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AUTO+ MEDICAL

MAN VS MACHINE

Land speed records are being broken at record pace and the FIA is ensuring that medical provisions for drivers keep up

AUTO+MEDICAL

Contents

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Welcome to the new issue of AUTO+Medical, which features the latest news and reports from the world of motor sport medicine. As a member of the publication's editorial board, I am pleased to present this edition.

In our cover story we hear how the FIA is applying universal standards to the medical provisions for land speed record attempts and we then introduce a new series of features that will study specific pieces of kit often used by medical motor sport personnel, with the first focusing on video laryngoscopes.

Elsewhere in this issue we speak with Dr Kelvin Chew, the CMO of the Singapore Grand Prix, about the challenges of running the medical team at Formula One's only full night race. We then take a look inside the World Endurance Championship's new medical car, and hear from Nick Heidfeld about his recovery from injuries sustained in a Formula E race last season.

Our scientific paper examines the latest theories and practices applied to resuscitation techniques, while discussing how these ideas could be best applied to motor sport medicine.

Finally, I would like to express my condolences to the family of Dr Phil Rayner, the FIA Formula E Medical Delegate who sadly passed away in May. You can read our full obituary to Phil on page seven of this issue.

I hope you enjoy the latest issue.

Dr Matthew Mac Partlin
Critical care physician, Australia, Deputy CMO WRC Rally Australia, Assistant CMO Formula One Grand Prix Australia, CAMS NMAC

LETTERS

In this section, we print the best letters and emails received from readers around the world. We welcome comments on articles as well as suggestions for future content. If you wish to send in a letter or email, please direct it to: medical@fiainstitute.com

Dear Editor,
I would like to share my thoughts about the motor sport medical training available to doctors, especially in developing countries, and the value of publications like AUTO+Medical to help prepare doctors for motor sport events. It is essential that doctors in all developing countries realise their role is much more important than just taking care of injured drivers.
By highlighting the range of motor sport medicine activities we can understand our duties may cover many different areas.
First, comes preventive measures concerning drivers, circuit and car safety. It is possible to keep up with the highest standards of motor sport safety by working together with organizers, engineers and drivers.
Second, comes the medical organisation itself. Despite having access to the FIA International Medical Regulations, the budget is not always available to follow them and there may be a need to adapt to the reality in the best possible way. Doctors should not be afraid not to follow the highest standards. Therefore, I suggest they should begin with the best they can achieve and try to pursue the ideal scenario. Experience, time and their commitment will convince other people to invest in ones' proposals. Training has always been a very important part of best practice.
Third item to tackle is the anti-doping program which is not an easy one but as important as any other medical practice. It makes competition fairer and safer.
Fourth comes recovery and reintegration of an injured driver back into to competition. The final decision may be the result of a medical panel of physicians from different specialties and other medical disciplines.
In conclusion, there is no other way to work in motor sport other than beginning to practice. Not having other experienced doctors in motor sport from their countries, doctors should work hard to acquire knowledge by themselves. Moreover, a doctor trained in pre-hospital care in a developing country should not hesitate to begin practicing but they should always keep in mind to pursue the highest standards of motor sport safety possible. AUTO+Medical is a publication that allows doctors at all levels to keep in touch with the latest developments and see how others are working in the sport.
Dino Altmann
Chief Medical Officer or the Brazilian GP

Dear Editor
We would like to buy a Formula One training chassis, like the one the FIA Institute developed to practice for our extrication teams. Could you help me and I'm sure other events by detailing where can we find one and how can we arrange it?
Thanks a lot,
Laszlo Gorove MD
Chief Medical Officer of the Hungarian GP

Editor: Thanks for your question. The F1 extrication simulators, an FIA Institute initiative, are used for training and practice at Grand Prix circuits around the world. Built from fibre-glass, these simulators (pictured right) are replicas of F1 cars from the bulkhead behind the driver to the nosecone. They offer the chance for track teams to practice before and during the event weekend. They can be purchased from the FIA Institute by contacting the FIA, the FIA Institute's education partner. For further information, please contact Kate Robson (krobson@fia.com) from the FIA Development Department, with a copy to Jacques Berger (jberger@fia.com) from the FIA Safety Department.

Teams practice on the extrication simulator at a training event at the Le Mans circuit

GLOBAL NEWS

The 26th ICMS annual congress takes place on 7-8 December

ICMS SET TO HOST 26TH ANNUAL CONGRESS

The 26th International Council of Motorsport Sciences' (ICMS) Annual Congress will take place on 7 – 8 December 2016.

The event, which takes place alongside the Performance Racing Industry (PRI) Trade Show at the Indiana Convention Center (ICC), will present and discuss the latest scientific, medical and educational research across all forms of motor racing.

"The ICMS' 26th Annual Congress will educate and inform international motorsports personnel, scientific and medical stakeholders, sanctioning body personnel, car designers and constructors, race team managers and drivers, and industry organizations on improving safety and performance for racers as well as highway drivers," read a PRI statement.

The second annual Race Track Safety Program (RTSP) will also take place on 9 December 2016. This seminar, which is presented in conjunction with the ICMS congress, includes educational and practical demonstrations of safety techniques to be used by on-track medical and safety teams working at motor sport events.

After the RTSP has concluded, a Race Track Safety Team Demonstration will be given by "some of the world's most experienced safety response teams", who will offer their own personal insights and experience of on-track safety initiatives. This event will be open to all those who attended the PRI Show at no extra charge.

DR PHIL RAYNER, 1950-2016

Dr Phil Rayner, Chief Medical Officer for the MSA and a long-serving member of the FIA Medical Commission, passed away suddenly at home on 4 May 2016.

A Consultant in Anaesthesia and Intensive Care in Chesterfield Hospital for many years, he recently retired from the NHS only to take on the role of FIA Medical Delegate for the newly formed FIA Formula E championship.

Dr Rayner was the Chief Medical Officer for Wales Rally GB for over 20 years, equally at home working as CMO with the rally as he was on circuits sitting in the Formula One chase car alongside Professor Sid Watkins. He was also Chairman of the MSA Medical Advisory Panel and a member of the FIA Anti-Doping Disciplinary Committee since its formation.

Dr Paul Trafford, who worked with Dr Rayner for many years, said: "Phil was totally unflappable, always having a sense of humour but always being a total professional. He will be missed by all those who worked with him and knew him and our sincere sympathies go out to his wife Pauline and the family."

Professor Gérard Saillant, FIA Institute President, said: "Phil was a leading member of the motor sport medical community with a great amount of knowledge and experience. I would like to express our sincere condolences on behalf of everyone at the FIA and our thoughts are with his family, friends and colleagues."

The medical centre at the 2016 London ePrix was named in memory of Dr Rayner

The Grand Prix Trust was established in 1987

GRAND PRIX TRUST RENAMED TO BROADEN MOTOR SPORT REACH

The Grand Prix Mechanics Trust has been renamed as the Grand Prix Trust as part of a drive to help more people involved in motor sport.

The Trust, which was established 29 years ago by Sir Jackie Stewart, provides support, help, and advice to current and former employees of Grand Prix teams and their families if something goes wrong.

Stewart created the Trust after becoming aware that many teams and mechanics competing in his era, and before, often did not have insurance, pensions or financial comfort to provide support in the event of fatal or serious incident.

The support offered by the Trust today ranges from financial assistance, to specialist medical advice, rehabilitation or repatriation, and guidance relating to rights and benefits. Each case is treated confidentially and mechanics from many eras of F1 have been helped.

A Grand Prix Trust statement said: "For 2016 we will be renamed the Grand Prix Trust to recognise the broader reach and scope of those whom we can help, as Formula One roles evolve. Our aim is to be there for those coming into the sport tomorrow as well as those who served it with honour in the past, and we appreciate your support."

DRIVERS TOLD TO COVER UP BY NEW FIA REGULATION

A new FIA regulation will require all competitors in circuit events, hill-climbs, special stages of rallies and selected sections of cross-country competitions to make sure their neck, wrists and ankles are doubly protected against fire.

The latest rule was included in the governing body's 2016 update of Appendix L of the International Drivers' Licences, Medical Examinations, Driver's Equipment and Conduct requirements.

The regulation states: "The neck, wrists and ankles shall always be covered by at least two articles of protective clothing. The balaclava and top underwear shall overlap by a minimum of three cm around the driver's neck, except at the front central line where they shall overlap by at least eight cm."

INJURED INDYCAR STAR PRAISED AFTER VICTORY

IndyCar safety consultant Dr Terry Trammell has hailed Josef Newgarden's return to racing after suffering a broken hand as "remarkable."

The Ed Carpenter driver fractured his right clavicle and right hand in a major crash at the Texas Speedway on 12 June but he climbed back into the cockpit for the next race at Road America just 12 days after the accident.

The American driver finished eighth on his return to action and then won the following event in Iowa.

"The kid is amazing," said Trammell. "A week after surgery he's back in the car and a couple of weeks later he's back in victory lane. For all my years he wins the prize for the fastest guy back in competition and, frankly, it's remarkable."

"I watched his steering input on a computer [at Road America] and he was so precise. Turning left all day with those G forces and he never turned the wheel more than one or two inches all day. And his hand was still plenty weak, so that made it even more impressive. He drove like a man possessed and never made a mistake and it was remarkable to watch."

See p34 for Formula E driver Nick Heidfeld on returning from wrist injury.

MDD NAMED FIA'S OFFICIAL MEDICAL PRODUCTS SUPPLIER

The FIA has appointed MDD Europe Ltd (MDD) as its official supplier for medical products.

MDD, which has been the medical and safety team provider for the FIA Formula E series since it began in 2014, produces a range of medical equipment from small tools to full medical centre refurbishment or new buildings.

The company also provides clinical and safety personnel, as well as specific training packages. Its Director Peter Schroeder hopes that the new deal will "develop and improve" medical and safety considerations in motor sport.

He said: "We are delighted to have been selected as the official supplier of the FIA in providing our range of services to the motor sport industry. We pride ourselves on our drive for high quality services regardless of motor sport level and recognition by the FIA of our commitment to continual development, quality improvement and service provision is well received. We aim to continue to build on its success by working in collaboration with the FIA to develop and improve the safety provision at all levels of motor sport".

Laurent Mekies, FIA Safety Director, added: "The FIA is pleased to extend its partnership with MDD, in several FIA Championships. We look forward to developing further medical technologies with them. It is also crucial for us to provide our teams on the ground with the highest standards of medical equipment and we know that MDD will deliver."

VIENNA SET TO HOST FIA MEDICAL SUMMIT

The 2016 FIA medical summit will take place in Vienna on 28–29 November.

The event, which will take place at the Hofburg Palace, will bring together leading medical motor sport personnel from around the world.

FIA President Jean Todt will open the summit with a welcome speech alongside Professor Gérard Saillant, the President of the FIA Institute.

The itinerary for the first day of the conference includes a round table discussion on concussion and the wider issues surrounding the subject, with contributions from Professor Jean-Charles Piette, Professor Peter Hutchinson and Dr Dino Altmann.

A second round table will examine the use of cervical collars for trauma patients, with contributions from Dr Michael Scholtz and Dr Jean Duby.

Papers will be presented on topics such as video laryngoscopes and the responsibilities of CMOs at motor sport events, and FIA Safety Director Laurent Mekies will provide an update on developments for frontal protection on single seater cars. The day will end with a welcome cocktail at City Hall.

The second day of the summit features a workshop session on intraosseous infusion and hands-on airway management on track (both surgical & non- surgical) by Dr Harald Hertz and Dr Amjad Obeid. The second workshop session will cover "Halo and Extrication with FIA training chassis and technique to open a visor without moving the head". Dr Jean Duby and Dr Theodoros Voukidis will then give a demonstration on the use of a motor sport survival kit.

Papers will be presented on topics such as consistency issues for extrication training, and simulator training of medical car and extrication teams. Professor Saillant will then deliver the closing remarks.

To register for the Summit, visit: www.bit.ly/medsummit16

INDYCAR STAR RACES USING WEARABLE TECHNOLOGY

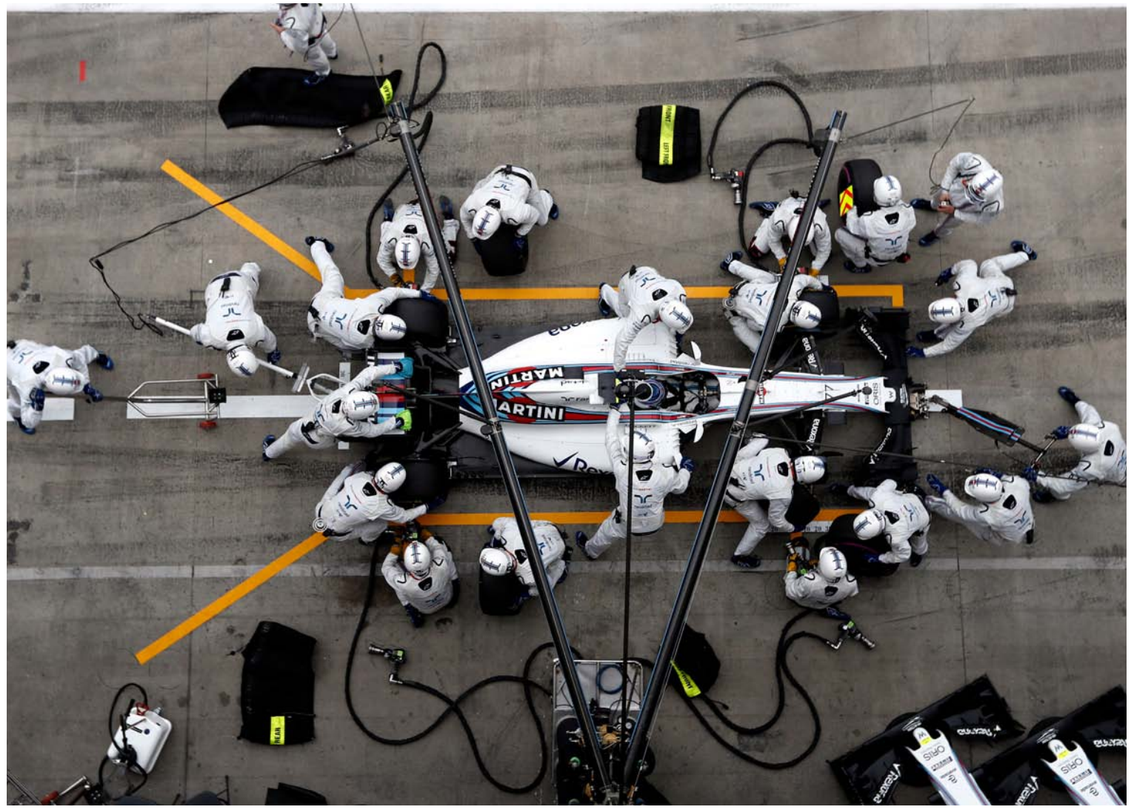
IndyCar driver Tony Kanaan has used biometric monitoring technology woven into his race suit to monitor his body during races in 2016.

The Brazilian driver has sampled the Hitoe shirt, which is produced by NTT Data, and measures heart rate, respiratory rate intervals, and muscle activity in the form of electrocardiogram (ECG) and electromyogram (EMG) waves.

Kanaan said: "The shirt is allowing me to see in great detail what is happening to my body when I'm in the car."

The Hitoe technology works by applying an electro-conductive polymer to nanofibers, which turns the shirt fabric into a collector of physiological electrical data.

"As a medical doctor, I saw people experiencing complications that could have been avoided if diagnosed and treated sooner," said Dr. Tsukada, the NTT researcher who invented the Hitoe wearable technology. "I wanted to provide doctors with the ability to monitor ECG and EMG on a consistent basis, allowing them to proactively treat conditions before they become worse."



WILLIAMS BRINGS F1 SKILLS TO NEONATAL CARE

The Williams Formula One team has offered its expertise in delivering rapid pitstop times to help improve care for neonatal patients at the University Hospital of Wales (UHW) in Cardiff.

The British team, which achieved the quickest pitstop at 11 out of the first 13 Formula One races held this season, sent members of its operations crew to UHW to discuss ways that the hospital could develop its practices when it came to resuscitating newborn babies.

The hospital has since audited and streamlined its equipment trolley to make locating it faster in emergency scenarios and has mapped out the floor space in its delivery theatres to clearly show the area where its team will work, much like Williams' pit crew does at each Grand Prix.

Speaking about the arrangement, Dr Rachel Hayward, specialist registrar in Neonates at the University Hospital of Wales, said: "There is a growing amount of evidence to support a systematic approach to resuscitative care, which is time-critical and dependent upon optimal team dynamics and clear communication.

"Analogous with the requirements of an effective pitstop, we have worked with the Williams team to implement Formula One techniques and processes to augment neonatal resuscitative care".

Claire Williams, deputy team principal of the Williams squad, added: "If some of the advice we have passed on helps to save a young life then this would have been an extremely worthy endeavour."

UHW is also developing a plan to get its staff to use more hand signals, an F1-style radio-check before each resuscitation, and apply video analysis and debrief sessions following every procedure it completes.

Other F1 teams have also worked with hospitals in recent years. McLaren repurposed its Electronic Control Unit to monitor young patients' vital signs at the Birmingham Children's Hospital, while Ferrari invited staff from London's Great Ormond Street Hospital to its Maranello base to learn how choreographed pitstop teamwork could improve their procedures during surgery.

AUTO+MEDICAL FEATURES

FEATURES

MAN VS MACHINE

Land speed records continue to be rapidly broken and Formula One's Dr Ian Roberts has been appointed to the FIA's Land Speed Records Commission to ensure that the medical provisions for drivers keep up

AUTO+MEDICAL FEATURES

Racing across a barren desert for mile-after-mile at speeds more associated with aerospace missions is what land speed records are all about. Despite the lack of visual reference points, the roar from the engine and the blur of distance markers confirms one thing: you are pushing the boundaries of what man and machine are capable of.

Such events need careful planning with medical and safety concerns high on the agenda. This is why the FIA's Land Speed Records Commission appointed Formula One medical rescue co-ordinator Dr Ian Roberts to its ranks at the end of 2015.

"The reason for the appointment was that specifically the Commission wanted some medical input into the Appendix D safety plan," says Roberts.

The safety plan is an addition to the FIA's International Sporting Code that focuses on land speed record attempts and the Medical Intervention section sets out exactly what medical equipment and personnel need to be

"BLOODHOUND IS VERY HIGH PROFILE BUT INDIVIDUALS WITH LOW FINANCES ARE PUSHING THE BARRIERS SIGNIFICANTLY"

The Bloodhound SSC machine will attempt to break the outright land speed record in 2017

in place before a high-speed run takes place.

"This is all to codify what is put into place," says Roberts. "There are obviously medical resources put into place for any attempt but they have not necessarily been to an official or regulation level. Certainly some would have been above what was necessary and some necessarily below. But it's really just to ensure that there is a minimum standard."

One of the most commonly referenced land speed record attempts is the upcoming Bloodhound SSC project, which will try to break outright record and the 1,000mph barrier in October 2017. But there are many more automotive speed records that the Land Speed Records Commission is required to adjudicate.

The Thrust SSC car, which travelled 763.035 over one mile in 1997, holds the current outright record but there have been other records set by diesel and even steam powered cars over the years. In August 2015, the Venturi electric vehicle company broke a land speed record for EV machines with its Buckeye Bullet car, which was built in conjunction with the Ohio State University.

"The Commission is looking across the board," explains Roberts. "Although the Bloodhound is very high profile there are also records being attempted by individuals who have very low finances and they are actually pushing the barriers quite significantly."

The Appendix D regulations state that during event racing operations two radio equipped ambulances are required, one that is located at the pit entrance and one at the venue's control tower, but it is up to the event safety

officer to determine if there are more suitable locations. These ambulances must be crewed by staff trained to a level that meets the local laws and rules for public first responders. There must be a minimum of two Emergency Medical Technicians in each ambulance and these vehicles must be at their stations before any racing operations can get underway.

A doctor proficient in resuscitation and experienced in the management of trauma victims is required for absolute and outright land speed record attempts, although this is strongly recommended for all other challenges.

PREPARING TO LAUNCH

But there are further overall medical considerations for any land speed record mission. In a project such as Bloodhound, with its ambitious targets, the driver will face problems from the heat and noise generated by running a car at such high speeds across the ground. Often he will be subjected to speeds and forces more commonly associated with aerospace missions.

So it's a good thing that Bloodhound's designated driver, Andy Green, is already an experienced RAF pilot, as well as the current land speed world record holder with Thrust.

"The body is quite good at detecting acceleration, which is significant for Bloodhound," he explains. "And the noise is another matter. The airflow into the jet intake is shaped and compressed by the 'pre-entry ramp', which is the top of the cockpit. This shape is designed to slow the relative airflow from 1000 mph to about 600 mph, as jet engines don't like supersonic airflow. That's a speed reduction of 400 mph over a distance of less than two metres, or in time terms about two milliseconds. This will generate some very powerful standing shockwaves on top of the cockpit, which will transmit a lot of acoustic energy into the vehicle."

To counter this, Bloodhound's cockpit has some very high quality soundproofing that utilises 'Basotect' foam, a material that is used on space rockets to protect their satellites during launch. Underneath the full-face FIA-spec helmet, Green will be wearing moulded earplugs complete with microphones built inside to enable two-way voice communications.

Dr Andy Timperley, Chair of the Aerospace Medicine Group at the Royal Aeronautical Society, explains that the potential danger for a land speed driver is not the high-speed itself but the acceleration required to get there, as there will be high G-forces acting on the body. There are also other factors to consider, such as vision problems caused by the acceleration: "During rapid acceleration and to a lesser extent, when travelling at constant high speed, it may be difficult for the driver to see in detail their surrounds, which may become a blur; this may be aggravated by vibration of the car and driver."

"FROM A MEDICAL POINT OF VIEW, IT'S ABOUT ENDURANCE PHYSIOLOGY. THE DRIVER HAS TO BE PREPARED FOR ADVERSE CONDITIONS"

It is also important for a driver to be fully fit to deal with the unique acceleration of a record attempt. Roberts adds: "Getting up to speed, it's the G-Forces that will be acting upon the body, which have various consequences for his cardiovascular physiology in terms of blood pressure, conscious levels, and those sorts of things."

Head movement is kept to a minimum in Venturi's record breaking electric car

Heat is another factor. "There's an enormous amount of heat not just in the car but also in the area that they run the attempt [usually a desert]," he continues. "So from a medical point of view, it's actually an endurance physiology point of view really. The driver has to be prepared for those adverse conditions."

Bloodhound's operations and medical crews have been working closely to prepare for any safety scenario from a problem with the car, to crush injuries to physical extremities, or puncture wounds from mishandled tools in its on-site workshop. If something were to go wrong, critical care would be administered immediately by engaging both its ground and air paramedic capabilities to help the team doctor, Charan Naidoo, who is registered with the South African Health Professionals Council. "It is our aim to deliver the Golden Hour on-site: stabilisation and promotion of recovery, before transporting to an appropriate secondary care facility," he says.

In the 14 months leading up the record attempt, the development of Bloodhound's safety plan will need to take into account the remoteness of Hakskeenpan, the South African desert site where the run will take place, from the established primary and secondary care facilities. The project's main safety precautions have already been considered and applied to the design of the car, support equipment, team training and operational processes. "It is our aspiration to train all team members to typical airline cabin crew standards," says Martyn Davidson, Bloodhounds's Operations Director. "All

The Venturi Buckeye Bullet is built around a modified IndyCar tub

vehicles and workshops will be equipped with medical response equipment appropriate to their role."

COCKPIT PROTECTION

A record-breaking machine also requires additional protection for the driver. The Venturi Buckeye Bullet, which last year set the record of 212.615mph in the sub-class for electric vehicles over 3.5 tonnes, uses an adapted IndyCar survival tub to add strength to the chassis and features master switches that safety crews can use to shut off the electricity in the event of a crash. Given the electrical nature of the car, which Venturi will again use to try and break the outright EV record later this month, the team briefs the safety personnel that work during its record attempts on how to react to an incident, such as an electrical fire.

Inside the car, driver Roger Schroer wears a helmet fitted with a bladder that can be inflated to aid its removal after a crash, as well as a HANS device and a nine-pointed harness to keep him secure in the cockpit. "I also have to force my head back into a tight cockpit surround area," he says. "I literally can't move my head from side-to-side or up or down in the event of a situation where the forces would be such that it would really shake your head. The idea is to restrain your head as much as possible."

Schroer explains that mandatory arm restraints work better if sewn into the sleeves of a fireproof suit than those that are just fitted around the outside. "You can't be too careful out there," he says "but paying attention to all of the little details could save your life."

SAFETY STANDARDS FOR ALL

Land speed record attempts such as the Bloodhound project will attract headlines and interest given the incredible speeds they are attempting to reach. By putting in place the minimum medical requirements for all teams, including those producing vehicles to try and break other categories of speed records, the FIA Land Speed Records Commission is aiming to make the sport safer for everyone involved. But it does not want to be prohibitive and that is a fine balance, according to Roberts.

"The land speed records that are being attempted, they vary enormously from single driver operated small teams, right the way up to the outright record attempt," he says. "So you've got a huge range of people and teams all the way down to teams where they are not running on a great deal of financial input. So we also have to be very conscious that we can't be too prohibitive in terms of saying: 'you need major trauma teams on alert and if that's no good the record attempt simply will not happen'."

"THEY ARE THE UNSUNG HEROES OF LAND SPEED RECORD ATTEMPTS, UPON WHICH EVERYTHING ELSE IS BUILT"

All sorts of vehicles from lorries to production cars are undertaking these record-breaking missions, so it is essential to be flexible and supportive of all attempts not just the most high profile, according to Roberts.

"I think they are the unsung heroes of land speed records really, upon which everything else is built. The FIA Land Speed Records Commission is well placed to make sure that their attempts are recorded and done under the best possible safety rules."

IMAGE: A4GPA (FLICKR)

DR KELVIN CHEW

Chief Medical Officer, Singapore Grand Prix

Dr Kelvin Chew became the Chief Medical Officer of the Singapore Grand Prix in 2009, one year after helping to organise the medical aspects of the inaugural event. He tells AUTO+ Medical about the challenges of running the medical team at Formula One's only full night race and how he would improve motor sport medicine.

AUTO+Medical: How did you become CMO of the Singapore Grand Prix?
Kelvin Chew: I was shortlisted to assist in organising medical support for the 2008 event because of my background as a sports medicine physician organising medical support for various sporting events. I had no experience in motor sport but within a year, I learnt about motor sport and picked up the intricacies involved in organising medical coverage for this sports discipline.

I had to immerse myself in various roles that year at various circuits and races. Credit has to go to my mentor, Dr Carl Le who was the medical delegate for V8 Supercars, an Australian race series, at that time. Within a year, he had systematically imparted all his knowledge on race administration, volunteer recruitment, logistics and training. Dr Le was CMO for the inaugural Formula One Singapore Grand Prix in 2008, but in 2009, I had to take it on as the CMO. So the learning curve was indeed steep.

A+M: What does your work as CMO at the Singapore Grand Prix involve in the period leading up to the race?
KC: The following sequence occurs in the period leading up to the race: work first starts nine months before the event with monthly

race organisation meetings to discuss matters pertaining to the circuit, such as volunteer recruitment, training, logistics, as well as security. Typically, we would start volunteer recruitment some 6-8 months before the event.

Thereafter, we would make modifications to medical deployment if needed to meet any changes in requirement of the circuit. This would also include the placement and layout of the temporary track medical centre. An agreement with the event's primary receiving hospital is subsequently worked out, ensuring all of the required specialist services will be on standby during race days.

We then get confirmation of the ambulance service and medical vehicles, as well as an update of medical equipment and supplies. Meetings with the national security and emergency agencies then take place to plan both track and spectator emergency contingencies. Training sessions occur months before with a series of lectures and hands-on sessions, with medical simulations and extrication practice leading up to the event week.

> **"DURING THE EARLY YEARS OF THE SINGAPORE GRAND PRIX FROM 2008 TO 2009, THE LEARNING CURVE WAS INDEED STEEP"**

The track medical centre only gets completed one month before the event, when we will start furnishing and equipping the place. The full circuit gets locked down only on the Wednesday of race week.

A+M: What is your role during an actual race weekend?
KC: A typical day during race weekend would involve arriving early at the circuit with a meeting for senior race officials in race organisation. We are updated on potential situations and any changes to the event schedule, as well as track and weather conditions, manpower and logistical issues. Such information is disseminated to the medical team in the daily brief for the members of the team. The briefings include reminders on personal safety and overall safety of the team, as well as team responsibilities.

The teams are subsequently deployed throughout the circuit and this is followed by a medical inspection. This will ensure that placements of the various medical teams are optimal and safe. Other track service teams or structures could hamper an emergency response and such situations will need to be sorted out before the start of the race. Thereafter, I will be stationed at Race Control to co-ordinate medical responses to any incidents at the circuit. In between sessions, if the schedule permits, I make my way on foot to various track positions to check on various teams. At the end of the day's events, a debrief is conducted. Through this, we get feedback from the ground as well as ensure that all personnel are accounted for. It is close to midnight at this point.

A+M: Can you describe the biggest challenge you have faced as a motor sport doctor?
KC: To me the biggest challenge was to take on the leadership role and responsibility for the Singapore Grand Prix during its inception. Given that motor racing at such a scale before 2008 had taken a 35-year hiatus in the city, we had to work from scratch.

One of my responsibilities was to recruit and train up a medical team with no motor sport experience. My apprehension was that of fielding a team that was unfamiliar with operating in a motor sport environment. The team needed to be familiar with extrication, communications, race operations and terminology. And most important of all was the issue of safety. Maximum efforts were placed on track craft and how to manoeuver safely in this high-speed environment.

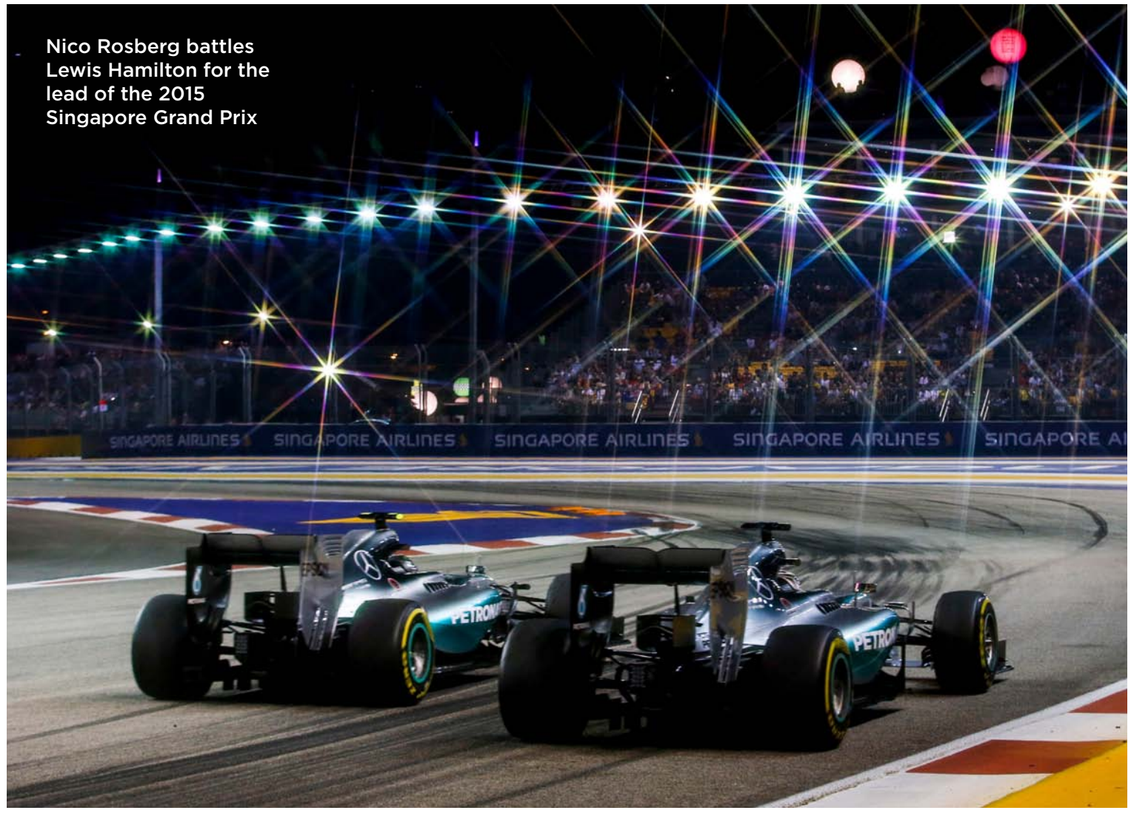
The event also needed the involvement of

various ministries and national emergency agencies to plan and possibly execute various contingencies for both track and spectator incidents at various scales. The amount of planning and table top exercises that went into the event was unfathomable. But fortunately, we made it through that inaugural event.

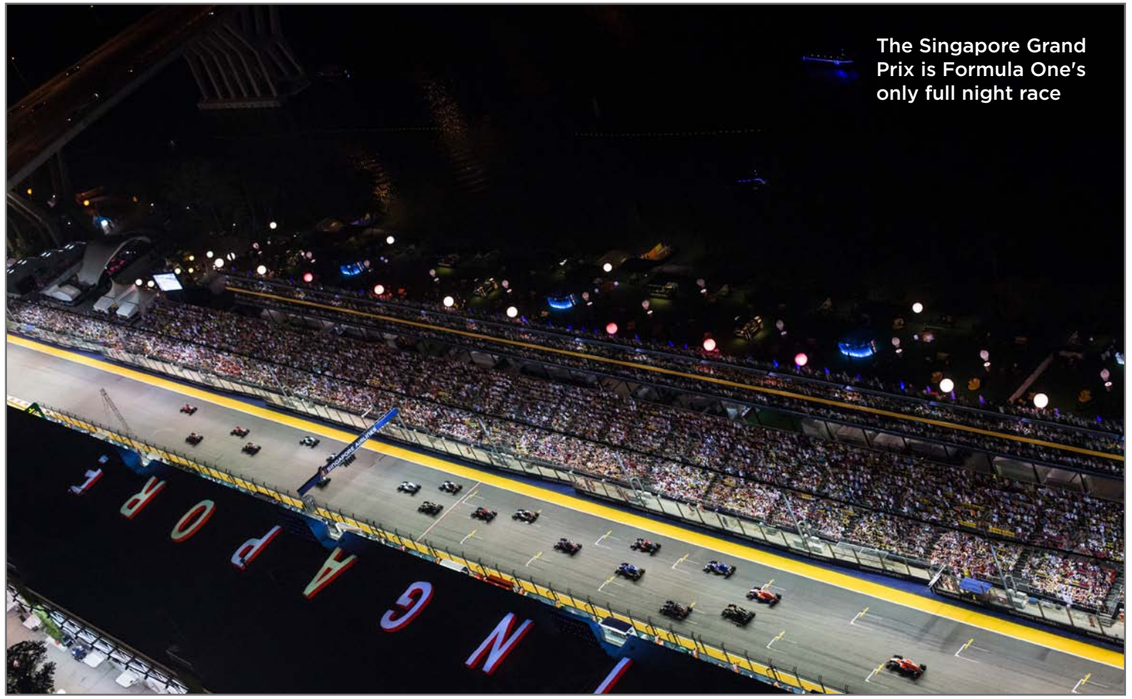
A+M: What has been your greatest achievement in motor sport medicine?
KC: I don't believe I have achieved anything great in motorsport medicine yet. But pulling through that first event with a brand new medical team was probably my greatest achievement.

> **"THE AMOUNT OF PLANNING AND TABLE TOP EXERCISES THAT WENT INTO THE 2008 EVENT WAS UNFATHOMABLE"**

A+M: Can you give any examples of incidents you have responded to during your time as a motor sport doctor?
KC: What comes to mind was a pit lane incident, where [Felipe Massa in 2008] was released too early before the fuel hose was disconnected injuring a mechanic. We had just



Nico Rosberg battles Lewis Hamilton for the lead of the 2015 Singapore Grand Prix


The Singapore Grand Prix is Formula One's only full night race

talked through various scenarios that could happen at the pit lane in the weeks before and were devising strategies to swiftly and safely manage such situations and then it really happened. Within minutes, together with the pit lane medical team, we stabilised and evacuated him to the medical centre via a pre-arranged route through the paddock. This incident impressed on me the importance of contingency planning and simulation training. This was how we were able to react and execute plans effectively in that scenario.

A+M: What medical and safety facilities do you use during the Singapore Grand Prix?
KC: The Singapore Grand Prix is held in the heart of the city. The street circuit setting means we are limited for space. The compact track medical centre is constructed on a plot of parkland and is completed one month before the event.

Other static medical elements include track posts at strategic turns and the pit lane medical teams. The dynamic medical elements include medical intervention cars, extrication vehicles and ambulances.

On average, the Marina Bay Street Circuit also has approximately 86,000 spectators within the Circuit Park daily, so there are also multiple first aid posts to service the spectators throughout that area.

A+M: Have there been many changes to the medical facilities and services since the Singapore Grand Prix began in 2008?
KC: Yes. We started out having the medical centre at the pit entry in 2008, but due to the space constraints of the street circuit, the medical centre is now situated in a compound close to the pit exit. This meant making changes to ambulance movement protocols to and from the medical centre and there were some pros

and cons to this. While this location may prove marginally less disruptive to the race, it is a slightly longer hike from the paddock.

A+M: Does the street circuit layout in Singapore affect the protocols for the medical team?
KC: Yes. The Singapore circuit is very challenging as some parts of the track are narrow with a lack of run-off areas, which means a smaller margin of error for the drivers. The medical team will need to be on their toes at all times, ready to respond to any incidents.

The street circuit layout means deployment of medical elements and vehicles is tricky. Access is mainly from the track. Once a medical vehicle is being deployed for an incident, it would be an intricate exercise to reset or cover that sector with another medical element without disrupting the race. So it is like a balancing act of juggling static and vehicular medical elements.

A+M: Are there any extra considerations for safety and medical protocols due to the Singapore race taking place at night?
KC: We were apprehensive for the inaugural race in 2008 and made several contingencies. But once we saw the track lit, our fears were allayed, as the lighting was four times brighter than a fully lit stadium.

The downside was that each day would end really late at night, which meant the medical team would only get to leave the circuit past midnight and get home in the wee hours of the morning. Fatigue is a potential problem we are keeping an eye on.

A+M: Does the unique timing approach of F1 teams to the Singapore race create any additional health and safety concerns?
KC: Maybe it's more for the standby team. We keep a small team at the medical centre past opening hours, so the medical centre is running for 24 hours every day. I remember in one year I had to stay up with a driver who needed specialist medical attention in the wee hours of the morning because he kept European timing.

"IT IS REWARDING TO SEE OUR MEDICAL VOLUNTEERS COME BACK TO THE SINGAPORE GRAND PRIX YEAR-AFTER-YEAR."

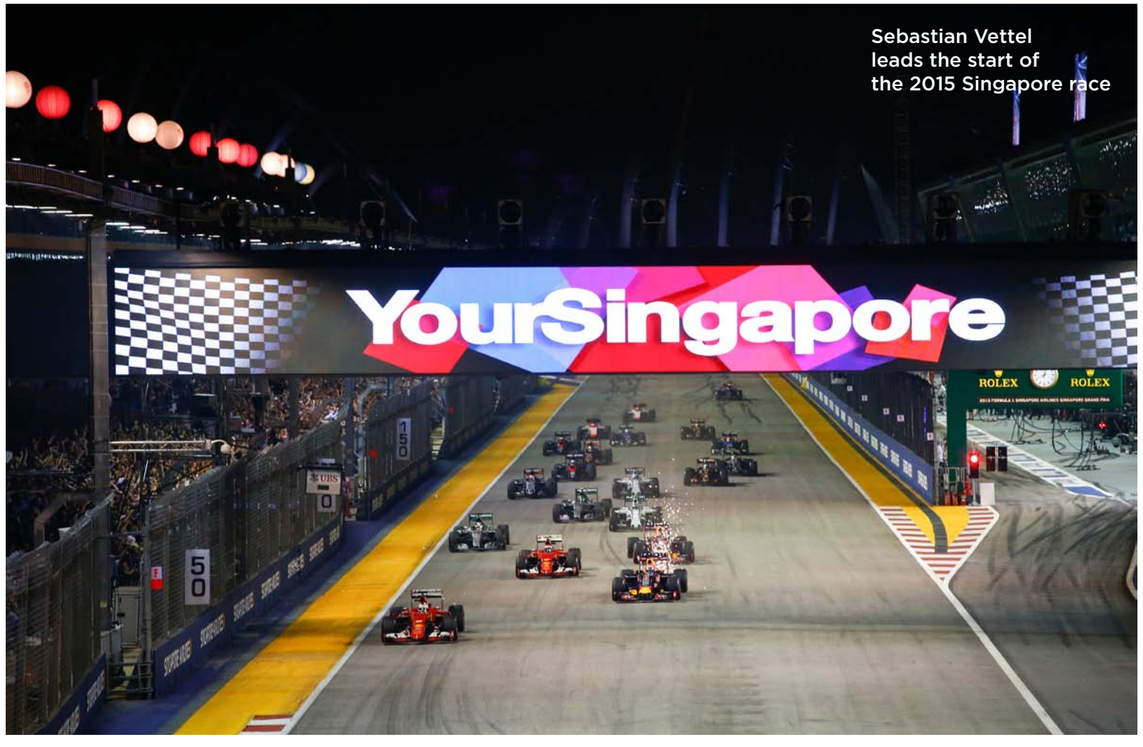
A+M: Do you have to train your medical and safety team differently due to the Singapore Grand Prix taking place at night?
KC: As the circuit is so brightly lit, protocols in terms of track craft and safety are similar to any other race during the day. It is only in areas beyond the run-offs that we had to cater for extra lighting.

A+M: What is the most rewarding part of your work in motor sport medicine?
KC: Having seen through a successful event and having provided the volunteers with a meaningful and engaging time. It is rewarding to see our volunteers come back year-after-year. I find that it is important to provide them with a positive volunteer experience. This includes providing effective training, engagement all year round, and listening to their feedback. Volunteering for motor sport is not an easy task. The hours are long and the conditions are not always the most comfortable. Sometimes little things like lollipops or ice cream in between sessions can be comforting. Most important of all is to keep our volunteers engaged throughout the event. We keep our medical volunteer retention rate at around 75 per cent and aim to improve that.

A+M: In what ways would you improve motor sport medicine?
KC: There are two things I would like to see being more done. Firstly, improvements in training and education for medical professionals involved in motor sport. Secondly, improvements in volunteer management.

It is difficult to standardise a training programme as culture and motor sport disciplines vary widely. One approach is with customised programmes that ensure that teams perform at a suitable standard. These programmes should include not only theoretical knowledge, but also practical skills and team-based simulation exercises focused on challenges in motor sport environments.

In many aspects of motor sport, volunteers make up the majority of race officials and are essential for a successful event. Efforts must be taken to ensure adequate training, safety and welfare of volunteers. Regular volunteer engagement, team-building efforts and seeking feedback are important.



Sebastian Vettel leads the start of the 2015 Singapore race

IMAGES: SINGAPORE GP PTE LTD

IN FOCUS: VIDEO LARYNGOSCOPES

AUTO+ Medical responds to a request for information about video laryngoscopes, equipment carried by anaesthetists working in motor sport series around the world

Contributors: Dr Paul Trafford, Dr Rob Seal and Dr Ian Roberts

Maintaining an airway is something that any doctor or paramedic may be required to do. Motor Sport provides some unique challenges, but basic airway manoeuvres should always be deployed first, with often a simple jaw thrust or clearing of the airway being adequate along with the use of an oxygen mask. Where further intervention is necessary, simple devices such as the oropharyngeal or nasopharyngeal airways should be used and if appropriate the i-gel or laryngeal mask.

Visualisation of the larynx, also known as laryngoscopy, facilitates the insertion of an endotracheal tube into the airway – a practice that is routinely carried out by anaesthetic specialists in hospitals, but this is something all doctors attending motor sport events in an emergency capacity should be familiar with. Yet even in the hands of a skilled anaesthetist this is not always an easy procedure. Rarely necessary on-track or in a stage of a rally, intubation is best performed under controlled conditions in a medical centre and where possible by a skilled anaesthetist with appropriate assistance.

We were asked for information on video laryngoscopes following publication of a recent paper in the British Journal of Anaesthesiology and whilst we are pleased to discuss the subject we want to point out that such devices are best left to the anaesthetic specialists and are not something to be added to the routine emergency medical bag," says Dr Paul Trafford. "We also hope to consider basic airway management in a future edition of this publication as this is something very important to all of us whatever our specialty."

The classic Macintosh laryngoscope has a handle containing a battery, to which various designs of blades can be attached depending on the circumstances that it is required for. A light source is usually situated at the end of the blade to illuminate the pharynx, epiglottis, vocal cords and tracheal opening, although in some cases the light source is actually located in the handle with fibre optics being used to deliver the light to the end of the blade. "In recent times many countries have made the blades, and in some cases the entire laryngoscope, disposable and they are thrown away after a single use because of concerns over infection control," explains Trafford.

The laryngoscope is held in the left hand, inserted into the mouth and used to push the tongue to the left side and lift the epiglottis, which obstructs the view of the vocal cords. To achieve this, the correct positioning of the patient's head and neck is essential – the neck needs to be flexed forward with the head extended backwards in a position often called

Medical cars in Formula One and other series carry a large bag for equipment

The large medical bag has a foldout design and contains a wealth of equipment, including a small portable automatic ventilator and all the airway equipment, such as the tubes to the video laryngoscope.

The Glidescope Ranger video laryngoscope (far right) is used in Formula One and by other medical personnel involved in motor sport worldwide.

The Glidescope Ranger in action. A small electronic screen similar to those fitted on smart phones is used to show the view of the Larynx

'sniffing the morning air'. The field of view with a laryngoscope is very limited even in ideal conditions and "this makes it difficult to show others what you are looking at," adds Trafford.

Where the anatomy is distorted, or in cases where mouth opening, head and neck mobility or prominent teeth cause issues with the visualisation of the pharynx and tracheal opening, it may become difficult and in some cases impossible to see what is going on. For this reason, when a difficult airway is encountered, anaesthetists have a series of alternative methods available to them, most of which are confined to the specialist in a hospital setting. Some, such as the use of the laryngeal mask (for example the i-gel), are commonly used in emergency pre-hospital care.

The video laryngoscope is a device that allows the user to demonstrate the anatomy to others as well as allowing visualisation of the pharynx and vocal cords where direct laryngoscopy is not suitable. A small electronic screen similar to those fitted on smart phones is used to show the view at the tip of the laryngoscope blade, which may not be visible via direct sight. "In skilled hands these devices can assist with correct placement of an endotracheal tube through the vocal cords and into the trachea," explains Trafford.

"Video laryngoscopes are now available in disposable form and are produced by a number of suppliers at reasonable cost," he continues. "They can be a useful tool for those familiar with its use." The devices are available in hospitals as part of the difficult airway protocol, and can be used for teaching the anatomy and learning intubation skills.

"Where the intubating conditions are difficult and the user is familiar with its use, a video laryngoscope in the pre-hospital setting can be really helpful in securing the airway," says Trafford. "To my knowledge they are carried in the medical cars for Formula One and the BTCC as well as other series where there are medical professionals familiar with their use, however evidence of their use in the difficult airway pre-hospital setting is limited, and we certainly aren't recommending them as an essential addition to the medical bag.

The image shown on the screen of a video laryngoscope can be difficult to see in bright light and it may be necessary to use a shield that is held over the person performing the intubation. Some models have a channel for guiding the endotracheal tube placement, but in those that do not it is necessary to use a 'stylet', or insert, to stiffen the ET tube and allow it to be bent into position, something many users may not be familiar with.

A paper recently published in the British Journal of Anaesthesia has reviewed the use of a video laryngoscope in a simulated difficult airway setting. Patients were fitted with a hard cervical collar that limited mouth opening from an average of 46mm without the collar, to 23mm with the collar. Attempts were made using a range of six different laryngoscopes (three with a channel to guide the ET tube into position and three without) in a total of 720 patients. The success rate during the first attempt was 85-90 percent, although the success differed markedly with the type of video laryngoscope used. According to the results of the study, those without a channel guide proved more effective.

The paper also included a note that explained how previous studies using in-line stabilisation of the cervical spine had a success rate for intubation that was far higher than when intubation was attempted in the presence of a hard cervical collar.

"We feel that if faced with the situation of having to intubate a competitor in a hard collar, the accepted procedure would be to loosen or remove the collar during intubation to allow mouth opening and have a colleague stabilise the neck and hold the head in line, replacing the collar after the procedure was complete," says Trafford. "This of course would not allow flexing of the neck or any extending of the head, but by allowing the mouth to open fully, the procedure would be made easier."

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- British Journal of Anaesthesia, 116 (5): 670–9 (2016)
- Evaluation of six videolaryngoscopes in 720 patients with a simulated difficult airway: a multicentre randomised controlled trial
- M. Kleine-Brueggeney, R. Greif, P. Schoettker, G. L. Savoldelli, S. Nabecker and L. G. Theiler

CALL FOR LETTERS

If you have an opinion on the use of video laryngoscopes in motor sport, whether you have used one as part of your emergency equipment or have experience using them, please write to: medical@fiainstitute.com.

In future articles we will be looking at new advances in equipment as well as existing medical items, so if you are aware of any new developments used in motor sport medicine or want to see a review of something you use, please write in and let us know your thoughts on the topic.

AUTO+MEDICAL FEATURES

INSIDE THE WEC MEDICAL CAR

AUTO+ Medical takes a look inside the World Endurance Championship's brand new Audi A6 medical car

The Audi A6 Avant 3.0 TDI competition quattro tiptronic made its debut as the World Endurance Championship medical car at the first race of the 2016 season, the Silverstone Six Hours.

The car can accelerate from 0-100km/h in 5.2 seconds and has a top speed of 250km/h. It is manned by three crewmembers – a driver, a doctor and a paramedic.

At tracks like the Nürburgring, which hosted the fourth round of the 2016 WEC season, there were three A6 medical cars stationed around the circuit in addition to the main car, which is located in the pitlane.

At each WEC race, the car's medical equipment is brought to the track by the race organisers and Audi employees from quattro GmbH fix the kit in place in the car's boot. The equipment, which is similar to that used in Formula One and Formula E due to its electrical components, requires additional kit, such as gloves and a hook for the intervention teams.

The WEC A6 is fitted with a blue roof beam lighting system and an aerial, which connects to a radio system installed in the armrest between the two front seats. The car's engines are permanently running during every WEC race to let the drivers instantly react to a problem.

AUTO+MEDICAL FEATURES

1 EMERGENCY BAG:
The emergency bag includes substances to ensure cardio-respiratory resuscitation, analgesic and an anesthetic, as well as intubation hardware, infusion sets, infusion fluids, O2, and a small portable suction apparatus. It also holds bandages, antiseptic, masks, gloves, a blood pressure monitor, ventilation equipment, tourniquets and splints.

2 HELMETS:
The helmets worn by all the crew of the medical car have a radio link to the on-site resuscitator and they must communicate directly with the event chief medical officer and medical delegate when attending to any serious incident.

3 MONITOR AND DEFIBRILLATOR:
A monitor and defibrillator are present in all WEC medical cars alongside one or more collars and a fire extinguisher.

4 INTRA-OSSEOUS VASCULAR ACCESS SYSTEM:
The WEC medical car is fitted with an intra-osseous vascular access system, which can be useful in certain circumstances, such as if a driver is stuck in a car making other approaches difficult.

5 INTERVENTION BAG:
The WEC medical crews will carry a small bag for intervention that holds a lamp, catheter, oximeter and fluid, as well as a cervical collar and resuscitator for the doctor to use when attending to a patient outside of the car.

7 KENDRICK EXTRICATION DEVICE:
A green Kendrick Extrication Device is used in the WEC to assist medical personnel when dealing with crashes involving GTE cars, although this is not adaptable for LMP1 or LMP2, and it sits at the bottom of the medical car's boot.

6 ELECTRICAL SAFETY EQUIPMENT:
A rubber mat and a hook are used to help the medical team extricate the driver without touching the car. These are used to ensure medical personnel are not hurt from the electrical systems used in some WEC cars.

THE ROAD BACK:

NICK HEIDFELD

The former Formula One driver and current Mahindra Formula E racer looks back on the injury he sustained at last season's Putrajaya ePrix and offers his thoughts on when it is right to return to the cockpit

During the close stages of last season's Putrajaya ePrix, Nick Heidfeld's Mahindra steering wheel jerked unexpectedly out of his hand. Although he was able to finish the race and was not aware of any serious injury, he had snapped a ligament in his wrist and was forced to miss the following race in Punta del Este. He spoke to AUTO+Medical about the incident and his recovery process.

AUTO+Medical: What happened during the Putrajaya ePrix that caused the damage to your wrist?

Nick Heidfeld: I had a big oversteer moment and I also brushed the wall, but it had nothing to do with the small impact. I think it was just the fact that I put a lot of opposite lock on and as the oversteer was quite huge and with this steering compared to other racing cars, you can actually turn the steering wheel quite far. You can nearly turn the car on the spot and the radius is very small.

So I was turning as much as I could and then the arms locked out. I assume that I had lot of force on all the muscles, but then as I couldn't turn my hand further it just dropped out of the steering wheel and I think this is when it snapped.

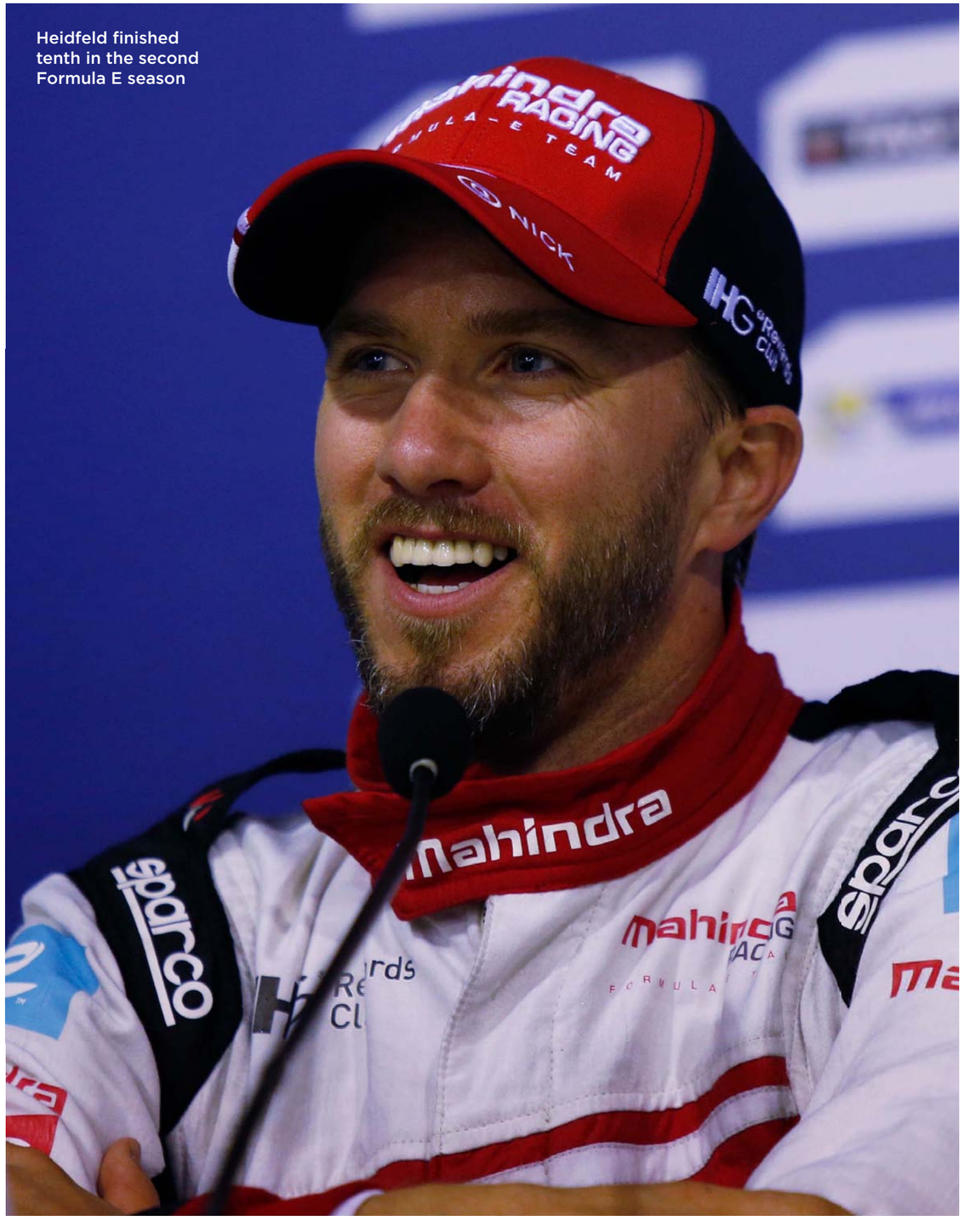
Afterwards it didn't hurt much, just a little bit, so I went to the doctors at the circuit. They put some ice on it and I thought it would be ok. They obviously looked at it but without a proper scan it was impossible to know. We were all sure there was nothing really too bad. But the next morning it got worse and then as soon as I was home in Switzerland I had it checked by a scan with some injections to see where all the fluid goes and then they could see that there was a scapholunate ligament that was cut through. This meant that we needed to organise an operation quickly because if we waited too long it goes back by itself and then it's too late to fix, so I got an operation date a week later in Zurich and it was operated on.

A+M: And how did that operation go?

NH: The operation was longer than initially planned and as my scar shows, they wanted to do it a bit smaller but they had to open it a bit more as it's quite complicated to get to the damaged part. I think the operation time was about 50 minutes long or something like that.

A+M: Did you know then that you would miss some Formula E races?

NH: Yes. Initially, from my understanding, it was like 'maybe I will miss one race' but then the more I spoke to the doctor and the physiotherapist and it was more like 'you will definitely miss one and very likely two, or even more races.' So this was quite tough to hear.



Heidfeld finished tenth in the second Formula E season

AUTO+MEDICAL FEATURES

A+M: What did they tell you to do to aid your recovery process?

NH: First of all I had two nails inserted into my wrist to immobilise the hand. On top of that I had something that covered the hand so I couldn't move it up and down. Those things were to stop it moving because they told me it was crucial not to move the hand at all for it to recover well. I had to wear the cover for like six weeks and when it was eventually taken off I had the two nails inside removed as well.

My physiotherapist told me all the time that I would surely miss two races. But I was always like 'yeah, maybe, but we can do it' and she said, 'no, it's not going to work'. They had warned me before that when the immobilising stuff was taken away, all the muscles had started to disappear after 48 hours as all the tendons and everything sort of fall asleep. So at the beginning I could barely move my hand. I remember on the first day I was not even able to push a button on the bottom of my phone with my left hand. Then when I was at the physiotherapist again she told me 'now you understand that you will not be able to do the next race!' But I still said, 'no, let's try.'

Then it was a long process. With the therapist in the beginning I saw her twice per week and she warmed it up, stretched it very lightly and I had to do a lot of exercises at home by constantly moving the fingers with different things and trying to move the wrist.

A+M: What happened after you missed the Punta del Este ePrix?

NH: Luckily then it started to go a bit quicker than expected and I had a test organised with Mahindra in Valencia, which was not with a Formula E car, because I told them if you want me to take a decision now if I can do the next race at Buenos Aires and I don't test anything before, I will say 'no'. This was because I had doubts and I could not be sure at all without a test.

The Putrajaya race is held in Malaysia's federal capital city

So it was arranged and I did a test in an old GP2 car and it worked out better than expected. I only did four or five laps not pushing flat out but I could see that maybe in ten days time I could do Buenos Aires. But again I told them I was not sure if I was able to do it because on the day of the test I would not have been able to complete a full race.

I needed to foresee what would happen, which is very difficult with an injury like this and I've never had anything like this before. I asked if it was feasible for them to let me drive the shakedown in Buenos Aires and have another driver on hand to take over if I couldn't do the race. Again, luckily, they agreed to do that because they definitely wanted to have me back in the car, which was a nice feeling to have the team pushing very hard and giving me every opportunity to maybe make it. Then, after the shakedown, it was still not an easy decision to start the race.

A+M: What did the wrist feel like when you got back in the car?

NH: On certain movements it would still hurt, not on all the movements but if I had any sudden oversteer to react to, it would hurt. The most important thing was that the doctor had assured me that I might feel it and it might hurt, but it was not dangerous. On top of that, my wrist strength wasn't at 100 per cent, and the doctors have said it will never be the same as before. Still now it's not as good as it was before and I'm still working on it.

I told Mahindra I was not sure if I would do the race in Buenos Aires because I was not sure if my strength would be enough. I said, "I can try it, it's very sensible to try it but I'm not 100 per cent sure'. The good thing was that Adrian Campos [boss of Mahindra's partner, Campos Racing] was there as well and he told me that he also had some injuries in his career and he said that once you get into the rhythm the adrenaline comes and it will be ok.

"THIS WAS PROBABLY THE BIGGEST ACHIEVEMENT THAT I FACED IN MY RACING CAREER DURING THE COURSE OF THE 2016 SEASON"

So we decided together that I would do the race on the Saturday in Buenos Aires, but I still told them I was not 100 per cent sure I would not have any pain and I might not have enough strength, and the end of the race would be poor because of that. But together we decided to try it and then the race went relatively ok, just in the last couple of laps I missed a bit of strength and in the high-speed chicane I couldn't push flat out there, but I didn't lose much time.

For me this was probably the biggest achievement I had in my racing career this year because getting my hand working again was by far the most difficult part.

Heidfeld managed to finish ninth in the 2015 Putrajaya race

A+M: Was this the first injury you have suffered in your career?
NH: Yes, it was the first big one. I had some small concussions but not something that put me on the sidelines for too long, so this was the biggest I ever had. Not only in racing, but also in general.

A+M: Did the nature of the Formula E car's steering play a part in your injury?
NH: I'm not sure. What probably made it more difficult is that we don't have power steering and in most other cars we do. So it's quite hard to turn and it puts quite a lot of stress on your arms, shoulders and wrists.

A+M: What advice would you give to other drivers who are recovering from an injury?
NH: First of all you have to be absolutely sure about the doctor getting the correct findings – and I was very sure with the doctors I had that they were right. I've had it before and there is a saying in Germany, 'three doctors, three different points of view', so you have to make sure that you know exactly what is going on and that you're fully behind what action you are going to take – whether you ultimately need to have an operation or not.

Just try to get the best people possible and then I think, as in anything, it is important to believe in yourself. For me, if I hadn't pushed flat out on my recovery I would have missed more races. It is a hard job and a lot of work but it was kind of easy because I love racing – like all other racing drivers do – so it comes easy to you to try everything you possibly can to recover as quickly as possible.

Heidfeld has raced in Formula E since the series began

SCIENCE

MOTOR SPORT RESUSCITATION REVIEW

Dr Matthew Mac Partlin discusses the latest theories and practices in resuscitation techniques and explains how these ideas can be applied to motor sport

Author: Dr Matthew Mac Partlin, critical care physician, Australia, Deputy CMO WRC Rally Australia, Assistant CMO F1GP Australia, CAMS NMAC.

Contributor: Dr Carl L Gwinnutt FRCA, Emeritus Consultant, Salford Royal Hospitals NHS Foundation Trust, & President, Resuscitation Council (UK)

INTRODUCTION

All healthcare professionals have an ethical and statutory responsibility to be familiar with developments that occur within their own speciality. There are a host of resources available which allow us to achieve this; through attendance at meetings organised by colleges and associations, peer reviewed journals, face-to-face courses and internet articles. These resources allow professional development using an evidenced-based approach to ensure that we provide the most up-to-date

Formula One driver Carlos Sainz is placed in an ambulance following his crash in practice for the 2015 Russian Grand Prix

care. For those of us involved with motor sport medicine, the same responsibilities apply. The vast majority of available information, however, is based upon public practice. There are some instances of military practice, but very few which address the specifics of event medicine and more specifically motor sport medicine.

Consequently, most healthcare professionals and indeed others who provide care at motor sport events e.g. fire and rescue, extrapolate from our day-to-day professional abilities and experience to try and identify what is likely to be applicable, what might need some adaptation and how this may be achieved. However, it is important to keep in mind many of the differences between motor sport and general public incidents, the key ones of which are the high speeds involved, ultra-rapid medical and rescue attendance at the scene and the variety of safety devices employed.

The aim of this article is to review a selection of recent changes in hospital and pre-hospital based acute care and explore how these may be utilised within motor sport rescue and medicine.

PRACTICE (R)EVOLUTIONS

THE GOLDEN HOUR FALLACY

The concept of the 'Golden Hour'was developed by the American Trauma surgeon, Dr. R. Adams Cowley and was the basis for the Advanced Trauma Life Support (ATLS) course. You can read more about his story here: About Advanced Trauma Life Support. He described a trimodal distribution of deaths after major trauma:

- immediate, following unsurvivable injuries e.g. thoracic aortic disruption,
- within the first hour from airway, breathing or circulatory problems,
- after days or weeks from sepsis or multiorgan failure.

ATLS was based upon recognising and treating the problems that caused deaths in the first hour, many of which were regarded as avoidable, hence the term "Golden Hour". This resulted in a misplaced assumption that a practitioner had up to 60 minutes to intervene in a major trauma victim, which is now recognised as an oversimplification. It also resulted in inaccurate measures of quality of care.

Clearly, some victims need intervention much sooner (e.g. tension pneumothorax, impact brain apnoea) while others might progress over a much longer time (e.g. subdural haematoma, pelvic venous plexus bleeding) (1). What is more important than assuming a window of one hour in which to provide care is the appreciation that a major trauma patient is at high risk immediately and requires a systematic approach at each stage of care in order not to miss life-threatening injuries. This is particularly true for circuit motor sport where the medical response team will be rapidly on scene after an incident and signs and symptoms of the injuries may be only beginning to develop, which may lead to an underestimation of severity of injury unless those in attendance understand the dynamics of the incident.

The concept of a 'fixed' period in which to deliver care also led to the presumed dichotomy of 'stay and play', providing advanced life support (ALS) skills at scene or 'scoop and run' providing basic life support

The medical helicopter at the Circuit of the Americas

(BLS) interventions, followed by a dash for the nearest major trauma centre (2). Once again, many experts consider this apparent mutual exclusivity to be an oversimplification.

Factors such as the injuries sustained, skills of those responding, and transport time/distance all have an effect on the outcome of the individual. This is reflected in motor sport whereby it may be perfectly reasonable to provide basic life support interventions followed by a two minute journey to the nearby trauma centre to a circuit competitor, a similarly injured Dakar competitor may require roadside decompression of the haemothorax or placement of an advanced airway to ensure their survival of the much longer transfer to definitive care.

DAMAGE CONTROL RESUSCITATION

In early trauma practice, the surgical team tried to repair all injuries, leading to prolonged surgery and disappointing outcomes, due in part to the triad of hypothermia, acidosis and coagulopathy (3).

Initial trauma surgery has evolved to:

- Treating rapidly any immediately life-threatening injuries e.g. haemorrhage from a hepatic laceration, pelvic fractures
- Transfer to the ICU to manage any physiological derangement and prevent subsequent complications
- Definitive surgery then takes place when the patient is stable, which may be several days later.

This process is referred to as 'Damage Control Surgery' and has resulted in improved outcomes and reduced complications. Further evolution of practice, influenced by military practice in recent

conflicts, has led to the concept of 'Damage Control Resuscitation', of which damage control surgery is a part alongside targeted permissive hypotension and haemostatic resuscitation. For a full review of the history and components of damage control resuscitation read Damage control resuscitation: history, theory and technique in the Canadian Journal of Surgery (4) and Damage control surgery in the era of damage control resuscitation in the British Journal of Anaesthesia (5).

How do these changes integrate into the management of trauma at motorsport events?

Clearly in nearly all cases surgery is not performed within the motor sport environment, but some key principles can be applied:

- Perform the minimum interventions necessary to ensure that the person survives to reach the Emergency Department or operating theatre of the receiving hospital; e.g. decompressing a tension pneumothorax, application of a pelvic splint, insertion of an advanced airway. Performing a pre-hospital resuscitative thoracotomy is controversial and is dealt with below.
- Where there is evidence of or a high index of suspicion of ongoing, uncontrollable haemorrhage i.e. intrathoracic or abdominal, consider permissive hypotension. For penetrating major trauma, which is relatively uncommon in motor sport, there is (moderate quality) evidence (6) to support accepting a systolic blood pressure of 90mmHg. Blunt trauma to either or both the thorax and abdomen is much more likely in victims of trauma in motor sport and although permissive hypotension has been extrapolated to blunt chest trauma, there is currently less evidence to support it, though it is not physiologically unreasonable.
- When there is an isolated head injury, the current recommendations are for a target systolic BP of >110 mmHg (mean arterial blood pressure > 90 mmHg) (7).
- A big problem here is the trauma victim with both ongoing blood loss and a head injury. There are mixed expert opinions on the best approach to this situation. For an overview of the controversies read Permissive Hypotension on the Critical Care Compendium of the Life In The Fast Lane blog.
- What is clear is that estimating the BP based on presence or absence of the radial pulse or which pulse is palpable, is not valid. In motor sports, blood pressure and perfusion should be measured using clinical estimates of perfusion and a non-invasive device, which is quicker and requires less equipment than invasive monitoring. Recognising the device limitations is important.
- Ensure that patient hypothermia is prevented, or even treated if the prehospital phase is prolonged. Minimise prolonged body surface exposure and the use of cold intravenous fluids.
- Blood and blood product strategies will be dealt with in the next section.

The medical team at the Silverstone circuit

AUTO+MEDICAL SCIENCE

“PERFORMING A PRE-HOSPITAL RESUSCITATIVE THORACOTOMY IS CONTROVERSIAL”

BLOOD AND BLOOD PRODUCTS

Alongside work on damage control resuscitation, there has been an evolution in the understanding of the haematological consequences of major trauma and its associated therapeutic interventions, in particular the risk of developing a coagulopathy in major trauma victims, usually referred to as the Acute Coagulopathy of Trauma (ACoT or ACT). An understanding of this condition has been part of the drive to minimise the large volumes of crystalloid and colloid fluids previously given in trauma in preference for blood and blood products; i.e. platelets, fresh frozen plasma (FFP) and packed red blood cells (PRBC) and within military practice, fresh whole blood. However, the use of such products is rare within motor sport practice as the need for cross-matching, appropriate storage and reconstitution of these products and limited 'shelf-life' makes it impractical for most venues. The search for a reliable synthetic haemoglobin is ongoing.

FFP and clotting factor preparations are an interesting area, with work being done on lyophilised, freeze-dried FFP and clotting factor fractions, which have long shelf lives, can be quickly reconstituted and have no compatibility issues (9,10,11).

Managing ACT has also led to the reconfigured role for Tranexamic Acid (TXA), an antifibrinolytic. There is increasing evidence for the use of TXA for major haemorrhage in trauma (CRASH-II trial (12) and the MATTERS trial (13)), and the fact that it is cheap, easily stored, transported and reconstituted makes it attractive for use either trackside or in the medical centre. The dosing is simple and giving the initial dose of 1g of TXA once the trackside basics have been attended to is well within the remit of the motor sport medical team. Some motor sport medical response teams now carry TXA as part of their pharmaceutical stock.
There is a good overview of the TXA controversies in this article in the Medical Journal of Australia - Trauma and tranexamic acid (14). The CRASH-III trial (15) plans to evaluate the use of TXA in the subset of trauma patients with head injury while the PATCH Trauma trial is being conducted to evaluate the role of TXA in mature trauma systems (16).

CARDIAC ARREST IN THE TRAUMA VICTIM

Cardiac arrest in the setting of trauma (traumatic cardiac arrest, TCA) (17) has traditionally prompted a bleak response from medics with a tendency to cease resuscitation efforts on the presumed basis of futility. This in turn has led to some conflict, including criticism for commencing resuscitative efforts. In the pre-hospital setting, there may be pressure to be seen to provide treatment, especially in the highly visibile circumstances of a major motor sport event when there are large crowds or the event is televised.

When cardiac arrest is caused by trauma, the mechanism, whether it is penetrating or blunt has until recently been a key determinant of resuscitative action. A penetrating wound resulting in a tension pneumo- or haemothorax which subsequently causes a PEA (EMD) arrest can be addressed rapidly with restoration of the circulation. Blunt trauma, a mechanism much more likely in motor sport, was considered to have a much worse prognosis, due to there being less likelihood of a readily correctible lesion. However, recent evidence questions this premise (18).

There are two main controversies in the management of traumatic cardiac arrest; the role of CPR and the role of the resuscitative thoracotomy.

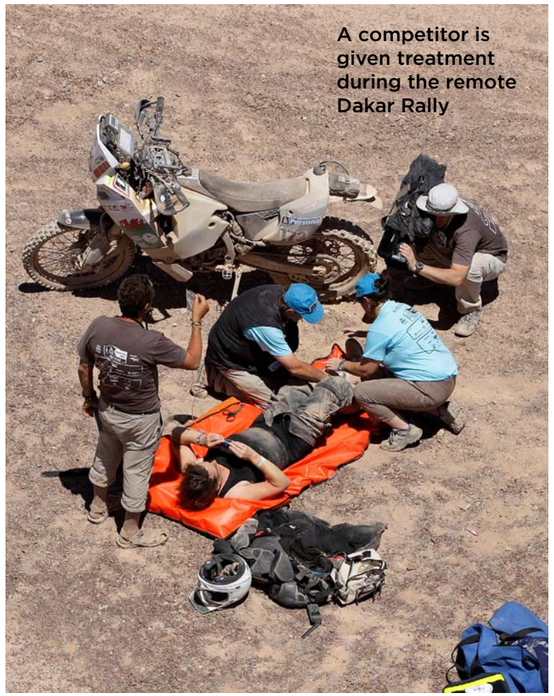
“THERE IS INCREASING EVIDENCE FOR THE USE OF TXA FOR MAJOR HAEMORRHAGE IN TRAUMA”

CARDIOPULMONARY RESUSCITATION (CPR)

The cardiac arrest may be the result or the precipitant of the trauma. Where it is the precipitant it is likely to have an underlying medical cause and management should be based upon standard basic and advanced life support interventions. Clues that the event may have a cardiac cause include:

- older age of the victim,
- a relative lack of other significant injuries
- evidence of loss of consciousness prior to impact; e.g. absence of crash avoidance indicators such as witness accounts or lack of braking tyre marks
- crash in an unusual location such as a straight or an easy turn.

Most trauma experts take the view that the majority of traumatic cardiac arrests are secondary to hypovolaemia from haemorrhage and that CPR therefore only serves to enhance exsanguination, interfere with other resuscitative efforts and delay transport to definitive care (19). Although this is probably true, as mentioned above, in those cases where cardiac arrest is the cause of the trauma, and the resulting trauma itself has not led to major blood loss, CPR may still be of benefit. Additionally although rare, a direct blow to the precordium can precipitate a ventricular fibrillation (VF) cardiac arrest, a condition called comotio cordis (20). This should always be considered a possibility where the victim is young and there is no immediate evidence of other injuries and mandates rapid ECG monitoring and where appropriate, defibrillation.



A competitor is given treatment during the remote Dakar Rally

RESUSCITATIVE THORACOTOMY

Performing a resuscitative thoracotomy involves opening the chest cavity rapidly in order to identify and temporise a limited number of injuries; a tamponading haemopericardium, an exsanguinating lung laceration, intercostal artery disruption and cross-clamping the descending aorta. It has largely been the domain of the cardiothoracic or trauma surgeon in the resuscitation bay of a major trauma hospital and typically only performed when the TCA had occurred within the preceding 5 to 10 minutes following a penetrating chest or upper abdominal injury.

There have been survivors of blunt chest injury TCA where a resuscitative thoracotomy has been performed, though the rates of neurologically intact survival while not zero are very low (<1%).

In recent years there has been evolution with this particular intervention, and although it has previously been considered a hospital procedure because of its complexity and high risk of complications, it has been performed with increasing confidence by leading prehospital services such as the UK HEMS and Sydney HEMS services. Both organisations have doctors as part of the response crews and have published guidelines for performing a pre-hospital resuscitative thoracotomy, which are embedded into their traumatic cardiac arrest policies (Sydney HEMS Traumatic Cardiac Arrest operating procedure). It would therefore seem appropriate that a member of the medical team at motor sports events should understand the principles of how to perform a resuscitative thoracotomy and preferably have ‘hands on’ experience by

attendance at a critical care workshop (23). At the end of last year the International Liaison Committee on Resuscitation (ILCOR) published its five year update on the International Concensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care with Treatment Recommendations (29). Having previously focussed mainly on medical causes of cardiac arrest, this latest document included an algorithm for the management of traumatic cardiac arrest. The recommended algorithm has been adopted with some local inflections by the European, American, Australian and United Kingdom Resuscitation Councils (the Resuscitation Council of Asia is yet to publish their full set of updated guidelines).

Below is a suggested version for how this algorithm might be applied to a motor sport competitor:

1. Arrive at scene and assess. Victim unconscious and showing no signs of life.
2. Open the airway and commence assisted ventilation with supplementary high flow oxygen.
3. In out of hospital TCA, only life-saving interventions are performed, so as not delay transfer.
4. If a medical cause is suspected:
   - Start treatment according to ALS Guidelines.
   - At the same time, control any external haemorrhage, check for and treat a tension pneumothorax and apply a pelvic binder device.
   - If commotio cordis is suspected, treat as per ALS. Early defibrillation is critical. Use trauma interventions as needed.
5. If a traumatic cause of cardiac arrest is suspected:
   - Perform bilateral thoracostomies for tension pneumo/haemothoraces. Use of a scalpel-finger technique is preferred to needle decompression(33).
   - Compress any obvious external haemorrhage. Use a tourniquet on limbs. Topical haemostatic agents or dressings are an option for some haemorrhaging wounds.
   - Apply a pelvic splint.
6. Gain secure IV or IO access. Once a spontaneous circulation is established, give judicious fluid volumes aiming for a systolic BP of 90mmHg unless a significant head injury is suspected (see above). Blood products are preferable but again there are often logistical barriers to their availability at motor sport events.
7. Secure the airway.
8. If there is no response to the above interventions in the setting of penetrating or blunt chest injury, perform a resuscitative thoracotomy, if there is the skill set and equipment available. A bilateral clamshell incision is preferred over an initial unilateral incision.
9. When the cause of the TCA is major trauma and a medical cause is unlikely, most agencies and associations suggest that after any reversible causes have been dealt with, it is reasonable to consider ceasing resuscitation efforts after 10 minutes.

This algorithm focusses on the mechanisms of TCA that will kill quickly and yet, with the correct intervention they can at least be temporised to buy time to transfer the injured person to a facility that can provide definitive care (ideally the receiving trauma hospital rather than the event medical centre). However, there will be situations where it will not be possible to follow exactly the components of this algorithm, for example in the case of a competitor trapped in the vehicle. In such cases, the steps should be applied according to the circumstances.

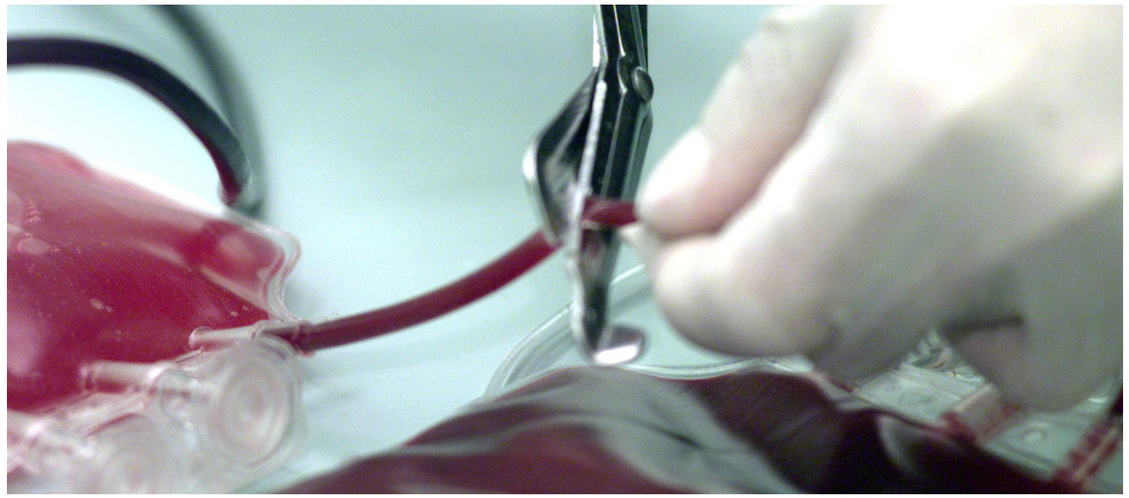
“ILCOR UPDATE INCLUDED AN ALGORITHM FOR MANAGING A TRAUMATIC CARDIAC ARREST”

The majority of competitors in this scenario who are going to survive will respond to steps 1 to 7. Step 8, the decision to perform a resuscitative thoracotomy, would be an uncommon occurrence, especially in the absence of the appropriate skills and equipment.

Step 9, the decision to cease efforts, should be made by the most senior member of the team and only after discussion with all other members. In the highly visible environment of a motor sport event, this may prove very difficult. However, provided that accepted guidelines have been followed and full documentation of interventions, responses and reasons for the decision have been made, it is defensible.

This algorithm, or some agreed version of it should be included in the event’s Medical Response Plan and be addressed at the medical briefing as this offers clarity and a degree or protection for members of the medical team should they be faced with a traumatic cardiac arrest situation. It is also clear that a successful outcome will be enhanced by clear communication, streamlined transport processes and regular education and training.

Motor sport medics practice with a spine board



IMPACT BRAIN APNOEA

Another trauma condition that has gained increased recognition is the syndrome of Impact Brain Apnoea (21). In this situation a direct or indirect blow to the head is thought to disrupt brainstem function transiently causing apnoea and a catecholamine surge that results in cardiovascular collapse, which may be misinterpreted as hypovolaemia. This phenomenon has been described in motor sport, mostly at motorbike races. Typically, on arrival at scene the competitor is unconscious, pale and apnoeic with dilated and sluggishly reactive pupils, but otherwise appears minimally injured. Hypoxia occurs rapidly in motor sport competitors due to their increased oxygen demand. The key resuscitation intervention is support of ventilation and oxygenation. These victims can and should make a full recovery as the condition is transient. For more on this topic listen to neurosurgeon, prehospitalist and motorsport enthusiast Dr Mark Wilson - Impact Brain Apnoea with Mark Wilson (22).

SUMMARY

This review has been an attempt to explore some of the evolutions in in-hospital and pre-hospital trauma management and how they might influence that care in a motor sport context; but by its very nature can only provide but the briefest glimpse of all the information available through a variety of media. There are a number of other aspects of trauma practice that have not been included in this review, such as concussion management and spinal immobilisation practice, which are no less (r)evolutionary and will hopefully be addressed in a future issue of this publication.

With time, experience and research, clinical practices evolve and hopefully improve. In order to provide optimal care for our patients, whether on or off the race track, we must endeavour to keep our knowledge and skills as current as possible using the resources that are available to us. We should also endeavour to maintain professional contact with each other and to keep discussions open and progressive.

Editors Note
The subject of the use of cervical collars and immobilisation is on the agenda to be discussed at the Biannual CMO conference in Vienna. We hope to report on the discussions in a future issue.

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For each submission please include a summary of the research and all necessary contact information.

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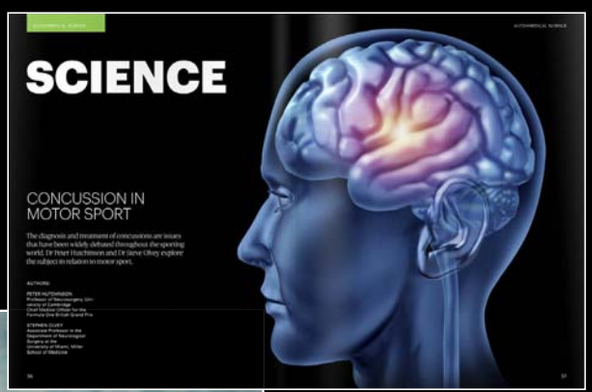

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