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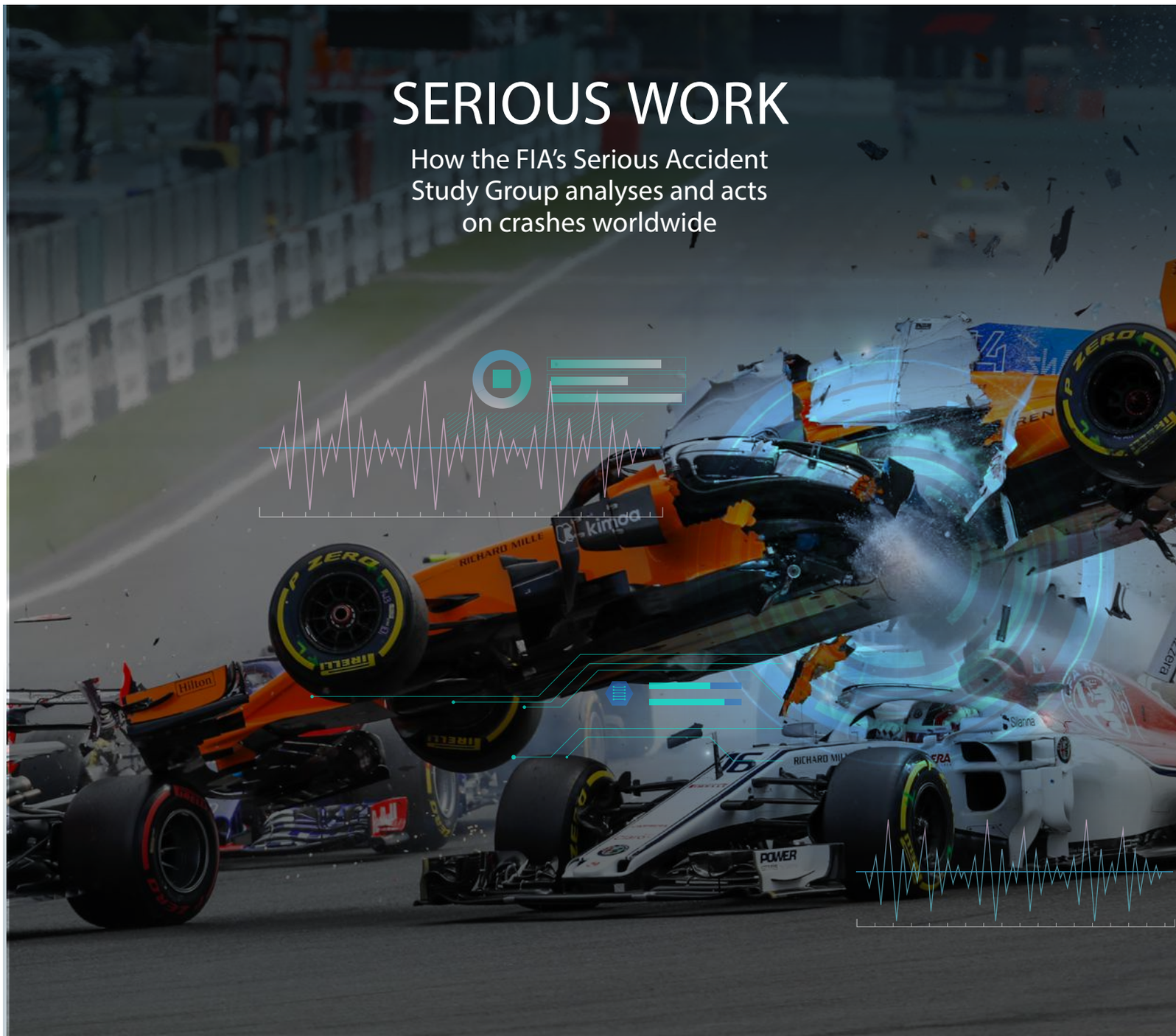


SERIOUS WORK

How the FIA's Serious Accident Study Group analyses and acts on crashes worldwide

CONTENTS+

GLOBAL NEWS/

VIEW FROM THE GROUND/

FEATURES/

STUDY/

Editor: Marc Cutler
Deputy Editor: Rory Mitchell
Designer: Cara Mills

We welcome your feedback: medical@fia.com

INTRODUCTION/

Sadly, we start this issue remembering FIA F1 Race Director and Safety Delegate Charlie Whiting, who died In Melbourne just before the first Grand Prix this year. He was a good friend to all the medical staff involved in motor sport, a great supporter of safety and known by many doctors around the world including all of us on the Editorial Board of *AUTO+ Medical*. Motor sport has lost a true gentleman.

Something most doctors will be familiar with is the collection of data and in this issue we look at the work of the Serious Accident Study Group, an initiative of FIA President Jean Todt, who has pushed to collect data from all serious accidents worldwide to steer the new FIA research team towards the most important issues.

This is a great initiative and one we must all support. Your ASN should be contributing and if you aren't aware of how the data is collected, ask your ASN. Continuing with the theme of data, we reproduce a paper looking at collecting data about driver fitness in various series and how the drivers perceive this. Much of what has been done in the past has been based on anecdote and word of mouth and it is good to see science playing a greater part.

Please continue to send us any research for publication, case reports or interesting features you think we should include, we are always interested to hear what you all think.

The Editorial Board

TRIBUTE TO CHARLIE WHITING

"On behalf of the FIA Medical Commission and the wider motor sport medical and safety community, I want to express our sincere sadness at the loss of our good friend and colleague Charlie Whiting.

He was truly a pioneer for motor sport safety and a highly respected figure amongst motor sport doctors worldwide.

We have lost an inspiring leader in our sport but I hope his legacy will live on through the work that we do to maintain the highest standards in motor sport safety."

Prof. Gérard Saillant,
President, FIA Medical Commission

GLOBAL NEWS

FIA LAUNCHES RALLY SAFETY GUIDELINES

The FIA has launched a new set of Rally Safety Guidelines to improve safety at every level of the sport, whilst maintaining the action and spectacle loved by fans across the world.

The guidelines gather the best practice that is currently applied at World Rally Championship level in a format that can be used by rally organisers at regional and national level.

Close proximity to the cars on stage is all part of the thrilling spectator experience. A key aspect of the guidelines is to help promoters further increase spectator protection.

There are also other suggestions for safety best practice throughout the 100-page manual.

For instance, the FIA is encouraging all of its National Sporting Authorities (ASNs) to have their own safety delegates at each event they sanction. This will be supported by a training programme for safety delegates, with a pilot training seminar this year. From 2020 onwards regional training seminars will be conducted for these Safety Delegates from each country around the world.

Other key points in the guidelines cover the role and responsibilities of officials; the use of safety cars and the safety plan; special Stage set-up; communication with marshals and fans; and incident handling. Many of these initiatives are designed to be implemented with little to no cost and the FIA will work with ASNs to ensure that is the case.

Yves Matton, FIA Rally Director, said: "Safety is the key for the sustainability of rallying in the future and one of the keys in safety is education - we see this around the world. These guidelines will help educate all to have the best procedures and the best habits in rallying."

The FIA Rally Safety Guidelines are available to download here.

FIA APPOINTS FIRST HEAD OF RESEARCH

Tim Malyon, former race engineer for the Red Bull F1 and BMW DTM teams, has been appointed by the FIA as its first Head of Research.

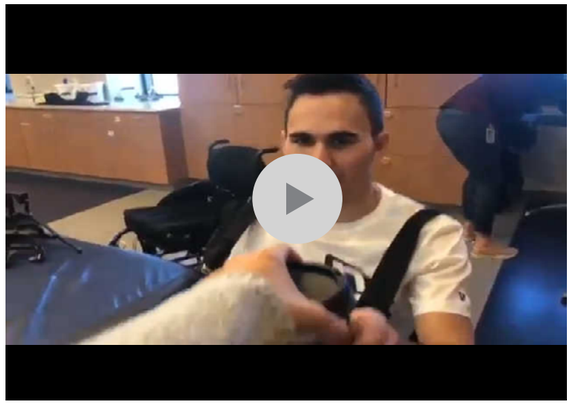
The new role, within the Safety Department at the FIA's Geneva office, has been created to oversee the growing number of safety research projects undertaken by the FIA. In addition, Malyon is tasked with managing the FIA's research groups and associated working groups, as well as an increased focus on accident investigation.

Malyon previously worked for Red Bull Racing for 12 years, having joined the team when it was known as Jaguar Racing. He worked in various race engineer roles and contributed to Red Bull's historic four Constructors and Drivers' championships. In 2015 he moved to Sauber Motorsport as its Head of Track Engineering before going on to work for BMW Motorsport as a Chief Engineer for its DTM programme in mid-2016. After two successful years at DTM, which included one championship victory, he took on the roles of both Track Engineering Department Leader and Chief Engineer for BMW's Formula E team.

One of Malyon's first tasks with the FIA will be to join the next meeting of its high-level Research Working Group, which studies the feasibility, technical aspects and practical applications of every safety research project. This Group has recently appointed new members and now brings together safety representatives from across motor sport including F1, WRC, IndyCar, Nascar, sports cars, motorbikes and drag racing.

Adam Baker, FIA Safety Director, said: "I'm delighted to welcome Tim to the team. Research is at the centre of the FIA's work in safety and Tim will bring a huge amount of experience and knowledge to the role."


Malyon (right) won four titles at Red Bull



WICKENS TAKES FURTHER STEPS TOWARDS RECOVERY

Injured IndyCar driver Robert Wickens has taken further steps towards recovery, following his 200mph+ crash at Pocono Raceway last year that left him with severe spinal and leg injuries.

Wickens has been taking part in gait training which is a type of physical therapy that can help improve his ability to stand and walk again, without the need of physiotherapists to help coordinate his forward foot movements.

In a series of videos posted to social media, Wickens can be seen pedalling a spin bike under his own power, walking with the aid of an exoskeleton, and getting back into his driver training regime.

"My left leg is getting some more strength, for the first time I was able to pull my left leg through consistently," said Wickens when walking using the exoskeleton. "My heart rate peaked at 167, who would have thought walking could be so hard!"

The full extent of Wickens' injuries from the crash were revealed in the days after the crash, which included thoracic spinal fracture, spinal cord injury, neck fracture, tibia and fibula fractures to both legs, hand fractures, right forearm, elbow, and four fractured ribs and a pulmonary contusion.

"The severity of the spinal cord injury he sustained in the incident remains indeterminate and under evaluation," said Schmidt Peterson Motorsports. "Physicians stress it could take weeks or months for the full effects of the injury to be known."

While Schmidt Peterson Motorsports has confirmed that Wickens will not form part of their driver lineup for 2019, they are leaving an entry open for when he is able to return.

DAKAR CO-DRIVER ESCAPES SERIOUS SPINAL INJURY IN CRASH

A co-driver in this year's Dakar Rally narrowly escaped serious spinal injury, after a heavy landing over a dune 16 miles into the gruelling rally's penultimate stage.

Stephane Peterhansel and his co-driver David Castera retired from the 2019 edition, after the 13-time champion crashed his X-raid Mini buggy shortly after the start of the 312km stage.

Castera had to be transported directly to hospital in Lima, having previously sustained whiplash after a drop off a dune earlier in the week. It was later revealed that Castera's injuries were not as serious as first feared - contusion of the spine rather than a fracture. He is expected to make a full recovery.

The uninjured Peterhansel managed to drive the car back to the service park following the incident, although his slim hopes of securing a 14th Dakar title were officially over by that stage.

DR CEM BONEVAL APPOINTED WRC MEDICAL DELEGATE

Dr Cem Boneval has been appointed as the new permanent medical delegate for the World Rally Championship, replacing Dr Jean Duby who stepped down last season.

Previously, Boneval has been the CMO for the WRC Rally of Turkey and the Formula One Turkish Grand Prix. He is also the Medical Commission representative for The Turkish Automobile Sports Federation.

Duby is stepping down after 19 years due to the age limit rules introduded by the FIA last year. But he will continue to remain involved in rallying as a consultant.

FIA CREATES STICKER FOR NON-AMBULANT DRIVERS

Following the creation of the FIA Disability and Accessibility Commission, the FIA has issued a car sticker to identify non-ambulant drivers involved in an accident.

The sticker will help marshals and race officials to identify the cars where the driver may need assistance to extricate themselves and get clear of the vehicle following a crash.

It is the first of its kind for motor sport as previously safety teams could have been confronted with obstructions in the event of a driver having to be extricated from the car.

Now any non-ambulant driver taking part in a race will need to include the sticker on their car from this year, which will further help rescue teams in their response to incidents on track.

FLÖRSCH WILL RETURN TO RACING AFTER MACAU F3 CRASH

Sophia Flörsch will return to single seater racing in the Formula Regional European Championship for 2019 following her serious accident at Macau last year.

Her immediate future appeared uncertain after being left with a spinal fracture but following a seven-hour surgery the day after the crash, she has spent most of the winter break training for the season ahead.

"I've put the accident behind me, because I'm just so happy that I can move all my limbs and start convalescence so soon," said Flörsch. "It's my goal to regularly make it to the top five and secure a win."

Flörsch will compete again with the Van Amersfoort Racing (VAR) squad, after racing with them last year in FIA European F3. "The team is fully committed to get both themselves and Sophia up to speed in this new race category," said VAR CEO Rob Niessink. "With the team's enthusiasm and Sophia's incredible drive to compete again, I am certain we'll do well."

The crash happened during the FIA F3 Cup race, when Flörsch hit the back of Jehan Daruvala coming into the flat-out Lisboa section of the track.

The impact destroyed the right side of Flörsch's car and caused it to skid uncontrollably into the braking zone at 170mph, where it launched into the catch fencing and hit a photographer's bunker. Four people were taken to hospital, although none suffered fatal injuries.

CAMS TO BUILD MOTOR SPORT CENTRE OF EXCELLENCE IN SYDNEY

The Confederation of Australian Motorsport (CAMS) has announced plans to build a Motor Sport Centre of Excellence at Sydney Motorsport Park.

The new facility would be home to an array of programmes including a karting initiative by Formula One driver Daniel Ricciardo, F1 in Schools, and Dare to be Different.

Funding for it has been pledged by the Berejiklian Government, should they be re-elected in New South Wales in this year's state election.

"This is a significant boost for motor sport in Australia," said CAMS president Andrew Papadopoulos. "Funding for CAMS' Centre of Excellence will ensure that we have a state-of-the-art community facility to host a range of programmes for those involved in grassroots right through to the elite level." Papadopoulos noted that the centre would not only benefit CAMS and motorsport in Australia, but would also provide benefits to the local economy and help attract advanced motor sport engineering jobs.

"The Centre is a unique opportunity for Western Sydney which will also attract advanced motor sport engineering jobs," said Papadopoulos. "Through our links with the FIA, the Centre can expect to see many international visitors who will utilise the talents of our local motor sport officials, who are regarded as some of the best in the world."

"There is strong international interest in this Centre of Excellence, and we have no doubt it will be used as a template for other motor sport governing bodies around the world," added Papadopoulos.

ICMS FOCUSES ON RACE TRACK DESIGN AND SAFETY

The 30th International Council of Motor Sport Sciences' Annual Congress took place at Indianapolis on 6-7 December 2018, where a range of topics concerning medical and motor sport safety were discussed.

Motor sport legends Al Unser Sr. and Al Unser Jr kicked off the conference on Thursday, by talking about their extensive careers to journalist Dave Despain. Lectures on race track safety design were next on the agenda, with the evolution of the SAFER Barrier announced as the new standard for track barriers.

The Dan Marisi Memorial Lecture featured former racing driver David Green, who outlined the pathway from problems to solutions in NASCAR crashes. This was followed by NASCAR's senior director for Safety Engineering John Patalak, who gave a presentation on driver position and seat design for thoracolumbar loading during frontal impacts.

Dr Vincenzo Tota gave a lecture on the potential injury with the use of a too stiff head rear in DTM, while Andy Mellor gave an

update on the latest from the FIA Safety Department.

In its fourth year attending, the Race Track Safety Programme (RTSP) did a seminar that delivered updates on best practices in C-spine management under simulation conditions and respiratory protection for motor sport safety personnel.

The morning didactic sessions also covered the advances in rescue tools/ techniques by Holmatro's Peter Fiset, and the implications for rescuers working with electric race vehicles presented by Stephen Martin.

SUPERCARS TO ADOPT IN-CAR WARNING SYSTEM AFTER BATHURST TRIAL

Supercars are set to introduce an in-car warning system designed to alert drivers of upcoming hazards, following a successful trial at the Bathurst 12-hour race this year.

The WEC-style in-car warning system was developed by MoTeC and fitted to every car in the 12-hour race, which enabled drivers to receive flag, Safety Car and race stoppage information

directly from race control.

The introduction of the additional safety measures comes after drivers voiced their concerns last year, when a heavy crash caused the race to end early.

While no driver was seriously injured, a full investigation by the Supercars Commission highlighted the need for additional warning signals through the high-speed, undulating mountains section of the Bathurst circuit.

"This system was a first for Mount Panorama," said Bathurst 12-Hour Sporting Director, David Stuart. "The technical team at Supercars has worked hard to ensure the system is fully functioning and reliable for implementation this year and we know it will add a great deal to the safety of all competitors."

NEW MEDICAL CHAIR FOR UK MOTORSPORT

Dr Paul Trafford has been named as the first Chairman of Motorsport UK's new Medical Committee.

Trafford effectively replaces Dr Ian Roberts, who was Chairman of the previous Medical Advisory Panel when the organisation was known as the Motor Sports Association (MSA).

Last year the MSA rebranded as Motorsport UK to help promote motor sport in the United Kingdom and improve regulation.

Trafford will take on the role alongside commitments as Medical Director in the British Touring Car Championship, member of the FIA Medical Commission and Chairman of AUTO+ Medical's editorial board.

INDYCAR BRINGS BACK LED PANELS TO HELP SAFETY TEAMS

IndyCar has reintroduced the LED displays on cars that help safety teams when attending crashes, and fans follow on-track action.

During the season opening round at St Petersburg the cars carried the LED panels situated on their roll hoops, which assist the safety team by displaying whether the car's engine is running. This allows them to determine if the driver needs assistance in restarting the car, so it can be released back into competition if possible.

"If the car's engine is running, the left-side LED will display a green 'snake' moving from bottom to top and the right-side display will show what gear the engine is in (including a "0" if in neutral)," said IndyCar President Jay Frye.

"If the engine is not running, the left-side LED will display horizontal red bars climbing from bottom to top and the right-side LED will display the gear the engine is in," explained Frye.

Last year IndyCar used the previous-generation matrix LED system for the first four rounds of the championship, however this was removed from the cars due to inconsistency with performance.

FIA PLANNING TO STANDARDISE HANDIKART EQUIPMENT

The FIA is looking at standardising the type of equipment used by disabled drivers in karting, to ensure they are safe and do not obstruct rescue teams.

Speaking at the FIA Medical Summit in St Petersburg, Professor Claude Meistelman highlighted the modifications that disabled drivers make in the French HandiKart Championship, and the problems they pose to safety.

"The big problem is that every driver has his own setup, there is no standardisation" said Prof Meistelman. "This is why with the FIA's support, we decided to try and improve things."

He noted that a lot of drivers tend to use their own modified seat setups, that can consist of dressing strips or adhesive tape.

"It makes things very complicated for the rescue teams in the event of an accident," said Meistelman.

One of the solutions to this is used in Italy, where a harness attaches to the roll bar.

"We would like to avoid using dressing strips and adhesive tapes which make things complicated," added Meistelman.

WRC CARS FITTED WITH COMPETITOR-FACING CAMERAS

The FIA World Rally Championship has installed competitor-facing cameras in all cars this season, which can be accessed remotely by rally Chief Medical Officers (CMOs).

Speaking at the recent FIA Medical Summit in St Petersburg, former WRC Medical Delegate Dr Jean Duby confirmed that the camera will focus on both the driver and the co-driver. It will be used to determine the severity of a crash and aid CMOs when responding to an incident.

"It would mean that he sees immediately what happened during the crash, the head of the driver and if they have lost consciousness or not," said Duby. "Because sometimes they only lose consciousness for a few seconds and afterwards when they are awake again, and they don't remember that they have lost consciousness."

It will be used at a select number of rallies at the start of the season, with the view of improving the equipment by the mid-season so it can be used where video frequency ranges won't be an issue.

This follows the introduction of a high-speed driver-facing camera in Formula One, which is used for accident analysis by the FIA.

AUTO+ MEDICAL VIEW FROM THE GROUND

VIEW FROM THE GROUND:

DR PANKIL PATEL

CHIEF MEDICAL OFFICER, KYALAMI GRAND PRIX CIRCUIT AND KILLARNEY RACE TRACK.
DEPUTY PRESIDENT, MEDICAL PANEL OF MOTORSPORT SOUTH AFRICA.

In the latest column from the frontlines of grassroots motor sport, Dr Pankil Patel gives his view from the ground in South Africa.

I have been involved in motor sport in various ways for 15 years as a doctor. Obviously, while growing up, I was interested and would go to various car exhibitions, race events and displays. I started off working for various car manufacturers during launch events, which then ended with me being involved with one of the Porsche racing teams. I was also involved during the Formula One two-seater event in South Africa and the A1 Grand Prix, alongside serving as Deputy President of the Medical Panel of Motorsport South Africa (the local National Sporting Authority).

I have worked at most of the circuits in South Africa, but only as part of the Porsche race team. Over the last two years, I have been the Chief Medical Officer for the FIA World Rallycross held at Killarney Race Track in Cape Town. I am however based at the revamped Kyalami Grand Prix Circuit, which I am CMO for, and International Convention Centre in Midrand, Johannesburg. As part of being accredited as CMO for WRX, I was required work at one of the other circuits/ events. I also worked as Deputy CMO in Mettet, Belgium during the 2017 WRX.

There is a lot of enthusiasm and talent coming out of South Africa. However, since we lack major international motor sport events, the motivation to get involved is lacking and very few local drivers are thus showcased on the international scene. Some local manufacturers have established motor sport driver development programmes and academies, which have been very successful, however there is a very limited number of seats available. The cost of getting involved in motor sport at grass roots level is also extremely high in South Africa, so it would be good to see it being reduced for competitors in the future.

Safety seems to have improved in keeping with international standards, as racing in South Africa has adopted the new safety products available. As general motor vehicle safety improves, so too has the safety in motor sport. MSA-sanctioned events are strictly monitored and required to be compliant with all safety rules and regulations. Tracks have also been upgraded over the past few years. Kyalami itself went through a complete revamp in 2015, and now hold a FIA Grade 2 license.

There are very few doctors involved in motor sport. We have lacked major international race events in the country, which limits the enthusiasm and career opportunities. Medical support at most motor sport events is provided by Advanced Life Support Paramedics. Most of the doctors involved have been working within the field of Emergency Medicine, either in Emergency rooms or with Ambulance services. I have also worked with firefighters and the South African Rescue team. This gives adequate exposure to the various aspects of emergencies that one would be expected to deal with at events. Unfortunately, South Africa still has a very high incidence of motor vehicle accidents on public roads, which means doctors working within the Emergency Medicine field are regularly exposed to these types of incidents and casualties.

If I could change two things about local motor sport in South Africa, I would reduce the cost of racing and get more of the car manufacturers involved with sponsoring motor sport events, and driver development programmes.

Dr Patel has worked on the World Rallycross Round in South Africa

AUTO+MEDICAL FEATURES

FEATURES

SERIOUS WORK

How the FIA's Serious Accident Study Group analyses and acts on crashes across motorsport worldwide

AUTO+MEDICAL FEATURES

19 August 2018, Campo Grande, Brazil: A Brazilian StockCar Light Championship race is well underway as a number of drivers pull into the pitlane for a stop. One driver, Erik Mayrink, is serviced by his pit crew and then tries to rejoin the pitlane but he is hit by a car on his outside. Mayrink's car then collides with another and is sent careering towards a group of mechanics, crashing into three of the workers before hitting a fourth who is sent flying into the air by the collision.

Three of those mechanics were rushed to the nearby Santa Casa de Campo Grande hospital, one suffering a broken tibia, another a broken foot and a third suffering brain swelling. Whilst all are expected to make a full recovery it was clearly a serious accident that requires analysis.

And that is exactly the purpose of the FIA's Serious Accident Study Group (SASG). This accident in Brazil was one of a number reviewed recently by the SASG, with recommendations for preventative safety measures sent to Brazil's National Sporting Authority (ASN).

For the FIA, safety is very much a global issue and it does not matter whether an accident happens in an FIA-governed world championship event like F1 or World Rally, or a national grass roots event. The remit is that all serious accidents should be investigated.

Of course, it also proactively assesses and recommends measures to prevent those types of accidents occuring the first place.

At its quarterly meetings, the SASG will study accidents that have caused fatalities or serious physical injuries – to drivers, co-drivers, or anyone else, such as staff, officials and spectators. The group will also look, when appropriate, at severe accidents where there might not be physical consequences, such as the crash between Fernando Alonso and Charles Leclerc at the 2018 Belgian Grand Prix, where the Halo frontal protection device prevented Alonso's car from hitting his fellow driver.

A car crashes into mechanics in the pitlane during the Brazilian StockCar Light Championship

Other accidents that the SASG has investigated recently include the 2018 FIA Formula 3 World Cup race in Macau, where Sophia Flörsch suffered a fractured spine after her car went airborne and left the track; and the 2018 Indycar race at Pocono, where a 200mph+ crash left Robert Wickens with severe injuries.

"The aim of this Group is eventually to reduce the risk of accidents," says FIA Medical Commission President and SASG Deputy Chairman Gérard Saillant. "And when an accident does occur, to reduce the physical consequences for the people involved."

The seriousness with which this work is taken is demonstrated by the fact that FIA President Jean Todt personally chairs each meeting of the Group. The other members are the presidents of every FIA sporting commission, including Single-Seater, Rally, Touring Car, Karting, Drifting, Drag Racing and Hill Climb. Also in attendance are the FIA safety staff and sporting department heads. No area of motor sport is left unrepresented.

"Through the SASG, great progress has been made by the FIA under Jean Todt's leadership," says Saillant. "And with each meeting attended by the President of each FIA Sporting Commission, it makes the SASG a great platform to raise awareness on these issues and exchange on them."


Robert Wickens suffered serious injuries from this 200mph+ Indycar crash

"EACH ACCIDENT THAT OCCURS SERVES TO PREVENT THE SAME TYPE OF ACCIDENT HAPPENING AGAIN"

Saillant believes that the awareness-raising element is crucial to improving safety standards in motor sport across the world. And every accident that is studied provides more knowledge and experience to deal with the next.

"In a way each accident that occurs, while it is regrettable of course, serves to prevent the same type of accident happening again," adds Saillant.

DATA DRIVE

The FIA's World Accident Database is central to this. Launched in May 2015, it brings together data from accidents around the world, from Formula One to karting, into a searchable, secure and confidential database that researchers can use to accurately identify areas for improvement in motor sport safety.

The Database is used by the FIA's 139 ASNs around the world to add data from any serious fatal accidents that may occur

across all motor sport disciplines. The data gathered includes acceleration and speed levels, detailed descriptions of the accidents, as well as the medical repercussions for the people involved.

"It is a crucial tool to have a good overview of all recorded accidents, sorted by discipline and countries," adds Saillant. "Through this tool, we can see and demonstrate for example that a number of accidents are not handled properly when they are not under the responsibility of an ASN, and that on the contrary, accidents taking place during ASN-covered events have much better handling. The objective of this tool is to improve safety at all racing events."

In this way, the FIA is able to identify best practice and apply it to all levels of the sport. The FIA may not be able to change the regulations of the championships it does not govern but it can offer a strong recommendation for the improvement and implementation of regulations, as it did for the Brazilian StockCar Light Championship.

The SASG works in conjunction with the FIA Research Working Group, which evaluates research into new safety products and processes conducted by the FIA. This all complements the work of the FIA Safety Commission, which puts forward recommendations to the World Motor Sport Council, the ultimate ruling body.

"The role of the Safety Commission is a regulatory one, the last step before the World Motor Sport Council," explains Saillant. "The SASG is more 'on the ground', plus it works in liaison with the various research groups of the FIA."

ACCIDENT ANALYSIS

The SASG benefits from the multi-disciplinary make-up of its members, which includes doctors, engineers, researchers and promoters, as well as FIA administrative staff. Each accident that is analysed is looked at from both technical and medical sides, and reports are then drafted.

The technical report will provide a very detailed analysis of the causes of the accident, of its mechanism, of the damages to the car, and so on. The medical report provides details on physical injuries and how these occurred. Then conclusions and deductions are made from these two reports.

As well as helping to improve motor sport safety this work will have an additional benefit – road safety.

"It is important to highlight that this is an area where the transfer of knowledge/ expertise from the track to the road is central," says Saillant. "For example, in the latest SASG meeting, the Group discussed the FIA expertise deployment into motorcycle helmet standard improvement."

It all demonstrates the strength and depth of the FIA's work in safety at all levels, across all disciplines and in all countries. The ultimate aim is that the FIA can learn and improve upon any serious accident that happens at any motorsport event across the world.

"THIS IS AN AREA WHERE TRANSFER OF KNOWLEDGE/ EXPERTISE FROM THE TRACK TO THE ROAD IS CENTRAL"

FIA SERIOUS ACCIDENT STUDY GROUP 2019		
Chairman	FIA President	Mr J. TODT
Vice-Chairman	President of the Medical Commission	Prof. G. SAILLANT
Member	President of the Land Speed Records Commission	Mr R. BANOWETZ
Member	President of the WRC Commission	Mr C. BARBOSA
Member	President of the Environment and Sustainability Commission	Mr F. CALDERON
Member	President of the Historic Motor Sport Commission	Mr P. CANTARELLA
Member	President of the Rally Commission	Mr W. CHRISTIE
Member	President of the Single-seater Commission	Mr S. DOMENICALI
Member	President of the Homologation Regulation Commission	Mr D. FAUSEL
Member	President of the Manufacturers' Commission	Mr F. FILLON
Member	President of the ENEC Commission	Mr B. GOESCHEL
Member	President of the Touring Car Commission	Mr A. GOW
Member	President of the Safety Commission	Mr P. HEAD
Member	President of the Drifting Commission	Mr A. IIDA
Member	President of the Cross-Country Commission	Ms J. KLEINSCHMIDT
Member	President of the Drivers Commission	Mr T. KRISTENSEN
Member	President of the Hill Climb Commission	Mr I. LAHOUD
Member	President of the CIK Commission	Mr F. MASSA
Member	President of the Disability and Accessibility Commission	Ms N. McGLOIN
Member	President of the Endurance Commission	Mr R. MILLE
Member	President of the Women In Motorsport Commission	Mrs M. MOUTON
Member	President of the Off-Road Commission	Mr G. OLAH
Member	President of the Drag Racing Commission	Mr L. PETTERSSON
Member	President of the Closed Road Commission	Mr R. REID
Member	President of the GT Commission	Mr C. SCHACHT
Member	President of the Circuits Commission	Mr G. SILBERMANN
Member	President of the Volunteers and Officials Commission	Mr C. SYN
Member	President of the Truck Racing Commission	Mr M. VIDAL
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FIA attendants	FIA Secretary General for Sport	Mr P. BAYER
FIA attendants	FIA Sports Car/Touring Car/FE Championships Department Director	Mr F. BERTRAND
FIA attendants	WRC FIA Permanent Medical Delegate	Dr C. BONEVAL
FIA attendants	FIA Head of the Historic/Hill Climb/Off-Road Departments	Mr V. CARO
FIA attendants	FIA Head of Safety Equipment Homologation	Mr N. COSTA
FIA attendants	FIA Safety Engineer	Ms N. ENCINAS
FIA attendants	FIA Rally Director	Mr Y. MATTON
FIA attendants	FIA Research Expert	Mr A. MELLOR
FIA attendants	CIK Executive Secretary	Mr K. OBERHEIDE
FIA attendants	FIA Research Expert	Mr M. PIRACCINI
FIA attendants	FIA Head of Circuit Safety	Mr S. ROBERTSON
FIA attendants	FIA Technical Director	Mr G. SIMON
FIA attendants	FIA Director of Formula 1	TBC

DINO ALTMANN

Deputy President, FIA Medical Commission
Chief Medical Officer, Brazilian Grand Prix

Dino Altmann is Deputy President of the FIA Medical Commission and Chief Medical Officer of the Brazilian Grand Prix, with almost 30 years' experience working trackside as a doctor. AUTO+ Medical spoke to him about the challenges facing doctors at race tracks and the future plans of the Medical Commission.

AUTO+ Medical: What came first for you, motor sport or medicine?
Dino Altmann: Motor sport came first. It started with go-karts as a teenager and I really thought I would become a professional driver when I was 18. Despite my skills I had no support from my parents and couldn't get a sponsor. That was the end of my racing career.

I then started business school but after a year I moved to the medical school, having in mind to become a cardiac surgeon, an idea I gave up after my second year of residence as I moved to surgical oncology. This is a more challenging specialization where you need to be disciplined, focused, precise and up to date. You will never find the exact same scenario twice, it pushes you all the time and I think it matches some of the skills needed to drive racing cars.

In 1990, when the Brazilian Grand Prix moved from Rio de Janeiro to Sao Paulo, I applied to be a trackside doctor. By that time, I had gained much experience in trauma emergency rooms and intensive care units. It was for me an amazing experience to be trackside in an ambulance and it was the beginning of my motor sport involvement as a Physician.

A+M: How were you able to combine the two?
DA: As a private practitioner I am able to manage my own schedule. The fact that most motor sport events happen during the weekends also makes it easier. The tough reality though is that sometimes I do work three or even more weeks in a row without a break, a pace which would not be easy to sustain all year; luckily, there is an off-season. The good news is that during free practice days I am all day in the medical car and am able to catch up with medical publications and other stuff that I am not able to do during the week.

A+M: What roles have you held in motor sport so far?
DA: I started in motor sport as a trackside doctor in an ambulance and the following year I was promoted to the extrication team. I worked as the supervisor of the medical team and the doctor responsible for the emergency room for international events for many years

In 2018, the FIA Medical Commission named Altmann as Deputy President

and in 1996 I was nominated as medical delegate and medical car doctor for the Brazilian Stock Car Championship. In the same event we had Formula Opel, F3 and Touring Cars.

During the past 22 years I have worked with many disciplines including the Maserati GT3 Championship, and I am still working with the Stock Car and the Porsche GT3 Cups / Brazilian Championship. Some years I had 28 weekend events plus the F1 race as well as medical commission meetings, nowadays I still have 20 weekend events plus F1 and medical commission meetings.

I have been the Chief Medical Officer for the Brazilian F1 GP since 2001 and at that time was invited as a guest to the FIA Medical Commission; afterwards I became member and in 2018 I was nominated as deputy president of the FIA Medical Commission.

A+M: Can you give some more details about this new role?

DA: I am very proud to be the Deputy President of the FIA Medical Commission. I want to make clear that it doesn't mean that I will be the next President.

I am there to support our President, Prof Gérard Saillant, and to contribute to the development of the medical aspects and safety of motor sport. In my view all the members of the commission are equally important and as the Deputy I am always pushing everyone to have more participation and to share their experiences with the Commission as they are all very skilled doctors in motor sport.

We have seen many important actions around the world to improve teaching in motor sport and the FIA has an important role in standardizing medical practice in motor sport.

Altmann still works in Stock Car and Porsche GT3 cup

Together with Prof. Saillant we decided the agenda for the last CMO and DCMO Seminar in Saint Petersburg. At the next Medical Commission meeting we will have a presentation about a platform for online virtual simulation that may be a useful tool to help doctors practice their skills.

A+M: What are the key issues in motor sport medicine at the moment?

DA: We have been through some important developments in the past few years and considering single seater racing, we have already achieved a very high standard of safety. Our attention now has to be towards safety in other disciplines such as electric cars, prototypes, super cars, touring cars, rally cars, and karting.

There is also a need to attract doctors to work at the circuits and we have different reasons for them not to come. Many doctors don't want to work during weekends, payment is not attractive and if someone is not passionate about motor racing it may not be very stimulating to stay for a whole day out on the circuit.

> **"DEALING WITH INJURIES AND ESPECIALLY DEATH IS ALWAYS CHALLENGING. YOU BECOME THE CENTRE OF ATTENTION AND SUPPORT"**

A+M: What would you say has been your biggest challenge working in motor sport?

DA: Motor sport medicine is a second specialization and it is time consuming. It has particularities and developments that you have to know, understand and apply. As a physician in charge of different disciplines you have the responsibility to address safety issues and implement preventive measures which encompass personal equipment and car and circuit safety. Working in a developing country where money is an important issue, this is not always easy.

We all know that motor sport is dangerous and accidents are part of the sport, but we are responsible for preventing injuries and above all death. Dealing with injuries and especially death is always challenging. You become the centre of attention and support in those situations including family, friends, team members and all other people involved in the event. You must be strong and understand the suffering to be able to give psychological support to them.

A+M: In your role as CMO of the Brazilian GP, what would you say have been the biggest advances in trackside care for drivers?

DA: I have been blessed to have almost the same team of doctors and paramedics working with me for the past 20 years. Four years ago, I reduced the team making it easier to work with, reducing costs and making it more efficient. This is fundamental toward delivering a high level of care.

Training and simulation exercises started even before FIA introduced them as mandatory for F1 and they make a huge difference in terms of the development of the medical team. Extrication exercises include not only the extrication teams but all trackside doctors in order to get better synchronisation. This training is fundamental, and I consider it as a huge advance in trackside care for drivers.

Extrication seats are now fitted not just in F1 but in many other categories and it makes extrication safer and simpler.

New medical equipment has been introduced to help first care, such as video-laryngoscope and many other devices for handling airways, bleeding, the circulatory system, open wounds and many other trauma injuries. The introduction of the safety warning light is helpful as are the biometric gloves.

A+M: What has been the most rewarding part of your job of working in motor sport medicine?

DA: When I started in motor sport almost 30 years ago medical care in motor racing in Brazil was almost non-existent. We had medical teams organized just for major international events. We organized what we called the itinerant motor sport medical course in six different regions and nowadays we have many doctors working around the existing circuits across Brazil on a regular basis and doing a great job.

For international motor sport events I have prepared some members of my team to be the CMOs and DCMOs. I am sure that when I decide to step out of motor sport I will have left a strong legacy.

In terms of our ASN I am proud to say that we now have our own Medical Commission and we introduced anti-doping tests in all Brazilian motor sport championships.

A+M: What plans does the FIA Medical Commission have for the future?

DA: The FIA Medical Commission is committed to the policy of the FIA vision zero which means that no life should be lost in motor sport. Unfortunately, we have had some deaths in the past years, mainly in Rally and we have to reduce those numbers.

The project for biometric gloves will offer trackside physicians an important tool to better understand the driver's condition even before reaching the accident and this will be particularly important in Rallies where the distances are bigger.

The continued development of ear accelerometers will provide better understanding of the G forces acting on the head of the driver, in turn furthering our understanding of concussion and other brain injuries.

Of great importance is the World Accident Database programme. We have always been reactive to injuries especially since Senna's accident at Imola in 1994. In order to be reactive we need to understand details of every serious accident and that is what the database is for.

Furthermore, electric car racing is increasing very fast and we need to understand all the issues involved on the safety side for drivers, the public and medical rescue teams. Despite our knowledge, many questions have not yet been answered; this does not mean we don't know how to do it, but as we gain more experience, we will gain more data to help develop new approaches to the different aspects of electric racing.

There is an ongoing project on concussion, we have the FIA Race True anti-doping campaign, and recently we started alcohol testing in motor sport.

A+M: Anything else you want to add?

DA: Following FIA guidelines and working with engineers, we have developed a very safe Stock Car, which is the most important professional series in Brazil, based on a tubular chassis. It features a strong lateral impact structure, frontal and rear impact absorbing cones, an updated seat developed in the USA and tested by FIA and a roof hatch.

"THE MEDICAL COMMISSION IS COMMITTED TO FIA VISION ZERO, WHICH MEANS THAT NO LIFE SHOULD BE LOST IN MOTOR SPORT"

Altmann has worked as the Chief Medical Officer of the Brazilian Grand Prix for 20 years

SAFETY IN OUR HANS

How the HANS device revolutionised driver safety and will continue to do so as a lasting legacy of Dr Robert Hubbard

Dr Robert Hubbard sadly passed away in February this year but he leaves behind a strong legacy in motor sport that has transformed driver safety and will continue to do so as the technology he invented is developed even further.

Hubbard's Head And Neck Support (HANS) device was the original Frontal Head Restraint (FHR) and these devices have become an integral part of motor sport, helping many drivers to survive numerous severe accidents. Since becoming mandatory in most forms of motor sport over 15 years ago, FIA research has shown they have helped to minimize head and neck injuries and virtually eliminate all instances of catastrophic injury to the craniovertebral junction (CVJ), which were previously a common cause of death in racing.

"The HANS has been one of the major safety devices introduced in motor sport," says FIA Head of Competitor Safety, Nuno Costa. "The FIA has studied a number of accidents and for some of them we estimate that the drivers and co-drivers would not have survived without the use of FHR devices."

HANS devices have become common sight in motor sport

LIFE SUPPORT

Hubbard was the engineer behind HANS, which was designed to prevent head and neck flexion-distraction injuries during high-velocity frontal accidents. The idea for HANS was initially brought to Hubbard by his brother-in-law and sportscar racer Jim Downing, after the death of one of his friends taking part in an American Le Mans sportscar race due to head injuries.

Downing believed that protection was necessary for drivers to help prevent injuries in sudden stops, where a driver's head would thrust forward too far, causing injuries from severe whiplash to basilar skull fractures. The first designs of the HANS device were conceived in the 1980s and after further testing, with help from General Motors and Ford, interest came from the FIA during 1994 as part of its targeted focus on safety in Formula One.

A significant turning point was when NASCAR legend Dale Earnhardt died due to head injuries during the 2001 Daytona 500. Following Earnhardt's death, it was not long before FHR devices became a familiar sight on drivers, with sales of the HANS increasing from 250 in the first 10 years to over 3,000 by the end of 2001.

IndyCar and NASCAR were among the first to make it mandatory. Since its introduction, there have been no deaths relating to CVJ injury in either championship.

In F1 it was made mandatory for use by all drivers in 2003, with it later playing a key role in protecting Robert Kubica during his massive crash at the 2007 Canadian Grand Prix. WRC shortly followed in 2005, before the FIA mandated the use of HANS in all of its major championships running with modern cars from 2008 onwards.

Although the early iterations of the HANS were branded too bulky and uncomfortable to wear by drivers during the extreme forces and accelerations imparted by motor racing, over the years various enhancements and adjustments have been made to improve the design.

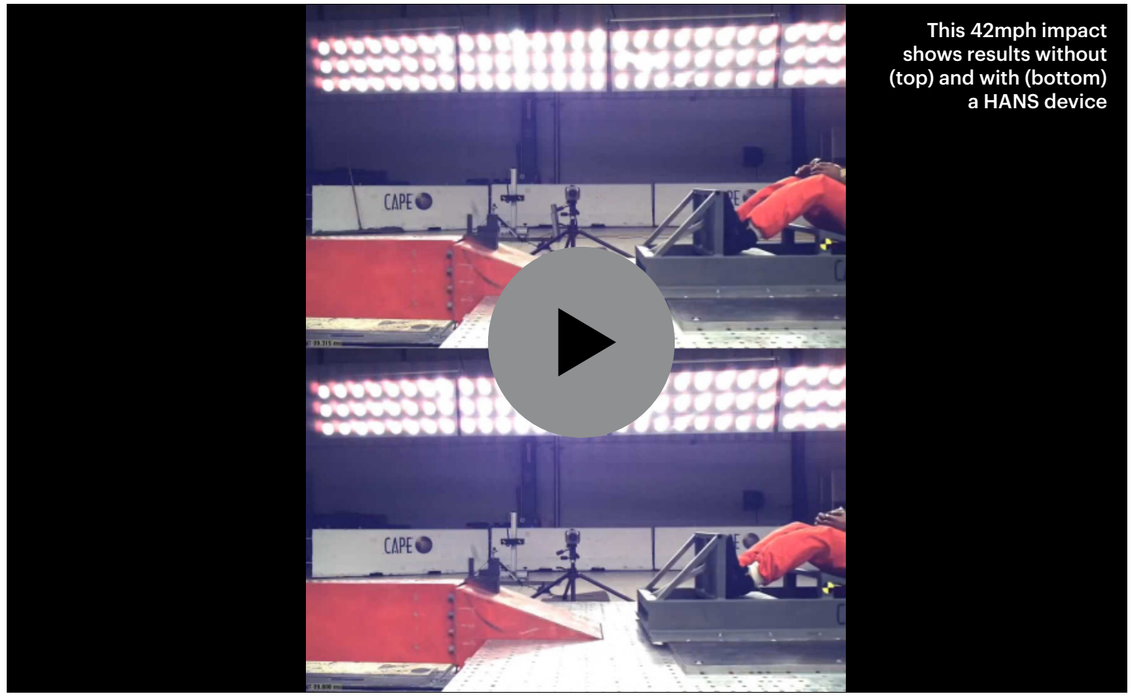
These include sliding tethers that improved driver comfort, significant weight reductions, new materials, and a revised shape for the HANS collar. One noteworthy version of the HANS device was the introduction of the Adjustable HANS in 2013, which allows the adjustment of the HANS collar depending on the driver's seat position in the cockpit.

HYBRID SYSTEM

Initially the HANS was the only FHR device accepted by the FIA. However from 2010 it approved an alternative frontal head restraint system for competitive racing, known as the Hybrid. The Hybrid device was added to the FIA Technical List and has become popular particularly for drivers and co-drivers who participate in rallying.

The Hybrid (and Hybrid Pro) was developed by Safety Solutions Inc now owned by Simpson Motorsport. Both use a combination of straps around the driver's body to maintain the position of a rigid collar, which provides a load path from the shoulder belts to the helmet using flexible tethers.

As for the HANS, the Hybrid is designed to protect during both frontal collision and angled-frontal impacts. Some drivers find it more comfortable, particularly with upright seat types and it is used by a number of rally drivers or co-drivers, as it allows them to easily remove their helmet for road sections



This 42mph impact shows results without (top) and with (bottom) a HANS device

> **"THE FIA'S TARGET IS TO ENSURE THAT ANY NEW DEVICE JOINING THE PROGRAMME PROVIDE THE SAME SAFETY OF CURRENT FHR DEVICES"**

and keep the device attached to their body.

To ensure that innovation can continue leading to the next generation of FHRs, the FIA has set up an FHR Panel comprised of world-leading experts who evaluate the safety performance of alternative frontal head restraint devices based on laboratory testing.

"The FIA's target is to ensure that any new device joining the programme provides at least the same safety level as that of the current FHR devices," says Costa. "Once the panel of experts takes a decision on a new device concept, the FIA safety department team designs the test procedures and pass/fail criteria, which are based on quasi-static tests."

The FHR devices are then tested in an FIA approval laboratory and a comprehensive homologation dossier, along with a test

report, is submitted to the FIA safety department. “The competitor safety group analyses the homologation dossier and takes the decision on whether or not the device can be homologated,” explains Costa. “As for any FIA-approved safety product, we also monitor the use of the FHR devices at the track as well, ensuring that the device is still meeting the FIA safety requirements.”

FUTURE STEPS

The FIA is targeting 360-degree protection for both drivers and co-drivers, with both the HANS and Hybrid offering frontal impact protection up to 30-degrees. Having approved a new research project last year, the FIA hopes to improve the performance of FHR devices by 2020.

“We are planning to look at the FHR basics, at the design and safety performance best practices,” says Costa. “The objective is to gather the feedback from drivers and teams, FHR manufacturers, the doctors and safety delegates with the target to improve the frontal impact performance, reduce the risk of misusing devices, increase the stability of performance for a heterogeneous range of end-user conditions and improve the comfort.”

Another area that the FIA aims to improve is the equipment cost for competitors. During 2016, Motorsport UK agreed to make HANS mandatory for all national championships; before this time, it was viewed as being cost prohibitive risking reduction in numbers of competitors. Even though the FIA has no direct control on costs, it works with manufacturers to help make safety equipment more affordable without any compromise on the quality or safety performance.

“THE TARGET BY 2020 IS TO IMPROVE FRONTAL IMPACT PERFORMANCE, COMFORT, AND REDUCE THE RISK OF MISUSING DEVICES”

“By writing the safety regulation in a way that allows the manufacturers to design new models with novel materials and processes, the FIA incentivises the introduction of cheaper devices while guaranteeing the minimum safety performance,” says Costa.

The FIA together with the FHR manufacturers ran a monitoring programme a few years ago to verify that old devices were (still) delivering the minimum safety performance required by the FIA safety standard. “We concluded that the devices that were not subject to high stress during severe crashes maintain their safety performance over time,” says Costa. “Therefore, the FHR devices continue to not have a validity date and this provides a further measure which keeps the cost down for the competitors.”

Although the HANS had an initially slow birth into motor sport, it was instrumental in establishing FHR devices as an essential part of a driver’s safety equipment. Every top-level driver wears some form of frontal head restraint, and with the additional work being done by the FIA this will continue to be the case.

It is not precisely known how many drivers in categories around the world owe their lives to the work conducted by Hubbard, but it is safe to say that their survival acts as a tribute to his ongoing legacy.

HANS devices were made mandatory in every FIA championship in 2008

AUTO+MEDICAL FEATURES

INSIDE THE AMR INDYCAR SAFETY TEAM RESCUE FACILITIES

The American Medical Response (AMR) Safety Team leads on-track safety response in IndyCar. AUTO+ Medical takes a look at the medical equipment, facilities and operations used in each IndyCar race weekend.

With it being one of the fastest forms of motor sport on the planet, IndyCar needs rapid response when it comes to safety teams. Renowned for its fast action and life-saving skills, the AMR Safety Team appears at every IndyCar and Road to Indy race weekend throughout the season.

Made up of a dedicated team of 30 members who have an average of more than 20 years of experience in their respective areas, they work each race with three Chevrolet Silverado 1500 Crew Cab safety trucks plus a Honda Pilot SUV Response vehicle.

Track safety manager Tim Baughman is one of the crew leaders, having previously worked as a firefighter with the Indianapolis Fire Department. He explains that because of the unpredictable nature of an incident on track, the IndyCar safety team have to be ready to improvise a response plan.

“It goes back to our basic training in mercy medicine. You do a very quick triage,” says Baughman. “We know what to do by looking at the cars and looking at the drivers when the first truck pulls up. We look for driver movement, we look for animation. We may see a driver taking the steering wheel off (a signal to safety workers that the driver feels OK) and drive by that car.”

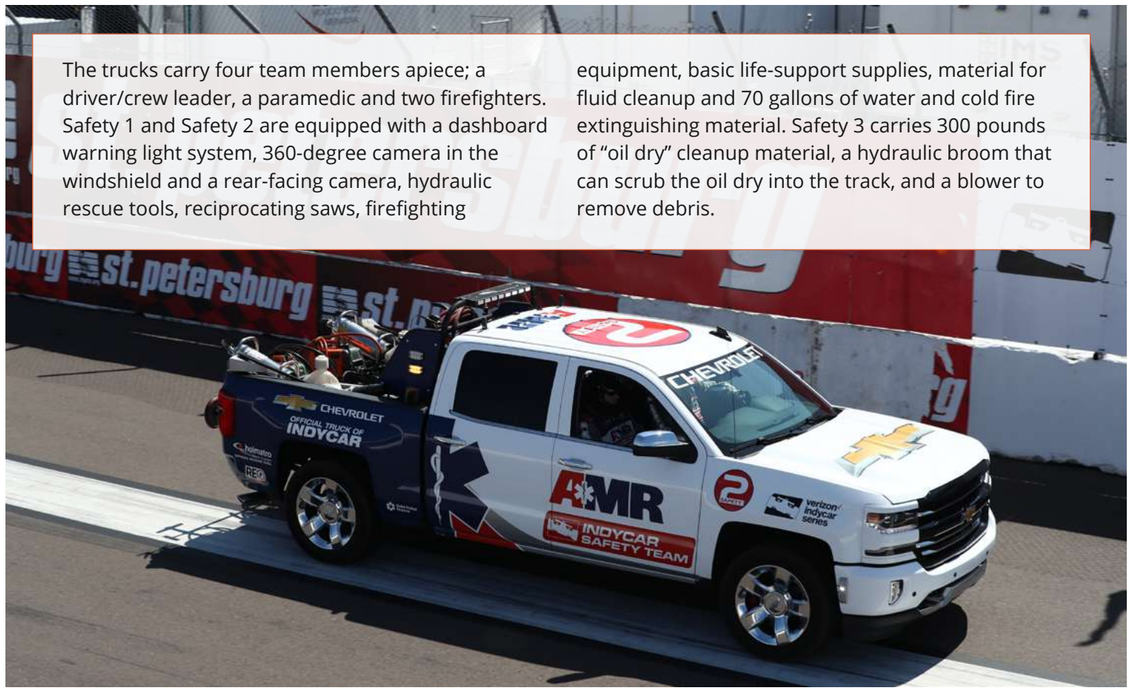
“If we see there is a driver with his head down or on fire, that (safety) truck will drive by everybody else to go to that one first, and then report back on the radio, ‘You take this car, you take that car,’” adds Baughman.

Each race weekend the IndyCar safety team meets with the track’s local safety and clean-up personnel, to ensure that they are all properly prepared.

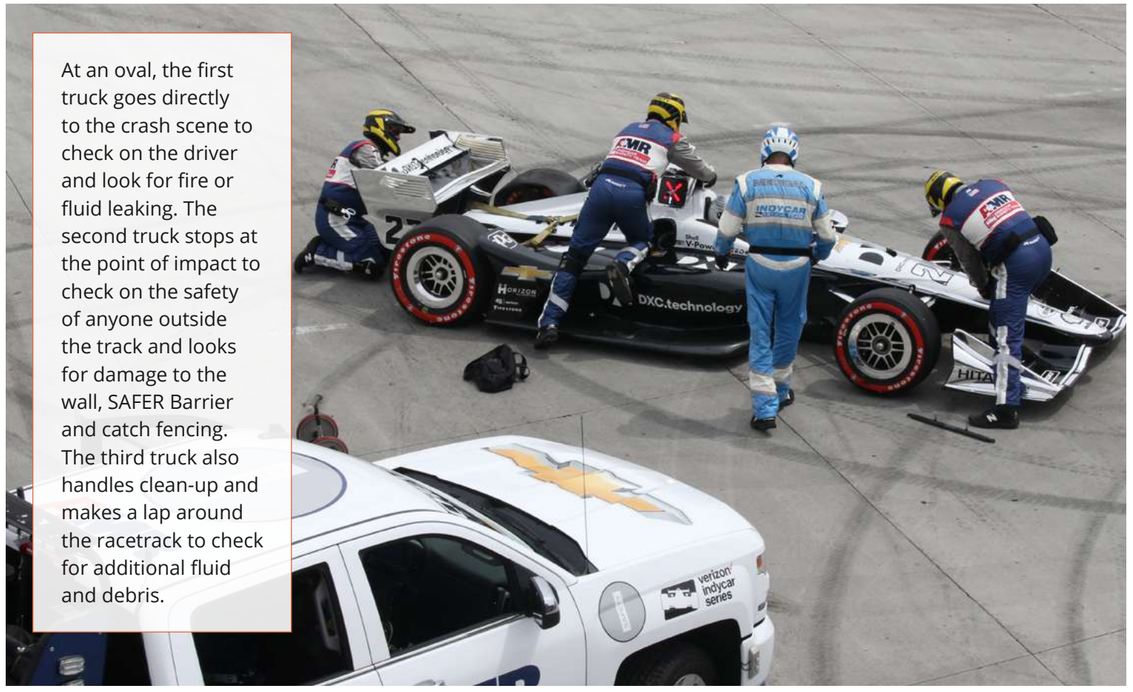
“There aren’t too many opportunities to do motorsports safety similar to this one,” added Baughman. “It’s a commitment. You’re giving away your weekends and your family time to be on the road. But probably more important as a firefighter/paramedic is the opportunity to practice at this level, where timing and teamwork and flat skill level is put to test week after week."

The safety response vehicle carries the INDYCAR medical director, a track doctor/emergency specialist, an orthopaedic specialist and a driver with a racing background. It is fitted with a computer that connects to a wireless network, which enables doctors to immediately download crash data, satellite TV and monitor and medical equipment.

The workers in each safety vehicle have specific assignments, with response protocol varying from ovals to road and street courses. The safety team adjusts assignments when there is an incident involving more cars than safety trucks, like the five-car crash in Turn 3 at the start of the Portland Race last year. In that case, the four-person crews split into two-person crews when they reached the crash.



The trucks carry four team members apiece; a driver/crew leader, a paramedic and two firefighters. Safety 1 and Safety 2 are equipped with a dashboard warning light system, 360-degree camera in the windshield and a rear-facing camera, hydraulic rescue tools, reciprocating saws, firefighting equipment, basic life-support supplies, material for fluid cleanup and 70 gallons of water and cold fire extinguishing material. Safety 3 carries 300 pounds of “oil dry” cleanup material, a hydraulic broom that can scrub the oil dry into the track, and a blower to remove debris.



At an oval, the first truck goes directly to the crash scene to check on the driver and look for fire or fluid leaking. The second truck stops at the point of impact to check on the safety of anyone outside the track and looks for damage to the wall, SAFER Barrier and catch fencing. The third truck also handles clean-up and makes a lap around the racetrack to check for additional fluid and debris.

THE ROAD BACK:

PIETRO FITTIPALDI

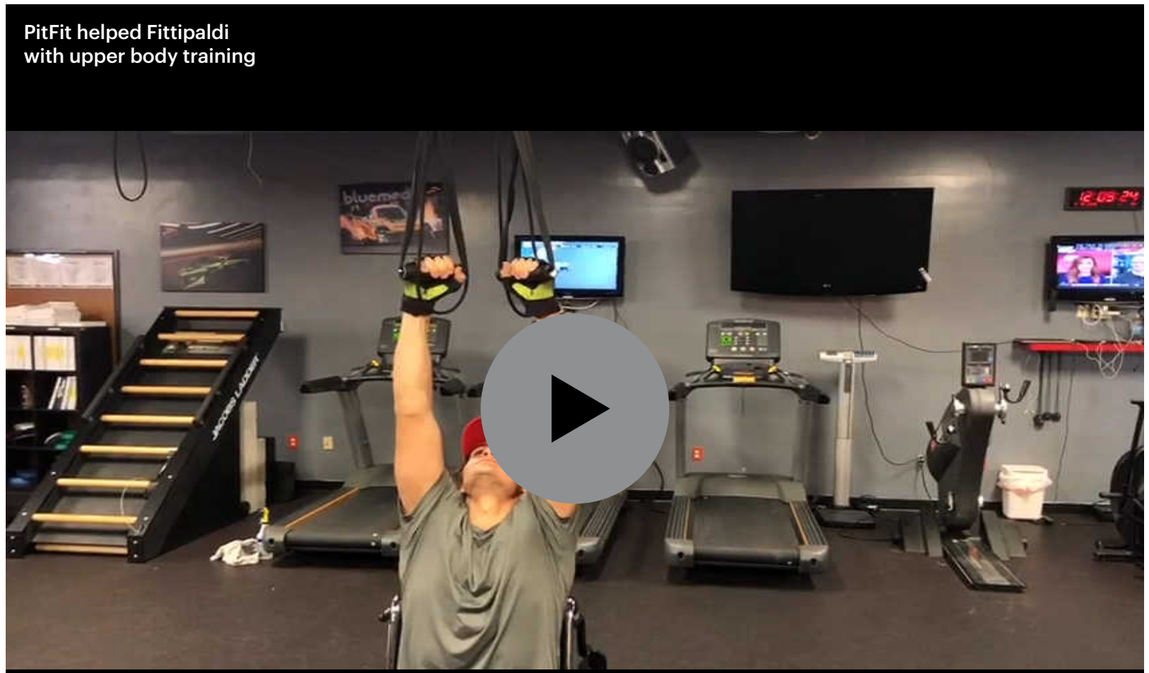
The Haas F1 reserve driver reveals his road to recovery after breaking both his legs at the 6 hours of Spa Francorchamps

During qualifying for the 6 hours of Spa Francorchamps last year, Pietro Fittipaldi was heading up the flat-out Eau Rouge corner on his first flying lap. Just before Raidillon he suddenly lost control of his LMP1 car due to a power steering failure, hitting the tyre barriers at 180mph. The impact broke both his legs and forced him to spend the next two and a half months on his recovery, getting help from expert doctors and physios at America's famous Indianapolis speedway. AUTO+ Medical spoke to him about the incident and his recovery journey.

AUTO+ Medical: **Talk us through the accident at Spa, what happened from your perspective?**
Pietro Fittipaldi: During qualifying of the 6 hours of Spa, I was driving the LMP1 car and I think it was our first 'push lap'. I was rolling up Eau Rouge, then in the middle of the corner I lost power-steering and the steering wheel went straight on me, and I hit the wall at something like 180mph. I was 100 per-cent conscious when I hit the wall, in fact I didn't feel any pain. I unbuckled my seatbelts and I went to climb out of the car, I had a marshal there with me who was helping me out and when I started pulling myself out I started to feel a lot of pain on my legs which I thought was strange. It was only until I looked down, that I saw my left leg and my right ankle basically bent and looking towards me! When the medical team came, they were trying to evaluate how they would take me out of the car and how to lift me because it's a closed cockpit car. I don't know how long it took them, I would imagine maybe it was 15 to 20 minutes to get me out of the car.

A+M: **What can you remember when you got to the hospital?**
PF: It was literally like a movie scene because I

Fittipaldi spent two and a half months recovering



was being pushed through the hospital on the bed, and all I could see was the lights of the hospital going by. I remember the doctor trying to speak to me, but it sounded like his voice was really far away – like as if he was in another room or something, but he was obviously right in front of me. I remember saying a few times 'Don't cut my legs off!' because I think I was so scared from when I saw my legs, and from past experience seeing other people's accidents I panicked. Then there was a certain point where I was holding one of the doctors hands, squeezing it and then I started to lose a lot of energy, like getting really tired. Usually when people faint they say they black out, mine was kind of weird because I was still conscious but my vision started to kind of white out. So initially my peripheral vision started to go really white and then the whiteness started to close in, and then my vision got completely white –

"I HIT THE WALL AT SOMETHING LIKE 180MPH. I WAS 100 PER-CENT CONSCIOUS, IN FACT I DIDN'T FEEL ANY PAIN"

I couldn't see anything for like five seconds or so. I don't know if the doctor gave me something, but my vision slowly came back and then they said, 'ok now we're going to lift you' and once they lifted me I passed out.

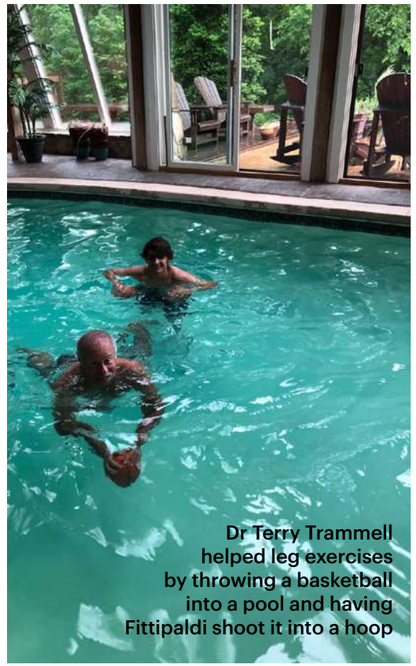
A+M: What was it like when you woke up?
PF: After the surgery my Dad and Uncle were with me, and my Uncle was trying to give me water and the nurse was like 'No don't give him any water' but I was extremely thirsty, like my mouth was really dry as if I'd been in the desert two or three days without drinking anything, and I was like 'Just give me some water, I don't give a shit what she's saying!' So my Uncle gave it to me anyway and as soon as I drank the water I just completely threw up all over him! So that didn't work out. But one thing he did which really helped, was he basically soaked a towel in water and put it in my mouth."

A+M: What were your injuries and what sort of treatment did you get?
PF: I had broken my Tibia and Fibula, I had a compound fracture on both legs. Then I broke my Talus in my right foot, which was also a compound fracture. On my left leg they fitted a Titanium rod to stabilise the Tibia with two nails underneath and on top, then on my right ankle I got put like five or six screws, just to put the bone back in place. So in May I could actually remove the rod in the left leg from the Tibia, but I'll probably wait until the next off-season because I don't want to do it in-season and for my right foot the screws are going to stay in there. But I just want to thank the surgeon Dr Eric Partoune (CHR de la Citadelle – Liège), because he did an amazing job.

A+M: What was your recovery like?
PF: I stayed about a week and a half in Belgium after it happened, my uncle Max Papis was there with me together with my Dad. My Uncle knows Dr Terry Trammell from IndyCar, and he was a tremendous help. I flew to Indianapolis 10 days after my surgery with my Mom, then every day in the morning I did my physical therapy at the medical centre with Dr Trammell overseeing that and all the IndyCar medical staff, and my upper body training at a place called PitFit in Indianapolis. It was about like six or seven hours of training every day because I wanted to get back racing as soon as possible. To try and get mobility back into my ankle and to reduce the swelling, Dr Trammell would let me go to his house

AUTO+MEDICAL FEATURES

IndyCar at Mid-Ohio was Fittipaldi's return to racing


Dr Terry Trammell helped leg exercises by throwing a basketball into a pool and having Fittipaldi shoot it into a hoop


Fittipaldi trained with PitFit every day during his recovery


Fittipaldi did physical therapy five times per-week

Haas ran Fittipaldi for two days in 2019 F1 pre-season testing

where he has a pool and this basketball hoop, and he would be like 'You're going to be shooting these basketballs inside the hoop for 30 minutes, but without touching the ground.' So I would force myself to keep kicking, and that way worked on the mobility of my ankle. I was doing that every day, so physical therapy, training at PitFit, and then using the pool. Those are the three things I was doing for like two and a half months when I was at Indianapolis, I mean I can say that I lived inside the motor speedway which is pretty cool.

A+M: Were you eager to return to racing? Or was it more important to focus on your recovery and return?
PF: I wanted to get back as soon as possible because I didn't want to miss races with the team that I had in IndyCar, so we had put a plan in place to come back at Mid-Ohio in the middle of July which was about two and a half months after my surgery. When I came back my right ankle was fully healed, but my left leg was still a little bit fractured and in my first race I was hitting the brake at 50 per-cent compared to what my team mates were hitting, so performance-wise it wasn't good. But I don't regret coming back that soon, I would do it again because I gained experienced from it. Every race week that would go by, my leg was getting stronger, so by the next race I was hitting at 60 per-cent, the one after by 70 per-cent, and the last race at Sonoma, which was four or five months after my accident, I was at about 85 to 90 per-cent what my team mates were doing on the brakes.

A+M: Were any adaptations made to the car to help you?
PF: I was always trying to find a way to adapt the brake and fine tune the brakes so I could have more leverage under braking. I was making my seat at a better angle, so I have more leverage to brake harder and also we used smaller master cylinders so I didn't have to hit the brake as hard. We did everything we could to help me under braking because my left leg just still wasn't strong enough. The other thing we did, just to help with the braking, is that Dr Trammell helped design this carbon brace for my leg, which really helped because it protected my limb but also gave me more support under braking so I could actually hit the brake harder – like probably 10 to 15 per-cent more than when I have the brace off.

A+M: What advice do you have for drivers who suffer similar injuries?
PF: You've got to have things to do, if you stay at home in bed for about a month or a month and a half, you can hit a dark place and it's not fun at all. I was doing physical therapy for five times a week and I was training for about two hours a day. The most important thing is to do everything you can to get back as soon as possible, keep your upper body strength high, and work a lot on mobility.

A+M: Anything else to add?
PF: I just want to thank everyone from the IndyCar medical centre, from the FIA as well that got me out of the car, Dr Partoune, he did an amazing job, Dr Trammell, the physical therapist who helped me with Indianapolis, IMS for allowing me to stay at the track and basically live there, they allowed me to do that, the people at PitFit who trained me because I was basically living there every day and doing the training, and my family and all the support they had with me there for two months baby-sitting me!

AUTO+MEDICAL SCIENCE

Each discipline of motor sport requires different fitness regimes

SCIENCE

FIT TO RACE:

Identifying the balance, type and sources of knowledge in fitness for motor sport

Authors
KEVIN HOYES - Institute of Coaching and Performance University of Central Lancashire

DAVE COLLINS – iZone Driver Performance Ltd, Institute of Coaching and Performance University of Central Lancashire, Grey Matters Performance Ltd

ABSTRACT

In motor sport, due perhaps to a lack of empirical evidence, it is not always clear what fitness training is required and what roles specific fitness components play, particularly outside the elite levels. Consequently, drivers and their trainers are often left to their own devices, placing reliance on anecdotal information. Accordingly, using a large sample of racing drivers, coaches and fitness trainers, the aim of this investigation was to identify the perceived importance and contribution of fitness components, the sources of information used to reach these conclusions and levels of confidence in the views reported. Survey data from 166 drivers (151 males, 15 females) showed that, in general, cardiovascular fitness, upper body strength, coordination and reactions were perceived as being the most important. Data on sources of information used supported the conjecture that training can often be based on "word of mouth". Despite a fairly high level of confidence in the views expressed, there is clearly a significant opportunity for practitioners working within motor sport to provide clearer, proven information so that drivers can feel confident that they are training optimally.

INTRODUCTION

Within motor sport there appears to be a consensus that fitness is an important factor, with many drivers anecdotally commenting on the physical challenges faced [e.g. 1, 2] and several fitness-related articles apparent in newspapers or magazines [e.g. 3, 4]. Despite this, however, drivers have rarely been subject to scientific research [5]. This could partly be due to data from elites not making its way to refereed journals, or filtering down to other levels. For example, we are aware that driver monitoring is used in Formula One and World Rally Championship (WRC), to help design driver's training, but none of this is actually published: understandably so as drivers and teams are trying to establish an advantage over their competitors. This is not to say that scientific data does not exist, there have been studies that have analysed driving performance [6], monitored drivers' in car [7-10] and those which have investigated the physical characteristics of racing drivers [11-13].

"FITNESS IN MOTOR SPORT POTENTIALLY SERVES A DUAL PURPOSE; THE ENHANCEMENT OF PERFORMANCE AND THE PROTECTION OF WELLBEING"

However, these didn't provide training history of the drivers, so it is unclear if these are adaptations or characteristics required for their sport, or results of their chosen training practices. In terms of practical guidance for drivers, trainers and coaches there are only Ebben's [14] suggestions for stock car racing and Jutley and Blow's [15] book with very general information. Therefore, it appears that many drivers base their fitness training on information or, perhaps, just rumour, from other sources. Accordingly, this investigation was set out to discover what is perceived to be important and why, together with which sources are used to obtain this information. Previous studies have tended to focus on small groups of drivers in a specific formula, for example Ebben and Suchomel's [2] focus on stock car racing. The authors are unaware of any other surveys being completed on a large scale and across different formulas of racing. As such, an initial descriptive investigation seemed warranted.

Arguably, the key parameter is the relative balance of fitness components, together with the extent to which these are agreed upon or disparate across formulas and individuals.

For training to have optimum impact in any sport, knowledge of specific parameters, training methods and exercises that fulfil the criteria for specificity are required [16, 17]. Slight modifications to training balance between components may also be required, depending on the role or discipline within a single sport; for example, training prescribed based on playing position in soccer [18]. In this respect, motor sport is particularly unique due to the wide range of different events and vehicles [19]. To name just a few, karting, touring cars, GT, single seaters and Rallying, all of which vary in duration and intensity. Table 1 presents a simple comparison across several disciplines in order to exemplify this variation within the

Category	Series Race	Distance or Time	Number of races in season	Approx. Top Speed (km/h)	Max Lateral Acceleration (G - force)	Power Steering
Single Seater	Formula One	305km, typically 75-120 minutes	20	Up to 370	Up to approx. 6.5	Yes
	GP3	30 minutes	15	300	2.6	No
GT	Blancpain Endurance (GT3)	3 x 3hour races, 1 x 1000km race 1 x 24-hour race (3 drivers per car, 1- hour stints)	5	290	Unavailable	Yes
Touring Cars/ Sports Cars	British Touring Cars	Typically 16-25 laps	30	225	Approx. up to 2	Yes
	Ginetta Supercup	20 minutes	23	240	Unavailable	Yes
Prototypes	World Endurance Championship (LMP1)	8 x 6 hours (1 x 24 hours 3 drivers per car)	9	330	Approx. 3.5	Yes
	Radical European Masters (SR8)	60 minutes (Either 1 or 2 drivers)	21	275	2.2	No
Rally & Rallycross	World Rally Championship	Typically, combined stages are 2.5 – 4 hours	13	200	Unavailable	Yes
	World RX	4-6 laps	12 (each has qualifying, semi-final and final)	190	Unavailable	Yes

Table 1. Comparison of different categories and championships with Motorsport.
Information is based on 2017 season regulations and data obtained from official championship and team websites.

Cardiovascular performance is most important for drivers

overarching category of motor sport fitness.

As a further complication, fitness in motor sport potentially serves a dual purpose: the enhancement of performance and the protection of wellbeing in the athlete. Reflecting this, we have suggested two categories of fitness components: firstly, “hygiene factors”, which can be described as factors which are only needed to a certain level, to prevent injury or to counteract negatives in performance; secondly, and as a sometimes overlapping but usually distinct group, there are “performance factors”, which contribute directly to the outcome. Simply, the more an individual has the better for their performance. These terms are now included in Motorsport UK's coaching scheme. It has been suggested that the initial focus of fitness training in motor sport was driver safety after Nelson Piquet collapsed on the podium in 1982 [15], so perhaps this may have led to an emphasis on “hygiene factors”. Accordingly, it was of interest to discover what factors are believed to be important for drivers’ performance and protection.

As well as finding out what people think, it’s also important to know why they think it. This becomes particularly important if those working within this field wish to influence or modify perceptions. Another important and parallel element is confidence in what individuals know. If they are unsure of the knowledge, there is a greater potential for change than if they were certain. In order to get the widest possible perspective on this, an online survey was selected to provide a broad range of data.

So, reflecting the concerns and issues identified above, the following issues were addressed:

- Participants’ perceived importance of different fitness components, the balance between them and the extent to which this varied across formulas.
- The balance of opinion on the perceived role of these factors (i.e. performance vs. hygiene).
- The sources of information participants used to reach these conclusions.
- The levels of confidence in these views reported by participants across the piece.

METHOD

PARTICIPANTS

Participants were recruited using three approaches. Firstly, by an email sent out to the iZone Driver Performance database. This contained a participant information sheet explaining the survey and a link taking those interested to the introduction page. This page indicated that completing the survey would represent their consent to participate. Secondly, convenience sampling was used to recruit drivers attending iZone for training sessions. During their visit, drivers were invited to participate in the online survey using a web link on a tablet. Subsequently, when completing the survey, participants were left alone to avoid any influence on the answers given. Thirdly, the same email invitation detailed above was sent out by Motorsport UK to their database. The study protocol for all three categories was reviewed and approved by the University’s Research Ethics Committee. These three processes resulted in 166 responses, from a wide range of driver ability, achievement and support profession.

INSTRUMENTATION

A twenty-page online survey was developed to obtain demographic information and to establish the level and sources of knowledge on fitness in a sample of motor sport participants (drivers, coaches, fitness trainers, mechanics and engineers) across formulas. As the first step, questions were generated against the specific objectives outlined above. Piloting was then completed with a sample of eight participants, who completed the questionnaire then were subsequently interviewed on the process to check levels of clarity and understanding. This led to some minor changes in wording, but the instrument as a whole remained unchanged. The questionnaire included three sections: (1) about the participant, which identified the amount and level of experience participants had in motor sport as a driver, coach or fitness trainer; (2) what physical fitness components are important and why, in which participants were asked to rate the importance of each fitness component for their formula as a percentage, summing to a total of 100%, as well as to indicate whether they believed each component to be a “hygiene factor” or a “performance factor” and; (3) sources of information used to inform decision-making and opinion. The survey took approximately twenty minutes to complete and is included as Appendix 1.

DESIGN

Given the preliminary nature of the investigation, this study was seen as primarily descriptive. Accordingly, subsets of the full

data set were used to address the 4 purposes identified in the introduction. Where appropriate, non-parametric statistical tests (the Chi Square or X2 with probability value set at p<.05) were used with SPSS software to examine the degree and nature of differences.

RESULTS

DEMOGRAPHICS

There were 166 respondents of which 110 completed the full survey; all the available data were used, so that the numbers of respondents varied between these figures across the survey. There were 151 males and 15 females with a mean age of 32.4 (SD 14.8) with the youngest respondent being 14 and the eldest 73. Table 2 shows the levels of experience reported, either as drivers and/or other roles within motor sport. The vast majority of participants had racing driver experience (151). Participants were allowed to select more than one role, so some reported multiple experiences; for example, a driver who also did coaching. As the statistics suggest, these were very skewed by a few individuals with long periods of experience whilst the majority had more homogenous levels of involvement. Those with driver coach or fitness trainer experience had worked with an average of 12 drivers in the previous 12 months (SD 18.72, range 80).

	n	Mean	SD	Range
Driver	151	10.33	8.89	54
Fitness Trainer	12	0.55	2.42	20
Driver Coach	38	1.19	2.78	12
Mechanic or Engineer	29	1.93	7.18	53

Table 2 Participants' experience of roles in motor sport

Table 3 shows a breakdown of the specific formulas which participants had experienced. Modal categories were Touring Cars, Sports Cars or Saloons and Karting; not surprising as this is a common entry into the sport and single seater categories. Of these, 1 driver had F1 experience, 1 in WRC, 16 had experience in GT racing at European or World level, 17 in touring cars at national level or above and 20 had single seater experience at European or world level (excluding F1).

Formula	Drivers	Fitness Trainers & coaches
Karting	81	25
Rally & Rallycross	15	12
Single Seater	37	11
Touring car, sports car, saloons	88	24
GT racing (including endurance)	24	13
Prototypes	28	7

Table 3. Specific formulas in which participants had experience

PERCEIVED IMPORTANCE AND BALANCE OF FITNESS COMPONENTS

The first objective was to examine the perceived importance and balance of fitness components for motor sport. Table 4 shows the average percentage allocated to each fitness component. Cardiovascular (CV) endurance was rated the most important, followed by coordination, upper body muscular strength and endurance and reaction time. Analysis of these data showed a significant difference in response rates ($X2(10) = 18.753.27$, $p<0.05$), suggesting that participants viewed the various components as differentially important.

	All Formulas Combined (n=111)		
	Mean %	SD	R
Cardiovascular endurance	17.5	13.2	90
Upper body strength	13.3	8.2	40
Core stability	8.3	5.0 3	0
Leg strength	7.3	6.0	40
Flexibility	4.3	4.0	25
Muscular Power	5.0	4.0	20
Speed	7.9	4.8	25
Agility	5.0	8.9	90
Balance	5.3	5.5	25
Coordination	14.2	11.1	75
Reaction Time	11.9	6.5	30

Table 4. Perceived importance and balance of fitness components in racing drivers

Table 5 shows a breakdown of these results categorised by participants' chosen formula. CV endurance was perceived as the most important on average in four of the categories: GT, single seater (equal with upper body strength), prototypes and rally/rally-cross although the rally category was skewed by a low number of participants (3) and, of those, one scored CV endurance at 90%, much higher than any of the other participants. Other components perceived as high importance were coordination which was rated most important in karting and touring/saloon and sports sars (and also rated high in single seaters and GT).

	Karting (n=12)			Rally/RallyX (n=3)			Prototype (n=10)		
	Av%	SD	R	Av%	SD	R	Av%	SD	R
Cardiovascular endurance	10.3	7.3	20	36.7	46.5	85	21.0	17.1	50
Upper-body strength	16.0	8.1	30	7.0	5.2	9	15.8	5.6	15
Core stability	9.4	6.1	24	5.7	4.5	9	9.8	3.4	10
Leg strength	3.8	3.4	10	5.0	4.6	9	7.5	4.0	12
Flexibility	3.0	2.5	5	7.0	7.2	14	3.8	2.0	5
Power	4.8	4.3	10	7.0	5.2	9	5.6	2.8	10
Speed	8.3	6.0	20	5.3	4.5	9	8.2	3.8	13
Agility	5.2	4.6	15	5.3	4.5	9	3.9	3.0	10
Balance	8.2	8.3	25	7.0	5.2	9	4.7	2.5	10
Coordination	19.6	18.4	65	7.0	5.2	9	9.5	6.2	20
Reaction time	11.7	4.4	15	7.0	5.2	9	10.1	6.5	20
	Single Seater (n=25)			**TC/SC/Saloon (n=49)**			**GT (n=12)**		
	Av%	**SD**	**R**	**Av%**	**SD**	**R**	**Av%**	**SD**	**R**
Cardiovascular endurance	16.5	11.9	50	15.9	8.4	40	25.6	13.7	48
Upper-body strength	16.5	10.0	39	11.0	6.6	30	13.0	10.0	30
Core stability	8.0	3.8	15	7.6	5.5	30	10.1	5.3	20
Leg strength	7.8	4.0	15	7.3	6.6	40	9.7	9.4	30
Flexibility	5.1	3.6	10	4.2	4.7	25	3.8	3.3	10
Power	6.3	4.1	15	4.1	3.6	15	5.3	5.5	20
Speed	6.7	3.9	15	8.9	5.0	25	6.6	4.9	15
Agility	7.5	17.6	90	4.5	3.6	10	2.8	3.3	10
Balance	4.4	3.7	10	5.7	6.2	25	2.8	2.6	7
Coordination	11.8	7.4	29	16.4	11.5	53	11.0	7.8	30
Reaction time	9.4	4.1	19	14.5	6.9	30	9.5	7.8	30

Table 5. Perceived importance and balance of fitness components in racing drivers of different formulas of racing

Reaction time was rated of high importance particularly in karting, prototypes and touring/saloon and sports cars. Generally, however, all other fitness components were closely matched in perceived importance.

Participants' views on the genericity of these perceptions were also evaluated; in short, how much they felt that fitness demands would vary across formulas and how confident they were in this view. Notably, only one participant believed that the balance of fitness components "wouldn't vary between formulas" of racing, 88 believed them to be "largely similar but a few specific aspects may vary" whilst 28 believed they "completely changed depending on the formula". With regard to their confidence in the veracity of their views, 72 of the 111 participants who answered this section indicated that it was "an informed view that they could justify", 20 were "certain", 4 were "50-50", 13 felt they were "possibly right" and 2 reported their results as "just a guess". These results showed a significant difference ($X2(4) = 166.7$, $p<0.001$) suggesting that the majority of respondents were very confident in their viewpoint.

PERCEIVED ROLE OF FITNESS COMPONENTS

The second objective was to investigate the perceived role of fitness components for drivers. Firstly, participants were asked to qualitatively justify their ratings to gain some understanding of possible reasons why.

Participants were also asked to distinguish between "hygiene factors" and "performance factors". Figure 1 shows the results from this question. Some components were clearly perceived as being more "hygiene factors" such as flexibility and muscular power. In contrast, three of the fitness components were clearly perceived as being "performance factors"; hand and foot speed, coordination and reaction time. Post-hoc analysis by X2 showed each of these differences to be significant at the .05 level. Opinion on other components was more evenly split. CV endurance was perceived marginally (although non-significantly) more as being a "performance factor" upper body strength; core stability, leg strength, agility and balance were marginally perceived as being more "hygiene factors". Once again, these differences were non-significant.

As before, there was some diversity of opinion on genericity. Seven participants believed that this role of fitness components "would not vary at all" between formulas, 88 believed it would be "largely similar but a few specific aspects may vary" and 16 believed that it would "completely change depending on the formula". 68 participants also indicated that this was an "informed view that they could justify", 9 were "certain", 18 were "50-50", 9 felt they were "possibly right", 7 were "just a guess"; so overall, quite a strong confidence in the answers given which showed a significant difference $X2(4) = 135.7$, $p<0.001$.

Sources of information used

The third objective was to investigate the sources of information used in motor sport for driver fitness and the level of confidence in these. In frequency of use, data showed a varied 'thirst' for knowledge, across the sample, whilst for availability of information, the majority of participants indicated that there was "some information available but more would be beneficial" across all the sources listed. The notable exception was scientific journals, where the majority "didn't know"; in short, suggesting that this source wasn't used.

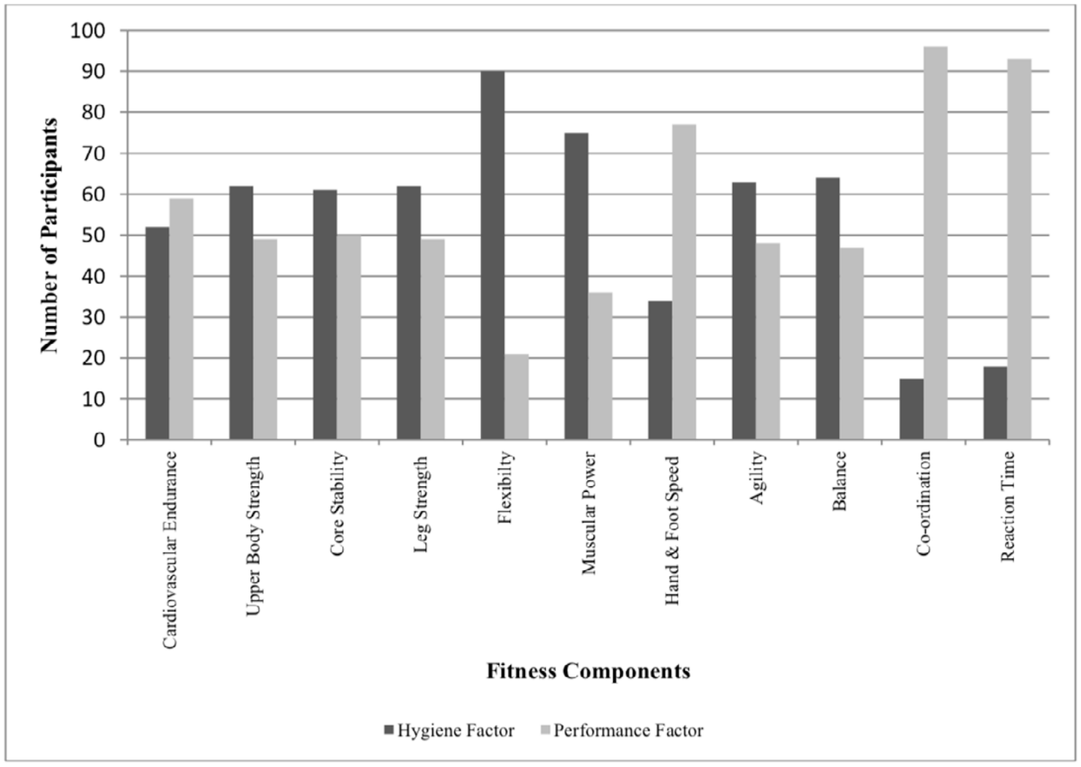


Figure 1

Finally, views were also varied on the accuracy of information available from these sources. All differences in this section showed high levels of variability and were unsurprisingly non significant.

DISCUSSION

On average across all formulas and in four out of six sub categories, CV endurance was rated by participants as the most important fitness component. Indeed, only in Karting was this component not considered in the top two most important factors. These findings do seem to fit with the available evidence. For example, single seater drivers have been found to experience significant CV stress, with similar VO2 and heart rate responses to running at 8-10 minute per mile pace [7]. However, there is no research into CV demands across different racing series with the exception of heart rate monitoring [8, 9], which is not a clear indication of physical demands due to the underlying psychological stress [10]. This is evidenced by the high heart rates recorded, even at low driving speeds [7]. Therefore, it is somewhat surprising that CV fitness was perceived of high importance across such a range of different formulas. However, looking at the range of responses in this field, it is clear that there were some

Drivers train muscles for reserve strength

extreme views with the highest importance given being 90% by an ex WRC driver and the lowest 0% given by a total of 5 participants, 4 drivers who had involvement in rally, karting, single seaters and touring car/sports car or saloons and one karting coach. Based on the mean data it appears more likely that the level of importance is around 10-25% (cf. Table 5), depending on the formula.

Of course, as well as knowing what components of fitness participants believed to be important, it is also important to know why they thought this. Interestingly, several responses mentioned heat and concentration as being reasons for the importance of CV training, whilst weight control was not mentioned. This could be down to the large number of participants in Touring Cars and Saloon Cars where the weight aspect may not be as important as in single seaters. From a mental perspective, research on the benefits of CV training for drivers is inconclusive, as the psychology literature has suggested a positive, but not significant, association between CV fitness and cognitive performance [20]. In the same study it was suggested that aerobic fitness is more likely to be the first event in a series that ultimately impacts cognitive performance. For example, it may help a driver cope with heat stress which is known to be associated with a deterioration of cognitive and psychomotor performance [21]. This is also inconclusive however, because, due to the environment,

racing suit and helmet, even fit subjects have been found to be unable to thermoregulate under similar conditions [22]. Although fitter athletes [23] and those with a lower body fat percentage [24] can potentially tolerate higher body temperatures for longer. Additionally, as shown in table 1, different formula categories can have different amounts of races and test days in a season and as a result, differing amount of overseas travel. Further research would be beneficial to explore whether this may influence the importance of CV fitness for drivers' optimal recovery between races. Despite the relative scientific uncertainty, anecdotal reports of these CV benefits certainly seem to have filtered through the sport, as the majority of respondents rated this as a performance factor.

Coordination was also rated highly, second to CV endurance overall, highest in karting and rated highly in the single seater, touring car and GT categories. However, similar to CV endurance, the range was very high, reflecting some individual contrasts. For example, several participants mentioned the importance of coordination for handling whereas others suggested it was not an area that could be trained outside of the car due to a lack of transferability. In similar fashion perhaps, reactions were also rated fairly highly amongst the categories, within the top four components but with a lower range and standard deviation than coordination, suggesting more of a consensus among participants. Once again, research on these aspects has been fairly inconclusive, partly due to the lack of tests specific to racing situations [11]. In single seater drivers, an association has been found between the reaction time and fine coordination [12], plus elite drivers have been found to perform better than junior drivers in strength, speed and coordination tests [11] suggesting that these are required to advance to higher levels. Clearly, devising tests and training procedures for these fitness components, as done in other sports [17], would be of great benefit, particularly as these were rated as the highest "performance factors" out of all the components.

Upper body strength and strength endurance was rated highly across the majority of formulas, suggesting a general agreement amongst participants for the importance of this component. Perhaps unsurprising, as drivers need a strong neck and upper body in formulas with high g forces [12] and across other categories to reduce risk of cervical spine injuries from collisions [14]. Obviously, there will be differences in the specific cars across formulas; if they have power steering for example.

Of the remaining fitness components, core stability was ranked slightly higher than others. This has been thought to be a potentially important factor for injury prevention due to chronic exposure to vibrations and back pain being reported as the most common related injury in rally drivers [25]. Research has only found rally drivers to have a greater strength capacity of the trunk than physically active controls [12]; drivers in different formulas were found to have no difference [13]. From this survey, core stability was rated fairly similarly across formulas and not greater in rallying (although this was limited by a small number of participants in that category). It was perhaps slightly surprising that it wasn't rated of greater importance for Karting especially as drivers are not strapped in and can experience high lateral G forces [26].

It was somewhat surprising that leg strength and muscular power was rated of low importance throughout the different racing categories, especially as drivers are required to rapidly create high pedal pressures in some formulas such as single seaters [27], GT cars and some touring cars (as mentioned by some participants in Table 5). The low perceived importance could of course be due to low numbers of our participants racing in those specific cars that have those requirements. Alternatively, it could be representative of a lack of awareness how this mode of training could have a benefit to braking performance.

These three components (upper body strength, core stability and leg strength) were similarly considered as being mainly "hygiene factors", understandable as only a certain amount of neck strength would be required for g force demands, upper body strength to control the car, core stability for injury prevention or leg strength to achieve a certain brake pressure. Of course, drivers may wish to train for strength in reserve, perhaps a possible reason why almost 50 of the participants in the survey believed them to be "performance factors". The other fitness components (flexibility, hand and foot speed, agility and balance) were generally perceived as holding a similar but low level importance. Again, however, there were individual differences as shown with some responses given for balance, speed and agility in Table 5. Flexibility, agility and balance were considered as being mainly "hygiene factors" whereas hand and foot speed was more "performance". Notably, CV endurance, upper body strength, leg strength, core stability, agility and balance were relatively closely balanced between performance and hygiene, suggesting that clarification of the specific role for fitness components would be beneficial for drivers, their coaches and fitness trainers.

"SHOULD DRIVERS IN MOTOR SPORT TRAIN SIMILAR TO WRESTLER, AMERICAN FOOTBALL OR RUGBY FORWARD LEVELS?"

Of course, if certain aspects are "hygiene factors", the key question is how much is required? For example, neck strength is an important hygiene factor; clearly vital for driver health and increasingly so as the G-forces increase with more powerful formulas, with loads of 26kg on the neck being reported in F1 [28]. Once again, however, there is a lack of accurate empirical data on exactly what the required levels across different formulas are. Should drivers train towards Wrestler, American Football or Rugby forward levels? Insufficient data exists to address this important question.

SOURCES OF INFORMATION USED

In the frequency of use of different information sources, the sample of participants was fairly split. For example, 41 used anecdotal data from other drivers "regularly" and 18 "as much as possible". In contrast, 39 used this source "rarely" or "not at all". This did show that, along with the regular use of the internet as a source, a lot of information for fitness within motor sport is based on "word of mouth". In short, cascade down from elite level drivers through other levels. The driver fitness specialist category had the highest number of participants using "as much as possible", but surprisingly 34 used "rarely". This could be down to several possible reasons such as accessibility or cost. Other fitness specialists who don't specialise in motor sport may be more accessible in local training centres for a lot of drivers. In terms of the availability of information, there appeared to be an agreement amongst the majority of participants that there either wasn't enough or only some information available, emphasising the need for more peer-reviewed scientific based research in this field.

Interestingly, participants reported a high level of confidence in information gained from other drivers, again supporting the view that many rely on this for their training. Also, books, magazines and internet sources were reported as at least "some confidence"; which highlights that, ideally, these sources need to provide quality information. Of course, there is also potential for information from scientific sources to filter down into these sources, especially if presented in a simpler, easier to understand way that highlights the key points.

LEVELS OF CONFIDENCE

In general, participants' confidence in their views on fitness were quite high, with the majority indicating that they had "informed views that they could justify". However, considering this meant that they were not completely certain, in that 19 participants' confidence on the importance of fitness components and 34 participants' confidence on the roles of the components were 50/50 or less. This reflects a significant opportunity for practitioners working within motor sport to provide clearer, proven information so that drivers can feel confident they are training in the best way possible for their sport.

Despite the satisfactory response numbers there were limitations in this preliminary study and potential for bias within the data. The sample was small against the numbers involved in motor sport worldwide.

Furthermore, the differences in representation across the formulas (only three rally drivers for example) means that the sample's representativeness must be questioned. Furthermore, as highlighted, such differences have made some data points susceptible to artefactual influences from extreme positions. Also, the survey was not tested for reliability. Given these shortcomings, the study should be looked at as a preliminary description that highlights a problem. Certainly, any analyses, where these have been completed, are of necessity non-parametric. Nonetheless, the data serves to illustrate a significant gap in both the literature and applied practice.

RECOMMENDATIONS AND NEXT STEPS

Limitations notwithstanding, the results reflect reliance on anecdotal evidence in decision-making on fitness for motor sport. For example, the importance of CV fitness seems more a result of "what xxx does" (cf. the reported involvement of F1 drivers in Iron Man Triathlons) than a particular scientific logic. There is always a need for practitioners to challenge drivers when prescribing fitness, to change opinions and justify logic and reasoning underpinning this. This is important in implementing any change [29] and in managing expectancy in what the client thinks s/he will get from the programme. Next steps are clearly to increase the evidence base across different formulas and levels of driver.

AUTO+MEDICAL SCIENCE

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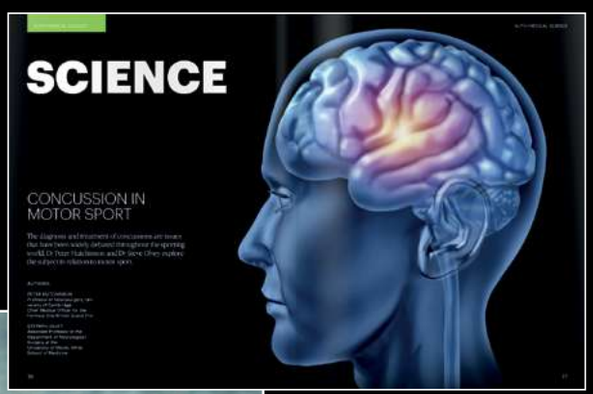
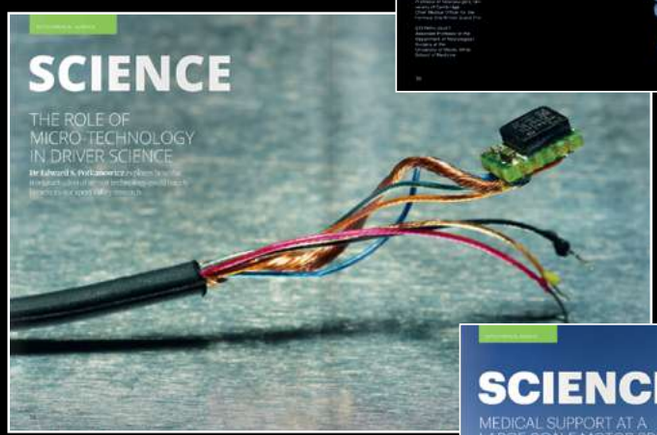
Every issue of AUTO+ Medical contains a scientific research paper that looks at the various medical issues that surround motor sport.

All submissions are welcome so if you have a study that you feel would be suitable for publication in future issues of AUTO+ Medical, please send it to: medical@fia.com

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

The editorial board will evaluate each submission before it is accepted for use in the magazine.





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