INJURY AND ILLNESS PROFILES DURING THE 2014 SOUTH AFRICAN IRONMAN ULTRA-DISTANCE TRIATHLON

by

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DECLARATION

I, Charles Reinecke Smit, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work or any part of it has been, is being, or has to be submitted for another degree in this or any other University.

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LIST OF ABBREVIATIONS

%:	**Percentage**
°C:	**Degrees Celsius**
ACSM:	**American College of Sports Medicine**
ACE :	**Angiotensin converting enzyme**
ADH:	**Antidiuretic hormone**
ANP:	**Arterial natriuretic peptide**
CHO:	**Carbohydrate**
cTnT:	**Cardiac troponin**
CVS:	**Cardiovascular**
EAC:	**Exercise associated collapse**
EAH :	**Exercise associated hyponatraemia**
EAMC:	**Exercise Associated Muscle Cramping**
ECG:	**Electrocardiogram**
EEV:	**Emergency equipment vehicle**
EIA:	**Exercise-induced asthma**
GI:	**Gastrointestinal**
GORD:	**Gastro Oesophageal Reflux Disease**
HRT:	**Hormone replacement therapy**
IMSA:	**Ironman South Africa**
ITU:	**International triathlon union**
IV:	**Intravenous**
JVP:	**Jugular venous pressure**
km:	**Kilometre**
m:	**Metre**
Mmol/L:	**Millimole per litre**
NSAIDs:	**Non-steroidal anti-inflammatory agents**
PHE:	**Periodic health evaluation**
PPE :	**Preparticipation examination**
PPI's:	**Protein pump inhibitors**
RICE:	**Rest, Ice, Compression, Elevation**
RMD:	**Race Medical Director**
SAMF:	**South African Medicines Formulary**
SCD:	**Sudden cardiac death**

SNRI's:	**Serotonin-noradrenaline receptor inhibitors**
SRSA:	**Sport and recreation South Africa**
Tb:	**Black globe temperature**
Td:	**Ambient temperature**
Tw:	**Wet bulb temperature**
U&E:	**Urea and electrolytes**
UFS:	**University of the Free State**
URTI:	**Upper respiratory tract infection**
UTI:	**Urinary tract infection**
VOC:	**Venue operations centre**
WGBT:	**Wet bulb globe temperature**

ABSTRACT

Background: The Ironman South Africa (IMSA) is one of 28 Ironman races worldwide and is one of the most prominent events on the South African sports calendar. The 2014 event was held on the 6th of April in the city of Port Elizabeth in Nelson Mandela Bay. Even though Ironman events are among the most popular long distance triathlons worldwide, there is a need for ongoing data gathering regarding the injuries and illness profiles of athletes during events. The importance of ongoing research is highlighted by the fact that these ultra-distance athletes are exposed to environmental conditions and physiological demands in excess of those that athletes participating in individual sporting events of similar duration experience. Consequently such an event requires a well-organised medical and emergency system.

Aim: The aim of this study was to analyse the medical information of athletes that received medical attention at the 2014 Ironman South Africa (IMSA) event (N=179). Demographic information and medical histories of the athletes that participated in the event were also collected. A detailed report of the weather conditions on race day was included as additional information in this study. The IMSA medical plan was also reviewed to analyse the treatment plans, medical resources and medical personnel that provided care at the event.

Method: The study was a retrospective, cross-sectional study. Athletes that presented for medical attention and their related medical notes recorded as standard procedure during the 2014 IMSA event were included in this study. This study undertook to use the information by transferring the data recorded in the medical notes to a data collection form developed for this study. The captured data was then coded and analysed. Descriptive statistics for the measures of central tendency presenting frequency, percentages, means and averages were calculated.

Results and Recommendations: Of the 2331 athletes who started the race8% required medical attention. This number is slightly lower than data documented for recent previous IMSA events. At the 2014 event weather conditions were mild and likely played a role in a somewhat lower incidence of injury and illness among the participants. However, the incidence is comparative with international data documented for international Ironman and other triathlon events. IMSA has seen a significant increase in

participants and a 1% increase in female participation. Although analysis of the data did not find a statistically significant difference for gender between the group of athletes that did not require any medical attention on race day and the group of athletes that did require medical attention, the trend of an increasing number of female participants needs to be considered in future planning. A statistically significant difference was found for age between the group of athletes requiring medical attention and those athletes that did not. Younger athletes between the ages of 18 and24 years had the largest number of injuries (15%), followed by athletes in the 25-29 year age group (13%). IMSA also recorded an increase in novice participation in 2014 of almost 12% from the previous year. This information, together with the incidence of injury among younger athletes found in this study also deserves further consideration. Race participants, especially novice athletes, should be clearly advised on conditions that may exacerbate heat illnesses such as obesity, lower levels of fitness, dehydration, lack of acclimatisation, a previous history of heat stroke, sleep deprivation, certain medications including diuretics and antidepressants, and sweat gland dysfunction or sunburn.

Exercise/exertion related diagnoses were made in 64% of these athletes, with 72 cases of Exercise Associated Collapse (EAC)/hypotension being diagnosed. This finding is supported by literature in which EAC is consistently listed as one of the most commonly encountered medical problems during Ironman and other endurance events. A significant finding of this study also supports existing literature highlighting pre-existing injuries and medical disorders as important factors in identifying the at-risk athlete with 19% of those athletes that received medical attention during the race were on chronic medication. The prevalent use of NSAIDs both before and during the event is another significant finding of this study. This finding may highlight an important need for more comprehensive pre-participation screening and continuous medical education among athletes. Specifically pre-participation screening, the viability of pre-race seminars, and comprehensive medical education by way of more effective and detailed communication with both medical personnel and race entrants needs to be investigated.

CHAPTER 1

INTRODUCTION AND SCOPE OF THE DISSERTATION

1.1 INTRODUCTION AND SCOPE OF RESEARCH

The sport of triathlon was established in the 1970s and has rapidly increased in popularity. The Ironman distance is the most popular long distance triathlon, with tens of thousands athletes competing in order to qualify for the Ironman Hawaii each year (Strock*, et al.* 2006). The Ironman South Africa (IMSA) is one of these 28 Ironman races worldwide and is a prominent event in the South African sports calendar (IMSA, 2014a). Research indicates a need for ongoing data gathering regarding the injuries and illness profiles of athletes during these various events as these ultra-distance athletes are exposed to excessive environmental conditions and physiological demands. Consequently such events require a well-organised medical and emergency system (Andersen*, et al.* 2013; McHardy*, et al.* 2006; Strock*, et al.* 2006).

1.2 AIM OF RESEARCH

The aim of this study was to analyse the medical records of athletes that received medical attention at the 2014 IMSA competition. This data were analysed to compile injury and illness profiles of the athletes that presented for medical attention during the competition. Demographic information and medical histories of the athletes were also collected. A report of the weather conditions on race day was included as additional information in this study. The 2014 IMSA medical plan was reviewed in order to gather a comprehensive outline of the treatment plans, medical resources and medical personnel for the event. The findings of the study will be used to assist in the planning of medical care for future events.

1.3 RESEARCH QUESTIONS

In order to achieve the research aims set out as above, the following research questions were asked:

1) What are the injury and illness profiles of athletes requiring medical attention at the IMSA 2014 event?

2) What demographic, environmental and medical factors affect injury and illness presentation in these athletes?
3) Should the existing IMSA medical plan be expanded or adapted for future events?

1.4 DISSERTATION SYNTHESIS

This dissertation consists of 5 chapters. Following this introduction and statement of the aims, Chapter 2 provides an overview of the relevant literature and motivation for the research. Chapter 3 gives an account of the research method, data collection and data analysis employed to achieve the aims of the study. Chapter 4 reports on the results of the research while Chapter 5 discusses the findings drawn from the results, the implications of the findings and recommendations stemming from the research. The limitations of the study are also discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The sport of triathlon was established in the 1970s and has rapidly increased in popularity. Triathlon combines the sports of swimming, cycling, and running into a single event over various distances. The official order of events is swimming, followed by biking, and finishing with a run (Strock*, et al.*, 2006).

The first ever triathlon held in 1974 at Mission Bay in the US consisted of a 457m swim, 8km of cycling and 9.6km of running. One of the participants in this event would later become the founder of the Ironman triathlon competition in Hawaii. Held four years later, this event consisted of a 3.8km swim, followed by 180km of cycling and 42.2km of running. The Ironman on Long Island in Hawaii captured the attention of the media and the sport became increasingly popular. At the Olympic Games in Sydney in 2000, triathlon was listed as an Olympic discipline for the first time (Dallam*, et al.*, 2005).

Today triathlon events are generally divided into short ("fun") events, sprint events (750m swim, 20km cycle, 5km run), Olympic distances (1.5km swim, 40km cycle, 10km run), Ironman distances (3.8km swim, 180km cycle, 42.2km marathon), and Triple Iron events (11.4km swim, 540km cycle, 126.6km run). The Ironman distance is the most popular long distance triathlon, with tens of thousands athletes competing in order to qualify for the Ironman Hawaii each year (Strock*, et al.*, 2006).

The Ironman South Africa (IMSA) is one of 28 Ironman races worldwide and is one of the most prominent events in the South African sports calendar (IMSA, 2014a). The 2014 event was held on the 6th of April in the city of Port Elizabeth in Nelson Mandela Bay. A total of 2331 athletes entered the race and 1643participantssuccessfully completed the race. A total of 179 athletes required medical attention during the event. On race day weather conditions saw a mean wind speed of 3.0km/h, a mean temperature of 17.3ºC, and mean humidity level of 81.9% during the swim segment. During the cycling segment of the race a mean wind speed of 5.7km/h, a mean temperature of 19.3ºC, and mean humidity level of 84.2% was recorded. During the final run segment of the event race a mean wind speed of 7.6km/h, a mean temperature of 20.1ºC, and mean humidity level of

82.2% was recorded. At the IMSA 2014 there were 50 qualifying slots for the Ironman World Championship in Hawaii. The event consisted of one lap of 3.8km sea swim, two 90km laps cycling (180 km total), and a 42.2km run consisting of three 14km laps.

Even though Ironman events are among the most popular long distance triathlons worldwide and medical data is commonly recorded,there is a need for ongoing data gathering regarding the injuries and illnessprofiles of athletes during these various events(Andersen*, et al.*, 2013; McHardy*, et al.*, 2006; Strock*, et al.*, 2006).

The importance of ongoing research is highlighted by the fact that these ultra-distance athletes are exposed to numerous environmental conditions and physiological demands in excess of those that athletes participating in individual sporting events of similar duration experience. Consequently such an event requires a well-organised medical and emergency system that is both aimed at increasing the safety of competitors and at positive risk management – that is the lowering of liability risk for sponsors and event organisers (Dallam*, et al.*, 2005). Injury surveillance also provides important epidemiological information and serves to inform directions for injury prevention. Data gathered during an event, such as the IMSA, on the injuries and illnesses that triathletes present withis also useful for monitoring long-term changes in the frequency and circumstances of injurywhich is strongly recommended for multi-sport events (Junge*, et al.*, 2008).

This review will subsequently discuss the physiological demands of triathlon to provide an understanding of the types of medical conditions that medical personnel should be prepared for on race day. Further discussion of the literature regarding illness and injury profiles will also focus primarily on available data of triathlon competitions rather than overuse injuries or injury profiles of triathletes while training. The requirements for medical coverage and planning will also be reviewed.

2.2 PHYSIOLOGICAL DEMANDS OF TRIATHLON

Triathletes, particularly those who compete in the longer distance events, are exposed to a range of environmental conditions and physiological demands that have been found to exceed those of single sport athletes competing in individual sporting events of comparable duration. Participants in triathlons such as the Ironman, essentially compete in three successive endurance events with very brief transition times between them (the times of which are included in the athlete's overall race time). Competitions can last between 1 hour 50 minutes (Olympic distance), and 17 hours (cut-off time for the Ironman distance) (Jeukendrup*, et al.*, 2005). Elite male and female athletes usually complete the Ironman distance in approximately 8 – 8.5 hours and 9 – 9.5 hours respectively (Dallam*, et al.*, 2005).

In addition to the endurance aspect of ultra-distance Ironman events, the very nature of triathlon itself means that each segment of the event requires the athlete to use different primary muscle groups. The extent of the physiological demands have been noted by Dallam*, et al.* (2005) regarding cases of well-trained triathletes that are able to sustain a relative maximum oxygen consumption (VO_2 max), together with a race-specific intensity,for the duration of the race similar to that which could be expected if each of the three race segments were undertaken as separate events. These athletes are able to sustain a cardiovascular and metabolic load above the anaerobic threshold throughout the three segments of the competition. This is an occurrence that is unlikely to occur would the same athlete be competing in single sporting event with a similar time frame.Participation in a triathlon therefore places huge stresses on the cardiovascular, musculoskeletal and heat regulating systems (Mayers & Noakes, 2000).

Strock*, et al.* (2006) and Tuite (2010) noted that triathletes averaged more hours of training per week than individual swimmers, cyclists and runners, as well as a higher incidence of injury than any of the single-sport athletes. Participants in triathlon events also compete for a number of consecutive hours on race day in conjunction with training for approximately 11 - 14 hours weekly on average prior to an event (Gianole*, et al.*, 2012; Mayers & Noakes, 2000).

The International Triathlon Union (ITU) similarly emphasises that the very nature of a triathlon is unique in that it incorporates three distinct sporting events into one endurance event. Energy demands can be increased by as much as 10-15 times from resting (ITU, 2013). As a result, triathletes may present with a wide variety of medical problems during competition, including exhaustion and dehydration; muscle cramping; hypothermia; heat stroke; postural hypotension; excessive exposure to ultraviolet radiation; overuse injuries; musculoskeletal injuries and trauma; hyponatraemia; various gastro-intestinal problems; sympathetic nervous system exhaustion; and haemolysis.Although the majority of race-day injuries are minor and self-limiting, it is important for medical professionals to quickly and accurately diagnose and treat those athletes presenting with more serious medical conditions (Dallam*, et al.*, 2005; Mayers & Noakes, 2000; McHardy*, et al.*, 2006).

Medical contacts have been found to vary between 25% and 71% of participants in Ironman competitions (Alexander, 2014; Martinez & Laird, 2003).

2.3 MEDICAL CONSIDERATIONS IN TRIATHLON COMPETITION

2.3.1 Planning for medical coverage

The Safety at Sports and Recreational Events Act of 2010 (RSA, 2010) provides measures aimed at ensuring the physical well-being and safety of persons and property at sports, recreational, religious, cultural, exhibitional or similar events. IMSA as a controlling body is therefore required to have proper safety and security measures in place and meet the requirements as set out in the act. In conjunction to a Venue Operations Centre (VOC), where the entire safety and security operation of the Ironman event and route is coordinated, a designated medical facility is required that will provide medical care to the athletes participating in the event. Furthermore, in this specific document outlining the regulations governing the provision of health and medical services at mass gatherings and events in South Africa, the requirement is stated that health professionals and medical services be involved in the pre-planning phase of an event in order to provide the safest possible event.

Medical care planning and implementation at the South African Ironman is not only shaped by South African legislature, but also by specific medical guidelines of the ITU (ITU, 2013). Physicians who cover triathlon events therefore need to be involved in the pre-planning of an event and require detailed medical knowledge on the management of race site emergencies and injuries. Planning for medical coverage should commence at least six months prior to an event (Triathlon Canada, 2000).

2.3.2 Medical personnel

As set out by the ITU, a Race Medical Director (RMD) is requiredwho needs to be a medical doctor with experience in providing medical care during endurance or multi-sport events. The RMD explicitly assumes responsibility for appointing additional medical personnel for race day, organising the medical tent, and equipping it with the necessary supplies. It is also recommended that a Medical Coordinator be appointed. While it is not necessary that the Medical Coordinator be a medical doctor, the individual should have medical experience and liaise closely with the RMD. The Medical Coordinator should ensure that the supplies and personnel required on race day are at the designated, pre-planned stations and that the medical coverage runs smoothly (ITU, 2013).

In addition to the RMD, guidelines require at least 1 doctor for every 200 athletes, as well as paramedics, ambulance personnel and at least 1 paramedical person in the medical tent for every 100 athletes. Furthermore a Lifeguard Coordinator and at least 1 lifeguard for every 25 athletes in an open-water swim need to be in place. The RMD has the authority to change the requirements for personnel depending on anticipated weather conditions, number of participants, type of course and access to hospitals (Dallam, *et al.*, 2005).

The ITU (2013) and IMSA (2014b) also provide in-depth guidelines and recommendations for the following (cf. policy documents for detailed discussions):

- Course design;
- Identification of medical personnel and the medical area/tent;
- Race number, medical forms andcapturing medical information of athletes prior to race day;
- Equipment and supplies;
- Ambulances;
- Medical support vans;
- Communication systems;
- Medical records;
- Drug testing;
- Medical protocols; and
- Traffic control.

At the 2014 IMSA medical coverage comprised (IMSA, 2014b):

1) a main medical tent in the athlete's village;
2) satellite medical tent inside the transition area;
3) 3 medical beach pods during the swim leg;
4) 6 ambulances deployed at various sections of the run and cycle course for athletes;

5) 1 stationary ambulance for the public;
6) 2 roving vehicles equipped with advanced life support;
7) 1 roving motorcycle equipped with advanced life support;
8) 3 medical 4 wheelers;
9) 1 golf cart based at the transition area to assist with conveying athletes; and
10) 1 Emergency Equipment Vehicle (EEV) stationed at the main medical tent.

At the 2014 IMSA the preplanning and deployment of medical personnel was based on the expected needs that were likely to arise during the various segments of the race. Specific consideration was given to the fact that higher volumes of athletes present to the medical tent as the cut-off time looms. Two hospitals were on stand-by with the following personnel stationed at the event itself during the time-slots as set-out below (IMSA, 2014b):

- **05h30 – 12h00**
    1) *Beach during swim segment*: 4 teams consisting of a doctor, ALS and ILS medic with a quad bike; 2 stretchers and 8 stretcher bearers
    2) *Main medical tent*: 3 doctors and 9 nursing sisters
    3) *Transition medical tent*: 1 doctor, 3 nurses, 2 stretchers with 8 stretcher bearers,8 biokinetic intern students, and 4 physiotherapists
- **12H00 – 16H00**
    1) As above plus one additional doctor and 2 physiotherapists at the main medical tent
    2) 2 physiotherapists stationed in the transition area
- **16H00 – 24H00**
    1) 14 doctors, 20 nurses, 8 biokinetic interns to assist where needed, 2 biokinetisists and 2 physiotherapists
    2) 16 stretcher bearers
    3) During the period between 15h30-17h30: 4 physiotherapists in transition area and 2 in the main medical tent
    4) During the period between 17h30 and 00h00: 1-2 physiotherapists in main medical tent

In Ironman events and other triathlon events further comprehensive medical planning and risk assessment is also divided into the three specific areas of the swim segment (aquatic safety), cycle segment and cycle route safety and the running segment and running route safety (Martinez & Laird, 2003).

2.3.3 Swim segment

In most triathlon events the swim section is regarded as the potentially most dangerous segment of the event due to the possibility of accidental drowning (Laird & Johnson, 2012; Martinez & Laird, 2003). In the 2013 South African half-Ironman event in East London, two swimmers drowned, likely due to cardiac arrest (IMSA, 2013). At all triathlon events some mechanism is required to verify that all competitors have emerged from the water and have passed through the transition area.

Although the possibility of accidental fatalities is concerning, generally relatively infrequent medical complications are seen during this first segment of the race. Injury presentation in this segment has also been found to be largely influenced by environmental aspects present on the actual race day such as water and air temperature, water type, water turbulence, presence of currents, water bacterial content, presence of aquatic sea life, the presence of submerged debris at the swim entrance and exit (as well as the nature of the bottom of these points), and the possibility of accidental collisions between athletes (Dallam*, et al*., 2005).

Medical personnel should be on hand at the swim exit and should be prepared to deal with hypothermia, hyperthermia, water aspiration, drowning and near drowning, cardiovascular arrest, minor abrasions and contusions, nausea and vomiting, minor trauma, corneal abrasion, exhaustion, and jelly fish stings with rare anaphylaxis(Dallam*, et al.,* 2005; ITU, 2013). Overuse injuries are not frequently reported in the swimming segment of a triathlon event (Tuite, 2010).

Triathlon Canada (2012) note that hypothermia should be suspected in any athlete pulled from the water and that a rectal temperature must be taken in order to determine exact body temperature. Triathlon Canada (2012) further recommends that an aquatic safety plan should aim to reduce potentially dangerous situations in the swim leg by way of:

- Ensuring a safe start and transition area free of rocks and debris and that provides non-slippery footing;
- A low ratio of swimmers to lifeguards and personnel on boats;

- A safe start method (with a maximum number of 400 for a mass start);
- Requiring swimmers to wear bright caps;
- Using a square or pennant-shaped course;
- Adhering to guidelines as to the use of wetsuits; and
- A safe finish area of the swim with a narrow funnel at the finish so that all athletescan be assessed for signs of fatigue or hypothermia.

2.3.4 Cycling segment

The cycling segment of competitions present a variety of potential medical concerns, many of which arealso influenced by environmental conditions on race day, as well as the design and characteristics of the cycle course itself as it relates to potential falls or collisions. When water temperatures during the previous swim segment are very cold (5 - 15°C) the potential for hypothermia early in the cycle leg may occur (Dallam*, et al.*, 2005). However, during this section of the race dehydration and trauma from falling are among the medical problems most frequently reported (Martinez & Laird, 2003).

During competition, cycling provides the best opportunity to ingest fluids. The optimum carbohydrate (CHO) concentration in drinks seems to be in the range of 5-8% and triathletes should aim to achieve a CHO intake of 60 – 70 g/hour (Jeukendrup*, et al.*, 2005). Triathletes should attempt to limit body mass losses to 1% of body mass. In all cases a drink should contain sodium (30-50 mmol/L) for absorption and prevention of hyponatraemia.

In Ironman distances the issue of fluid intake and replacement becomes significant in this segment of the race and even more so during the subsequent running segment of such an event(Speedy*, et al.*, 2001). Specifically, the risk of hyponatraemia is an important concern(Jeukendrup*, et al.*, 2005; Laursen, 2006). Given that it is a condition associated with endurance sporting events including triathlon, this condition will be discussed in more detail under those medical concerns primarily linked to endurance sports.

The following measures can be implemented to maximise cycle route safety and reduce the risk of collisions (ITU, 2013; Triathlon Canada, 2012):

- Course design and ensuring surface quality;
- Inspection of bikes and helmets prior to the race; and

- Speedy communication and deployment of medical personnel to injured athletes in the event that a collision occurs.

2.3.5 Running segment

The medical considerations during the running segment of the Ironman race are varied (Dallam*, et al.*, 2005). However, epidemiological studies indicate that that the majority of triathlon injuries occur during this segment, likely due to the cumulative physical and mental stress of the previous two legs of the race (McHardy*, et al.*, 2006).

Heat injury is one very important area of medical risk during this section as many athletes start this final segment of the race already suffering from some degree of dehydration, fatigue and an elevated body temperature during the hottest part of the day. However, cases of hypothermia have also been reported but the likelihood of this will be dependent on environmental conditions such as the ambient temperature and relative humidity, the nature and design of the course, and the provision of fluids on the course (Dallam*, et al.*, 2005). Laird and Johnson (2012) noted that the marathon run has the highest drop-out rate, mostly due to dehydration and exhaustion, though serious medical conditions such as renal stones, intestinal ischaemia, cardiac ischaemia and hyponatremia(Martinez & Laird, 2003).

Triathlon Canada (2012) and the ITU (2013) both note that run leg safety can be improved by:

- Ensuring that participants and officials understand the risk of thermal injuries and how to minimize it;
- Assessing weather conditions on race day and taking action accordingly; and
- Providing adequate fluid stations – every 2km.

2.4 ENDURANCE ASSOCIATED INJURIES AND MEDICAL CONCERNS

2.4.1 Exercise associated collapse (EAC)

2.4.1.1 *Presentation and diagnosis*

EAC is one of the more commonly encountered medical problems during Ironman triathlon events (Mayers & Noakes, 2000). EAC can be defined as collapse in a conscious athlete (in the absence of neurological, biochemical or thermal abnormalities), who is unable to stand or walk unaided as a result of light-headedness, faintness and dizziness or syncope causing a collapse that occurs after completion of an exertional event or stopping exercise (Sallis, 2004). The ITU (2013) describes EAC as a lack of postural tone that occurs after prolonged exercise to the extent that the participant cannot walk or stand upright unaided. EAC is noted to be a common condition with incidences of between 17% and 85% documented depending on the definition of EAC used in the study (Alexander, 2014; Anley*, et al.*, 2011;Speedy*, et al.*, 2003).

EAC can be caused by one or a combination of a) electrolyte loss through sweating, b) fuel depletion within skeletal muscle, c) lactic acidosis, d) altered baroreflexes causing vaso-vagal features and e) hypothermia or hyperthermia depending on the environmental conditions (Asplund*, et al.*, 2011; Gibson*, et al.*,2013). Although dehydration leading to hyperthermia has been suggested in the past as a primary contributory factor to EAC, recent studies suggest that they can be considered to be possible risk factors rather than causal factors as such (Speedy*, et al.*, 2003).

The collapsed athlete will generally present in the medical area supported by two aides. Athletes may present as an unhealthy shade of white or grey and can appear to be near syncopal and an upright pulse and blood pressure may be unobtainable (Mayers & Noakes, 2000). Other presenting symptoms may include fatigue, muscle cramps, dizziness, nausea and vomiting, abdominal pain, diarrhoea, feeling very hot or very cold (ITU,2013).

Noakes (2006) furthermore notes that EAC on completion of an event should be distinctly differentiated from the collapse of a triathlete before the finish line as this suggests a serious cause of collapse. Also, whether or not the athlete is conscious or unconscious is the most important indicator guiding a differential diagnoses (Speedy*, et al.*, 2003; Gibson*, et al.*, 2013).

2.4.1.2 ***Management***

Once the collapsed athlete is placed on an appropriately slanted bed so that they are lying in a head down position and other possible causes of collapse are excluded, the ITU (2013) recommends the following assessment protocol:

- Mental status using the Glasgow Coma Scale;

- Heart rate, blood pressure and respiratory measures;
- Ability to take oral fluids;
- Severity of muscle cramps;
- Continuing fluid loss from vomiting or diarrhoea;
- Ability to mobilise (i.e. walk about); and
- Presence of hypothermia or hyperthermia diagnosed by a rectal (core) temperature.

In athletes who present with ominous features such as altered mental status, epileptic seizures or neurological signs, plasma sodium measurement to check for exercise associated hyponatraemia (EAH) is mandatory in addition to the core temperature measurements (Asplund*, et al.*, 2011; Noakes, 2006).

The above mentioned protocols should be aimed at establishing the severity of the athlete's symptoms. The following classifications can be used (Sallis, 2004; Mayers & Noakes, 2000) (cf. Table 2.1).

TABLE 2.1: CLASSIFICATIONS AIMING AT ESTABLISHING SYMPTOMS

BENIGN COLLAPSE	SEVERE COLLAPSE
Appearance: Conscious and alert	*Appearance* Unconscious or altered mental status
Physical Examination Results: Rectal temperature < 40°C Systolic blood pressure >100 mmHg Heart rate <100 beats per minute Weight loss 0-5%	*Physical Examination Results:* Rectal temperature >40°C Systolic blood pressure <100 mmHg Heart rate >100 beats per minute Weight gain or loss > 0-5%
Laboratory Test Results: Blood glucose = 4-10 mmol/L Serum sodium = 135-145mmol/L	*Laboratory Test Results:* Blood glucose = 4-10.mmol/L Serum sodium = <130 or >148mmol/L

The management of EAC includes (Sallis, 2004; Triathlon Canada, 2012):

1) fluid redistribution or replacement to improve cerebral or core circulation;
2) lie the patient supine and raise legs;
3) encourage oral fluids if the athlete is conscious and able to drink;
4) in athletes with an altered mental statuswhoare unable to drink, or are vomiting excessively, intravenous fluids may be provided if there is no objective evidence of EAH;
5) replace body fuel through sugary drinks or energy bars in individuals who are not vomiting;
6) treat temperature (either hypothermia or hyperthermia); and
7) treat plasma sodium.

2.4.2 Exercise Associated Hyponatraemia (EAH)

2.4.2.1 *Presentation and diagnosis*

EAH is a potentially dangerous medical condition that medical personnel managing Ironman events need to be aware of (Dallam*, et al.*, 2005; Jeukendrup*, et al.*, 2005; McHardy*, et al.*, 2006). EAH is defined as a serum sodium concentration variably of <135mmol/L and is a possible medical complication of participating in endurance events (Gibson*, et al.*, 2013). The incidence of EAH has been documented to vary from between 10% and 40% in endurance athletes. Most cases of [Na] above 130mmol/L are asymptomatic, but severe cases (serum sodium < 125mmol/L) may present with altered mental status, lethargy, confusion, or seizures and can be fatal if not diagnosed quickly and accurately (Dallam*, et al.*, 2005).

The aetiology of EAH has been a contested issue with competing theories that a) large water and sweat salt losses from prolonged exercise lead to hypovolaemic hyponatraemia, and b) that the excessive intake of hypotonic fluids causes hypervolaemic or dilution hyponatraemia (Montain*, et al.*, 2005). However, hormonal regulation of fluid and sodium status involves an intricate interplay of vasopressin (antidiuretic hormone – ADH), arterial natiuretic peptide (ANP), aldosterone and the renin-angiotensinsystem. Findings on hormonal abnormalities have noted inappropriate secretion of ADH and the subsequent retention of free water. Impaired renal functioning also plays a possible role in EAH (Noakes*, et al.*, 2004).

Anecdotal observations of Ironman triathletes fluid intake practices has lead to the hypothesis that many athletes appear to consume an excess of diluted low sodium fluids thereby gradually reducing their serum sodium concentration. This results in fluid retention, a reduced ability to sweat or absorb fluids, and in some cases a progressive weight gain and peripheral oedema. The conclusion of research to date has been that significant fluid overload is the primary cause of hyponatraemia and that the avoidance of over-drinking is the sole factor needed to prevent EAH (Hsieh 2004; McHardy*, et al.*, 2006).

EAH therefore usually presents several hours after the start of a race due to excessive fluid intake (ITU,2013). EAH was first described in 1985 and to date most cases have been found in athletes participating in endurance events lasting eight hours or more, but has also been found to occur in slower runners participating in marathon (42 km) races (Montain*, et al.*, 2006). Although Ironman competitors are generally experienced athletes with self-knowledge about their nutritional and fluid requirements, evidence suggests that overhydrating remains a common error made by many participants on race day (Mayers & Noakes, 2000).

A core temperature measurement will rule out heatstroke and athletes may present with recognisable features of fluid overload such as tight fitting rings, oedema, and clinical evidence of fluid overload such as raised jugular venous pressure (JVP) and no features of hypovolaemia (Noakes, 2006).

2.4.2.2 ***Management***

The severity of EAH needs to be determined as soon as possible (Sallis, 2004). Treatment in confirmed cases with severe symptoms such as epileptic seizures or severe mental changes that are indicative of likely worsening cerebral oedema, should be with hypertonic saline (to correct sodium to a level of 125 mmol/L over 1-2 hours and to a normal level over the following 2-4 hours). In the IMSA protocol, initiation of treatment in the medical tent is only performed under senior medical supervision while awaiting ambulance transfer of the athlete. The ITU (2013) also recommends that a bolus of 100ml 2,7% saline be administered in order to raise the sodium rapidly and prevent cerebral oedema. Up to 2 further boluses of 100 ml 2,7% saline may be administered at 10 minute intervals if there is no clinical improvement.

2.4.3 Heat illnesses

2.4.3.1 ***Presentation and diagnosis***

Exercise-induced heat stroke is a serious and life-threatening condition that triathletes competing in the ultra-distances may be susceptible to. Heat is often a greater factor in triathlon competitions than in marathons given that the running portion of a triathlon event typically only starts later in the day when it is already warmer (Strock*, et al.*, 2006). Heatstroke and exercise-associated collapse are the most likely causes of distress or collapse while exercising in hot weather. Heatstroke is characterised by a core body temperature of > 41°C, while persisting exertional hyperthermia is defined as a rectal temperature above 40°C more than 10 minutes after activity (Mayers & Noakes, 2000; Noakes, 2006).

Heat stroke may present with or without significant dehydration. In its most severe form, heat stroke presents with a rectal temperature greater than 41°C, together with an altered mental status such as lethargy, apathy, nausea, confusion, dizziness, headache, stumbling, seizures or unconsciousness, disorientation or irrational behaviour, aggression or drowsiness that may progress to a coma, organ damage and mortality if not treated promptly (Dallam*, et al.*, 2005; Noakes, 2006). The diagnosis should be made by way of a core temperature measurement on all confused athletes.

Studies indicate a clear increase in the number of athletes presenting with heat illness and collapse at endurance events with higher ambient temperatures and humidity (Holtzhausen, 2003). The amount of activity that should be undertaken in hot conditions is dependent on the wet bulb globe temperature (WGBT) (Noakes, 2006). This index is used for heat stress prediction and is calculated by way of ambient temperature (Td), relative humidity, dewpoint, wet bulb temperature (Tw), black globe temperature (Tb) and wet globe temperature (WGBT). The WGBT (0.7 Tw + 0.2 Tb + 0.1 Td) is considered to be the determining index for when activity or events should be curtailed or cancelled (Roberts, 2007).

Dallum, *et al.* (2005) and Roberts (2007) refer to specific guidelines as set out by the American College of Sports Medicine (ACSM), as well as military guidelines, regarding temperature and humidity during distance running events. Cancellation of an event is recommended with a WBGT index of more than 28°C or an ambient temperature in excess of 35°C. A WBGT index of 26-28°C requires providing warning signs as exercise associated heat stroke is high in less fit, non-acclimatised athletes. The ITU (2013) utilizes this same classification system to denote flag colours indicative of the level of risk at a specific event:

TABLE 2.2: RISK CATEGORIES IN WBGT READINGS

Risk Categories in WBGT Readings		
Flag Colour	**Heat Index**	**Risk**
Black	>28°C	Extreme
Red	23 - 28°C	High
Yellow	18 - 23°C	Moderate
Green	< 18 °C	Low

Sports physicians and other medical personnel at events should also be aware of various factors and considerations known to likely exacerbate heat illnesses (Dallam*, et al.*, 2005; Mellion & Shelton, 2002; Noakes, 2006):

- poor fitness; adequate training reduces risk;
- dehydration;
- previous history of heat stroke;
- lack of heat acclimatisation; prior training in heat promotes acclimatisation ;
- sleep deprivation;
- certain medications;
- sweat-gland dysfunction;
- sunburn or illness 1-week prior to event participation; and
- adequate fluid intake before and during an event reduces risk (though excess fluid intake over several hours may lead to dilutional hyponatraemia).

2.4.3.2 *Management*

The management and treatment of heatstroke is aimed at rapidly reducing the rectal temperature to 38°C. This can include attempts at rapid cooling such as ice-packing or immersion in a cold water tub or bath of ice water (Noakes, 2006). Research suggests that the mortality rate from heatstroke in healthy athletes should be zero if they are cooled promptly and that generally athletes can be expected to be fully recovered within 30-60 minutes of collapse in the absence of an additional, predisposing medical condition (Mayers & Noakes, 2000).

2.4.4 Hypothermia

Hypothermia is another medical consideration for triathletes that will be dependent on environmental factors such as water temperature, ambient temperature, wind or rain on race day. Hypothermia is classified as severe when the rectal or core temperature is less than 30°C, moderate between 30°C and 34°C, and mild between 34°C and 36°C (Speedy*, et al.*,2003). The hypothermic athlete usually presents with mild confusion and intense shivering, though slurred speech, ataxia, and a stumbling gait may also be observed (Sallis,2004). Medical personnel at endurance events may also need to be cognisant of the early presenting symptoms of frost bite such as numbness, burning sensation, pain and paresthesia (Koehle, 2006).

Management of the hypothermic athlete requires removing them from the cold, wet or windy conditions with gentle or minimal handling. Insulation to prevent further heat loss and nutritional and fluid support are required. Further passive or external active rewarming can be administered but internal active rewarming can only be performed in a hospital setting (Koehle,2006). Medical personnel at endurance events should be prepared to encounter both heat illnesses and hypothermia during the same event, as elite athletes and slower athletes may react differently physiologically to similar environmental conditions (Mayers & Noakes, 2000).

2.4.5 Hypoglyaemia

2.4.5.1 *Presentation and diagnosis*

Hypoglycaemia (blood glucose level <3.6 mmol/L) is not commonly encountered in endurance events though initial symptoms include sweating, headache, nervousness, tremor and hunger (Hoffmann & Hislop, 2006). Although there are no specific data regarding Ironman athletes, generally the athletes at risk are documented to be those competing in very long endurance events who fail to ingest adequate carbohydrate or who have an eating disorder. Patients with type 1 diabetes are greatly at risk if they fail to consume sufficient carbohydrates during exercise (Mayers & Noakes, 2000).

2.4.5.2 *Management*

Hoffman and Hislop (2006) suggest that at the first indication of hypoglycaemia athletes should ingest oral carbohydrates in either liquid solid or solid form, while glucose gel or tablets elicit a more rapid rise in blood glucose (Berg, 2002). Management of the semi-conscious or unconscious diabetic athlete the administration of an IV infusion of 50% glucose (Speedy, *et al.*, 2003).

2.4.6 Dehydration

2.4.6.1 *Presentation and diagnosis*

The presentation and measurement of dehydration is complex given that prolonged exercise always results in a dynamic process of body water loss (Laursen, *et al.*, 2005). However, clinical signs of dehydration include a dry mouth, decreased skin turgor, and persisting hypotension and tachycardia despite elevation of the legs and pelvis. Another helpful clinical sign of dehydration can be the inability to spit. However, it is strongly recommended that all athletes participating in endurance events undergo prerace weighing so that accurate weight change and hydration status can be determined. In this way dehydration can be determined by weight changes in addition to associated clinical symptoms (Sallis, 2004).

2.4.6.2 *Management*

Medical personnel can suspect dehydration particularly among elite runners when participating in events in extreme heat and humidity. Dehydration with of up to 10% will significantly impair an athlete's performance and can have serious health consequences. Management of dehydration should be oral fluid replacement, with IV fluids only being considered in those athletes following careful further assessment and at least presenting with a number of clinical signs such as sunken eyeballs, loss of skin turgor and dry mucous membranes. IV fluids can also be administered to the unconscious athlete, those athletes experiencing significant cardiovascular instability due to their dehydration levels and to individuals with a serum sodium concentration exceeding 130 mmol/L (Mayers & Noakes, 2000).

2.4.7 Rhabdomyolysis

2.4.7.1 *Presentation and diagnosis*

This serious but rare condition is potentially a complication of prolonged or intense exercise. Exertional rhabdomyolysisis characterised by the breakdown of skeletal muscle cells with leakage of cellular contents into serum a result of prolonged, heavy, or repetitive exercise (Martinez & Laird, 2003). The diagnosis should be suspected when acute muscle weakness, swelling or pain is noted. The athlete may also present with dark/brown-coloured urine, oliguria or anuria in severe cases. An altered level of consciousness may also be present. Special investigations that may assist in the diagnosis are an elevated creatine kinase level, high potassium and uric acid levels and myoglobin present in urine (Walsh*, et al.*, 2002).

2.4.7.2 *Management*

Rhabdomyolysis requires urgent medical care to prevent acute renal failure and possible cardiac arrest. Exertional rhabdomyolysis can often occur together with heat stroke, thereby further increasing the risk of renal failure (Mellion & Shelton, 2002). IV fluid replacement and maintenance of high urine output is of great importance (Dallam*, et al.*, 2005).

2.4.8 Exercise associated muscle cramping (EAMC)

2.4.8.1 *Presentation and diagnosis*

EAMC can be defined as a syndrome of involuntary painful skeletal muscle spasms that occur either during or after physical exercise. EAMC usually presents as painful localised muscle cramping that occurs spasmodically in different exercising muscle groups – commonly the calf, hamstring or quadriceps muscles (Schwellnus*, et al.*, 2011). Studies to date document the prevalence of muscle cramps in triathletes at Ironman distances to be between 30% and 67% either during or after competitions (Martinez & Laird, 2003).

Despite EAMC being such a common occurrence in triathletes, the aetiology and risk factors of the condition are still not well understood. However, recent studies have largely discounted traditional hypotheses that heat, severe dehydration and substantial sodium chloride lossesare the cause of EAMC. Recent theories hold that EAMC may be the result of muscle fatigue, an abnormal spinal reflex activity and participating in endurance events at a high level of pace and intensity (Martinez & Laird, 2003; Mayers & Noakes, 2000; Schwellnus*, et al.*, 2011).

2.4.8.2 *Management*

Single spasms will likely respond to stretching the relevant muscle and is often best achieved by assisted walking. Mayers and Noakes (2000) note that although no objective evidence supports the efficacy of massage and gentle stretching of the involved muscles, most athletes consider the treatment to be helpful and therefore should be offered. Repeated cramps may require treatment with fluids and carbohydrate (usually orally). In very severe cases in a collapsed runner with extremely painful cramps IV fluids and even

IV Diazepam 1-5 mg can be considered, though it will be necessary to monitor respiration in these cases. Magnesium sulphate can also be used (ITU,2013).

2.4.9 Pulmonary disorders

Exercise-induced asthma (EIA) is one of the more common pulmonary conditions found in endurance athletes and triathletes (DiDario & Becker, 2005). .Treatment of acute exacerbations in the medical tent should follow standard treatment protocols including providing salbutamol, oxygen, and steroids (Dallam*, et al.* 2005; Koyabashi & Koyabashi, 2002).

2.4.10 Cardiac disorders

Brukner and Kahn (2006) note that sports physicians need to be aware of various cardiovascular presentations associated with exercise including palpitation, syncope and chest pain, and cardiac murmur. Despite actual sudden cardiac death (SCD) being uncommon among athletes (1:50,000 – 1:100,000) it remains the single biggest challenge to sports physicians and receives significant media attention (Varro & Backzo, 2010).

Intense physical exercise in competitive athletes is known to result in adaptation of the cardiovascular system ("athlete's heart"). Structural adaptations in the heart can be due to pressure overload (commonly associated with resistance training), or due to volume overload (associated with endurance training). In endurance athletes the left ventricular end diastolic diameter increases with a proportional increase in the ventricular wall thickness (Brukner & Kahn, 2006). Varro & Baczko (2010) note that myocardial hypertrophy has been found to be more pronounced in male than in female athletes and that the degree of hypotrophy varies with different types of exercise training. In a review of existing literature, these authors also noted that the most significant increase in ventricular cavity and wall thickness (more than 75% was detected in cyclists, cross-country skiers, rowers, football players and water polo players, while weight lifters, fencers, and wrestlers were found to show milder changes - less than 50%).

Studies are ongoing as to whether actual cardiac damage occurs as a result of prolonged strenuous exercise, though "athlete's heart" remains an important risk factor for SCD (Varro & Baczko, 2010). Similarly a recent study found increased levels of cardiac troponin T (cTnT) of clinical significance among a group of Ironman athletes (Tulloh*, et* *al.*, 2006). Although echocardiographic evidence of abnormal left ventricular functioning was also found, the clinical significance and long-term effects of these observations remain to be determined. Generally it is expected that normal compensatory hypertrophy reverses after a 2-3 month sports activity free period (Varro & Baczko, 2010).

Brukner and Kahn (2006) also note that the likelihood of any specific cardiac condition being the cause of sudden death has been found to vary according to the age of the athlete. These authors subsequently recommend dividing athletes into two groups – those under the age of 35 years and those over the age of 35 years. Moreover, death in younger athletes is more likely to be attributed to a pathological, congenital cardiovascular lesion (most commonly hypertrophic cardiomyopathy), compounded by the effects of compensatory hypertrophy (athlete's heart) (Varro & Baczko, 2010). The leading cause of sudden death in athletes over 35 years has been found to be more commonly due to mitral valve prolapsed, acquired valve disease and hypertrophic cardiomyopathy (Brukner & Kahn, 2006). Additional rare risk factors include genetic defects leading to cardiac repolarisation disturbances, medications that can lead to polarisation prolongation (including frequently used non-cardiac drugs such as H1 antihistamines and antibiotics), the use of steroids, and unknown cardiac electrophysiological effects of special diets, vitamins and supplements used by many competitive athletes (Varro & Baczko, 2010).

However, the occurrence of actual cardiac emergencies is rare during endurance events, although those that do occur have been found to occur during the competition itself, rather than at the finish line (Dallam*, et al.*,2005). In the case of a cardiac emergency, standard cardiac arrest protocol should be followed. Successful resuscitation may also require treatment for hypovolaemia and hypoglycaemia in triathletes (ITU, 2013).

2.4.11 Gastrointestinal disorders

Several disorders can be commonly found in high-performance athletes (Jeudenkamp*, et al.*, 2005). These include gastrointestinal (GI) bleeding, epigastric pain from ischaemic gastritis, gastro-oesophageal reflux, abdominal pain from colic disorders, mesenteric ischaemia due to reduced splanchnic blood flow, and 'caecal slap syndrome' or repeated microtrauma of the caecum against a hypertrophied abdominal wall (Dallam*, et al.*, 2005).

Dietary intake also seems to play a role in the symptoms that Ironman triathletes may experience during the competition (Jeudenkamp, *et al., 2005*). For example, eating within 30 minutes of the start of an event has been found to lead to vomiting in many athletes during the swim segment of the race. The type of prerace meal and drinking of hypertonic beverages has also been linked to a higher incidence of nausea and vomiting. Treatment and management should be symptomatic (Cox*, et al.*, 2010; Dallam*, et al.* 2005).

2.4.12 Dermatologic injuries

Prolonged sun exposure occurs at most Ironman events and although sunburn can develop, the acute injury is usually self-limiting and the treatment should focus on the prevention of the long-term problems associated with sun exposure. Blisters and chaffing are other common skin problems caused by excessive friction and ill-fitting shoes (Dallam*, et al.*, 2005; Mayers & Noakes, 2000). Blisters should only be drained under aseptic conditions and the skin left in place. Subungual haematomas (black nails) should be referred for treatment after the race (ITU, 2013).

2.5 CONCLUSION

There is still much data needed to be gathered regarding the injuries and illnesses profiles of Ironman athletes during events (Andersen*, et al.*, 2013). As discussed, the importance of ongoing research is highlighted by the fact that ultra-distance athletes are exposed to environmental conditions and physiological demands in excess of those that athletes participating in individual sporting events of similar duration experience (Dallam*, et al.*, 2005; Jeukendrup*, et al.*, 2005). Injury surveillance will also provide important epidemiological information as well as informing directions for injury prevention. Data gathered during an event on the injuries and illnesses will also allow for monitoring long-term changes in the frequency and circumstances of injury (Junge*, et al.*, 2008). However, the paramount goal for triathlon events is to ensure that a well-organised and effective medical and emergency system is in place that is informed by up-to-date research in order to increase the safety of competitors (Holtzhausen & Noakes, 1998).

CHAPTER 3

RESEARCH METHODS

3.1 AIM

The aim of this study was to analyse the medical records of athletes that received medical attention at the Ironman South Africa (IMSA) competition that was held in Port Elizabeth on the 6th of April 2014. The data were analysed to compile injury and illness profiles of the athletes that presented for medical attention during the competition. The outcomes of the studywill be used to assist in planning future events of this nature.

3.2 METHODS

3.2.1 Design of the study

The study was a retrospective, cross-sectional descriptive study.

3.2.2 Study participant

The study population in this study were all the competitors (n=2331) who participated in the 2014 IMSA event. The research sample itself comprised those athletes that required medical attention at the medical tents during the event (n=179).

3.2.3 Inclusion criteria

Athletes that presented for medical attention and their related medical notes recorded as standard procedure during the 2014 IMSA event were included in this study.

3.2.4 Exclusion criteria

The clinical notes and medical information of spectators and staff that were treated at the medical facility that were recorded as standard procedure during the 2014 IMSA event were excluded from this study.

3.3 PROCEDURE

When an athlete presented for medical attention during the IMSA event, their data and race number were logged electronically. Following this, standard medical notes (cf. Appendix A) for all of these athletes were completed. This means that a standardised data gathering procedure was used. This study undertook to use the information by transferring the data recorded in the medical notes to a data collection form developed for this study (cf. Appendix B). The captured data werethen coded and analysed.

3.4 MEASURMENT

3.4.1 Measurement instruments

The primary measuring instrument in this study was the data collection form as described in Section 3.3 (cf. Appendix B). This form was anonymous.

3.4.2 Collection of data

As described in Section 3.3, the medical information of all athletes requiring medical attention was documented as a standard procedure at all IMSA events. Demographic information and medical histories of all the athletes that entered the event were also collected. Once again, as standard procedure mandated for the IMSA event, all athletes are required to submit this information prior to race day.

All medical doctors on the IMSA medical team were briefed prior to the event regarding the proper completion of all sections of the medical forms and regarding the medical protocols to be followed in cases of injury and illness. The completed medical forms were obtained from the Race Medical Director (RMD) of the IMSA after the event.

As discussed in Chapter 2, risk for injuries and illness in triathlon competitors is strongly influenced by environmental conditions such as ambient temperature, water temperature and turbulence, humidity and wind speed. An increased risk and higher incidence of medical contacts are commonly seen under more extreme environmental conditions (ITU, 2013). A detailed report of the weather conditions on race day was obtained from the RMD and included as additional information in this study. Furthermore, the 2014 IMSA medical plan (cf. Appendix C) was reviewed in order to gather a comprehensive outline of the treatment plans, medical resources and medical personnel that provided the medical care at the event.

3.4.3 Measurement errors

All medical contacts were required to be logged electronically and systematically throughout the event, allowing for all participants that met the inclusion criteria to be included in the study. In order to further minimise the risk of poor data collection, all medical staff at the 2014 Ironman was briefed prior to the event regarding completion of the medical forms and medical treatment protocols and specific diagnostic algorithms to be followed. The researcher and study supervisor were both available during the event to assist in completion of routine medical forms. In order to prevent inter-observer bias only the principal researcher captured the data.

3.5 STATISTICAL ANALYSIS

Statistical analysis was done by the Department of Biostatistics, UFS, using SAS version 9.3.Descriptive statistics for the measures of central tendency presenting frequency, percentages, means and averages were calculated. The level of statistical significance was set at 0.05when comparing differences between injuries and other variables.

3.6 ETHICAL CONSIDERATIONS

Permission for the study was obtained from the Medical Ethics Committee of the Faculty of Health Sciences, UFS (Ethics approval number ECUFS 119/2014) (cf. Appendix D). Consent was obtained from the RMD of the 2014 IMSA, Dr. K. Von Hagen, prior to the conceptualisation of this study (cf. Appendix E).

Data weretranscribed from the Ironman Medical Forms (cf. Appendix A) to a confidential data collection form thereby ensuring the anonymity of all study participants (cf. Appendix B).

CHAPTER 4

RESULTS

4.1 INTRODUCTION

In this chapter, the data on the frequency and type of medical care at the IMSA 2014 event are described. Data are summarised by means of description, tables, figures and frequency distributions.

4.2 DEMOGRAPHIC DATA

4.2.1 Population

A total of 2331 athletes started the 2014 IMSA competition. During the event a total of 179 athletes (8%) required medical attention.

4.2.2 Gender

Of the 2331 athletes who entered the race, 1911 (82%) were male and 420 were female (12%). Of the total number of competitors, 7% of the total number of male athletes and 9% of the total number of female athletes required medical attention.

As shown below in table 4.1, of the 179 athletes who required medical attention, male athletes comprised 89% (n = 141) and female athletes 21% (n = 38).

TABLE 4.1: GENDER DISTRIBUTION OF ATHLETES REQUIRING MEDICAL ATTENTION

GENDER	INJURED	NOT INJURED
Female	38 (9%)	382 (91%)
Male	141(7%)	1770 (93%)
Total	179 (8%)	2152 (92%)

This data were analysed further and Fischer's exact test was performed. The difference between the group of athletes that required medical attention on race day and the group of athletes that did not require medical attention for the biographical variable of gender was found not to be statistically significant (ϕ= 0.024).

4.2.3 Age of participants

The mean age of the athletes that received medical attention on race day was 37.7 years with a standard deviation of 8.4 years. Ages ranged from 21 years of age to 63 years of age. This data are presented in Figure 4.1.

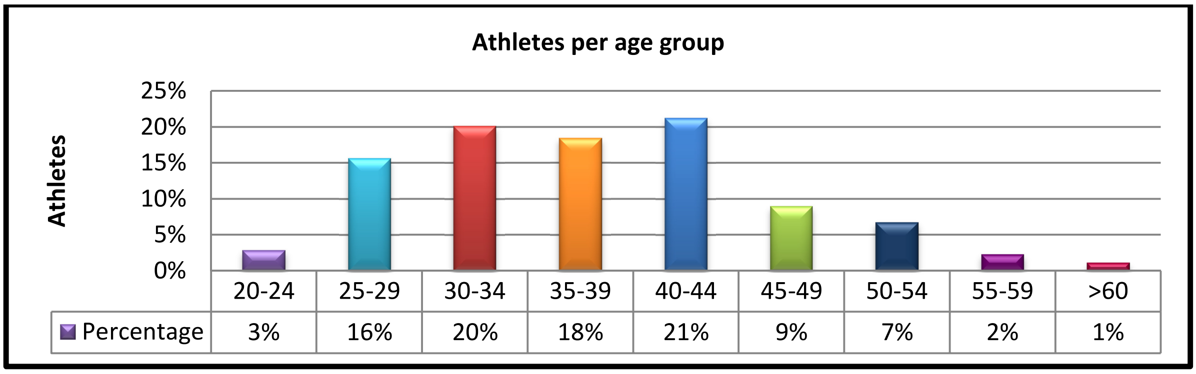

FIGURE 4.1: FREQUENCY DISTRIBUTION OF AGE OF ATHLETES REQUIRING MEDICAL ATTENTION

Fischer's exact test was also performed on this data regarding the difference between the group of athletes that required medical attention and the group of athletes that did not. As can be seen below in Table 4.2, a statistically significant difference was found for this biographical variable of age (ϕ= 0.086). Younger athletes between the ages of 18-24 years had the highest number of injuries (15%), followed by athletes in the 25-29 year age group (13%). Interestingly, in the over 65 year age group no injuries were reported.

TABLE 4.2: BIOGRAPHICAL VARIABLE OF AGE

AGE GROUP	GROUP 1	GROUP 2	NUMBER OF ATHLETES
18-24	5	29	34
25-29	28	191	219
30-34	36	410	446
34-39	33	410	443
40-44	38	503	541
45-49	16	308	324
50-54	12	191	203
55-59	4	83	87
60-64	2	24	26
65+	0	8	8

4.3 RACE INFORMATION

4.3.1 Segments of IMSA and cut-off times

At the 2014 IMSA event the cut-off time for the swim segment was 2 hours 20 minutes after race start, while the cut-off time for the cycling segment was 10 hours 30 minutes from race start. Finally, cut-off for the marathon segment of the events was 17 hours from the start.

4.3.2 Weather conditions

During the swim segment conditions the average wind speed was recorded at 3 km/h and the temperature measured 17.3°C, with the humidity at 81.5%. During the cycling segment of the IMSA 2014 race wind speed measured at 6.1km/h on average and the average temperature recorded was 19.7°C. The average humidity level was 84.3%. During the running segment the temperature averaged at 20°C with an average wind speed of 7.8 km/h and average humidity levels recorded at 82.3%. Figure 4.2 below summarises this data.

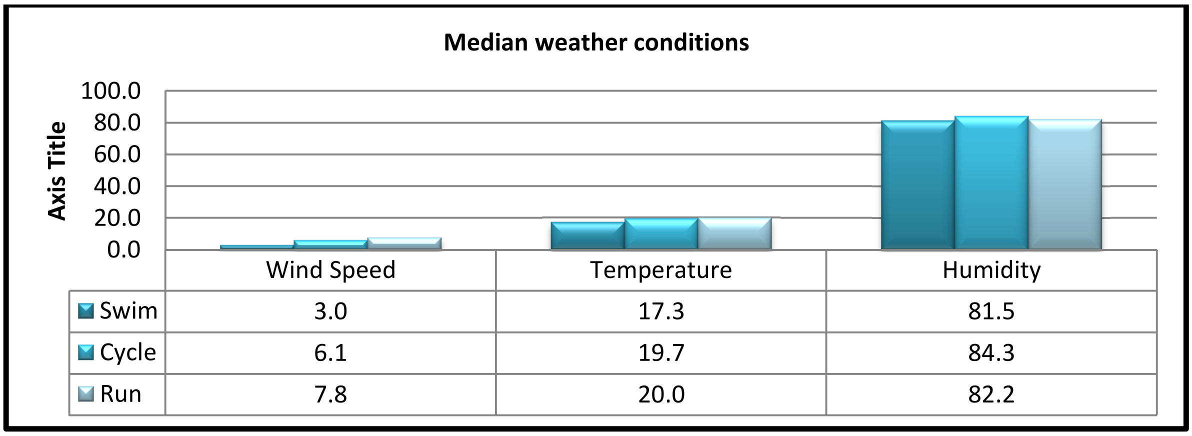

FIGURE 4.2: WEATHER CONDITIONS DURING DIFFERENT STAGES OF THE 2014 IMSA

4.3.3 Time of presentation for treatment

Information regarding the time slots that the athletes presented for treatment is depicted in Figure 4.3.

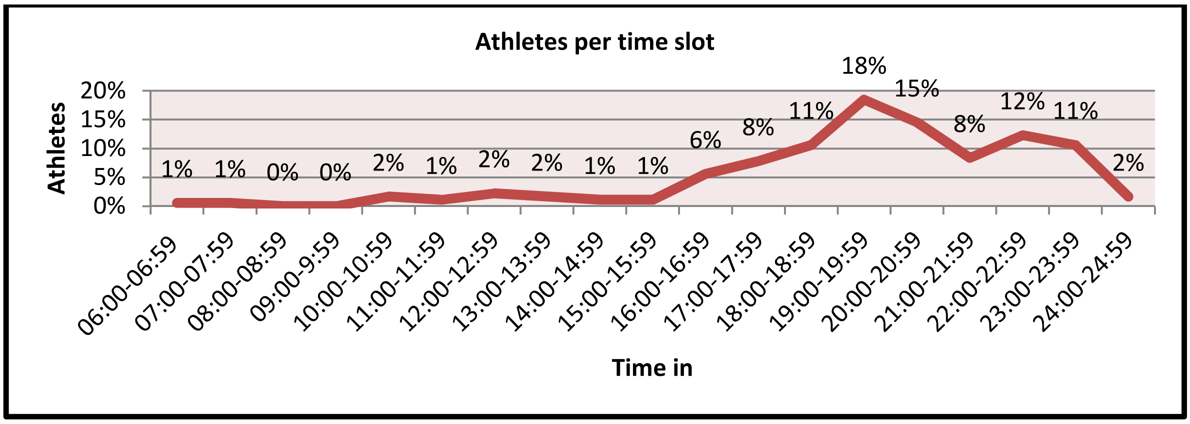

FIGURE 4.3: DISTRIBUTION OF MEDICAL CONTACTS PER TIME OF DAY

The largest percentage of athletes (n=33; 18%) presented to the medical facility between the time period of 19h00 and 19h59. During the next hour, 26 (15%) of the athletes were seen. The time span between 18h00 and 18h30 saw 11% of the athletes presenting for medical assistance. There is a clear increase in athlete presentation from 16:00, which remained high until approximately 23:00.

4.3.4 Duration of stay in medical facility

The duration of stay in the medical facility ranged from two to 161 minutes per patient. The duration of stay in the medical facility are presented as quartiles of the population. Twenty five percent (n=40) of athletes visiting the medical facility, stayed for a duration of between 2 and 16 minutes. A further 25% (n=37) had a duration of stay of between 17 and 26 minutes. The third 25% (n=39) of athletes stayed between 27 and 42 minutes, and the final 25% (n=39) stayed between 43 minutes and 161 minutes. The discharge times of 24 athletes were not recorded. The median duration of stay was therefore 26 minutes.

4.3.5 Stage where athletes quit due to medical reasons

Table 4.3 shows the part of the race during which the athletes presented with medical complications. By far the most athletes requiring medical attention (n=129; 72%) completed the race before seeking medical attention. The second highest number of presentations to the medical facility came from the cycling section (n=17; 9%).

TABLE 4.3: STAGES OF RACE COMPLETED

AT WHICH STAGE ATHLETES STOPPED DURING THE RACE		
Stop during	**Percentage**	**Athletes**
Swim	1%	2
Stopped at 1st transition	0%	0
Stopped during cycling	9%	17
Stopped at 2nd transition	2%	4
Stopped during marathon	5%	9
Completed the race	72%	129

4.4 PRE-RACE MEDICAL CONDITIONS AND MEDICATION USE

4.4.1 Use of chronic medication

Use of chronic medication was reported by 19% of the athletes that received medical attention during the race (n=34). The total number of medications used is more than 34 because of multiple medications used by some athletes. Data for four of the athletes regarding the use of chronic medication were found to be missing on analysis of the data. The most common chronic medications used were asthma medications and anti-hypertensives. Detailed data regarding the categories of chronic medication used are summarised in Table 4.4.

TABLE 4.4: CHRONIC MEDICATION USE DURING THE IMSA 2014

CHRONIC MEDICATION ATHLETES USED		
Medication	**Percentage**	**Athletes**
Asthma	5%	9
Antihypertensives	4%	7
Thyroid replacement therapy	3%	5
Anti-depressants	2%	4
Protein pump inhibitors (PPI's)	2%	4
Statins	2%	3
Allopurinol	1%	2
Antihistamines	1%	1
Aromatics Medicine	1%	1
Hormone Replacement Therapy (HRT)	1%	1
Insulin	1%	1
Non steroidal anti-inflammatory (NSAIDs)	1%	1
Serotonin noradrenline receptor inhibitors (SNRI's)	1%	1
Stimulants	1%	1

4.4.2 Use of medication three days preceding the race

The medication used by athletes requiring medical attention in the three days preceding IMSA 2014 is listed in Table 4.5. Of the 179 athletes, 36% (n=63) reported using medication in the last three days before the race, while 64% did not (n=111). Further analyses of the data found missing data for 5 of the athletes. The total number of medications used is more than 63 because of multiple medications used by some athletes. The most common medications used in the three days preceding the race were NSAIDs (n=22; 12%), analgesics (n=10; 6%), antibiotics (n=7; 4%) and cold and flu medication (n=5; 3%).

TABLE 4.5: MEDICATION USED BY ATHLETES 3 DAYS PRECEDING IMSA 2014

MEDICATION ATHLETES USED 3 DAYS BEFORE THE RACE		
Medication	**Percentage**	**Athletes**
NSAIDs	12%	22
Painkillers	6%	10
Asthma	4%	8
Antibiotics	4%	7
Antihypertensives	3%	5
Colds and flu	3%	5
Antinausea/vertigo tablets	2%	4
Antidiarrhoeal medication	2%	4
Antidepressants	1%	3
Antihistamines	1%	2
Muscle relaxants	1%	2
PPI's	1%	2
Statins	1%	2
Vitamin supplements	1%	2
Allopurinol	1%	1
Aromatic medicine	1%	1
Cortisone	1%	1
Insulin	1%	1
Melatonine sleeping tablets	1%	1
Salt tablets	1%	1

4.4.3 Use of medication during the race

Similar information regarding the athletes' use of medication during the IMSA event was also recorded (cf. Table 4.6). The results show that 35% of athletes requiring medical attention reported the use of some form of medication during the race (n=61), while 65%

of the athletes did not use any medication during the event (n= 113). The total number of medications used is more than 61 because of multiple medications used by some athletes. Further analysis of the data found missing data for 5 athletes.

TABLE 4.6: MEDICATION USE DURING IMSA 2014

MEDICATION ATHLETES USED DURING THE RACE		
Medication	**Percentage**	**Athletes**
NSAIDs	16%	28
Analgesics	14%	25
Anti-diarrhoeals (Imodium™ and Pectrolyte™)	4%	7
Muscle relaxants	4%	7
Anti-nausea/vertigo/abdominal cramp tablets (Valoid™, Buscopan™ and Zofar™)	2%	4
Crampease™	2%	3
Antacids	2%	3
Magnesium tablets	1%	2
Salt tablets	1%	2
Asthma meds	1%	2
Antihypertensives	1%	1

4.5 RECENT ILLNESS OR INJURIES

Data was also gathered regarding acute illness in the last 30 days before the IMSA 2014. It was recorded that 28% (n=48) of the group of athletes requiring medical attention suffered from a recent illness. The majority of athletes (72%) reported no recent illness (n=125), with missing data for six of these athletes. Thirty six athletes (20%) had an upper respiratory tract infection (URTI) in the 30 days preceding the IMSA 2014. Further detailed information regarding the types of illnesses recorded for this group of athletes is summarised and presented in Table 4.7.

TABLE 4.7: ILLNESS AMONGST ATHLETES REQUIRING MEDICAL ATTENTION IN THE 30 DAYS PRECEDING IMSA 2014

RECENT ILLNESS AMONGST ATHLETES		
Illness	**Percentage**	**Athletes**
URTI	20%	36
Gastro-enteritis	3%	5
Lower back pain	2%	3
Tick bite fever	1%	1
Urinary Tract Infection (UTI)	1%	1
Pulmonary emboli	1%	1
Other Infection	1%	1

4.6 MAIN COMPLAINT ON PRESENTATION AT THE MEDICAL FACILITY

Important information regarding the main complaints of athletes requiring medical attention was collected. This data were categorised and are summarised in Table 4.8. Thirty main complaints were recorded among the 179 athletes. The most common complaint (n=75; 42%) was nausea, with a further 22 athletes (12%) presenting with vomiting.

As can be seen in Figure 4.4, gastrointestinal complaints were the most common when grouped together (n=101) at 56%, followed by neurologic complaints (n=73) at 41% (mostly dizziness and subjective reports of confusion), musculoskeletal complaints (n=34) at 19%, and metabolic complaints (n=24) at 13%. Various types of skin complaints were reported by 13 athletes (7%) while seven athletes complained of cardiovascular and respiratory symptoms (4%). One complaint of a bee sting was recorded (though later two diagnoses of bee stings would be made). These clinical categories of complaints are summarised in their various categories in Figure 4.4.

TABLE 4.8: MAIN COMPLAINTS OF ATHLETES REQUIRING MEDICAL ATTENTION (table continues on next page...)

MAIN COMPLAINTS OF ATHLETES		
Main complaints	**Percentage**	**Athletes**
Nausea	42%	75
Dizziness	36%	64
Vomiting	22%	39
Muscle cramps	12%	22
Abdominal cramps	10%	18
Exhaustion	8%	15
Confusion	6%	10
Diarrhoea	4%	8
Skin abrasions	3%	6
Headache	3%	6
Shortness of breath	3%	6
Blisters	2%	4
Fatigue	2%	4
Feeling cold	2%	4
Lower back pain	2%	4
Syncope	2%	4
Abnormal urine	2%	3
Painful leg	1%	2
Painful calf	1%	2
Dehydration	1%	2

Painful shoulder	1%	2
Thirsty	1%	1
Abscess	1%	1
Skin rash	1%	1
Painful ankle	1%	1
Bee sting	1%	1
Low blood pressure	1%	1
Painful foot	1%	1
Painful knee	1%	1
Sun burn	1%	1
Heartburn	1%	1
Seizures	1%	1

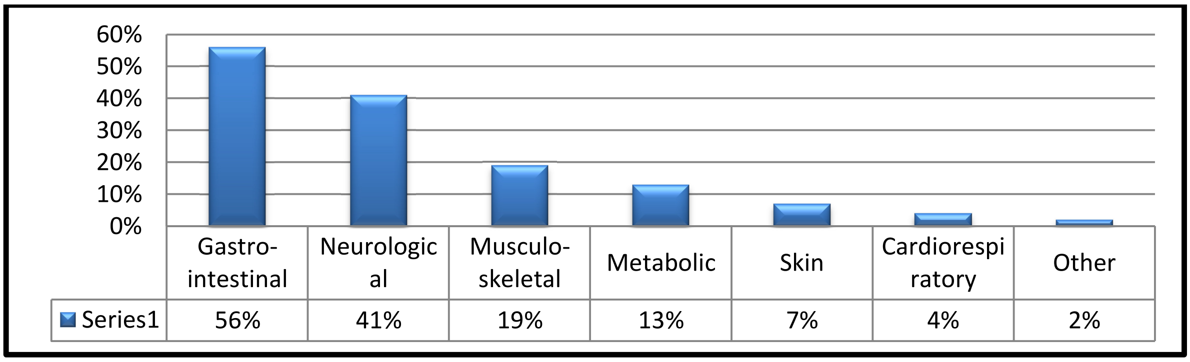

FIGURE 4.4: MAIN COMPLAINTS ACCORDING TO SYSTEM

4.7 CLINICAL FINDINGS AND VITAL SIGNS

The clinical findings and vital signs of athletes requiring medical attention were recorded. Concerning the level of consciousness, the vast majority of athletes (98%) were alert and orientated, with 2% of the athletes documented as being "verbally responsive" on the clinical notes. No athletes were recorded as being only pain responsive or unresponsive. Missing data were found for 17 athletes in this regard.

4.8 CLINICAL DIAGNOSES OF PATIENTS REQUIRING MEDICAL ATTENTION

The diagnoses that were made for each of the athletes that required medical attention during the IMSA 2014 event were also recorded. It should be noted that more than one diagnosis was recorded for some athletes on the medical forms. This information is summarised in Table 4.9.

TABLE 4.9: CLINICAL DIAGNOSES OF ATHLETES REQUIRING MEDICAL ATTENTION

PATIENT DIAGNOSIS DURING IRONMAN		
Diagnosis	**Percentage**	**Athletes**
Exercise Associated Collapse (EAC)/Hypotension	40%	72
Dehydration	11%	20
Nausea	7%	13
Trauma	7%	13
Exertion	6%	11
Muscle cramps	6%	11
Hypothermia	6%	11
Skin rash	6%	10
Blisters	4%	7
Gastritis	3%	6
Gastroenteritis	3%	6
Hyponatreamia	3%	6
Hypoglyceamia	3%	5
Lower back pain	2%	4
Achilles Tendinitis	1%	2
Bee sting	1%	2
Celulitis	1%	1
Arial fibrillation	1%	1
Peroneal tendinitis	1%	1
Cervicogenic headache	1%	1
Asthma	1%	1
Urine discolouration	1%	1
Patello femoral pain	1%	1
Shoulder dislocation	1%	1
Sun burn	1%	1
Iliotibial band	1%	1
Bronchospasm	1%	1
Gastro oesophageal reflux	1%	1
URTI	1%	1
Pulmonary emboli	1%	1
Salt water ingestion	1%	1
Hyperthermia	1%	1

The most common diagnosis during the IMSA 2014 was EAC or postural hypotension. Seventy-two athletes (40% of all admissions to the medical facility) suffered from this condition. The second most common diagnosis was dehydration (n=20; 11%).

The diagnoses were also further grouped into affected systems. Once again it is important to note that several athletes had more than one diagnosis.

As shown in Figure 4.5, the most common grouping was the category exercise/exertion-related diagnoses. This diagnosis was made in 115 cases (64%). Gastro-intestinal conditions (n=27) accounted for 15%, while musculoskeletal (non-trauma) conditions (n=22) accounted for 12%. Skin conditions (n=19) and trauma (n=19) accounted for 11% of the diagnoses made on race day respectively. Cardiovascular/respiratory (non-exertion) related conditions (n=5) represent 3% of diagnoses. The remaining diagnoses (other) (n=3), represent 2% of the diagnoses made for the athletes. Data was found to be missing in two cases.

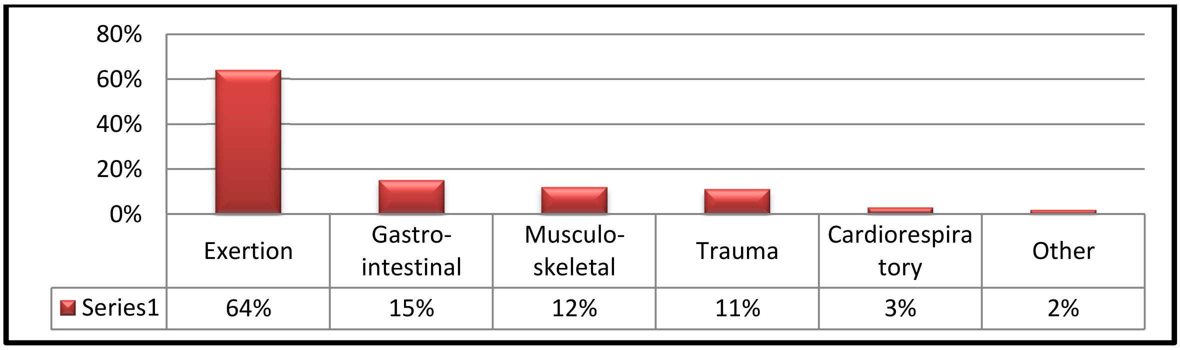

FIGURE 4.5: CLINICAL DIAGNOSES ACCORDING TO AFFECTED SYSTEMS DURING IMSA 2014

4.8.1 Exertion-related conditions

The various types of exercise/exertion-related diagnoses (n=126) made are depicted in Figure 4.6.

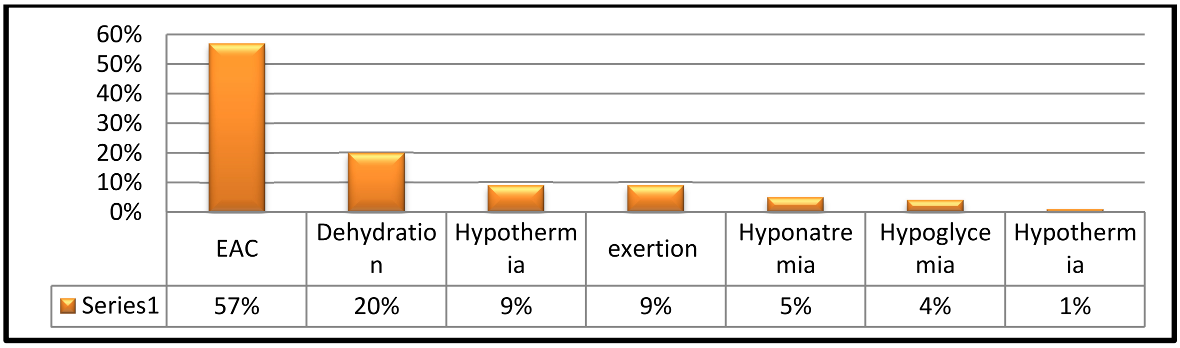

FIGURE 4.6: EXERTION-RELATED DIAGNOSES DURING IMSA 2014

As shown in Figure 4.5, there were 72 diagnoses of EAC/hypotension. This diagnosis comprises 57% of the total number of exercise/exertion-related diagnoses made. Diagnoses of dehydration (n= 20) accounted for 16% of exercise/exertion-related diagnoses made. Diagnoses of hypothermia (n=11) and exertion (n=11) accounted for 9% of diagnoses made in this category respectively. A diagnosis of hyponatraemia was made in 6 athletes and accounted for 5% of exercise/exertion-related diagnoses made. Hypoglycaemia (n=5) accounted for 4% of exercise/exertion-related diagnoses, with hypothermia (n=1) accounting for less than1%.

4.8.2 Gastro-intestinal diagnoses

Nausea and vomiting accounted for nearly half of the gastro-intestinal diagnoses (48%). Gastroenteritis and gastritis accounted for 22% respectively. One diagnosis of salt water ingestion was made. One athlete was diagnosed with Gastro Oesophageal Reflux Disease (GORD).

4.8.3 Musculo-skeletal diagnoses

Exercise-associated muscle cramps (EAMC) was the most common musculo-skeletal diagnosis with 11 cases (50%). Overuse tendinopathy collectively accounted for 23% of musculoskeletal diagnoses (n=5), while four cases of mechanical back pain were noted (18%). One diagnosis of shoulder dislocation and one of neck spasm were made.

4.8.4 Trauma diagnoses

Diagnoses of lacerations and skin abrasions were made in 11 cases, representing 58% of trauma diagnoses. Various sprains and strains were diagnosed in six athletes (67% of trauma diagnoses) and two athletes (11%) were diagnosed with concussion.

4.8.5 Skin diagnoses

Ten skin conditions were diagnosed during IMSA 2014. Seven cases (70%) of these were blisters, and one case of sunburn, rash, and cellulitis/infection respectively.

4.8.6 Cardiovascular / Respiratory diagnoses

Five patients presented with cardiorespiratory conditions. Two of these (40%) were asthma and bronchospasm. One case of pulmonary embolism, atrial fibrillation and URTI respectively were also recorded.

4.8.7 Other diagnoses

Two diagnoses of bee stings and one of urine discolouration of unknown origin were made.

4.9 SPECIAL INVESTIGATIONS

The special investigations performed on some of the athletes on race day are summarised and presented in Figure 4.7. Blood glucose testing was performed on 85% (n=152) of the athletes while blood gas and U&E were done in 30% of the athletes respectively (n=54). ECGs were done in 2% of the athletes (n=4).

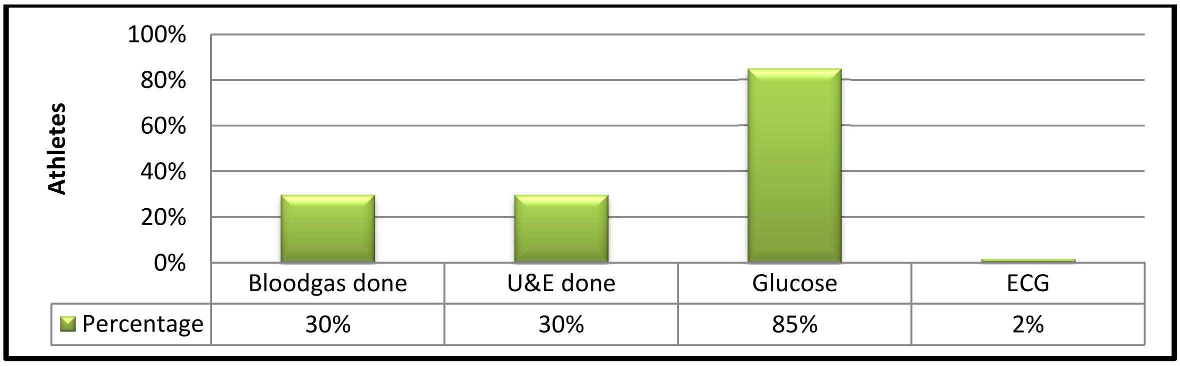

FIGURE 4.7: SPECIAL INVESTIGATIONS DONE DURING IMSA 2014

4.10 CONCLUSION

This chapter presented descriptive data on the extent and type of medical care during IMSA 2014. The main findings were:

- A total of 2331 athletes started the race and 179 (8%) athletes required medical attention;
- Male athletes comprised 79% of the total number of athletes requiring medical attention (n= 141) and female athletes 22% (n= 38);
- The mean age of the athletes that received medical attention on race day was 37.7 years with a standard deviation of 8.4 years;
- A statistically significant difference was found for age between the group of athletes requiring medical attention and those athletes that did not - younger athletes between the ages of 18 and24 years had the largest number of injuries (15%), followed by athletes in the 25-29 year age group (13%);

- Most injuries were minor and self-limiting but athletes presented with a wide variety of medical problems;
- The majority of athletes (72%) requiring medical attention presented at the finish line on completion of the running segment;
- The largest percentage of athletes (18%) presented between the time period of 19h00 and 19h59, with only a maximum of 2% of athletes presenting prior to 16h00
- 19% of the athletes that required medical attention were using chronic medications with the most common medications being asthma medications and anti-hypertensives
- 36% of the athletes had used medication in the three days prior to race day with NSAIDs being the most commonly used (12%) followed by analgesics (10%), antibiotics (4%) and cold and flu medication (3%);
- 35% of the athletes used medication during the race with NSAIDs being most common (16%), followed by the use of analgesics (14%) and anti-diarrhoeals and muscle relaxants (4% respectively);
- 28% of the athletes reported to having a recent illness;
- Gastro-intestinal complaints were most common and almost all athletes were alert, responsive and orientated on presentation;
- The most common diagnoses made were exercise/exertion-related diagnoses such as EAC/hypotension and dehydration, followed by various gastrointestinal conditions; and
- A diagnosis of EAH was made in 6 athletes.

The results are discussed further and subsequent recommendations made in Chapter 5.

CHAPTER 5

DISCUSSION OF RESULTS

5.1 INTRODUCTION

The sport of triathlon is unique in that it incorporates three distinct sporting events into one gruelling endurance event, with competitors commonly presenting with a wide variety of medical problems on race day. While research indicates that medical problems and injuries are generally minor and self-limiting, it remains vital that medical professionals are able to quickly identify, accurately diagnose, and treat those athletes presenting with more serious medical conditions (Dallam, *et al.*, 2005; Mayers & Noakes, 2000; McHardy, *et al.*, 2006). In this chapter, data regarding the injury and illness profiles of athletes at the 2014 Ironman South Africa (IMSA) triathlon event are discussed and recommendations made regarding the medicalplanning for IMSA and other similar events.

5.2 INCIDENCE AND BIOGRAPHICAL CHARACTERISTICS – DISCUSSION AND IMPLICATIONS FOR PLANNING

IMSA, as with most other medical care teams, relies on historical data collected from previous events to plan the medical facility and services for a race. This planning requires data on the predicted number of casualties, the nature of the casualties and their severity (Ewert, 2007; Holtzhausen & Noakes, 1998).

During the IMSA 2014 event, out of the 2331 athletes who started the race, a total of 179 (n=179) athletes required medical attention (8%). This number is slightly lower than data documented for the 2013 IMSA event of 10.1% (n=156) (IMSA, 2013), and by Alexander (2014) regarding the 2011 IMSA competition with an incidence of 10.3% (n=183). These results are however comparative with international data regarding the incidence of injury and illnesses during Ironman and other triathlon events. Laird and Johnson (2012) recorded data over a number of years for the Kona Ironman in Hawaii and found that generally about 90% of participants completed that event. A number of similar studies note a treatment presentation rate of between 2% and 15% (Martinez & Laird, 2003). Although some reviews have documented medical contacts of between 15% and 30% (Holtzhausen & Noakes, 1998), comparison of these studies indicates that either extreme or adverse weather conditions on race day may account for the range of reported medical contacts as well as the types of injuries recorded (Dallam, *et al.*, 2005).

At the IMSA 2014 event weather conditions were mild and likely played a role in a slightly lower incidence of injury and illness among the participants than commonly documented for Ironman distance events. Future medical planning for IMSA events could plan to accommodate for a maximum of 15% of participants, though historical data suggest than approximately 10% will be more likely. Currently pre-race planning of IMSA does include regular weather updates and communication in this regard with the race medical director (RMD) and this should continue to remain a priority in future events. The RMD should brief all medical personnel prior to the start of the race about the expected conditions for race day and the kinds of medical conditions that may be more prevalent due to weather, such as hypothermia in cold conditions and exertional hyperthermia in warm conditions, and ensure that facilities and equipment are prepared for potentially higher numbers of athletes (Holtzhausen & Noakes, 1998).

It is important to note that IMSA continues to see a significant increase in participants with 688 finishers recorded at the first IMSA in 2005, compared with 1643 finishers at the 2014 event. This increase in participation will need to be an important consideration in future medical planning and is in keeping with international data showing that triathlon is a rapidly developing sport with growing numbers of entrants in events worldwide (Strock, *et al.*, 2006). IMSA, as with other triathlon events, are also reporting a growth in the number of female participants (Lepers, *et al.*, 2013). IMSA 2014 saw a 1% increase in female participation (IMSA, 2014c).

While the total number of medical contacts during the 2014 event is comparable with previous years, the ratio of male versus female athletes treated on race day appears to be changing somewhat with an increase in female athletes being evident. During the 2011 competition the percentage of male versus female athletes requiring medical attention was 84.7%% and 15.3% respectively (Alexander, 2014). At both the 2013 IMSA and the 2014 IMSA male athletes comprised 79% of the total number of athletes requiring medical attention and female athletes 21% (IMSA, 2013). Although analysis of the IMSA 2014 data did not find a statistically significant difference for gender between the group of athletes that did not require any medical attention on race day and those that did, the trend of an increasing number of female participants needs to be considered in future planning.

This should incorporate ensuring that all medical personnel are aware of the medical risks that are relevant to female athletes. For example, it is likely that IMSA medical personnel may well see an increase in the triad of disorders that are particular, but not exclusive to, women. Prior to 2014 this was referred to as the "female athlete triad". In 2014 this was renamed as the "relative energy deficiency in sport" or "RED-S (Mountjoy, *et al.*, 2014). The three main components of which include low energy availability (with or without an eating disorder), amenorrhea/menstrual dysfunction, and osteoporosis/or impaired bone heath (Gottschlich, 2014). These factors are associated with an increased risk of stress fractures. Female athletes may also present more often with patella femoral pain. Medical personnel should therefore be aware of the likelihood of encountering higher numbers of these kinds of injuries in future events. Medical planning should also consider the possibility of seeing more athletes with exercise induced asthma (EIA) as women are also more susceptible to EIA (Bennell & Alleyne, 2006).

When data of the other biographical characteristics were analysed, a statistically significant difference was found for age between the group of athletes requiring medical attention and those athletes that did not. Younger athletes between the ages of 18-24 years had the largest number of injuries (15%), followed by athletes in the 25-29 year age group (13%). Interestingly, in the over 65 year age group no injuries were reported. IMSA also recorded an increase in novice participation in 2014 of almost 12% from the previous year. This information, together with the incidence of injury among younger athletes found in this study also deserves further consideration. For example, although physical training knowledge has increased, race organisers cannot assume that all participants are well prepared or adequately informed about safety (Holtzhausen & Noakes, 1998). Given the increase in novice participation in IMSA, this is particularly important. Race participants, especially novice athletes should be clearly advised on conditions that may exacerbate heat illnesses such as obesity, lower levels of fitness, dehydration, lack of acclimatisation, a previous history of heat stroke, sleep deprivation, certain medications including diuretics and antidepressants, and sweat gland dysfunction or sunburn (ACSM, 2007a). Further research into the average age that most participants enter their first Ironman event may also be beneficial in identifying at-risk athletes.

5.3 RACE INFORMATION – DISCUSSION OF RESULTS AND IMPLICATIONS FOR PLANNING

At the IMSA 2014 most athletes completed the race before seeking medical attention (72%), with the second highest number of admissions to the medical facility coming from the cycling section (9%). The duration of stay in the medical facility ranged from two to 161 minutes per patient and is indicative of the wide variety of medical problems that athletes may present with on race-day and that medical staff needs to be prepared for. The presentation of athletes began to increase steadily from 16h00 and reached a peak between 19h00 and 19h59. During this time the staffing in the main medical tent comprised 14 doctors, 20 nurses, 8 biokinetic interns, 2 biokineticists, 2 physiotherapists, and 16 stretcher bearers (IMSA, 2014b). Analysis of the medical plan of the 2014 event, the number of doctors, physiotherapists and other support medical staff are adequate. Guidelines recommend that in addition to the race medical director, one additional doctor per 200 athletes (with a minimum of two) should be available (Dallam, *et al.*, 2005). Therefore based on the 2331 starters in the IMSA 2014 event, 12 doctors would have been required and 14 were on duty during the race. However, based on the 2331 starters, 24 nurses are recommended whereas only 20 nurses were on duty. Future medical planning should aim to ensure that the recommended number of medical personnel across all categories is above or equal to the recommended guidelines.

5.3.1 Clinical data – discussion of results

Clinical data gathered during the 2014 IMSA event should form an integral part of future planning as pre-existing injuries and medical disorders have been well documented to be significant predictors in identifying the at-risk athlete (Holtzhausen & Noakes, 1998). During the IMSA 2014 event, 19% of those athletes that received medical attention during the race were on chronic medication. The most common chronic medications used were found to be asthma medications and antihypertensives. A further 36% reported using medication in the last three days before the race. The most common medications used in this time period were NSAIDs (12%), analgesics (6%), antibiotics (4%) and cold and flu medication (3%).

The finding of the common chronic use of asthma medications is in keeping with data documenting a higher prevalence of asthma in elite athletes compared with non-athletes. Also exercise induced asthma (EIA) can increase 50-90% in persons with persistent asthma and is more common in women than in men (DiDario & Becker, 2005, Storms, 2009). The condition is also a risk factor for unexplained death in young healthy individuals (Schumaker, *et al.*, 2011), other negative health consequences and increased asthma-related difficulties (Avallone & McLeish, 2013). Given the high number of athletes that are using asthma medications and are presenting for medical attention, medical personnel should ensure that they are familiar with the common adverse effects of beta 2 agonists such as tremor, nervousness, headache and dizziness, and even cardiac stimulation such as tachycardia and palpitations. The possibility of nausea and vomiting in these athletes (particularly at high dosages) and the possible interaction with corticosteroids resulting in a higher risk of hypocalcaemia and hyperglyceamia should also be emphasised (Holzer, 2006). Similarly, athletes should be aware that commonly used cold and flu medications may increase their risk of EIA. Allergic rhinitis has been associated with up to a 40% increase in EIA (Brukner & Kahn, 2006).

Pre-race briefing of medical personnel should also focus on the likelihood of treating athletes in the event medical facility that are using antihypertensive medication. For example, medical personnel should be aware that while angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers are suitable for hypertensive athletes (given that they do not limit maximal oxygen uptake), the risk for exercise-related dehydration, hypotension and dizziness in these athletes may be increased. Similarly, medical personnel should be vigilant for commonly encountered side-effects associated with the use of beta-blockers in athletes participating in endurance events as they may reduce cardiac rate and output and attenuate the athlete's normal physiological response to exercise. In endurance events in particular such as the IMSA, athletes on these medications may experience restricted exercise capacity which could result in postural hypotension, asthma, and the masking of hypoglycaemia in diabetes (Taunton *et al.*, 2006).

The prevalent use of NSAIDs by the athletes that required medical attention both before and during the IMSA event is another significant finding for medical personnel to consider (12% three days prior to the race and 16% during the race). Specifically, ibuprofen has been found to aggravate exercise-induced small intestinal injury and induce gut barrier dysfunction in healthy individuals (Van Wijck, *et al.*, 2012). During episodes of demanding physical exertion, NSAIDs may also interfere with skeletal muscle perfusion and in states of dehydration may enhance renal toxicity. Gastrointestinal irritation together with an increased risk for gastrointestinal haemorrhage in these athletes also needs to be anticipated, as does dizziness, and the possibility that the use of NSAIDs may actually mask the symptoms of infection (SAMF, 2010; Wiegand, 2014).

Twenty percent of the athletes who required medical attention on race day also were those athletes that had been suffering from URTIs, colds and flu in the month prior to the race and had subsequently also been using analgesics and antibiotics. Similar findings of high numbers of race-day medical contacts with recent URTIs, colds and flu have been documented across various endurance events (Holtzhausen & Noakes, 1998). Athletes need to be aware of the fact that most URTIs are due to viral illness and that they may have an "open window" for infection after prolonged and intense exercise and training (Holzer, 2006). Here again, communication with athletes about when not to train and/or compete will be important. Holtzhausen and Noakes (1998) have reported on the successful reduction in the incidence of casualties by way of continuing education of participants in endurance events. Specifically, communication with future IMSA entrants should include information about the so-called "neck-check". That is when symptoms are present only above the neck (runny nose, nasal congestion, sore throat) athletes may train at half intensity for 10 minutes and if symptoms worsen they should stop exercising. If symptoms do not worsen they may then continue as tolerated. However, when symptoms under the neck are present (such as a fever of more than 38°C, malaise, muscle soreness, coughing and gastrointestinal pain) no training or competing should be undertaken (Brukner & Khan, 2006; Holzer, 2006).

Although the use of antibiotics does not generally have a negative effect on exercise performance, both medical personnel and athletes need to be aware of gastrointestinal intolerance as a frequent side effect that may lead to diarrhoea. The use of amoxicillin also has rare but important allergic reactions, while the use of macrolides (such as Azithromycin and Clarithromycin) can be associated with abdominal pain, cramping, nausea and vomiting. Erythromycin and macrolides also carry a risk of QT interval prolongation or inducing Torsades de pointes. High dosages of antibiotics, together with increasing age and cardiac related disorders are additional risk factors that medical staff should be aware of (Guo, *et al.*, 2010). Moreover, the use of Quinolones in exercise should be discouraged as their use can lead to tendonitis and even tendon rupture (SAMF, 2010).

On presentation to the medical facilities, over half of the athletes reported some form of gastrointestinal complaint (56%). The most common gastrointestinal complaint was nausea (42%), followed by vomiting (12%). Other studies similarly note gastrointestinal distress as a commonly encountered medical problem in endurance athletes though findings as to the incidence vary from between 8% to as high as 93% (Dallam, *et al.*, 2005). The findings of an incidence of 56% in this study suggest that medical personnel should be well prepared for the presentation, effective diagnosis and management of various gastrointestinal problems in large numbers of athletes in future IMSA and other similar endurance events.

In this study, complaints of dizziness made by the athletes were included in the category of neurologic complaints. Qualitative analysis of the data did not reveal any ominous neurologic complaints,although thirty six percent of the athletes complained of dizziness and six percent reported subjective feelings of confusion. Despite these recorded complaints, the vast majority (98%) of the presenting athletes were alert, orientated and responsive despite some subjective feelings of confusion being reported. Other common complaints were musculoskeletal in nature (19%) or metabolic related complaints (13%). Further assessment of the presenting athletes resulted in exercise/exertion related diagnoses (including dehydration) in 64% of these athletes, with 72 cases of Exercise Associated Collapse (EAC)/hypotension being diagnosed among this specific group of athletes. This finding is supported by literature in which EAC is consistently listed as one of the most commonly encountered medical problems during Ironman and other endurance events (Mayers & Noakes, 2000). The presentation, diagnosis and management of EAC have been discussed in detail in Chapter 2 of this study. Given the large number of athletes that presented with EAC, blood gas and U & E testing were commonly performed special investigations at the event. It is therefore recommended that an additional blood gas analysis machine be made available at future events (currently only one machine is used). The overall current medical treatment protocol of IMSA for EAC is in-line with well researched management protocols, as well with the guidelines set-out by the International Triathlon Union (ITU) (Asplund, *et al.*, 2011; ITU, 2013; Mayers & Noakes, 2000; Speedy, *et al.*, 2003). Future IMSA research may wish to encourage medical personnel to document additional data on the medical forms that may be beneficial in clearly distinguishing EAC from possible differential diagnoses such as heatstroke, hypothermia and EAH. This may include the following (Mayers & Noakes, 2000).

- Amount of fluid ingested during the race
- Amount of urine passed during the race
- Occurrence of vomiting and/or diarrhoea before and during the race
- Amount of carbohydrate ingested before and during the race
- Medications taken before and during the race
- Recent illnesses
- Race preparation and heat acclimatisation
- Training schedule and training volume

Data gathering regarding the above mentioned factors may be further relevant given the diagnosis of EAH that was made in 6 athletes at the 2014 IMSA event (the diagnosis and management of which has also been described in Chapter 2 of this study). The exact aetiology of EAH remains a contested issue (Montain, *et al.*, 2005) and further data gathering at IMSA and similar events may provide important information to assist in developing a clearer understanding of the complex aetiology of EAH in triathletes.

5.4 LIMITATIONS OF THE STUDY

The aim of this study was to analyse the medical records of athletes that received medical attention at the 2014 IMSA competition that was held in Port Elizabeth on the 6^{th} of April 2014. This data was analysed to compile injury and illness profiles of the athletes that presented for medical attention during the completion in order to assist in planning future events. One limitation of this study may be the missing data of athletes, particularly some of the data recorded during the peak times of athlete presentation such as at the finish line when large numbers of athletes require medical assessment and attention simultaneously. Also, the study does not allow for specific conclusions to be drawn on contributing factors to various medical problems due to the fact that data were not gathered on the athletes that did not require medical attention.

Future studies should also aim to analyse longitudinal tendencies of the data that has been gathered to date, particularly given the international trend seen in triathlon of increasing numbers of participants and increasing numbers of female triathletes. Future studies may also include more data gathering of a clinical nature. For example, while data are commonly recorded regarding volumes of athletes, diagnoses made, presenting complaints and medications used on actual race day, the medical records made during such events lend themselves potentially to recording more detailed clinical data. Particularly more case studies could be generated for the less common, but more severe medical conditions encountered in triathlon events such as EAC, EAH and cardiac emergencies.

5.5 CONCLUSION AND RECOMMENDATIONS

The results of this study support widespread findings that the medical problems and injuries that most athletes present with during Ironman and other similar triathlon or endurance events are generally minor and self-limiting, yet also highlight the responsibility of sports physicians and other medical personnel to quickly identify, accurately diagnose, and treat those athletes presenting with more serious medical conditions (Dallam, *et al.*, 2005; Mayers & Noakes, 2000; McHardy, *et al.*, 2006). Specific recommendations based on the findings of this study have been made regarding the anticipated number of athletes likely to require medical attention on race day, the anticipated nature of the most commonly encountered injuries and illnesses, as well as the role that expected weather conditions will likely play in the detailed planning of medical teams on race day.

However, one of the most significant conclusions of this study may lie in the identification of the changing trends of those athletes participating in IMSA events. A significant rise in the number of Ironman competitors both locally and internationally can be seen, together with an increase in the number of female athletes competing in IMSA events. Moreover, an increase in novice participation together with statistically significant data documenting a higher incidence of injuries and illness among younger athletes regardless of gender in this study, suggest that further data collection in this regard is needed. Also, the high incidence of athletes that required medical attention during the 2014 IMSA event that were either taking chronic medications or had had a recent illness in the month prior to the race warrants further investigation. This finding may highlight an important need for more comprehensive pre-participation screening and continuous medical education among athletes that has to date been recommended by many in the field of sports medicine (Holtzhausen & Noakes, 1998). Specifically pre-participation screening, the viability of pre-race seminars, and comprehensive medical education by way of more effective and detailed communication with both medical personnel and race entrants needs to be investigated. Furthermore, the implementation of a pre-participation examination (PPE) and a periodic health evaluation (PHE)by qualified sports physicians should also be investigated. The ITU (2014) recommends that these examinations should include 1) Personal history 2) Family history 3) Physical examination and 4) 12 lead Electrocardiogram (ECG).Further evaluation may include trans-thoracic echocardiography, maximal exercise testing with 12 lead ECG, and 24-hour ECG. While a recent ACSM panel did not reach consensus on ECG screening as routine part of PPE, it was agreed that a history and physical exam focusing on cardiac risk was essential and that an ECG should be used when increased risk is found (Roberts, *et al.*, 2014). In cases where other medical risk is identified, both a PPE and a PHE can allow the athlete to make an informed decision as to their health, training and participation in triathlon. Additional advantages of a PHE may include (ITU, 2014):

- the identification of conditions and barriers to performance;
- establishment of a useful tool for continuous health monitoring of the athlete;
- opportunity for relationship development between the athlete and medical personnel;
- the provision of educational opportunities for health and anti-doping initiatives;
- being an entry point for medical care in some athletes; and
- determining eligibility to participate.

The establishment and implementation of various effective preventative strategies, despite challenges such as cost, access, and level of participation (Roberts, *et al.*, 2014) can assist in ensuring that the benefits of regular physical activity far outweigh the potential risks of participation in the sport of triathlon (ACSM, 2007b).

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APPENDIX A

IRON MAN MEDICAL FORM

APPENDIX A

IRON MAN MEDICAL FORM

IRONMAN MEDICAL RECORD 2014

1. TIME IN [ ] TIME OUT [ ]

NAME:____RACE NUMBER:_______________AGE:___
SEX: M F

CHRONIC MEDICAL CONDITIONS:____

ALLERGIES:____

2. RACE INFORMATION:
ARRIVED FROM: Ambulance Massage Finish Line Other___________

Did you:

	Complete the triathlon
	Stop during swim
	Stop at first transition
	Stop during cycling
	Stop at second transition
	Stop during marathon run
	Other:

3. MEDICATION:

Do you use: Chronic medication YES NO
What chronic medication do you use?
....
....

Did you use any medication in the last three days before the race? YES NO

What medication did you use in the three days before the race?
....
....

Did you use any medication DURING the race? YES NO

What medication did you use DURING the race?
....
....

4. RECENT ILLNESS (in the last month): YES NO

If yes, what was the diagnosis?...

5. MAIN COMPLAINT:

	Confusion		Seizures			Exhaustion			Short of Breath	
	Vomiting		Diarrhoea			Abd Cramps			Muscle Cramps	
	Dizziness		Syncope			Nausea			Headache	
	Trauma: (Specify)									
	Other: (Specify)									

6. **CLINICAL FINDINGS/ VITAL SIGNS:**

LEVEL OF CONSCIOUSNESS:

	ALERT		VERBAL RESPONSE		PAIN		UNRESPONSIVE

TIME	PULSE	BP supine	BP Sitting	TEMP	HGT	**U&E**				
						Na+	K+	CL	Urea	Other

7. **DIAGNOSIS:**

EAC/ POSTURAL HYPOTENSION		HYPOGLYCAEMIA	
HYPERTHERMIA		DEHYDRATION	
HYPOTHERMIA		TRAUMA	
HYPONATREMIA		OTHER	

If TRAUMA OR OTHER, please state diagnosis:-
………
………

8. **TREATMENT**:………
………
………

9. **DISCHARGE**:

Treated and discharged		Admitted to ICU section	
Transported to hospital		Referred for non-emergency follow-up	

10. **DISCHARGE NOTE/PATIENT ADVICE:**

………
………
………

SIGNATURE DOCTOR___________________________ **SIGNATURE NURSE**_______________

APPENDIX B

IRON MAN DATA COLLECTION FORM

APPENDIX B

IRON MAN DATA COLLECTION FORM

IRONMAN 2014

☐☐☐☐	1-4

11. TIME IN: ☐☐☐☐ 5-8

TIME OUT: ☐☐☐☐ 9-12

RACE NUMBER: ☐☐☐☐ 13-16

AGE: ☐☐ 17-18

SEX: ☐ 19

CHRONIC MEDICAL CONDITIONS (Y/N): ☐ 20

ALLERGIES (Y/N): ☐ 21

12. RACE INFORMATION:

a) **ARRIVED FROM (Y/N):**

Ambulance	☐	22
Finish line	☐	23
Other	☐☐	24-25

b) **PORTION OF RACE COMPLETED (Y/N)**

Stop during swim	☐	26
Stop at first transition	☐	27
Stop during cycling	☐	28
Stop at second transition	☐	29
Stop during marathon run	☐	30
Completed the race	☐	31
Other	☐☐	32-33

13. MEDICATION:

Do you use: Chronic medication (Y/N) [ ] 34

What chronic medication do you use?

Asthma medication		35
Statins		36
Anti-hypertensives		37
NSAIDs		38
Other		39-40

Did you use any medication in the last three days before the race? (Y/N) [ ] 41

What medication did you use in the three days before the race? (Y/N)

Asthma medication		42
Statins		43
Anti-Hypertensives		44
NSAIDs		45
Cold and flu remedies		46
Pain killers		47
Other		48-49

Did you use any medication DURING the race? (Y/N) [ ] 50

What medication did you use DURING the race? (Y/N)

Asthma medication		51
Statins		52
Anti-Hypertensives		53
NSAIDs		54
Cold and flu remedies		55
Pain killers		56
Other		57-58

[ ] 59

14. <u>RECENT ILLNESS (in the last month): (Y/N)</u>

If **<u>yes</u>**, what was the diagnosis?

Cold/flu		60
Gastro-enteritis		61
Dehydration		62
Infection (e.g. skin, dental)		63
Other		64-65

15. <u>MAIN COMPLAINT</u>: (Y/N)

Confusion		66
Vomiting		67
Dizziness		68
Seizures		69
Diarrhoea		70
Syncope		71
Exhaustion		72
ABD cramps		73
Nausea		74
Shortness of breath		75
Other		76-77

16. <u>CLINICAL FINDINGS/ VITAL SIGNS:</u>

LEVEL OF CONSCIOUSNESS: (Y/N)

Alert		78
Verbal response		79
Pain response		80
Unresponsive		81
Other		82-83

17. DIAGNOSIS: (Y/N)

Exercise associated collapse/hypotension		1
Hyperthermia		2
Hypothermia		3
Hyponatremia		4
Hypoglycaemia		5
Dehydration		6
Trauma		7
Other		8-9

IF TRAUMA, please state diagnosis:

	10-11
	12-13
	14-15

IF OTHER, please state diagnosis:

	16-17
	18-19
	20-21

18. TREATMENT:

	22-23
	24-25
	26-27

19. DISCHARGE: (Y/N)

Treated and discharged		28
Transported to hospital		29
Admitted to ICU section		30
Referred for non-emergency follow-up		31
Other		32-33

20. DISCHARGE NOTE/PATIENT ADVICE:

	34-35
	36-37
	38-39

APPENDIX C

MEDICAL PLAN

MEDICAL PLAN 6 April 2014 **3rd Ed.20/02)**

INTRODUCTION

The Ironman South Africa is a triathlon which takes part on 6 April 2014
Race is in progress from 06:30-00:00 (Midnight)

Transition and Finish Line	Hobie Beach, Port Elizabeth
Swim	3.8 km (one lap of 3800m) **Swim Course Closes at 09:20** Hobie Beach*
Bike	180 km (two laps of 90km) **Bike Course Closes at 17:30** Marine Drive Beach Road, Walmer Boulevard, Heugh Road, Buffelsfontein Road, Sea View Road, Old Sea View Road, Lakeside Road, KraggaKamma Road, De Stades Road, Maitlands, Elizabeth Road, Seaview Road, Heron Road, Sardinia Bay Road, Victoria Drive, Marine Drive
Run	42 km (three laps of 14km) **Run Course (& event) Closes at 00:00 (Midnight)** Marine Drive, Beach Road, Admiralty Drive, NMMU main entrance to Marine Drive Entrance, back to Marine Drive.*

1. Key Points:

1. Medical Tent: (the main medical tent in the athletes' village)

Set-up of the Medical tent:

1. 4 ICU beds with ICU equipment
2. 36 general beds – 1 monitor per 4 beds.
3. 1 x Blood Gas analysis machine
4. 1 x ECG and nebulizer
5. O2 cylinder per 4 beds
6. 1 x portable defibrillator
7. All drugs needed for a Medical tent.

8. Transition Medical Tent: (inside the transition area)

Set-up in the satellite Medical tent:

9. 4 Physiotherapy beds under gazebo
10. 4 beds in medical tent
11. Strapping for physiotherapy
12. Appropriate basic equipment in auxiliary to Main Medical Tent where further treatment would be done.

13. Medical Beach Pods during the Swim Leg:
(There are athletes in the water between 06:30 and 09:20, with swim cut off)

1. Three beach pods are spaced on the swim course for resuscitation. These pods will be on Hobie Beach, Humewood Beach and Kings Beach respectively.
2. Each of the three beach pods will have a Doctor, ILS and ALS Paramedic on the beach as well as a Quad Bike.
3. There will be an additional team to the above three which will be on standby and replace any team that may be working on a patient whom has been brought on to the beach.
4. EMS will have quad bike available on the beach to assist with moving patients to the medical tent or hospital
5. All three beach pods will have an ambulance as close as practically possible for the duration of the swim
6. Read in conjunction with the water safety plan. (under the supervision of Clyde Scott)

<u>MEDICAL STAFFING:</u>

1. AMBULANCE:

EMS Port ElizabethMetro Ambulance Service is contracted.

Deployment

6 X Stationary Ambulances which will be deployed for athletes as follow:
2 X the Main Medical Tent
1 X Mount Pleasant
2 X Heron Road
1 X Maitland's
1 X Schoenmakerskop

1 X Stationary Ambulances which will be deployed for the public on course:*
1 inWalmer (9^{th} Ave)
*This public ambulances are there to serve spectators on the course, in order to move them to a public/private hospital in the case of an emergency. These ambulances are activated through a call to the JOC.

2 X Roving Vehicles (with advanced life support)
1 X Roving Motor cycle (with advanced life support)
3 X Medical 4Wheeler Beach Pods andon Marine Drive/NMMU
1 X Golf Cart (based at transition to assist with athlete conveyance)
1 X EEV Truck (Emergency Equipment Vehicle parked at Main Medical Tent)

2. DOCTORS/NURSES/BIOKINETICITS/PHYSIOTHERAPISTS:

Medical Director (Dr Konrad von Hagen)
Medical Logistics (Dr Ansa von Hagen)
EMS Ops Head (Gideon Nortier)

<u>O5h30 – 12h00:</u>

Beach for swim – 4Teams existing of a Doctor, ALS and ILS Medic with a Quad Bike, 2 stretchers with 8 stretcher bearers.

Main Medical tent – 3 Doctors and 9 sisters

Transition Medical Tent – 1 Doctor, 3 nurses, 2 stretchers with

8 stretcher bearers
8 Biokinetic Interns
2 Biokineticist
05:00-07:00: 2 Physiotherapists
07:00-09:20: 3 Physiotherapists
09:20-11:30: 1 Physiotherapists to Main Medical, and 2 off duty)

12h00 – 16h00:

As above but extra doctor
11:30-15:00: 2 Physiotherapists to Main Medical, and 2 in Transition)

16h00 – 24h00:

14 Doctors
20 Nurses
8 Biokinetic Interns (assist where needed)
2 Biokineticist
2 Physiotherapists
16 stretcher bearers (army personnel)
15:30-17:30: 4 Physiotherapists in Transition and 2 in Main Medical)
17:30 – 00:00: 1-2 Physiotherapists in Main Medical as athletes will need Rx for cramps etc. but no strapping.

GENERAL:

Athletes Info:

3. The Medical director to receive a list of all medical conditions as listed by the athletes on the website, one week before the race. He is to receive an updated list the night before the race.

4. The general info tent will carry info for the public/family on athletes admitted and released from the medical tent, as well as the hospital of admittance in the case of hospitalizations.

5. Medical personnel shall have the ultimate and final authority to remove an athlete from the race if the athlete is judged to be physically incapable of continuing the race without risk of a serious injury or death.

6. Medical transport of any athlete will result in disqualification.

Communication:

7. The Medical director is in contact with EMS head and the VOC.
8. There will also be two way radio communication between five points during the event: (1) Main Medical Tent, (2) the satellite Medical in Transition and (3, 4 and 5) the three Medical Beach Pods during the swim
9. There will be a Radio Hams member with radio inside the main Medical Tent and at the Medical Beach Pods during the swim. He/shewill be in contact with the VOC and the Race Director. (See in conjunction with the Radio Hams ops plan on points covered on the course by their members)
10. The medical director can also communicate with the VOC on mobile phone to 079 266 6263.
11. The Medical team will have Spanish, French and German interpreters on call if needed. Their numbers will be on a board inside the main medical tent
12. REPORTING of all medical emergencies must take place through the JOC/VOC

13. WHEN REPORTING a medical MUST include the RACE NUMBER of the athlete and a very detailed description of the place with landmarks.

Hospitals on Stand By

14. Green Acres Hospital is the main referral hospital.
15. St Georges Hospital is on standby.

Medical Tent Security

16. The Medical Tent is a restricted zone. Only medical staff, athletes whom are being treated and key Ironman staff are allowed inside the tent. **No one else: This includes Family, VIP's and the Media.** Nationwide Security will have two MIB guards to enforce this policy.
17. Ambulance access is through 2nd Avenue to the back of the Casualty side of the Medical Tent.

RISK ASSESSMENT

PARTICIPANT TRANSPORT

SWIM	Blue bottles Shark attack Current Swimmer in trouble
CYCLE	Fall Traffic
RUN	Fall Traffic

HEAT/ COLD

SWIM

BLUE BOTTLES

Blue bottles are possible at this time of the year.

Stings can result in extreme pain to a severe anaphylactic reaction and death.

PREVENTION AND MITIGATION

1. The pre swim safety check must scan for blue bottles.
2. In the event of blue bottles, participants and medical staff to be briefed.
3. Adequate emergency drugs to be available on site for dealing with multiple incidents.
4. Adequate medical staff capable of treating severe anaphylaxes to be deployed.
5. The overwhelming number of athletes swims with wetsuits. Only faces, necks, hand and feet are exposed

SHARK ATTACK

The warm water at this time of year is suitable for sharks. Heavy rain can result in very murky water.

Shark attacks are extremely rare but could occur.

PREVENTION AND MITIGATION

1. Tower and watercraft to be on lookout for any sharks.
2. Decision on the merits of the case to be taken in an event of a spotting.
3. Medical teams to be prepared for a shark attack.

CURRENT

Inland competitors will be unfamiliar with the currents and drifts of the sea.

Early morning conditions are usually relatively calm.

PREVENTION AND MITIGATION

1. A pre start assessment will be conducted.
2. Swimmers and rescue teams to be fully briefed.
3. Deployment of rescue teams will be informed by the pre start assessment.

SWIMMER IN TROUBLE

Swimmers may experience a range of problems that will impact on their ability to complete the swim.

PREVENTION AND MITIGATION

1. Swimmers and rescue teams to be briefed on the universal hand signals to be used, in a distress situation.
2. A dedicated water rescue radio network must be established.
3. Two way radio contact with NMBM Beach Office Laurence Ginn (in charge of water). He will be in contact with medical director who will contact JOC

CYCLE

FALL

Cyclists may fall for a number of reasons.

PREVENTION AND MITIGATION

1. A pre course check to identify potholes and loose material must be conducted in time to correct problems.
2. The event makes provision for distances between riders, this to be strictly enforced.

TRAFFIC ON ROUTE

The road will be closed to general traffic.

A number of support vehicles will be on the route. This will include: -
1 x Lead vehicle men
1 x Lead vehicle ladies
$^{+}$/- 30 Motorcycles
Camera vehicles
3 x Support vehicles
2 x Sweeper vehicle
Ambulances.

PREVENTION AND MITIGATION

1. Strict control at all access points to the route.
2. Pre-race sweep of the route.
3. Aerial monitoring with a helicopter during the event will enhance safety.
4. Support vehicle drivers to be fully briefed on speed limits and safety measures.

RUN

FALL

Runners may fall for a number of reasons.

PREVENTION AND MITIGATION

1. A pre route inspection must be conducted to identify tripping hazards.
2. Measures must be taken to repair damage and/or mark tripping hazards.

TRAFFIC ON ROUTE

The risks and hazards as well as prevention and mitigation will be similar to the cycle section.

PREVENTION AND MITIGATION

1. Deployment of adequate Police and Security staff.

HEAT/ COLD

2. Check weather forecast day before.

Medical tent ready for both conditions

APPENDIX D

ETHICS APPROVAL LETTER

ETHICS APPROVAL LETTER

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
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UFS UV

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Ms H Strauss

2014-07-30

REC Reference nr 230408-011
IRB nr 00006240

DR CR SMIT
C/O MS S VAN DER MERWE
DIVISION OF SPORT AND EXERCISE MEDICINE
UFS

Dear Dr Smit

ECUFS NR 119/2014
DR CR SMIT **DEPT OF SPORT AND EXERCISE MEDICINE**
PROJECT TITLE: INJURY AND ILLNESS PROFILES DURING THE 2014 SOUTH AFRICAN IRONMAN ULTRA-DISTANCE TRIATHLON.

1. You are hereby kindly informed that the study was approved at the Ethics Committee meeting held on 22 July 2014.

2. Committee guidance documents: Declaration of Helsinki, ICH, GCP and MRC Guidelines on Bio Medical Research. Clinical Trial Guidelines 2000 Department of Health RSA; Ethics in Health Research: Principles Structure and Processes Department of Health RSA 2004; Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa, Second Edition (2006); the Constitution of the Ethics Committee of the Faculty of Health Sciences and the Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines.

3. Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

4. The Committee must be informed of any serious adverse event and/or termination of the study.

5. All relevant documents e.g. signed permission letters from the authorities, institutions, changes to the protocol, questionnaires etc. have to be submitted to the Ethics Committee before the study may be conducted (if applicable).

6. A progress report should be submitted within one year of approval of long term studies and a final report at completion of both short term and long term studies.

APPENDIX E

CONSENT FROM RMD, IRON MAN SOUTH AFRICA

APPENDIX E

CONSENT FROM RMD, IRON MAN SOUTH AFRICA

Intercare
MEDICAL AND DENTAL CENTRES

27/02/2014

Dear Dr Louis Holtzhausen

Re. : Ironman 2014

I hereby give you permission to perform a study about the profile of illness and injury sustained during the 2014 South African Ironman to be held on 6 April 2014.

Kind Regards,

Dr K. Von Hagen
MBChB Msc Sports Medicine (Pret)
Ironman Medical Director

DR. K.W. VON HAGEN
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