicle accident (MVA) poses great threat to road users. In 2005 and 2006, MVA was the fourth major cause of death among the population (Department of Statistics, 2009a; Department of Statistics, 2009b). Although this

figure dropped by one rank in 2007 and 2008, it remained the second leading cause of death for male for the past four years (Department of Statistics, 2009c; Department of Statistics, 2010). Among all types of vehicles, 60 percent of death involved motorcycles (Radin Umar, 2006).

Studies on the incidence of trauma in Malaysia are limited. Death caused by MVA or transport accidents, which is one of the major causes of trauma in developing countries was ranked the fifth principal cause of medically certified death in Malaysia in 2008 (Department of Statistics, 2010). In the same year, it was also the third primary cause of death in Sarawak, a state in Malaysia. A prospective study that involved five tertiary referral government hospitals in Malaysia was conducted in 2006 to 2007 (Sabariah *et al.*, 2008). During the period of the study, 123,916 cases of trauma were reviewed. About 0.8 percent of the cases were major trauma and 84 percent were blunt injuries. Approximately 73 percent of the trauma cases were caused by road traffic accidents (RTA) or MVA.

1.1.2 Aetiology of Trauma

The nature of the occurrence of trauma can be divided into intentional or unintentional act of the victims (Greaves *et al.*, 2009). The common causes of intentional injury or trauma are violence attack or homicide, suicide, war and terrorism. Alcohol and illicit drugs used are significant factors aggravate the violence attack and suicide. In majority of the cases of trauma that occur unintentionally, MVA is one of the common causes. Other causes include poisoning, falls, domestic injuries, occupational injuries, fires, drowning and disaster.

In general, the aetiology of trauma varies according to demographic factors and country. In developing countries, majority of the hospitalized MFT cases were caused by MVA. In Iran, of 1,393 trauma patients studied by Motamedi *et al.* (2009), nearly 36 percent of cases were caused by traffic accidents. The patients were largely comprised of young male adults. A study done in Korea showed slip and fall were the primary cause of all cases of injury admitted to hospital among paediatric patients (Geol *et al.*, 2010). These findings suggest that causes of trauma are related to the behaviour and daily activities of the patients in most of the cases.

The most commonly encountered trauma are head trauma, maxillofacial, ophthalmic, spinal, abdominal and musculoskeletal injuries or trauma (Greaves *et al.*, 2009). The system or organ where the injury or trauma occurred largely depends on the mechanism of trauma. Therefore, the understanding of aetiology and mechanism of trauma and consequently the type of trauma is crucial in deciding the management of trauma.

1.2 Maxillofacial Trauma

Maxillofacial trauma (MFT) or oral and maxillofacial trauma (OMFT) refers to any injury to the face or jaw caused by physical force, foreign objects or burns (Dorland, 2007). MFT is simply known as facial trauma or injury. Among trauma patients, victims of MVA commonly suffered from MFT. Based on anatomy sites of injury, MFT is further sub-classified to mandibular trauma, maxillary trauma and other types of trauma. The most common MFT is mandibular trauma (Lee, 2008).

1.2.1 Epidemiology of Maxillofacial Trauma

The prevalence of MFT is varies in different countries. It was reported in between 5 to 33 percent (Down *et al.*, 1995; Goodisson *et al.*, 2004; Shahim *et al.*, 2006). In a study by Shahim *et al.* (2006) which had recruited 4,430 trauma patients, it was reported that 16 percent of the patients had MFT and 1,887 injuries occurred around the maxillofacial region.

Published articles reporting the incidence and prevalence of MFT in Malaysia are limited. Studies available are mainly focused on the pattern of MFT. An earlier study by Nor and Lian (1988) only showed that nearly 80 percent of facial fractures were caused by RTA. A retrospective study on geriatric population by Abdul Rahman *et al.* (2010) from 1998 to 2002 found 134 geriatric patients were diagnosed with maxillofacial and dental injuries in a secondary referral hospital. Among these geriatric patients, 35.7 percent and 34 percent were diagnosed with mandible fracture and fracture of the zygomatic complex respectively. Another study on paediatric population showed a total of 521 cases of MFT were reported in three hospitals in Malaysia from 1999 to 2001 and approximately half of the MFT reported were laceration wounds (Abdul Rahman *et al.*, 2007).

1.2.2 The Aetiology of Maxillofacial Trauma

In many developing countries, MVA is reported to be the leading cause of MFT. A study in Iran reported approximately half of the maxillofacial injuries from a total of

237 cases were caused by MVA in which 54 percent of the MVA involved cars (Motamedi, 2003). A higher rate of MVA related MFT were reported in Turkey (Ozkaya *et al.*, 2009) where 67 percent of the cases were caused by traffic accidents.

Other causes of MFT besides MVA are falls, animal attacks, assaults, gunshots, domestic violence, sport injuries, industrial accidents and war. MVA were the main cause of MFT in developed countries before assaults and fall emerged as significant aetiology. This was shown in many studies published in past decade. In Ontaria, Canada, a prospective study involving 2,969 patients from 1992 to 1997 found nearly 70 percent of MFT cases were the results of MVA (Hogg *et al.*, 2000). Assaults and falls are currently the most prominent aetiology in developed countries (Adi *et al.*, 1990; Hussain *et al.*, 1994; Tanaka *et al.*, 1994). This trend is increasing and becoming the leading cause of MFT.

An eleven years of prospective study in New Zealand by Lee (2008) showed that violence accounted for nearly half of the cases of face fractures. About half of 1,045 patients identified with mandibular fractures were due to interpersonal violence. This was followed by sports (16.4%), falls (12.8%) and MVA (9.8%).

MVA is still remained an important cause of MFT in many countries including developed countries. In Germany, Bormann *et al.* (2009) had carried out a retrospective study to review 444 patients with facial trauma at a university hospital between 2000 and 2005. From their finding, RTA remained the leading cause, comprising 32 percent of total cases. The second and third primary causes are fights (28%) and falls (26%).

In Malaysia, MVA is also the main cause of facial fractures (Royan *et al.*, 2008). Another study conducted in Penang, Malaysia, by Hashim and Iqbal (2011) reported that more than half of the 194 cases of MFT were caused by MVA that involved motorcycles. MVA was also the primary cause of MFT in children below 16 years old (Abdul Rahman *et al.*, 2007). Accident was the second important cause after falls in children below 4 years old. Most of the MFT were caused by MVA, as found by Nor and Lian (1988). The patterns of MFT caused by MVA differ by gender, age and mechanism of injury.

1.2.3 Diagnosis and Management of Maxillofacial Trauma

Although MVA is the main cause of MFT, however, MFT is not the only injury manifested in this group of patients. Multiple sites body system injuries are common and these are related to mechanism of injury. In the management of MFT, a thorough history taking of the accident, mechanism of injury and patient profile is required to ensure an effective treatment. An effective treatment is also determined by the type and severity of MFT. The definite diagnosis of MFT is concluded by oral and maxillofacial (OMF) specialists or trained doctors and in some of the cases also involve ophthalmologists if orbital bone fracture was suspected (Fonseca *et al.*, 2005).

The basics in managing MFT is to provide basic life support and prevent further injury (Wax, 2005; Ceallaigh *et al.*, 2006). As the region of injury or trauma involved head and neck, the principle of ABC is applied to support patient life. The A refers to airway, B is breathing and C is circulation. The airway of the patient is checked and

secured. Patients are made sure they can breath normally. Patients who have difficulty in breathing are given adequate ventilation. Following that, patients are examined for adequate circulation and whether or not they suffered any cervical spine fracture. When patient condition is stable, definite diagnosis and treatment are given. These include management of soft tissue injury and more invasive treatments.

Advance management of MFT involves multidisciplinary action. For example, ophthalmology expertise is needed in the treatment team when orbital bone fractures and eye injuries are involved. Definite management of OMFT is required when a more extensive injury or facial fracture occurred. Other than conservative oral and soft tissue treatment, surgical procedure is also important and common. The common surgical procedure is open reduction and fixation which is carried out under general anaesthesia (Fonseca *et al.*, 2005).

1.2.4 The Effects of Maxillofacial Trauma

MFT can cause significant facial function disabling. The unfavourable consequences of severe MFT are vision, hearing, olfaction, respiration, mastication and speech loss (Shahim *et al.*, 2006). The spectrum of severity of MFT is wide. It can be a minor injury such as laceration and abrasion to serious injury such as bone fracture, vision disturbances or loss, tooth loss or jaw dislocation. Multiple sites injury is also common. The severity and patterns of injury will determine treatment choices and cost.

Dental injuries are associated with many cases of MFT, especially in patients with mandible fractures (Lieger *et al.*, 2009). Results from this study emphasized the important of MVA as the most prominent cause of injury among these patients. The authors also reported that cyclists mainly suffered MFT with or with out dental injury.

1.3 Legislation Control and Intervention Programme

Differences in the causes of MFT in each country may be associated with social and cultural factors. The road safety programme and legislation enforced in developed countries to protect the safety of road users can be an important factor in preventing MVA. In New Zealand, a cohort study aimed at finding the effectiveness of two education programmes had proven that resilience-focused programme had significantly reduced 44 percent of car crash. Relative risk obtained was 0.56 and 95% confidence interval was 0.34 to 0.93 (Senserrick *et al.*, 2009). Another randomized controlled trial had evaluated the effect of school-based helmet promotion programme on the level of knowledge, attitude and practices on the participants across different school types. The findings from the study suggested that tailoring the road safety education programme to the need of special targeted group is an effective road safety programme. Such strategy may promise positive effect in reducing MVA (Germeni *et al.*, 2010). The role of traffic police in enforcing road safety laws was studied by Soori *et al.* (2009). The effect of four interventions was studied: three types of law enforcement and an educational programme. The results showed that there was a significant reduction in death rate caused by MVA in the intervention group.

Johnson *et al.* (1995) were interested in assessing the benefit of wearing helmet in reducing the incidence and severity of injury among patients involved in MVA. Helmeted motorcyclists were better protected and resulted in fewer facial trauma and craniofacial soft tissue injuries. However, another study found that the protection by helmet is limited and confined to head only (Tham *et al.*, 2004). Other than that, helmeted motorcyclists also suffered multiple sites injury, apart from head and face trauma. In Malaysia, a study by Ramli *et al.* (2008) also showed that wearing helmet minimises head and facial injuries. The effects of enforcing road safety laws was reviewed by Hyder *et al.* (2007). Conclusion from the review was that by enforcing mandatory helmet wearing laws, the benefit-cost ratio gained was 1.33. In addition to that, the seat belt installation and use also associated with positive benefit-cost ratio.

In Malaysia, the introduction of Motorcycle Safety Programme was found to be effective in reducing the MVA rate. Study that evaluate the effectiveness of this programme was conducted by Law *et al*. (2005). That study also found that economy recession was associated with the reduction of MVA rate. However, the definite explanation is yet to be investigated.

1.4 Economic Evaluation in Health Care Programme

Health economy is the application of economic knowledge in medical practices (Napper and Newland, 2010). The benefit of health economic study is to provide evidence for health care professionals in the decision making of choosing the effective treatments or health care programmes that have minimal economic burden to the patients and community. This is an important issue today and in future health care

management because the cost of health care service is escalating and resources are limited. Therefore, the incorporation of economic evaluation in the health care planning and management is essential in order to optimize the value of limited resources available in many developing countries.

There are three basic types of economic evaluation studies. The most common type is cost-effectiveness analysis, which is normally known as CEA. Other types of studies are cost-utility analysis (CUA) and cost-benefit analysis (CBA) (Drummond *et al.*, 2005; Napper and Newland, 2010). Cost analysis is a specific type of analysis which merely measures the cost of a health care service or procedure of interest. In cost analysis study, no measurement of the consequences gained by the patients is recorded. CEA compares the cost of two or more health care services to the benefit obtained from each service. The benefit can be measured and expressed in term of life-years gained, disability-days saved or any positive clinical observation. In CUA study, the outcome measured is healthy years gained by patients after receiving a treatment or management of known expenditures to the investigator. The clinical approach is studied and the effects are observed in CBA and both are measured in term of monetary unit.

There are two types of cost in economic assessment: direct and indirect cost. Direct costs are costs associated with the consumption of goods and services. In the process of determining direct cost, fixed costs, gross cost and micro-cost are taken. Fixed costs are costs that do not change but needed in the services (Muennig, 2007). For example, building cost and equipment cost are included in the fixed-cost. Gross cost is an aggregate cost needed in a health event. It is included in the bill charged on

patients. Micro-cost involves the calculation and sum of cost of every single item of known unit cost and quantity consumed by patients in the process of providing health care. Medications and laboratory tests are examples of this type of cost.

In determining the direct medical cost, macro-cost and micro-cost are calculated for every case observed. Macro-cost includes the calculation of fixed cost and some gross cost. The calculation of macro-cost required a wide range of data. These data are the total number of staff and salary, total number of visits and admission to the hospital and ward, equipment cost, building cost and operational cost. Consumables and surgical products for operating daily health care services are included in operational cost. Micro-cost is the sum of cost of various components related to health event and are with known quantity (Muennig, 2007).

In cost analysis study, there are costs that can not be quantified directly. Indirect costs refer to the costs other than the consumption of goods and services required in delivering health care services. One example is the lost of productivity of the patient suffered from the disease due to absenteeism from work or school day. Intangible costs are costs of events which are difficult to be transformed to monetary unit. Cost of pain or emotional stress is an example of this cost.

1.5 Rationale of the Study

MFT is a common health problem in Malaysia. The clinical burden in managing MFT is inevitable in health care institution, especially in emergency department. MFT due

to MVA can cause tremendous unwanted consequences to the individual involved, either physically, emotionally or economically.

Many studies on MFT were designed to investigate the epidemiology, aetiology and types of facial injury associated with MFT (Hussaini *et al.*, 2007). A few studies on the financial aspect of several modalities of treatment of MFT were available (Dodson and Pfeffle, 1995; Schmidt *et al.*, 2000; David *et al.*, 2003; Erdmann *et al.*, 2008). However, research aimed at finding the association between cost of management and MFT are limited.

Apart from that, factors other than type of treatment which may possibly be associated with the cost of management are also worth explored. There are other factors related to the cost of management such as length of hospitalization, complications, type of injury, type of procedure and demographic factors. This study intended to evaluate factors which may influence the economic aspect on health care service in managing patients suffered MFT caused by MVA. Results from this study may generate an idea on the amount of economic burden of MFT in local health care institution. Consequently, the findings obtained might be relevant to authority is on the incidence of MVA and anticipation of increase health care expenditure, where applicable. Education programmes tailored to the need of specific group of population can be considered in the effort to overcome the high rate of MVA.

CHAPTER TWO

LITERATURE REVIEW

2.4 Economic Evaluation of Maxillofacial Trauma Management

MFT which is associated with MVA had resulted in significant impact on the clinical burden of public health services in many countries. Many studies on the economic impact of MFT management had been conducted. Few studies have investigated the cost needed to treat MFT regardless of aetiology causing the trauma. The cost of treatment in managing MFT patients was studied mostly in developed countries. These researches were done following the tremendous increase of cost of health care from year to year. Most of the studies were aimed at finding the association of possible factors with the cost of treatment. Pieces of information obtained were used planning on the management of health care resources.

Costs in treating isolated MFT and combined MFT with other injuries were summarized by Moncrieff *et al.* (2004). Demographic data such as mean age, gender, mean length of stay, number of days admitted to intensive care unit, injury severity score and mechanism of injury were recorded. For better assessment of total hospital cost, all related costs were included in the analysis. This information included salary of medical officers and nurses' salary, visiting medical officer expenses, other nonmedical staff salary, costs of emergency room, pathology, medications, imaging services, depreciation, prostheses and operating room cost. However, there was no statistical analysis applied in comparing the significant differences between costs of treatment.

Research targeting hospitalized patients with mandibular fractures was carried out by Abubaker *et al.* (1998). The total number of patients recruited was 97. The objective of the study was to assess the trend in changes in costs, charges and hospital income between 1991 and 1993. Patient insurance status, reimbursement, total revenue and income loss which contributed to total income were included in the study. Age, gender and cause of fractures were taken as study factors. The study concluded that costs and charges on hospitalized patients had increased between the years of study, however, hospital income was in the opposite direction.

A few attempts were made to explore the cost of treatment of trauma caused by MVA. Juillard *et al.* (2010) tried to evaluate the direct cost in treating MVA cases. Costs of formal and traditional treatment were compared. Formal treatment which included hospital and private physicians was USD35.64. Traditional treatment consumed lower cost, which was USD6.65. In another study, costs of treatment were compared between groups of patients involved in MVA, some requiring extrication from vehicle (Siegel *et al.*, 1993). Patients who required extrication from vehicle consumed higher operating room cost, critical care cost and total cost of treatment.

2.5 Factors Associated with Cost of Managing Maxillofacial Trauma

i. Severity of Maxillofacial Trauma

The severity of MFT is highly associated with the cost of treatment. It is hypothesized that severity score is also associated with mechanism of trauma. The aetiology of MFT served as an important factor affecting the severity of

injuries (Adi *et al.*, 1990). Therefore, aetiology of MFT is associated with type of treatment which consequently may affect the cost of treatment. Conservative treatment was needed for mild injury caused by falls. Definite treatment, involving surgical and dental disciplines, was required to manage cases of MFT arising from MVA and interpersonal violence (Lee, 2008). Apart from the type of treatment, causes of MFT also affected the length of hospital stay. Therefore, the association of aetiology of MFT and cost of treatment is an interesting scope of study. As this study only focused on patients involved in MVA, aetiology as a factor was not analyzed.

ii. Type of Fracture

A retrospective study was designed by David *et al*. (2003) to evaluate the cost-effectiveness of treating isolated mandible fracture, a specific type of MFT, in order to reduce hospital resources. Study factors considered were age, gender, length of hospital stay, mechanism of injury, surgical procedure, charges and follow up. Total charges on the patients included; operating room hours, materials consumed in the operation and hospital charges. Cost-effectiveness was compared between patients admitted and awaiting surgical procedure from emergency department and patients given elective surgical procedure after discharged from emergency department. When the three contributors to total charges were analysed separately, only differences of hospital charges between groups was found significant. Therefore, David *et al.* (2003) suggested it was more cost effective treating patients with isolated mandible trauma who were clinically stable by giving scheduled surgical procedure after assessment at emergency department and discharged thereafter.

Sanger *et al.* (2004) conducted a study which was similar to David *et al.* (2003). In addition to isolated mandible fractures, Sanger *et al.* (2004) had recruited patients with isolated midface fractures. Additional inclusion criteria were clinically stable patients, no concomitant injuries and patients recruited had complete documentation of any postoperative follow up information. The same results were obtained where there were no significant differences between study groups with regards to cost charged on operative time and materials. The difference in hospital charges was significant.

iii. Type of Procedure

Site of injury is highly related to treatment decision and therefore could have influence the cost of managing MFT. In the study by Bormann *et al.* (2009), open reduction treatment where intraoral or extraoral approach was mostly used, was found in 83 percent of all fractures. The second most common treatment was closed reduction. In cases where osteosynthesis were done the need for plates or screws increase the cost of management.

Another study by Motamedi (2003) showed that choices of treatment were different by sites of injury. Closed reduction methods were used in nearly 57 percent of mandibular fractures, followed by open reduction and observation treatment. In treating maxillary fractures, nearly half of the cases were treated using closed reduction. Open reduction was used in 65 percent of zygomatico-orbital fractures, whereas only 26 percent of the same fractures used closed reduction.

A large number of the studies were designed to compare the cost-effectiveness of several mode of treatment of facial trauma. Dodson and Pfeffle (1995) had compared cost-effectiveness between open reduction/nonrigid fixation and open reduction/rigid fixation in managing mandibular fractures. Dodson and Pfeffle (1995) had selectively recruited 34 patients, who had single mandibular fractures and received open reduction/rigid fixation, the mandibular fractures were limited to angle or posterior body or postoperative complications after open reduction/rigid fixation required hospital admission. In the same study, cases selected were limited to those which were recorded completely, either the completeness of billing information or medical treatment. Results shown that rigid fixation was more cost effective compared to non-rigid fixation method.

Comparison of cost-effectiveness between closed reduction with maxillo-mandibular fixation and open reduction and rigid internal fixation in treating mandibular fracture was conducted by Schmidt *et al.* (2000). Charges included were operation fees and hospitalization charges. Variables considered were length of stay, operation time and duration of anaesthesia. Total charge and charge for primary treatment was significantly lower in patients who underwent closed reduction with maxillo-mandibular fixation. However, the differences were not statistically significant in the charges for treating complication.

iv. Type of Vehicle

In the cases of MFT caused by MVA, types of vehicle could have different impact on the severity of face injury. In addition, types of vehicle could have resulted different mechanism and pattern of injury. All these factors can affect the cost of managing MFT that is to be investigated. Cars and motorcycles are owned by most Malaysian. The riders of these vehicles are subjected to comply with road safety legislation to protect them from injury when MVA occurs. Bicycle is another important mode of transport but is least protected and exposed to the utmost dangers. This aspect requires attention by the public and authority as most cyclists on the road are school children and they are the most vulnerable group.

The number of cyclists in Malaysia may be small but the danger on the road is inevitable. It was estimated that only 7.3 percent of New Zealanders preferred cycling as daily mode of transportation and more for recreation and exercise purposes. However, 16 percent of the cyclists had involved in road bicycle accidents (Lee and Chou, 2008). Nearly half of the bicycle-related MFT cases were isolated midface fractures. Other fractures were mandibular fractures and multiple sites fractures. Types of treatment of these patients were different and many required hospital admission. Therefore, mechanism of injury for patient with MFT may be related to the cost of trauma management.

v. Safety Device

In the occurrence of MVA, midface and mandible are vulnerable to injures. The severity of MFT can be reduced to minimal level by wearing safety

helmet for motorcyclist or bicycle rider or prevented by the activation of air bag inflation. Restrain used by car drivers and passengers or motorcyclists and pillions is hypothesized to prevent MFT or able to reduce the severity of injury resulted when collisions occurred. The results from Hogg *et al.* (2000) suggested patients whom had fastened seat belt able to reduce incident of MFT and had fewer concomitant body injury. As head injury was less severe, that study also shown patients not fastening seat belt had higher injury severity score. Consequently, this factor could have associated with cost of treatment.

vi. Sites of Injury

The manifestation of MFT is varied by site of injury. Bormann *et al.* (2009) showed 42 percent of mandibular fractures occurred at condyle area. Other commonly fractures areas are symphysis or parasymphysis (21%), angle (20%) and horizontal ramus (15%). A few studies on the pattern of MFT caused by motorcycle related MVA were conducted. The patterns of injury observed among this specific group of patients were differed between motorcyclists, pillions and pedestrians. Motorcyclists suffered injuries more on lower and middle third of faces compared to pillions or pedestrians (Oginni *et al.*, 2006). Choices of treatment in MFT also were determined by sites of injury (Motamedi, 2003). Therefore, sites of injury may associate with the cost of managing MFT.

vii. Demographic Characteristics

There are limited literature that reported the association between demographic characteristics and cost. However, due to various presentation of MFT caused

by MVA, demographic characteristics could possibly have affected the outcome of management and subsequently the cost of management in this group of patients.

The distribution of age among patients suffered MFT is an interesting aspect of study. Teenagers and young adults were commonly presented with MFT at accident and emergency department compared to other age group. Study by Lee (2008) presented 63 percent of all patients who experienced MFT were aged 16 to 30 years old. The second largest age group was 31 to 45 years old. In all age groups except patients above 60 years old, number of men suffered MFT was reported several fold higher than women.

A similar trend of age distribution also found in the study by Bormann *et al.* (2009). The age group of 16 to 25 years old comprised 32 percent of total patients, while 23 percent of patients were aged between 26 and 35 years old. A larger group of patients severely injured was investigated by Hogg *et al.* (2000), from 1992 to 1997 in Ontario, Canada. The similar trend of age distribution were found and remained until present. Ozkaya *et al.* (2009) also concluded that most patients age fell in the third decade of life.

In many studies, male had higher profile than female in cases of MFT caused by MVA. Lee (2008) had showed approximately 84 percent of male patients suffered MFT, which was five times the number of female patients regardless of age. The results from Hogg *et al.* (2000) study showed men were three times more than women had MFT and more patients fell in age group between

25 to 34 years old. In Malaysia, a study which only focused on motorcycle related MVA had number of male patients 15 times more than female (Ramli *et al.*, 2008). By considering the significant differences in age group and gender among MFT patients, the treatment of MFT may distinguish between these groups of patients and probably associated with cost of managing MFT.

2.6 Conceptual Framework

Cases selected for this study were MFT caused by MVA. The outcome of the study was total direct medical cost (TDMC) involved in the management of these cases. TDMC was the sum of macro-cost and micro-cost. The TDMC was calculated in Malaysian Ringgit (RM). Three main factors that were hypothesized associated with TDMC were socio-demographic factors, mode of injury and clinical characteristics of the participants. Socio-demographic factors included age, gender, ethnicity, marital status, education level of participants, occupation and monthly income. Mode of injury studied were type of vehicle used by participant, position of participant at the time of accident, mechanism of accident and safety device. Clinical characteristics considered in this study were level of consciousness, length of stay, number of soft tissue injury, number of maxillofacial fracture, the presence of bacterial infection, operation, open reduction internal fixation procedure, complications and co-morbidity. Severity of trauma was not included in the study. Conceptual framework of the study is presented in Figure 2.1.

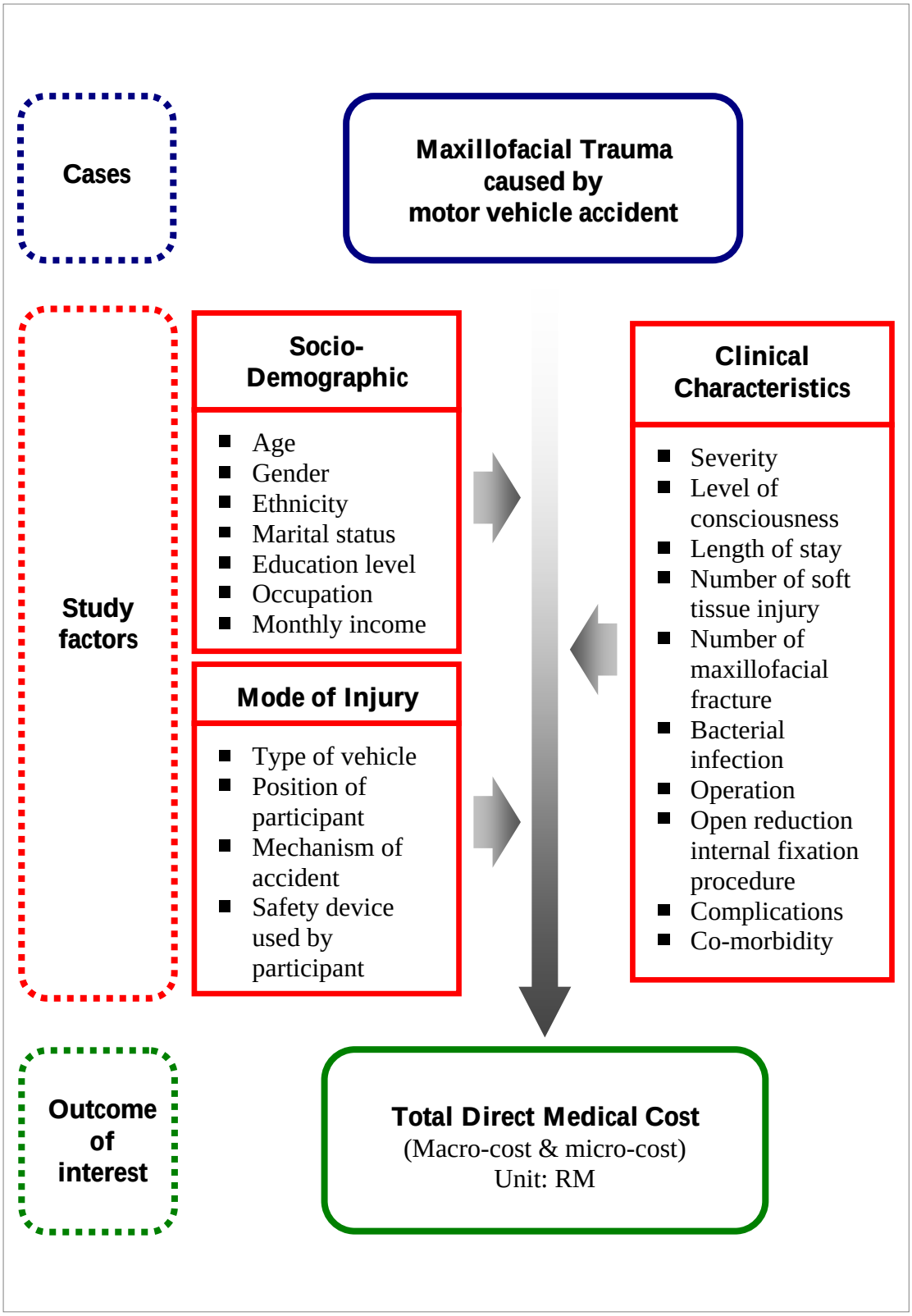

Figure 2.1: Conceptual framework of the study (Severity was not included in the study)

CHAPTER THREE

OBJECTIVES

3.1 General Objective

To evaluate the total direct cost of managing maxillofacial trauma and related injuries caused by motor vehicle accidents and factors associated with the cost in Hospital Universiti Sains Malaysia

3.2 Specific Objectives

i. To determine the cost of managing maxillofacial trauma and related injuries caused by motor vehicle accidents (total direct medical cost, macro-cost and micro-cost)

ii. To identify the factors associated with the total direct medical cost of managing maxillofacial trauma (MFT) and related injuries caused by motor vehicle accidents in Hospital Universiti Sains Malaysia

3.3 Research Questions

i. What is the cost of managing maxillofacial trauma and related injuries caused by motor vehicle accidents at Hospital Universiti Sains Malaysia?

ii. What are the factors associated with the total direct medical cost of managing maxillofacial trauma and related injuries caused by motor vehicle accidents in Hospital Universiti Sains Malaysia?

3.4 Hypothesis

The total direct cost of managing maxillofacial trauma and related injuries caused by motor vehicle accidents is associated with age, gender, ethnicity, marital status, education level, occupation, monthly income, level of consciousness, length of stay in hospital, number of soft tissue injury, number of maxillofacial fracture, bacterial infection, operation, open reduction internal fixation procedure, complications, co-morbidity, type of vehicle, position of participant, mechanism of accident and safety device used by participant.