Review paper

Epidemiology of traumatic maxillofacial injuries in Queensland, Australia

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Abstract

Maxillofacial injury, also called facial trauma, is a major public health problem, representing a group of injuries in which there is an external force that traumatically injures the face. They comprise hard tissue as well as soft tissue injuries that exhibit different patterns of clinical features based on the severity and mechanism of the trauma. Traumatic maxillofacial injuries not only are a leading cause of morbidity and mortality in Queensland, Australia, but also have negative effects on quality of life, functional status, and social functioning. Further, they have a range of economic impacts, including on health care costs, employability, productivity, and insurability. Thus, control, minimization, and prevention of traumatic maxillofacial injuries have immediate health effectiveness, and considerable economic benefits.

Key words: maxillofacial injuries, facial trauma, epidemiology and facial trauma, epidemiology and maxillofacial injuries.

The purpose of the literature review

The aim of this literature review is to analyze the prevalence, severity, pattern, incidence, and influencing factors (risk factors) of maxillofacial injuries in Queensland (QLD), Australia, and, in addition, to assess and to evaluate the prevalence and the epidemiological pattern of traumatic maxillofacial injuries, not only in prevention strategies of maxillofacial injuries, but also in decision making for patient care, development of optimal treatment regimens, and appropriate resources allocation (both the management and the outcome) in Queensland, Australia.

This literature review involved searching online databases and electronic resources, including PubMed, central PubMed (PMC), Medline, Health Reference Center Academic, and Academic Search Premier. No date limits were applied to the articles included in the review.

The key words used to research the subject were: Maxillofacial injuries, Facial trauma, Epidemiology and facial trauma, Epidemiology and maxillofacial injuries

Introduction

Maxillofacial injury, or facial trauma, is any external physical trauma to the face, which constitutes a substantial proportion of cases of trauma [1]. Further, maxillofacial injuries are a common presentation to every general practice and every hospital emergency department in Queensland, Australia.

They occur as isolated injuries or in combination with other severe injuries including cranial, spinal, brain, and upper and lower body injuries depending on the etiology and severity of the injuries [2].

Injuries to the maxillofacial region may be particularly disabling because it is the region of specialized functions such as vision, hearing, olfaction, respiration, mastication and speech [3]. In addition, important vascular and neural structures which are closely associated are present in this region and might be affected by maxillofacial injuries. For example, damage to the central nervous system may occur and injuries in this region can result in serious dysfunction and might cause disability [3]. Also, the psychological impact of disfigurement or even scars in the face after recovery may also add to the level of resulting morbidity [4].

Moreover, severe maxillofacial trauma can expose patients to life-threatening complications such as airway obstruction and hemorrhagic shock or intracranial and brain injuries [5].

Most patients with such injuries need hospitalization, possible emergency interventions by immediate investigations together with a proper observation, as well as resources for treatment, and a follow-up schedule [6].

Thus, early assessment and intervention can significantly reduce morbidity and mortality of traumatic maxillofacial injuries and avoid complex reconstruction as well [7].

Signs and symptoms of traumatic maxillofacial injuries

Maxillofacial injuries, like other injuries, may be associated with pain, bruises, abrasion, avulsion, lacerations, and swelling of the surrounding tissues (such symptoms can occur with and without bones futures), as well as bones fractures.

In addition, dental and dent-alveolar injuries might occur such as tooth fracture or sunken teeth which do not align properly, and tooth avulsion that may need to be treated urgently in many cases [8].

Fractures of the nose, base of the skull, or maxilla may be associated with profuse nosebleeds and nasal fractures may be associated with deformity of the nose, as well as swelling and bruising [9].

Deformity in the face, for example a sunken cheekbone, suggests the presence of fractures. In addition, asymmetry of the face can suggest facial fractures or damage to nerves depending on the type and severity of injury [10].

Further, a patient with a black eye may have an underlying fracture; therefore a computed tomography scan (CT scan) should be recommended for every patient with minor facial injury who presents with a black eye [11].

People with mandibular fractures often have pain and difficulty or limitation of their mouths opening, and may have numbness in the lip and chin [12].

The severity of traumatic maxillofacial injuries

Many trauma registries have used the Abbreviated Injury Scale (AIS) to measure the severity of injuries of a trauma patient with a numeric method for ranking anatomy-based specific injuries. The AIS assesses the severity of the anatomical injury on a six-point scale (from 1 to 6) as follows [13]:

1. Minor injuries are clinically superficial skin lacerations, abrasions, dental and dent-alveolar injuries, and bruises but no other neurological signs.
2. Moderate injuries are major abrasions or lacerations, and bone fractures (single fracture).
3. Serious injuries are with nerve lacerations or multiple bones fractures. They necessitate other investigations such as magnetic resonance imaging (MRI), X-ray, and CT.
4. Severe or major injuries are dangerous with probability of survival.
5. Critical injuries are with extensive/deep laceration to organs such as the brain with low probability of survival.
6. Unsurvivable injuries are without possibility of survival (untreatable).

The AIS scores are created according to many dimensions of the injury, including impacted energy, extent of damage, threat to life, permanent impairment, and period of management. The mortality of a given AIS value is assumed to be similar across all body regions. Additionally, the Abbreviated Injury Scale (AIS) served as a fundamental base of many severity scoring systems, for example, the Injury Severity Score (ISS) and the New Injury Severity Score (NISS) [13].

The mechanism of maxillofacial injuries is the most influential factor in the severity of injuries that result from trauma. In general, traffic accidents are associated with more severe injuries than other causes, because the large amounts of energy transferred from all stages of a crash, from an object to the vehicle, from the vehicle to the body, and finally from organs and vessels colliding within the body itself, can result in multiple severe injuries [14].

More importantly, the Injury Severity Score is a predictor of intensive care unit (ICU) admission and hospital length of stay (LOS) among patients with maxillofacial injuries [15].

Patterns of maxillofacial injuries

To categorize patients by patterns of maxillofacial injuries, the facial skeleton is divided into

4 facial subunits: frontal unit, upper mid-face unit, lower mid-face unit, and mandible [16] (Figure 1):

- Fractures of the frontal sinus and orbital roof are included in the "frontal" category or unit.
- Lateral orbital wall fracture, medial orbital wall fracture, orbital floor fracture, nasal fracture, naso-ethmoid orbital fracture, and zygomatic arch fracture are included in the "upper mid-face" category.
- Maxillary sinus fracture, bony palatal fracture, and pterygofacial (Le Fort I) fracture are counted in the "lower mid-face" category.
- Zygomatico-maxillary complex (ZMC) fractures and pterygofacial (Le Fort) II and III fractures are counted as fractures of both the upper and lower mid-face.
- All mandible fractures are counted in the "mandible" unit [16].

The pattern of maxillofacial injuries depends on the mechanism and severity of injuries. A retrospective study of all patients presenting to Cairns Base Hospital with maxillofacial injuries over a 3-year period was performed [17]. The result was that assaults (74%) were the principal cause. The second most common mechanism was sporting injuries (17%), followed by motor vehicle accidents (5%) and falls (4%), with different maxillofacial injuries patterns and severity.

The zygomatic complex bone (34%) was the most frequent fracture site, followed by frontal bone fracture, nasal bone fracture, and mandible fractures (body and angle) with 8% (18) (Figure 2).

A clearer understanding of the demographic patterns of maxillofacial injuries can aid in establishing clinical and research priorities for effective treatment and prevention or reduction of these injuries. In addition, they will assist health care providers as they plan and manage the treatment of traumatic maxillofacial injuries. Furthermore, such epidemiological information can also be used to guide the future funding of public health programs geared toward prevention or control the incidence and severity of maxillofacial injuries (Figure 3) [16, 18].

Figure 1. Facial fractures

Incidence of maxillofacial injuries

Incidence: the term is commonly used to describe the actual number of new cases and as a synonym for both the incidence rate and cumulative incidence [19].

The incidence of maxillofacial injuries varies from one country to another [20].

Unfortunately, the incidence of maxillofacial trauma is increasing at an alarming rate in Australia [2]. Maxillofacial trauma presentations in 2011 at the Royal Brisbane Hospital (Queensland) have risen 28% in the same 10-month period compared to 2010 [2, 21]. Despite a decrease in the incidence of facial trauma from motor vehicle accidents due to safety improvements such as airbags and seat belts, injuries due to inter-personal violence continue to rise [22].

They are many factors affecting the incidence and the outcome of traumatic maxillofacial injuries. Consequently, an understanding of such factors can assist in establishing clinical and research priorities for effective treatment of these injuries. Also, such factors can help to guide the development of new methods of injury prevention, and preventative measures [22].

Injury risk factors

Age factor

It all depends on the population under study, with regard to type, severity, and the cause of inju-

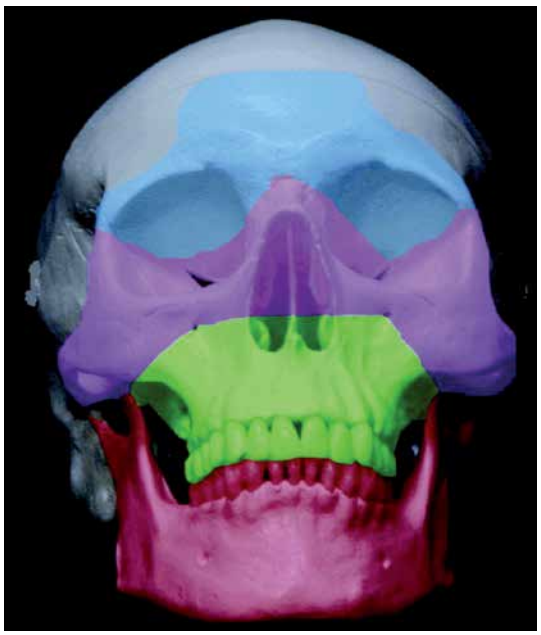

Figure 2. The 4 facial subunits: frontal unit (blue), upper midface unit (magenta), lower midface unit (green), and mandible (red)

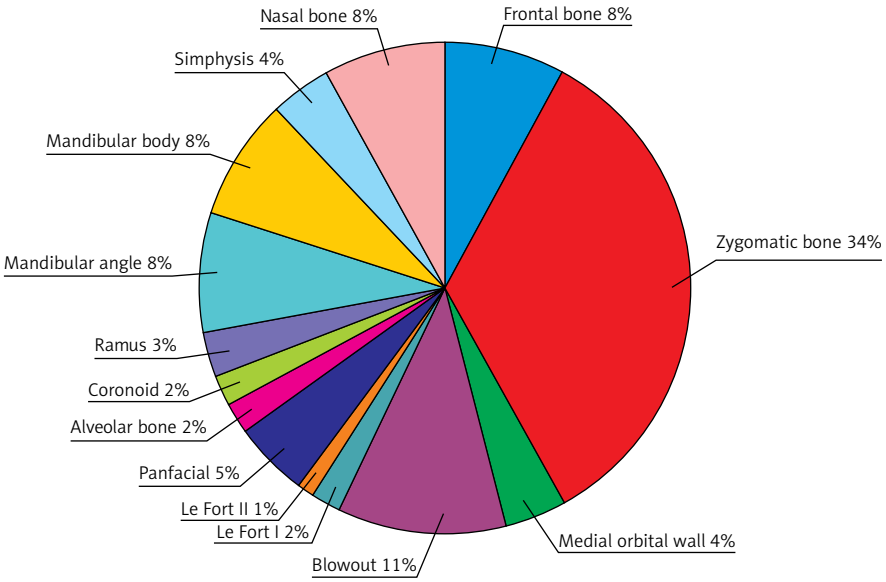

Figure 3. Pattern of maxillofacial fractures

ry [4]. However, and because of the increasing elderly population of developed countries including Australia, more maxillofacial injuries occur in this population than before due to falls [23, 24]. This fact has important implications, because there are considerable differences in the response to trauma between the old and the young populations [22].

The prevalence of preexisting diseases in the elderly individuals, change in cardiovascular homeostasis, and reduction in lung complying, all contribute to an increase in morbidity and mortality in patients who already have limited physiological reserves [25].

Additionally, in the population aged 65 years and over, 30% are visually impaired, and there is an association between falling and visual impairment in individuals over 75 years old [26]. The possibility of falling dramatically increases each year from about 20% of women aged 45–49 years to almost 50% of women 85 years and older [22].

The frequency of fracture increases with age in both sexes, after low or moderate trauma, reflecting a combination of lower bone density and bone osteoporosis and the increased tendency to fall in the elderly [27]. Further, due to the chronic medical conditions and medication interactions (the use of antiplatelet and anticoagulant medications) in older patients, even a minor collision results in a higher incidence of intracranial hemorrhage [28]. Most falls occur when elderly people are performing their usual daily activities such as rising from a chair or ambulating.

Thus, the management of the elderly trauma patient can present some unique challenges [25, 29]. To staying safe at home, home environment hazards assessment should be considered in an older population who are at high risk of falling [30]. A study in Brisbane suggested that occupational therapists need to identify home environmental audit recommendations for older community dwellers, as well as to consider a wide range of intrinsic and extrinsic factors, which may contribute to adherence with home modifications [30].

On the other hand, the highest incidence of maxillofacial injuries was found in the young group due to road accidents, interpersonal violence, and alcohol and drug consumption [31, 32]. Moreover, the rate of alcohol-related emergency department (ED) presentations in young people has increased dramatically in recent decades throughout Queensland, Australia. Therefore, there is a need for more effective ways of identifying the degree of alcohol involvement in injuries among young people presenting to EDs [33].

Regarding children, play accidents are usually more frequent in the first decade of life. They are very susceptible to craniofacial trauma because of their greater cranial-to-body mass ratio. However, forces of impact are minimized in children because of their smaller size and weight [34].

Age of the patient also affects the site of the fracture. For example, condylar fractures are the most common type of maxillofacial fractures in children [20].

Gender factor

The preponderance of males with maxillofacial injuries is a similar result found in several studies of facial injuries, with the range in male-to-female ratio varying from 2 : 1 to 32 : 1 [35].

The majority of fractures were encountered in males probably due to higher physical activity by males and also because men have higher rates of involvement in outdoor activities and traffic acci-

dents, reluctance to use helmets, exceeding speed limits, lack of tolerance and more altercations [35].

However, a study examined the effect of gender, Indigenous status and remoteness to health services on sustaining assault-related injuries in patients aged 17 years and under in Queensland, Australia by using data from the state-wide trauma registry from 2005 to 2008 [36]. The study revealed that Indigenous females were at the highest risk of sustaining assault-related injuries, followed by Indigenous males and non-Indigenous males. Additionally, the researchers emphasized the need to develop of effective preventive measures and trauma management plans focusing on high-risk groups who are most likely to sustain assault-related maxillofacial injuries at young age [36].

Geographic region and cultural aspects

The geographic region can also be a factor of influence in maxillofacial trauma. It has been shown that in the more economically advanced societies and communities, maxillofacial injuries are more often caused by IPV in the form of fights, assaults, and gunshot injuries [22, 37].

However, studies have shown that road crashes are the predominant cause of maxillofacial trauma in some societies [20, 38]. This may be attributed to the availability of motor vehicles to young people, high-speed driving, insufficient stress on the use of seat belts, and less enforcement of traffic rules and regulations. Further, less common causes of facial injuries are falls, industrial accidents, and sports [38].

Even for facial injuries caused by sports, the influence of geographic region can be observed. The differences in the incidence of maxillofacial injuries due to sports in different studies can be attributed to different sporting activities practiced in different geographic regions, and may also reflect the level of participation in sports activities. For example, most sports-related injuries occurred during football games in Australia, Gold Coast in Queensland, which has the highest incidence of facial fracture due to football [39].

Socioeconomic status (SES) factor

Many studies have shown effects of lifestyle, employment, and education of people on the incidence and pattern of maxillofacial injuries [22].

A cross-sectional study, a random sample survey of primary school children from 32 schools in Brisbane, was performed. Interviews and house audits were conducted between July 2000 and April 2003 to collect information on socioeconomic status (income, employment and education) and previously identified household hazards. The researchers concluded that the differential distribution of environmental risk factors by socioeconomic status of household may help to explain the SES differential in the burden of injury and provides opportunities for focusing efforts to address the problem [40].

In addition, a prospective cohort study was conducted in one tertiary referral hospital in south-east Queensland, Australia and showed that injured patients who required admission to intensive care provided consent. Participants completed questionnaires prior to hospital discharge. Data included demographic and socioeconomic details, pre-injury health, injury characteristics, and acute care factors, post-acute factors (self-efficacy, illness perception, perceived social support and psychological status) measured. Approximately 20% of participants reported post-traumatic stress disorder symptoms, while approximately half the participants reported psychological distress. Moreover, average quality of life scores were significantly below the Australian norms both 1 and 6 months after discharge. Thus, the researchers emphasized that effective discharge planning and communication across the care continuum are essential to facilitate access to healthcare providers and other support services in the community setting [41].

Temporal and climatic influence factor

Time can be an influence on maxillofacial trauma by a variation in the time of the day, weekday, and season. It has been found that one quarter of the patients of their sample suffering facial trauma were injured between 2:00 and 7:00 P.M. The researchers believed this may be a consequence of the high incidence of motor vehicle accidents (MVA) [37]. It is common for vehicles to be on the road between 2:00 and 7:00 P.M., commuting home from work or picking up children from school. The end of this range is also the time, particularly in the winter months, when daylight diminishes and potentially causes visibility problems on the roadways. Fewer patients were injured between 3:00 and 8:00 A.M. [37].

In addition, the distribution of injuries in the day of the week shows a predominant distribution of accidents causing facial injuries at the weekends, particularly on Saturday and Sunday [42]. Further, these are the days of great opportunity for outdoor and sports activities, day trips, and recreation. Moreover, these findings may also be related to increased alcohol and drug consumption during extended spare time activities and during weekend parties [22].

A retrospective analysis of data from the Queensland Trauma Registry was undertaken, and included all patients admitted to hospital for ≥ 24 h during 2003 and 2004 with an injury severity score (ISS) > 15. Demographic, injury,

environ-mental, care and clinical status factors were considered. The researchers concluded that trauma patients in a predominantly sub-tropical climate region in Queensland are at risk of accidental injury as well as endogenous hypothermia, with associated higher mortality and care requirements. In addition, in the same study, the researchers emphasized that prevention of hypothermia is important for all severely injured patients including facial trauma ones [43].

Also, the incidence of maxillofacial trauma can change according to the latitude of the country where the study is conducted. This might due to differences in the seasons [44]. Further, torrential rain can be a climatic influence on the incidence of traumatic maxillofacial injuries, beyond the fact of having long periods of sun or rain [22].

Alcohol and drug related factors

Alcohol appears to play a role in trauma through several important mechanisms. Alcohol consumption is known to be a central nervous system depressant, resulting in increased confidence, and the subjective feeling of increased mental and physical ability with poor judgment and coordination. Such physiological effects explain the increased incidence of Interpersonal violence (IPV) reported in some studies [45, 46].

In addition, consumption of drugs such as barbiturates, amphetamines, and cannabis can have similar effects as alcohol does [22].

Alcohol consumption is considered a part of the lifestyle of the present generation, and the proportion of the youth with this habit is increasing with time. Moreover, the increasing availability, affordability, and acceptance of alcohol as a social tool have contributed to its becoming more of a social problem [47].

The most prevalent effect of acute alcohol intoxication is an altered level of sensorium [47]. Many neurophysiological effects of alcohol result in decreasing ability of an intoxicated person to appropriately defend himself or herself during interpersonal violence (IPV). Also, with acute intoxication, the effects of alcohol include loss of inhibitions, increased and perhaps over-exaggerated self-confidence, slurred speech, and euphoria [22, 48].

The costs of alcohol-related injuries to the Australian community are high, whether experienced directly by the victim through physical injury and emotional suffering, or indirectly through the distress caused to families and the loss of productivity in the community [22].

Watt *et al.* [49] have shown that acute alcohol consumption appears to confer a generic increased risk for injury to the host and not a tendency for a particular injury type. Further, the personal characteristics, and not beverage-specific properties, explain the associations between beverage type and type of injury [50].

Moreover, when known confounders (i.e., demographic and situational variables, usual drinking patterns, substance use, and risk-taking behavior) are considered, there is no significant association between acute alcohol consumption (quantity, beverage type, or drinking setting) and injury type as measured by the nature of the injury or the body region injured [50].

However, obviously there is evidence of increased mortality and morbidity in patients who abuse alcohol and present with facial injuries [44]. Studies have consistently shown the face to be a commonly targeted region in alcohol- and drug-related violence [50, 51]. Further, the role of alcohol in maxillofacial trauma was well established, with alcohol being implicated in 40–58% of maxillofacial injuries [38, 52, 53].

Many studies have shown elevated blood alcohol levels in 26–54% of patients at the time of facial injuries presentation. Watt *et al*. found that 16.2% and 8.3% of their study population in Gold Coast, Australia (individuals presented in the hospital with body injuries influenced by the consumption of alcohol) had head/neck and face injuries, respectively, where the mechanism of injury was alleged IPV.

However, alcohol is often far more commonly involved, with 55–87% of maxillofacial injuries due to alleged assault physically involving alcohol [22, 54].

Furthermore, the quantity of alcohol consumption has been shown to be more predictive of IPV-related injury than the frequency of drinking [22]. A study has shown that people most at risk of injury are those who drink during the six hours before the incident, and those who normally drink small amounts of alcohol or none, but periodically drink large quantities (binge drinking) [50].

Elledge *et al.* [55] also noted the absence of any meaningful relationship between patient's gender or age and the likelihood of the episode of maxillofacial trauma involving alcohol, suggesting that the problem of alcohol and maxillofacial trauma may not be restricted to a single age group or to either gender.

Also, studies have shown a clear association between alcohol consumption and helmet use, finding that non-helmeted motorcyclists are more likely to be legally intoxicated than helmeted cyclists [22, 56]. Additionally, it has been found that non-helmeted motorcyclists with facial fractures were almost 40 times more frequent than helmeted motorcyclists with facial fractures. Thus, alcohol plays an important role in the compliance with protective device usage [22].

Further, the involvement of alcohol in patients with facial injuries increase the relative risk of requiring surgical intervention, because the cases

where alcohol is involved result in a mean facial fracture severity score that was significantly higher than those that did not involve alcohol, and a large number of mandibular fractures were related to the involvement of alcohol [45].

Compliance with road traffic legislation

There is a growing body of evidence suggesting a number of road safety benefits associated with average speed enforcement, including high rates of compliance with speed limits. Additionally, it has been reported that there are reductions in crash rates also in association with average speed enforcement, particularly in relation to fatal and serious injury crashes. Moreover, an improvement of traffic flow and reduced vehicle emissions have also been associated with high levels of public acceptance [57].

In Queensland, Australia, a study has long been conducted to recognize the risky behavior of young novice drivers to contribute to their overrepresentation in fatalities and injuries arising from road crashes. The Behavior of Young Novice Drivers Scale (BYNDS) was designed specifically to measure this risky behavior, and has been found to be reliable [58]. Also, the Graduated Driver Licensing (GDL) program has been introduced in Queensland, Australia, in an attempt to ameliorate the significantly greater risk of death and injury for young novice drivers arising from road crashes [59].

In addition, in Queensland there are data emphasizing the need for children to use full protective equipment, especially helmets. Children should be protected by legislation mandating safety standards. Regulating rider age and safety standards (protective equipment, training and vehicle maintenance) may reduce the rate and severity of injury [60].

Furthermore, since 2008 Uniting Care Queensland (UCQ) has been providing a coordinated driver education program in road safety. Road traffic safety refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. The users of a road include pedestrians, cyclists, motorists, their passengers, and passengers of on-road public transport, mainly buses and trams. Additionally, best-practice road safety strategies focus upon the prevention of serious injury and death in crashes in spite of human fallibility (which is contrasted with the old road safety paradigm of simply reducing crashes assuming road user compliance with traffic regulations) [61].

Thus, Queensland, Australia, MVA-related facial injuries are on a decline as a result of better driving conditions, improved car safety mechanisms, and education and public awareness campaigns of alcohol-related trauma over the past decade.

Domestic violence

A study showed that most women victims of domestic violence sustain a high number of maxillofacial injuries [62]. Some explanations for this include preference and accessibility of the face as a target for assailants. The upper limb is also a common site of injuries and accompanied with traumatic maxillofacial injuries. This may reflect the tendency of victims to defend themselves with their hands during the assault [62].

Studies have shown that domestic and family violence incidence is high in both the Indigenous and non-Indigenous populations, but Indigenous people are twice as likely as non-Indigenous people to be hospitalized for injury, and have a 17-fold greater hospitalization rate for interpersonal violence using data for the Northern Territory, Western Australia, South Australia and Queensland for the period 1 July 1999 to 30 June 2004 [63, 64].

Furthermore, the use of alcohol and/or illicit drugs has been a controversial topic in domestic violence. Some clinicians believe that they are causative in both violent acts and victimization, whereas others believe that alcohol and drug abuse by the victims may be a result of husband to wife violence [65]. There is no question that there is an association. Alcohol was found to be associated with at least one third of the domestic violence and more than half of the patients had a history of illicit drug use [62]. In addition, data from a retrospective study revealed that many more of the patients were under the influence of alcohol at the time of abuse [62].

Little research has been undertaken in the area of domestic violence in a regional or rural setting in Queensland, Australia. A retrospective analysis of de-identified data obtained from the Queensland Injury Surveillance Unit was performed to determine the reported prevalence of domestic violence to females in the Emergency Department of Mackay Base Hospital (MBHED) for the period 1 January 2001 up to 31 December 2010, and to describe the level of domestic violence reported at the MBHED [66]. The research revealed significant underreporting in this regional emergency department in Queensland, Australia, so further studies need to outline the barriers to reporting. In addition, underreporting and poor management have affected how domestic violence victims are cared for within the health care system [66].

Osteoporosis

Osteoporosis is defined by the World Health Organization as a disease characterized by low bone mass and microarchitectural deterioration

of bone tissue leading to higher bone fragility and a consequent increase in fracture risk [22].

Geographic variations in bone fracture rates have been demonstrated even within countries, suggesting that environmental factors (including dietary factors and vitamin D levels) are important in the pathogenesis of bone fracture [67].

Further, osteoporosis related changes result in a significant decrease of bone strength in the elderly population. All osteoporotic fractures increase patient morbidity and mortality [67].

A study showed that worsening osteoporosis is significantly associated with higher incidence of maxillofacial injuries. Also, the same study indicated that osteoporosis appears to predispose elderly patients to maxillofacial injuries in low-impact situations as well as high-impact situations [68].

Further, a retrospective study using a standardized database was conducted in 16 Australian hospitals to examine current fracture prevention strategies through the recognition, investigation and treatment of osteoporosis in patients presenting to acute hospitals with minimal-trauma fracture. The study concluded that most patients presenting to Australian hospitals with minimal-trauma fracture are neither investigated nor treated for osteoporosis. As this group is at high risk of subsequent fracture, this is a missed opportunity to reduce fracture burden [69].

Preventing fractures in older people is important. But Järvinen et al. believe that they should put efforts into stopping falls not treating low bone mineral density [70]. As well as recommending interventions such as strength and balance training, sufficient intake of vitamin D and calcium, and smoking cessation, general practitioners should refer people identified as at high risk of falling for professional environmental assessment, for example, to occupational therapy [70].

The treatment of osteoporosis in Queensland, Australia is challenging. A study on osteoporosis in Australia estimates that the condition will cost the Queensland government $611 million in 2017 for people aged 50 and over. The report shows that four out of five Australians treated for an osteoporotic fracture were not tested for osteoporosis – a fact Royal Brisbane and Women's Hospital endocrinologist Syndia Lazarus called "worrying". She said "There is a significant gap in osteoporosis care, and our hospitals are becoming revolving doors for fracture patients being sent home and returning with new fractures." [71].

Etiology of traumatic maxillofacial injuries

The pattern and etiology of maxillofacial injuries vary from one region to another depending on prevailing socio-economic, cultural environmental factors, lifestyle, transportation, and legislative measures [72].

Facial injuries commonly resulting from various traumatic insults to the face can be classified as intentional and unintentional (accidental) injury [48].

The term accidental or unintentional injury is described by the World Health Organization (WHO) as 'injury' occurring as a result of an unplanned and unexpected event which occurs at a specific time from an external cause [73]. However, the term "accidental injury" is implied when the causes of injuries are random in nature, while researchers use the term "unintentional injury" to refer to injuries that are non-volitional but preventable [74]. Within the field of public health, efforts are made not only to prevent unintentional injury, but also to reduce "intentional injury" [74].

The consequences of maxillofacial injuries remain of great significance both functionally and esthetically. Such injuries are often associated with disfigurement, functional impairment, severe morbidity, and considerable financial cost [75].

Many studies have reported that the most common mechanisms of facial trauma in Queensland, Australia are as follows:

Motor vehicle accident (MVA)-related maxillofacial injuries

A study has revealed that maxillofacial injuries as result of motor vehicle accidents (MVAs) are still relatively high in Queensland, Australia, regardless of legislation for compulsory seatbelt use to reduce the risk of head and face impacts to front seat occupants in a frontal collision [76]. The airbag is also well established as an effective means of preventing serious head and face injury. However, more research is required to further reduce the incidence of maxillo-facial injuries as a result of MVAs [76]. Passengers in motor vehicles sustain most of the maxillofacial injuries, followed by the drivers of motor vehicles and then pedestrians [77].

Regarding the demographics and injury details in Queensland, Australia, it has been demonstrated that acute care factors and outcomes of both minor trauma cases and major trauma cases were evaluated by using data from the state-wide trauma registry in Queensland, Australia, from 2005 to 2010 [10]. Also, the impact of changes in Abbreviated Injury Scale (AIS) versions on the classification of minor and major injury cases was also assessed [77].

In addition, the Queensland University of Technology's (QUT) Centre for Accident Research and Road Safety (CARRS-Q) was inviting drivers to take part in an online survey asking what they think is "too close". The project was gathering informa-

tion about driver knowledge and their perception of following gaps with an aim to reduce rear-end crashes [78].

Further, a research from Queensland University of Technology discussed the negative impact of mobile phone use on car-following behavior of young drivers. The researchers concluded that the findings will improve the collective understanding of distraction on driving performance, in particular car-following behavior, which is most critical in the determination of rear-end crashes [79].

Motorcycle-related maxillofacial injuries

Motorcycle riders are clearly overrepresented in fatal and serious injury crashes, with the rate of injury per kilometer travelled higher than for any other vehicle type [80].

A study has demonstrated that the 23–27 year old age group is the most commonly affected by motorcycle accidents for both males and females although there were three times more motorcycle licensees in Queensland, Australia, in the 40-to-49 year age group [76].

Additionally, a population-based study of motorcycle-related children trauma, resulting in fatality or hospital admission beyond 24 h to any Queensland public hospital was performed (2007–2009). Data were collected by the Statewide Trauma Network and Commission for Children and Young People and Child Guardian [81]. These data emphasized the need for children to use full protective equipment, especially helmets because children are not protected by legislation mandating safety standards. Further, regulating rider age and safety standards (protective equipment, training and vehicle maintenance) may reduce the rate and severity of injury in Queensland, Australia [81].

Due to the popularity of mopeds and motor scooters (as a sub-group of all motorcyclists) in Queensland, Australia, consideration of the riders of this group is significant. Of all motorcyclists, full protective equipment especially helmets are required.

A comparison of demographic injury and acute care characteristics between seriously injured moped/scooter riders and motorcycle riders was undertaken using data from the state-wide trauma registry in Queensland, Australia, from 2006 to 2010 [80]. The results of this study suggested that riders of mopeds/scooters and motorcycles may have different patterns of injury, but sustain a similar injury severity. Further, in Queensland at the time the research was conducted, moped riders did not require additional licensing or training experience [80]. Additionally, the results of this study may suggest an under-appreciation of the significance of potential moped-related injuries. Hence, evaluation of the injuries sustained by moped riders is required to more fully understand their impact, and to ensure licensing restrictions are based on appropriate evidence.

Domestic violence (DV)-related maxillofacial injuries

Domestic violence is a serious issue in Australian society. The commonness of oral-maxillofacial trauma due to domestic violence is high, and the main associated factors are place of residence and mechanism of aggression [82].

In Queensland, Australia, the prevalence of domestic violence is high, as well being a national health crisis. Former Governor General Dame Quentin Bryce has delivered the task-force report on domestic violence, titled "Not Now, Not Ever: Putting an End to Domestic and Family Violence in Queensland" because of 66,000 domestic violence incidents in Queensland last year (2015) [83]. Furthermore, the annual cost of domestic and family violence to the Queensland economy is estimated to be between $2.7 billion and $3.2 billion [84].

There were data confirming that most victims of domestic violence sustain maxillofacial injuries. Mid-face injuries predominate. The preponderance of facial injuries makes it very likely that oral and maxillofacial surgeons will be involved in the care of those victims [62].

In addition, three separate domestic violence deaths just days apart in south-east Queensland have prompted Premier Annastacia Palaszczuk to fast-track the implementation of the recommendations of the Special Taskforce on Domestic and Family Violence [85, 86].

Moreover, a retrospective analysis of de-identified data obtained from the Queensland Injury Surveillance Unit was performed to determine the reported prevalence of domestic violence to females. The report contains a number of key recommendations relating to the professions, including [83]:

- "The Queensland Government should evaluate the frequency and efficacy of ante-natal screening for domestic and family violence, and report to the Audit Oversight Body."
- "The Queensland Government should commission the Australian College of Midwives to develop training for midwives on asking pregnant women about exposure to domestic violence during ante-natal appointments."
- "Hospital and Health Services should ensure all midwives receive appropriate training and that all women attending ante-natal clinics should be asked about their exposure to domestic and family violence."
- "The Queensland Government and domestic violence (DV) Connect should work together to provide specialist domestic and family support

and referral services within all maternity hospitals and emergency departments."
- "The National Code of Conduct for Health Care Workers should include a requirement that the Standing Council on Health must be familiar with domestic and family violence and child harm indicators, and to intervene."

It has been shown that there is a relationship between empowerment, domestic violence, and health. Also domestic risk factors, including alcohol and multiple unions, increase domestic violence. Furthermore, education decreases domestic violence and cooperative decision-making reduces domestic violence [87].

Regarding the physical abuse of children, it has been reported there is a need for more training in both recognition of risk factors for child abuse and neglect, as well as the effects of domestic violence on children [88].

Cycling-related maxillofacial injuries

Cycling as a recreational sport activity, as well as an alternative transport opportunity, continues to gain popularity. However, with increasing numbers of cyclists, there is an increasing number of cycling injuries.

Furthermore, data collected by the Australian Government reveal that severe injuries and fatalities for cyclists are increasing with fatality rates 10–20 times higher than for car occupants. Cycling fatalities in Australia in 2013 ($n = 50$) were the highest in over a decade and accounted for 4% of road fatalities, while in Queensland, roadside collisions involving a cyclist account for 6–8% of all transport-related injuries [14].

In addition, studies indicated a relatively high incidence of bicycling injuries in a sample of cyclists in Queensland, Australia, the majority of which are non-serious injuries [89]. These injuries requiring treatment in hospital facilities highlight the importance of understanding the patterns of cycling-related injuries to target prevention initiatives [14].

Head and face injuries in cyclists and cycling injuries of children have been the focus of many papers [90–92] with the prevention measure of legislated helmet use associated with a 63–88% reduction in the risk of head, face, and severe brain injuries for all ages of bicyclists. Also, trauma systems provide the opportunity to investigate cost and incidence of cyclist injuries with more precision than has been possible in the past [93].

Prevention strategies could be improvement of cycling lanes, development of ergonomic protective gear like joint protectors and the introduction of laws to keep distances to cyclists during overtaking. Further, helmet enforcement and mandatory helmet law is potentially one of the most cost-effective interventions available [22, 89].

Bullying-related maxillofacial injuries

Bullying continues to be a concern in schools, workplace, and communities. There was reported the death of a student at a Catholic boy's school in Brisbane in 2010, allegedly at the hands of a fellow student. Bullying remains a hot topic in the school. But, who is to blame? Often the finger is pointed at schools, while others ask if school and government anti-bullying policies are doing enough [94].

Maxillofacial injuries are due to the physical bullying, means the bully confronts the victim face-to-face in physical actions such as hitting, kicking, and shoving [95].

A study has suggested that the etiology of bullying is more directly related to conditions at home rather than to conditions at school. Thus, the researcher has hypothesized that bullying is associated with physically harming children in their homes and the coping responses that result from this physical harm [96].

Relating to bullying prevention, research and applied behavioral sciences show how educators, school psychologists, counselors, and other professionals can address the problem of bullying and aggression in schools. Bullying prevention programs can be effective in reducing bullying and victimization among school-aged youth, there is a great need for more work to increase the acceptability, fidelity, and sustainability of the existing programs in order to improve bullying-related outcomes for youth [97].

Fall-related maxillofacial injuries

Falls are the leading cause of maxillofacial injuries in older adults, with a third of those aged 65 and over, and a half of those aged over 85, falling each year [98]. The consequences of falls are disability, reduced quality of life, and financial costs to individuals and society [98].

Falls are the most common adverse events reported in hospitals, comprising 20–30% of all incident reports [99]. Geriatric and rehabilitation wards have higher rates of falls (between 10 and 17 per 1000 patient bed days) [100] than surgical or acute care wards [101].

Additionally, falls have potentially negative consequences for older inpatients. About 30% of in-hospital falls result in physical injuries, while fractures are a consequence in approximately 2% [102], which incur increased costs [103]. Non-injurious falls are also associated with substantially raised costs through increased lengths of stay in hospital (LOS) [104].

Further, patients who fall while in hospital increase health system costs. Some Australian data suggest that overall, hospital fallers stay approximately twice as long and have double the costs of non-fallers. However, other Australian data indicate that the cost per fall is approximately equivalent between cognitively intact and cognitively impaired patients and that falling in hospital appears to affect length of stay (LOS) and subsequent costs arising on sub-acute wards more than acute wards [104].

Also, elderly patients who have been recently discharged from hospital and receive assistance with activities of daily living are at high risk of injurious falls indoors, most often in the bedroom. These data suggest that targeted interventions may be needed to reduce falls in this population [105]. Moreover, diabetes mellitus and orthostatic hypotension (OH) in addition to osteoporosis, are risk factors for falls and fractures which are the commonest in older age [106].

There is little published on the relevant predictors of injury, mechanistic factors, severity, and injury patterns in the aged group. Furthermore, multiple interventions that are not tailored to individually assessed risk factors are effective at reducing both the number of people that fall and the fall rate. Hence, a variety of actions is significant to reduce the number of accidental falls suffered by older people in terms of fall prevention as well as best practice guidelines for public hospitals and state government residential aged care [107].

Regarding children, falls in children are a common cause of injury and hospital presentation [108]. Falls from window, furniture and stairs are important causes of morbidity in children. Therefore, more anticipatory guidance should be developed and given to families to help in prevention of such injuries resulting from falls [109].

Fall mechanisms involving children being dropped by adults, and falls from cots, beds or couches carry the highest clinical burden. These mechanisms should be targets for injury prevention and inform the design of safe equipment and environments for babies [108].

Alcohol and drug-related maxillofacial injuries

Alcohol overconsumption has continued to be a major social problem in Australia [47]. Injuries are the most common type of youth alcohol-related emergency department (ED) presentation, yet little is known about these injuries in young people. Moreover, the impact of acute alcohol use is differ from chronic effects of consumption (such as those that occur in people who abuse alcohol or are dependent on it) [31].

Reporters have concluded that alcohol use is associated with driving accidents because alcohol impairs driving ability and increases the risk of an accident as well as its consequences. Further, alcohol is the substance most frequently found in crash involved drivers, and has been extensively examined in experimental and epidemiological studies [110].

Moreover, alcohol is associated with violence, and alcoholics become more violent, and this may be the reason for the higher incidence of IPV-related maxillofacial injuries among male alcoholics [54], and injuries such as falls, that is non-traffic injuries in general [111, 112].

Unemployment and economic recession may result in increased alcohol abuse and related risk of injury as high alcohol consumption has been shown to increase risk of interpersonal violence (IPV) and motor vehicle accidents (MVA) [22, 37].

A study has highlighted the role of an open-space CCTV (closed circuit TV) system in limiting alcohol-related assault injuries in a late-night entertainment precinct in a tropical Queensland city. However, the same study emphasized the need for further research, particularly to evaluate the effects on preventing injuries through targeted awareness training to improve responsiveness and enhance the preventative capacity of similar CCTV systems [113].

In 2002/03 the Queensland Government responded to high rates of alcohol-related harm in discrete Indigenous communities by implementing alcohol management plans (AMPs), designed to include harm reduction and treatment measures [114].

Furthermore, there are data on implementation of setting-based strategies for the prevention of alcohol-related violent injury [115], and evidence of a generic effect of alcohol supports the increasing development of national policies that are exposure-based rather than being event-specific [116].

Other drugs have been shown to impair human performance, or have been implicated in epidemiological studies as increasing the risk of violent injury [110].

The drugs of current concern are marijuana, the benzodiazepines, other psychoactive medications, the stimulants and the narcotics. No one or group of tests achieved the need for detecting and documenting an impairment, either in the laboratory or at the roadside [110]. Moreover, the study of the effects of drugs other than alcohol is more complex because of the number of substances of potential interest, the difficulties estimating drug levels and the complexity of the drug/subject interactions [117, 118].

Occupational-related maxillofacial injuries

Work-related maxillofacial injuries were defined as those injuries occurring during physical work activities requiring a trained skill, mostly using a tool, a vehicle or machinery [119].

The nature of the work was classified as: 1) agriculture and forestry, 2) construction, 3) manufacturing, 4) transportation and warehousing, and 5) services.

Accidental blow to the face by machinery or tools is the most common cause of facial injuries and fractures, comparable to studies which also reported a high proportion of injuries involving accidental blow from thrown, projected or falling objects. The majority of such injuries may have arisen from misuse of equipment due to lack of training or instrumentation, fatigue, inattentiveness, and faulty equipment [120].

Workplace accidents disable and take the lives of thousands of workers every year. In addition, workplace accidents cost organizations and the economy billions of dollars annually [121].

There are both individual and organizational factors that can influence accidents in the workplace. Individual factors include gender, age, experience, education, handedness, and health disorders of the workers. There is also some evidence suggesting that diabetes, asthma, depression, obesity, hypertension and cardiovascular disease affected workers are at excess injury risk [122].

Organizational factors or environmental factors often involve certain working conditions that impact the safety and health of the workers. They are more controlled by management than individual factors, for example, the presence of a dedicated occupational health and safety committee, proactive return-to-work (RTW) programs, supportive employer participation, and early communication between injured workers and workplace stakeholders. In addition, the promotion of a people-oriented work culture has been shown to be important in preventing new injuries and also in facilitating work reintegration for injured workers. Further, understanding of the influence of workplace organizational factors in prevention and management of work-related injuries is needed.

Moreover, a reliable and valid measurement of workplace organizational policies and practices (OPPs) is needed to evaluate their influences on the prevention and management of occupational injuries [123].

The effect of work injury on the health depends on the severity of accidents. Fatal and severe injuries have generally been given high priority in occupational injury, as well as prevention strategies employed by the national authority [124].

Hence, the best way of treating work-related maxillofacial injuries is through prevention. That should include adequate training of workers, recognition of possible occupational hazards, and the implementation of strict safety measures in the workplace [119].

A study was conducted to investigate the occurrence of occupational maxillofacial injuries using a newly installed relational database. This study demonstrated the power of modern databases to identify specific occurrences that may provide the basis for prevention injuries in the future [125].

Regarding coal mining industries, they are dangerous industries that, in the past, had more than their share of injuries, disease, fatalities and disasters [126]. Australia is among the major coal producing and exporting countries in the world. Production overwhelmingly comes from mines in Queensland and New South Wales. In Queensland, there are about forty opencast and underground coalmines, mainly owned and operated by large global mining companies [127].

Mining injuries can cause serious disruption of the production process, escalate already high workers' compensation costs, and increase staff absences and reputational risk [128]. They can also threaten the company's 'social license to operate', which is increasingly important, given that community expectations of occupational health and safety (OHS) performance have risen. However, failures in OSH may spill over and threaten access to new mine sites, and the imposition of more strict environmental controls [128].

Australian occupational health and safety (OHS) legislation is overly complex and biased unfairly against the employer. Significant advances in OHS achieved by construction unions working together with employers and government authorities are now at risk, to the detriment of workers [128, 129].

Sports-related maxillofacial injuries

Sports-related maxillofacial injuries contribute a significant proportion of the workload in a maxillofacial unit. Further, the most common injury sustained was zygomatic complex fracture. Additionally, mandibular fracture occurred in orbit fracture, and nasal bone fracture [130]. The most common sporting injuries were as follows: Gaelic football, soccer, rugby, and equine sports.

The most common mechanism of injury was from a clash of heads followed by an elbow to the face – hence the need to educate all players regarding use of personal protective equipment and adherence to the rules of sports [130]. In addition, stricter regulations are needed to discourage violent play, rather than relying on the use of protective equipment. Moreover, patients should be advised when they can resume sports activities, particularly in the case of professionals and semi-professionals [131].

In Queensland, Australia, it has been revealed that there are two main groups of subjects injured during horse-related activity, which are young female riders injured during sports/leisure activities and adult males injured while working [132].

In addition, it was found that non-riders accounted for more than 27% of cases, and minors accounted for more than 90% of injured children; neither group has been comprehensively reported [132]. Moreover, geographic location and activity type have an impact on the incidence of horse-related injury in Queensland [133].

There was a retrospective cohort study reported on the epidemiology of horse-related injuries for patients presenting to the only tertiary pediatric trauma hospital in Queensland. The authors emphasized that a helmet should be recommended for children handling horses as non-riders, in addition to being compulsory whilst horse riding and any other safety clothes worn, such as body protectors [134].

Research can target prevention strategies, and inform trauma management practices for these identified at-risk populations. Additionally, to investigate the occurrence of sports related maxillofacial injuries, computerization of trauma and emergency units and the introduction of customized software can significantly reduce the workload of researchers and doctors. The effective use of new computer technology should have a considerable influence on research and the quality of future prospective and retrospective studies [135].

Interpersonal violence (assault)-related maxillofacial injuries

Interpersonal violence is seen more in developed countries with better roads, and better transport facilities [136]. Also, there has been observed a remarkable increase of injuries from interpersonal violence, and a divergence from conservative treatment with time [137].

In addition, it has been found that there is an association between alcohol outlet density and IPV, and the strength of this association varies by outlet type. Moreover, alcohol plays an important role in community violence rates, and IPV is factor associated with oral-maxillofacial trauma. In other words, there is a strong possibility that patients with maxillofacial fractures will be victims of aggression or violence [138]. Therefore, criminology can be beneficial in this respect, and should encourage further criminological and sociological investigation of the nature of the ecological association between alcohol and violence [138].

Further, assault and interpersonal violence-related maxillofacial injuries occur in both Indigenous and non-Indigenous populations. The largest differential between Indigenous and non-Indigenous injury-related hospitalizations was for interpersonal violence, particularly for women. About half the excess morbidity from interpersonal violence among Indigenous people is due to factors associated with remote living [63]. Additionally, Australian Indigenous people suspected of interpersonal violence were ambiguous about its objectives and its means [139].

Thus, culturally appropriate interventions that tackle a wide range of social and economic issues are needed to alleviate Indigenous interpersonal violence [63]. Further, there is a need to identify and clarify intervention strategies at all levels of prevention in geographically isolated living.

Adventure and ecotourism-related maxillofacial injuries

Adventure tourism has been defined as the 'deliberate seeking of risk and the uncertainty of outcome' , and certainly appears to satisfy tourists' desire to engage in 'at risk' or risk-taking behaviours [140].

Both adventure and ecotourism sectors are significant to the Australian, and especially the Queensland, Australia tourism product, with its high proportion of outdoor and nature-based tourism experiences.

A study concerned with overseas visitor injuries in Queensland hospitals involved the analysis of admissions data for 161 Queensland hospitals. As in the case of visitor fatalities, and previous Queensland hospitalization studies, motor-vehicle crashes were the most common type of injury, comprising 22% of overseas visitor injuries, while falls on the level (16%) were the next most common injury cause, followed by various types of injuries [140].

A further study analyzed medical record data from seven regional hospitals in Queensland to determine the types of medical conditions and injuries that resulted in overseas and interstate tourists being admitted to hospital. This study revealed that the main reasons for admission of overseas tourists, based on principal diagnoses, were injuries due to falls or accidents. In addition, the same study emphasized the burden of care placed on the admitting hospital's resources, and the growing number of visitors to Queensland needing health care [141].

Moreover, the effectiveness of an on-line survey for collecting safety information from ecotourism operators was evaluated in relation to the future development of an industry safety monitoring system. Survey findings indicated a relatively low level of reported incidents, with slips, trips and falls being the most common incident type [140]. Thus, the risk factors should be identified by Queensland adventure and ecotourism operators related most

frequently to adverse and changeable weather conditions and client skills and behavior. A notable proportion of the operators reported that they did not apply important safety management practices. Furthermore, a model of injury control should be presented to assist the operators in their risk management practice, and to perform evaluation in relation to the future development of an industry safety monitoring system.

Gunshot-related maxillofacial injuries

Gunshot injuries were further categorized as penetrating, perforating or avulsions. Data showed important differences in anatomic location, gender, and race distribution of maxillofacial gunshot wounds between military and civilian populations. Future research comparing surgical strategies in these two environments could assist maxillofacial surgeons in providing optimal care to their patients [142]. Gunshot-related maxillofacial injuries data and studies in Queensland are very few.

Traumatic maxillofacial injuries diagnosis and treatment

Patients who sustain maxillofacial trauma commonly present to their general practitioner (GP) or the emergency department, especially to seek help after hours. It is important, therefore, for medical practitioners to correctly diagnose and manage these patients. Time is of the utmost importance when dealing with traumatic maxillofacial injuries because it can have a significant impact on the prognosis of hard and soft tissues [143]. Furthermore, guidelines involving airway compromise, major hemorrhage and visual loss are the key problems to rule out on initial assessment, so accurate assessment is crucial [2, 144].

Maxillofacial injuries remain a challenging problem that frequently requires a multidisciplinary team approach for oral and maxillofacial surgeons, and demanding both skill and a high level of expertise [145]. In addition, the diagnosis of maxillofacial fractures can be challenging, because hematoma and swelling can mask the extent of the underlying injury. Further, overlooking a fracture may not have immediate consequences, but can result in disfigurement and permanent disability that may affect the patient's ability to perform their occupation [2].

Infection was the most frequent complication, followed by malunion, teeth injuries, malocclusion, and temporal mandibular joint (TMJ) dysfunction [10]. This rate of complications, particularly of postoperative infection, considered in relation to the large number of open reduction procedures performed by surgeons in this setting, is particularly encouraging, and perhaps reflects the use of prophylactic antibiotics and patients' compliance with the postoperative instructions [10].

Further, patients with maxillofacial injuries with or without facial bone fractures are at risk of acute or delayed traumatic brain injury [146].

Regarding the diagnosis, radiography, imaging of tissues using X-rays, is used to rule out facial fractures. Angiography (X-rays taken of the inside of blood vessels) can be used to locate the source of bleeding as well. However, the complex bones and tissues of the face can make it difficult to interpret plain radiographs, so CT scanning is better for detecting fractures and examining soft tissues. Also, CT scanning is often needed to determine whether surgery is necessary, but it is more expensive and difficult to obtain. CT scanning is usually considered to be more definitive and better at detecting facial injuries than X-ray. CT scanning is especially likely to be used in people with multiple injuries who need CT scans to assess for other injuries.

All types of traumatic maxillofacial injuries require rapid actions (diagnosis and management) and a strong collaboration between surgeons and anesthesiologists [5].

Moreover, most patients with maxillofacial injuries undergo hospitalization and considerable resources are needed for treatment, thus placing an enormous burden on the health care system. In addition, patients who sustain severe maxillofacial injuries may need more attention to the psychological as well as the physical health to ensure an optimal recovery following these devastating injuries because severe injury is always associated with considerable psychological distress [147].

Hence, although the mechanism, pattern, and distribution of forces vary, the resultant damage to hard and soft tissues requires dedicated planning and a treatment protocol for these injuries involves meticulous surgical exploration, and assessment, execution of debridement, and early definitive reduction/fixation, and reconstruction are necessary [148].

Two significant points about maxillofacial injuries should be taken into consideration:

(i) Of all the multiple trauma patients entering an emergency department (ED), approximately 80% will have sustained injury to the head, face and neck [149], and

(ii) life-threatening maxillofacial injuries are those that involve the airway, produce massive hemorrhage or are associated with a cervical spine or brain injury [144].

The number of complications the patient incurs after facial injury can predict length of intensive care unit stay (ICUS). Further, length of ICUS, Injury Severity Score (ISS), and number of complications incurred are the strongest predictors for total

length of hospital stay [150]. Infectious, respiratory, and hematologic complications are the complications most closely correlated with increasing length of ICUS and total hospital stay [150].

Indeed, the treatment chosen may differ as there are many factors including cost of treatment, affordability by the patient, feasibility in the hospital, doctor's decision and skill, patient's willingness to benefit from the treatment advised – all of which may vary from one area to another.

Additionally, traumatic maxillofacial injuries cause considerable economic expense due to procedural costs, the time a patient is off work, and the associated loss of income. For these reasons, it is an important health and economic issue [22].

The epidemiology of traumatic facial injuries varies with regard to injury type, severity, and causative factors that depend on the population studied. Hence, understanding of these factors can aid in establishing clinical and research priorities for effective treatment and prevention of these injuries [21].

As with other injuries, epidemiological data of maxillofacial injuries provide an important basis for the evaluation of access to treatment, resource allocation and planning within the health services. Further, they may also be used to develop preventive strategies and may provide information about the quality of care provided [4].

Therefore, retrospective studies of traumatic maxillofacial injuries can help in prevention or reduction of maxillofacial injuries, and quantifying demands for services.

Traumatic maxillofacial injury preventive strategies in QLD

Maxillofacial injury prevention is an effort to prevent or reduce the severity of facial injuries caused by external mechanisms, such as accidents, before they occur. Injury prevention is a component of safety and public health, and its goal is to improve the health of the population by preventing injuries then improving quality of life. Thus, It is necessary to identify the best setting and technique for the prevention of injuries to the patient because they result in such extensive morbidity and mortality [74].

In addition, understanding the injury mechanisms is of extreme importance for correct diagnostic evaluation. Specific injury models can be created to exactly determine trauma mechanisms. Also, understanding the way of injury may be a key to solving ambiguous injuries. Therefore, some life-threatening injuries may be diagnosed without present clinical symptoms at the moment of examination [151].

The national injury prevention plan for Australia and an implementation plan have been developed as a collaborative attempt by all Australian governments with advice from non-government agencies, professional bodies and industry organizations. The plans were approved by the Council of Health Ministers in August 2001. The four priority areas are falls in elderly people; falls in children; drowning and near drowning; and poisoning in children. These were selected on the basis of the evidence of injury burden and potential health gain; effectiveness, cost-benefit and acceptability of a range of interventions; and of there being a clear and actionable role for the health sector [152].

Other significant injury areas are being addressed through specific national strategies on road injury and workplace injury. The plan is intended to focus national effort towards the priority issues; to improve knowledge, strengthen infrastructure, and implement injury prevention activities; and to promote evidence-based, sustainable injury prevention interventions [152].

Moreover, a specific and separate plan is to be developed for injury prevention for indigenous people. Responsibility for implementing the plan rests with what is called the Strategic Injury Prevention Partnership, a group that includes representatives of state and federal health departments. The implementation plan identifies specific actions, key players, and possible allies for specific action, with identified actions in each of the priority areas [152].

Recommendations for an epidemiological model of traumatic maxillofacial injuries in QLD

Unfortunately, the incidence of maxillofacial trauma is increasing at an alarming rate despite the preventive strategies against traumatic maxillofacial injuries in QLD.

Despite the decrease in facial trauma from motor vehicle accidents due to safety improvements such as airbags and seat belts, injuries due to interpersonal violence continue to rise. In Australia, maxillofacial fractures are the third most common trauma in falls in elderly individuals after neck of femur and upper limb fractures [2].

More preventive strategies need to be reinforced, considering quality of life, disability and cost of rehabilitation. In addition, more evaluation studies should be conducted to assess the physical, social and psychological quality of life for patients affected with maxillofacial trauma.

Furthermore, the database needs to be improved further to enable information on alcohol use and vehicle safety restraint system use to be assessed in vehicle-related trauma. This could be achieved through linkage with police and road authority databases.

The significant elements that need to be highlighted or considered to improve the epidemiolog-

ical model of traumatic maxillofacial injuries in Queensland, Australia are the following:

Severity of traumatic maxillofacial injuries

The measurement of injury severity is an essential element of the use of epidemiology for injury control, and the measurement is based on numerous clinical signs and symptoms such as respiration rate, consciousness, blood pressure, heart rate, and number and types of organ and system damage, such spinal cord. Data without valid indicators of severity may be misleading because the relevant factors to reducing severe injuries are often not involved as frequently in non-severe injuries. Further, improved means of quantifying severity of injury and disability are under investigation. Case identification requires knowledge of the flow of cases among treatment facilities [153].

Statistics of traumatic maxillofacial injuries

The simplest statistical description of maxillofacial injuries is the distribution by severity, obtained by counting the numbers in specific categories such as fatal, hospitalized, and ambulatory or the severity scale of interest. Rate of injury is calculated by dividing the number of injuries by the population at risk or measures of exposure, such as miles traveled for motor vehicle injuries. Rates are useful for inferring relative risk in relation to factors that can be changed to reduce risk. Rates are misleading when they are high, but based on relatively rare exposures, or when they do not reflect the future exposures inherent in the lifetime exposure to a product or activity [48].

National traumatic maxillofacial injury surveillance

Surveillance of who, when, where, and how people are injured has proved to be a powerful tool for targeting injury control measures of known effectiveness. Some extant surveillance systems have quirks in the data can mislead the user. Missing data elements are a major problem in many cases. Certain data, such as police codes of injury severity and self-reported injuries and behaviors (e.g., seat belt and alcohol use), are valid [154].

Local traumatic maxillofacial injury surveillance

Certain hospitals have increased the recording of data on injuries in trauma registries, partly for use in monitoring quality of care and partly as a database for research. Data are sourced from the Queensland Emergency Department Information System (EDIS) and the Queensland Injury Surveillance Unit (QISU). EDIS data are collected for all patients in Queensland who attend EDs who use the EDIS software system, and the data are estimated to cover 75% of ED presentations in Queensland [155]. QISU data contain injury surveillance information collected from persons presenting with an injury or – in the case of children – from the accompanying adult [155].

The use and abuse of causal analysis

A specific causal path in a complex causal sequence is often a goal of "basic" science, but can be misleading in injury control. Usually, all of the potential risk factors can be ignored if a controllable necessary condition for harm is known. Also, because energy is the necessary and specific agent of injury, control of the energy or the way it is conveyed to the host will control the injury. Further, a complex causal model may be useful for understanding sometimes out-of-control systems that affect injury, such as alcohol use. Generally, however, the more removed the hypothesized "cause" is from the energy that injures, the less likely that its control would reduce injury [156].

Research designs and data analysis

Commonly used epidemiology study designs – case-control, cohort – can be used to investigate factors in injury incidence or severity. Controlled experiments are the most valid methods for research but are not used in the study of injury causation for ethical reasons, although they can be used to study certain interventions. Study designs that rule out false inferences, and the use of statistical techniques quantifying parameters that can be changed for injury control, must be learned and applied [157].

Human factors

Injury control is inordinately oriented to behavior change. Theories of behavior contain conflicting hypotheses regarding behavioral motivations and limits on individual abilities, particularly in emergency situations. Furthermore, injury rates at various stages in human development are a result of changing abilities, activities contributing to differential exposure to energy, and changing susceptibility to energy [48].

Evaluations of laws and rules directed at individual behavior

Compliance with laws or rules aimed at reducing injury is influenced by the degree of consensus regarding the justification for the law and probability of detection of a violation. If violations are not publicly observable or the behavior can be changed easily when enforcers are approaching,

the effect is diluted. Severity of punishment is less important than its prominence in political debate would indicate. Further, identifying clusters of violence, drunk driving, and other risky behavior in space and time, if revealed by surveillance, has been used to increase the efficiency and effects of law enforcement. In addition, persons at increased risk of injury less often use protection required by law, which reduces the real protection to less than would be expected technically. However, evidence does not support the theory of offsetting behavior by those who do comply (risk compensation) [158].

Evaluations of programs to change human factors voluntarily

Behavior change efforts are most successful when they decrease exposures to energy, but they are harmful if exposures are increased by interventions. Additionally, response to persuasion declines in relation to frequency of behavior necessary to reduce the risk. Further, diffusion of effort toward many behaviors dilutes the effect. Personal counseling and community-based programs, particularly if incentives are included, are more effective than impersonal approaches such as advertising [48].

Evaluation of agent, vehicle, and environment modification

Changes in agents, vehicles, and environment can be made by designers, manufacturers, and marketers of products based on research on hazardous characteristics. Also, regulations to impose standards for products and processes that cause injuries have been associated with a large reduction in death rates. Furthermore, environments may affect the behavior, in addition to exposing people to hazards. They can be modified to reduce violence as well as exposure to inanimate energy. The best studies of reduction of risk from product or environmental modifications indicate no effect on offsetting behavior, but claims for compensation are influenced by increased availability of money, above inflation, for such claims [159].

Energy characteristics and control strategies

Energy, in its various forms, is the agent of injury. Research should be focused on modification of the agent or means of exposure to the agent that will contribute most to injury control [48].

Research objective and usable data

Research questions should focus on homogeneous subsets of severe injuries and changeable factors possibly related to incidence and severity. Certain variable data sources emphasizing non-changeable factors in the same research such as age, gender, and classification are not useful [160].

Evaluation of post-traumatic maxillofacial injuries, treatment, and rehabilitation

Well-placed and organized emergency medical systems with staff experienced in treatment of traumatic facial injuries increase the probability of survival of the injured that withstand the initial energy insult. Questions remain regarding the efficiency of certain treatments at the scene of injury. However, the existence of trauma centers, where probability of survival is increased, is threatened by evolving trends in organization and financing of the medical care system. Resolution of these issues, as well as clinical trials of acute care rehabilitation regimes, would benefit from examination by epidemiological methods [161].

Traumatic maxillofacial epidemiology and economics

The results of epidemiology studies, specifying factors that can be changed to reduce injuries, can be used to project the effects of policies regarding those changes. Many current injury-control efforts are administered by government agencies and private organizations that seem to have no system for establishing priorities and no systematic knowledge of policies and programs that are effective. Additionally, those who also learn the approaches to injury control that are effective or ineffective are in a position to increase rationality in the policy-making process [159]. Further, routinely collected epidemiologic data demonstrate that injury is a substantial public health problem, but funds would be better spent (and the aims of health economics be better served) through estimation of the effectiveness, costs, and benefits associated with different injury prevention strategies, rather than on cost of injury studies [162].

Conclusions

Traumatic maxillofacial injuries in Queensland, Australia, present a clinical challenge in regard to their diagnosis, treatment plan, and prognosis to prevent deterioration or to avoid later complications. Thus, they are placing a big burden on the health care system of QLD.

Understanding the epidemiology of traumatic maxillofacial injuries is essential in trying to develop strategies that help to reduce this load as well as have immediate health effectiveness, and economic benefits as well.

Hence, interventions can reduce incidence of such injuries, and minimize their severity or con-

sequences by modifying these factors (incidence and severity) at specific phases of injury before and during the acute phase and afterward.

Conflict of interest

The author declares no conflict of interest.

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