



AUTO+ MEDICAL

PHYSICAL EXAMINATION

A look at the unique and specific comfort adaptations in race cars for drivers P26

DBX MEDICAL CAR

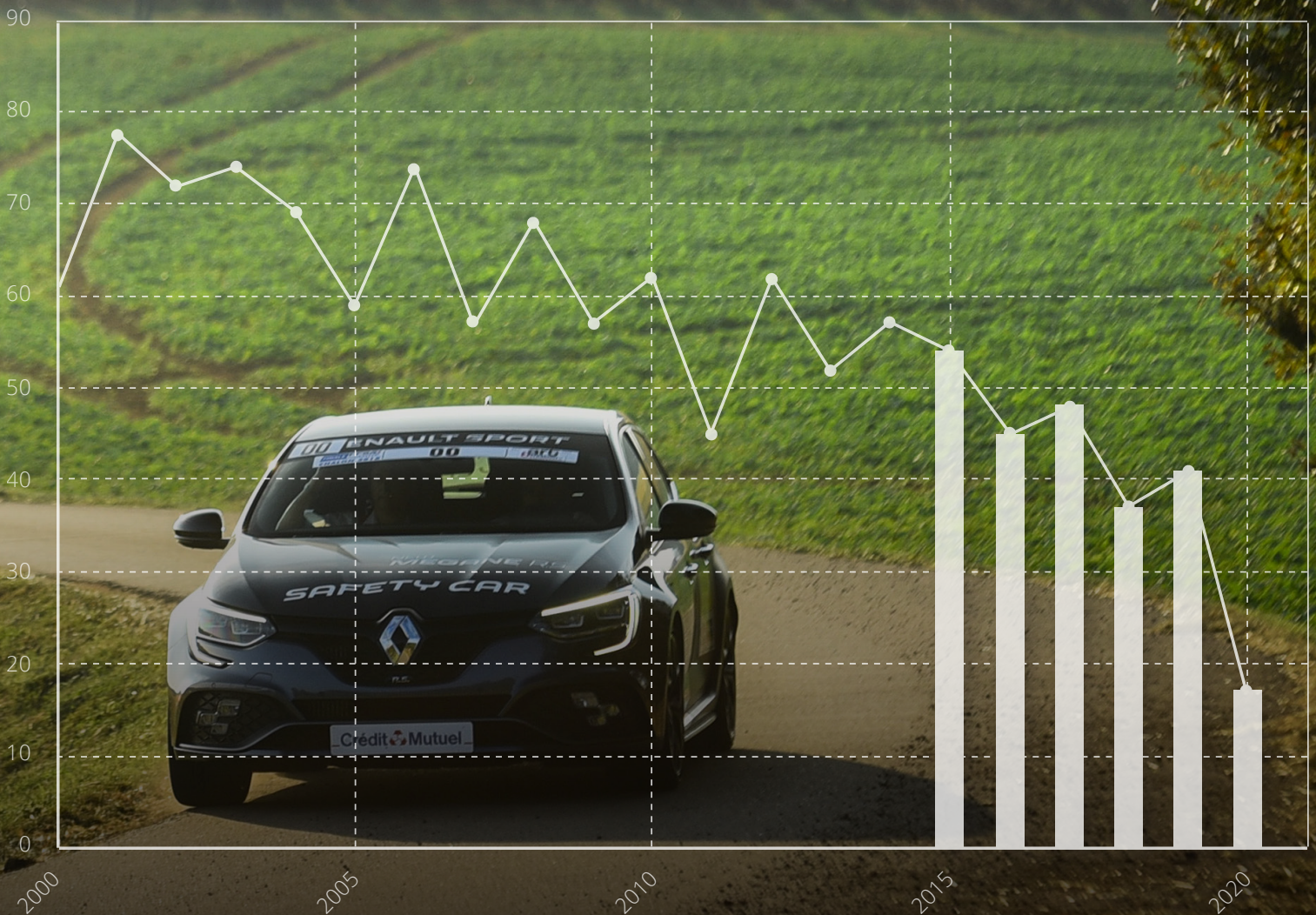
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KATHERINE LEGGE

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VISION ZERO

The FIA has a clear vision to reduce deaths and serious injuries in motor sport to zero





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INTRODUCTION/

Firstly, congratulations to our fellow Editorial Board member Dino Altmann, who takes over as President of the FIA Medical Commission. He outlines his ideas for his term of office inside this issue.

Our cover story takes an in-depth look at the FIA's new Vision Zero campaign. This is a fantastic initiative which aims to prevent death and serious injury worldwide, involving all the ASNs in the FIA network and the FIA safety department, who's work often goes unnoticed but who have made a tremendous difference to safety over the years.

We also hear from Dr Paul Rea, who takes over as Head of Medical and Rescue at the FIA and also joins the Editorial Board of AUTO+ Medical. Paul gives us an insight into his experience both as competitor and doctor involved in motor sport.

In our feature on physical examination we reveal the differences between men and women in a motor sport environment - you may be surprised as how little you knew! You can read about Dr Ian Roberts being awarded the well-deserved FIA Presidents award for bravery and the findings from the FIA on Romain Grosjean's crash.

Finally our scientific article looks at the difference between amateur and professional drivers physiology.

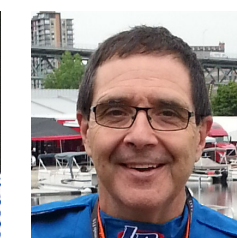
COVID is still with us and impacting on all our lives and our sport, please look after yourselves and your colleagues.

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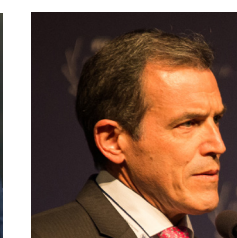
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GLOBAL NEWS

DINO ALTMANN NAMED AS PRESIDENT OF FIA MEDICAL COMMISSION

Dr Dino Altmann has succeeded Professor Gérard Saillant as President of the FIA Medical Commission.

Altmann was the Deputy President of the FIA Medical Commission having taken up the role in 2018, alongside his work as Chief Medical Officer of the Formula One Brazilian Grand Prix. He is also President of the Brazilian National Sporting Authority Medical Commission.

With almost 30 years of experience working trackside as a doctor, Altmann has worked with

many disciplines in motor sport including Stock Car, Porsche GT3 Cup, Formula Open, F3 and Touring Cars.

Most recently he worked with the Brazilian Stock Car Championship engineers to produce a car that is based on a tubular chassis. Following FIA guidelines, it features a strong lateral impact structure, frontal and rear impact absorbing cones, an updated seat, and a roof hatch.

In addition to his work in motor sport medicine, Altmann is a surgical oncologist and practices at the Hospital Israelita Albert Einstein in Sao Paulo, Brazil.

Dr Dino Altman Q&A

What are your ambitions for the FIA Medical Commission?

"We, Medical Commission members, together with the Safety Department and Medical & Rescue Department, have to be aligned in pursuing FIA Vision Zero (zero fatalities in motor sport) and promoting better safety to grass-roots disciplines in motor sport. Additionally, we may bring our knowledge of motor sport medicine to support doctors and paramedics working in pre-hospital trauma, mainly in low-middle income countries."

How will you achieve these objectives?

"Firstly, a virtual platform, which is already in construction, will be essential for promoting a better interaction between FIA Medical & Rescue Department, CMOs, DCMOs, and grass-roots medical professionals. Through video conferencing, e-learning webinars recordings, live webinars, and even real-time live events we will be able to share experiences. Such a platform will allow links to FIA online services like FIA Networks, the FIA Hospital database, and medical questionnaires, regulatory Appendices, and other resources. Furthermore, it will be an important tool for collecting data on serious accidents, thus contributing to



the analysis of the causal factors of important injuries and fatalities, which will lead to the development of new safety measures.

Just to add emphasis, the virtual platform will unify all FIA regulatory, protocol, and medical training resources within a comprehensive virtual environment which will allow access to clinical support services, trauma/surgical education, while providing state-of-the-art content and training for all users, regardless of location, just having an internet connection."

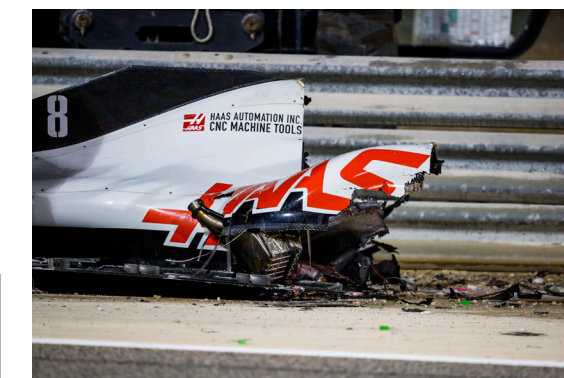
Is education a priority?

"As we all know, technology is playing a major role in all professional areas and it is especially advancing in education. It is now possible to find any kind of e-learning course and this has proven to help elevate all standards of care among health professionals.

Further steps will allow us to bring competency data together across hospitals and health professionals from different cultures, develop programmes, share experiences, and create panels for discussion and clinical intervention algorithms."



FIA CONCLUDES GROSJEAN CRASH INVESTIGATION



The FIA has concluded its investigation into Romain Grosjean's crash during the 2020 Bahrain Grand Prix.

The car veered sideways into an armco barrier just 180 meters after Turn 3 shortly after the start of the race, with the Haas car splitting in half as it impacted the barrier at 192kph, before becoming engulfed in flames.

While rescue teams attended to the fire, Grosjean was able to climb out of the cockpit to safety.

The FIA Serious Accident Study Group (SASG) looked at all of the evidence, video footage, data, and interviewed those involved to come to a conclusion. According to the SASG: "The fuel tank inspection hatch on the left-hand side of the chassis was dislodged and the engine fuel supply connection was torn from the fuel tank "safety bladder"; both providing primary paths for the escape of fuel from the tank."

Crucially the SASG determined that several factors worked in the drivers favour that enabled him to walk away without serious injury. These vital areas include the driver helmet, HANS frontal protection device, safety harness, survival cell, seat, headrest and the Halo frontal cockpits protection.

FIA President Jean Todt said: "The enduring commitment of the FIA, particularly the Safety Department, on reducing risks associated with motor sport enabled Romain Grosjean to survive an accident of this magnitude. Safety is and will remain FIA's top priority."

FIA SAFETY LAUNCHES ON INSTAGRAM

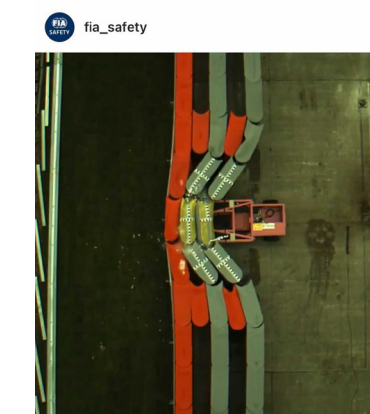
The FIA Safety Department has launched an Instagram account, [@FIA_Safety](#).

The account highlights the FIA's work to continuously improve safety in all forms of motor sport.

Posts include never before seen videos of crash tests and a look at the various methods used to test FIA certified equipment before it is deemed safe for the track.

The launch coincides with the FIA's Purpose Driven initiative, which seeks to show how motor sport technology is benefiting real world applications, and Vision Zero, which seeks to prevent death across all disciplines of motor sport worldwide.

In the first month the account has already attracted over 16,000 followers, with over 1 million views of posts. Ferrari Formula One driver Carlos Sainz also posted his praise of the account, and the FIA is encouraging other drivers, doctors, and National Sporting Authorities to spread the word.



169,411 views · fia_safety TecPro barriers are an essential fixture in high speed corners at @F1 circuits worldwide... more

V8 SUPERCARS DRIVER WINS WITH BROKEN COLLARBONE AND RIBS



Shane van Gisbergen swept the Sandown SuperSprint V8 Supercars race with a broken collarbone and three broken ribs scans have shown.

The discovery comes two weeks after he suffered a mountain bike accident in which he also broke his left collarbone and sustained ligament damage to his acromioclavicular joint.

The Kiwi was absent from the first GT event of the year at the Phillip Island Grand Prix Circuit due to the injury and was subsequently replaced by Supercars team-mate Jamie Whincup.

The driver underwent surgery immediately after suffering the injury to install a plate in his collarbone, which he will have for the rest of the season.

After advice from supercross legend Chad Reed and two-time Dakar winner Toby Price, Van Gisbergen went on an aggressive recovery process that included two hours per-day in a hyperbaric chamber, with support from the physiotherapist for V8 Supercars team Triple Eight, Chris Brady.

This helped him heal sufficiently

to race at next three events for the Sandown SuperSprint.

A few changes had to be made to the car before he got back in, with Van Gisbergen winning all three races with the aid of a lower and longer steering column in his Holden V8 Supercar.

"We started with the gearshift [resistance] lower, but the strength isn't too bad, it's just the movement - lifting my arm and stuff," he explained. "I had to lower the wheel and bring it a lot closer. It feels a bit weird, but once I was out there I got used to it."

Following the races Van Gisbergen returned to his surgeon to see if driving the car had done any further damage, only to discover that he was also racing with three cracked ribs.

"Interesting visit to the surgeon," he said. "Didn't do any more damage to the collarbone but found three broken ribs from the shunt."

He returned to the car for the Easter weekend double header at Bathurst for both the GT World Challenge Australia race and the Bathurst Six Hour endurance race.

FIA LAUNCHES CHIEF MEDICAL OFFICER WEBINAR SERIES



In summer 2021 the FIA Medical and Rescue department will launch a Regional Chief Medical Officer Webinar series. The bi-monthly program will provide each region with specific and relevant content relating to their motor sport activity.

The COVID-19 pandemic has seen a global shift to online activity and learning, the webinar series will continue and aims to:

- Increasing the number of touch points between the FIA Medical and Rescue Department, FIA Medical Commission, ASNs and medical and rescue personnel.
- Promoting professional discussion.
- Providing a platform for continued professional development.
- Promoting networking.

The webinar series will start in June, with each session being one hour. The sessions will focus on two key medical and/or rescue topics delivered by guest speakers with questions and professional discussion. Attendees will have the opportunity to suggest key issues for discussion and to nominate themselves or others as key note speakers for future sessions.

FIA Head of Medical and Rescue Department, Dr Paul Rea, said "These webinars will be region specific and will focus on local issues affecting motor sports within that region. This means that the topics and discussion will be wholly relevant for the attendees who register."

The webinar series will utilise the Zoom platform and will be delivered at a region-specific time in order to be as accessible as possible for all attendees.

For more information, please contact medical@fia.com

INDYCAR TO ADOPT NEW SAFETY DEVICES IN 2021

IndyCar will adopt two new safety devices that will provide detailed data about the forces on the cars and drivers during a crash.

The new devices will be an Accident Data Recorder (ADR) which will be fitted to the car, and an Ear Plug Accelerometer (EPA) used by the drivers, both designed to deliver highly accurate data quickly.

Both have been developed by advanced engineering company EM Motorsport.

The ADR uses internal accelerometers and gyros as well as a Controller Area Network interface

to capture "at the scene" accident data in order to aid post-event analysis and safety research. Additionally, EM Motorsport's ADR is smaller and lighter than the unit it replaces.

This will work with the EPA, which is a small device with a 3-axis accelerometer that fits inside each of the driver's ear plugs to help obtain crucial information about a driver when they are involved in an accident.

This device can assess the wellbeing of a driver whilst they're inside the cockpit through an accelerometer that detects the speed and amount of movement a driver's head has in an accident and includes driver's radio communications.

IndyCar has moved to use EM Motorsport's ADR4 and EPA devices following successful

tests, which were undertaken throughout the 2020 season.

EM Motorsport has been developing safety devices for the past decade. Many championships around the globe use their FIA homologated safety technology devices, including Formula One, Formula 2, Extreme-E, 24 Hours of Le Mans, W Series and FIA Formula 4 championships.



DAKAR RIDER RESUSCITATED BY RIVAL AFTER CRASH

Dakar rider Paul Spierings had to resuscitate fellow competitor CS Santosh, after the latter suffered a big crash on the fourth stage of the 2021 Rally.

Santosh was unconscious when Spierings arrived at the crash scene, after he hit a rock around 135km into the 685km-long stage on the gravel track.



Spierings went over to Santosh and after realising that he had lost his pulse, began to resuscitate him before three rescue helicopters came to the scene.

"When I stopped my bike I pushed the emergency button. After I got at him, we did resuscitation and after

fifteen minutes three helicopters from the organisation arrived," said Spierings. "They took over from me, but at that stage I felt his heart was beating again. I was very relieved by that."

Santosh was attended to by the medical team on the ground and was later flown to Saudi German Hospital in Riyadh, where they confirmed that he had suffered from a Diffuse Axonal Injury, a type of brain trauma that is medically described as the resistant inertia that occurs to the brain preceding and following its sudden acceleration against the skull, causing shearing of the axonal tracts of the white matter.

After spending 10 days in an induced coma, he was flown to his hometown in Bengaluru, India to recover. Two months after the crash he is now able to walk again, and plans to begin moderate physical workouts and cycling.

ICMS CAFE BRINGS TOGETHER MEDICAL PROFESSIONALS IN MOTOR SPORT

The International Council of Motorsport Sciences (ICMS) has launched an online café social event, bringing together doctors, paramedics, fire-rescue operatives, engineers, and researchers from the world of motor sport.

The monthly social event is hosted using Zoom and each one is recorded and available to watch again via the ICMS website to its members. You don't have to be a member to attend the free live event, anyone with an interest can come along and participate.

Dr Matthew Mac Partlin hosted the first conference in November last year for 45 participants, which included a discussion on Traumatic Cardiac Arrest in motor sport. The event explored the challenges and strategies for rapidly identifying and treating reversible causes, to bring about the best outcome possible for this uncommon but critical entity in motor sport.

Earlier this year in January, FIA Formula E Race Director Scot Elkins talked café participants through the key logistics issues in electric vehicle racing. Of particular interest was the planning required for an off-road electric race car series with a

relatively large footprint in remote and ecologically sensitive locations.

Elkins highlighted developments in real time circuit monitoring technology with advancements in early warning systems for race control and competitors. There was also a discussion on predictive algorithms, A.I. supplemented automated alerts and the ability to provide benefit for grassroots motor sport.

The most recent café was led by Dr Jenny Bertin, Mr Rickard Johansson and Dr Roberto Hernandez. This examined the lessons learned from running motor sport in 2020 and adapting to the emergence of COVID-19 in order to look forward to how motor sport and rescue-medical response might play out through 2021.

The key points explored were the topics of quarantine and work bubbles, the various testing methods (rtPCR, rapid antigen testing and antibody testing), the evolution and impact of the various Covid vaccines and the role of vaccine passports.

For details on future Cafes, go to <https://ICMSmotorsportsafety.org/cafe> or look up the ICMS on Instagram and LinkedIn.



DR IAN ROBERTS RECEIVES FIA PRESIDENT AWARD

FIA Formula One Medical Rescue Coordinator, Dr Ian Roberts, was given the FIA President Award at the 2020 Prize Giving.

Dr Roberts was recognised along with Medical Car Driver Alan van der Merwe and the Bahraini Marshals, for their bravery and exceptional reaction in coming to the aid of Romain Grosjean following his accident on the opening lap of the Bahrain Grand Prix.

As the car burst into flames on impact with the Armco barrier at Turn 4, the combined heroics of this group meant that Grosjean emerged with only minor burns to his hands.

The Bahraini marshals were joined by Abdulaziz Al Thawadi, representing his Excellence Sheikh Abdulla Bin Isa Al-Khalifa, the President of the Bahrain Motor Federation, to receive the accolade from FIA President Jean Todt and Professor Gérard Saillant, President of the FIA Medical Commission.

"It is the role of the FIA to improve safety. As motoring is progressing, motor sport is also progressing. Motor sport has to be a laboratory and every year we improve the running of motor sport events which benefit mobility," said President Todt.

"We are relieved that Romain could escape, but we need to understand more about the accident. We need to learn from this as we do with every accident. That is how we make motor sport safer still."

Grosjean added his praise to the work of the rescue teams: "What I went through, I wish it to no one. Seeing the footage is still difficult for me but it makes me really proud of the medical teams and the marshals."

VIRTUAL MEDICAL SUMMIT FOCUSES ON COVID-19 RESPONSE



The 2020 FIA Medical Summit brought together leading motor sport medical personnel from around the world to discuss the latest developments in the field.

The summit was opened virtually by outgoing President of the FIA Medical Commission, Professor Gérard Saillant, from the FIA offices in Geneva in front of more than 220 members from around the world.

"As you know 2020 is a very difficult and very challenging year, and the meeting this year is also very special because its via video," said Professor Saillant. "We have to adapt to the new situation and the format of these meetings is a good proof of this adaptation, but we hope that next year it will be a physical attendance because the speeches are important."

Tom Clarkson hosted the summit and introduced the five medical delegates who started off by giving an update of incidents and events from 2018 to 2020. These included overviews from Formula One, Formula E, World Rally Championship, World Rallycross Championship, World Endurance Championship, and World Touring Car Cup.

These updates were followed by a presentation on Women in Motorsport which was opened by FIA Social Responsibility Programmes Manager, Barbra Silva, who gave an update on the various projects and how some had to be adapted to be

virtual in 2020 due to the COVID-19 situation.

Alfa Romeo F1 Tatiana Calderon and Leena Gade also offered their driver and engineering perspectives on how cars can be adapted to suit different body physiques.

Discussion then moved on to an update on the RESCUE-RACER concussion study by Dr Naomi Deakin and Professor Peter Hutchinson, who provided results from the latest survey and the latest forms of concussion assessment.

This included using current assessment tools such as SCAT-5, computerized neurocognitive test IMPACT, and IPAS along with a new overt assessment using DX100, which utilises software specifically designed for motor sport, and an ultra-field MRI scan.

A roundtable discussion about the COVID-19 response from the FIA was presented by Professor Eric Caumes, who was joined by Professor Saillant and Dr Pau Mota, with a focus on the human factors and key traits involved in incident response. Dr Pau Mota outlined the main outcomes of the COVID-19 protocols being implemented, which included F1 being the first international sporting event to recommence after lockdown and pandemic declaration.

The day was rounded off with session on High Fidelity Simulation by David Halliwell who delivered a description of the latest technology for training in this area. This utilises detailed mannequins also used in major motion pictures as a way to train extrication teams.

RESCUE ROAD TRAFFIC CONCUSSION PROJECT LAUNCHED



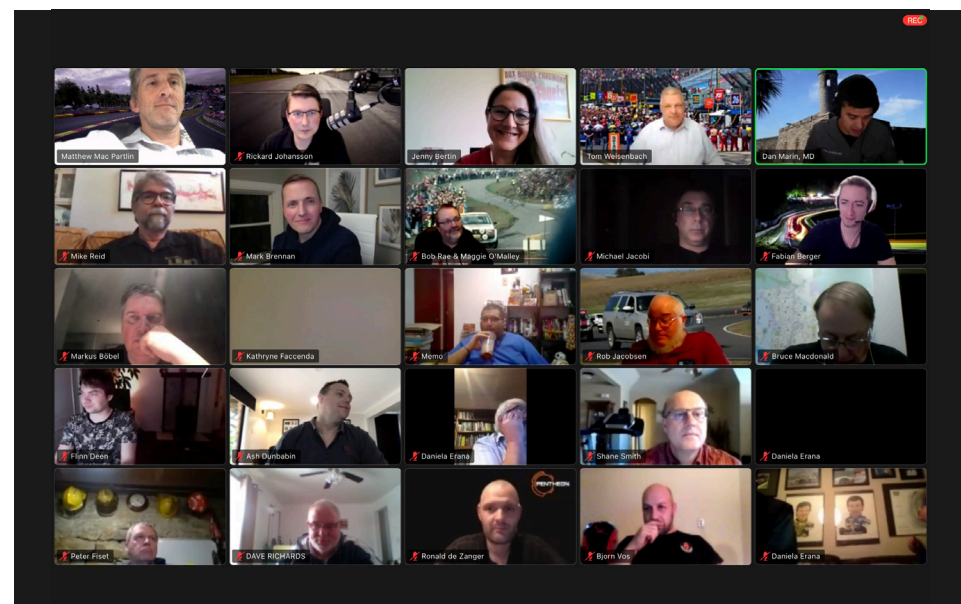
The FIA Foundation has launched a Rescue Road Traffic Collision (Rescue-RTC) project, which seeks to translate technologies demonstrated as effective in motor sport to the road.

The collaborative project will aim to identify concussion accurately and rapidly in road traffic accidents, and to generate evidence on recovery to inform the return to road use decision.

It will include the Academic Division of Neurosurgery, the Division of Anaesthesia, and the Departments of Emergency Medicine, Rehabilitation Medicine and Psychiatry. Participant recruitment will be at Addenbrooke's Hospital, a Level 1 Trauma Centre for the East of England.

Participants will be road users of any type aged 16+ involved in an RTC. At an initial presentation, consented participants will be assessed with a modified Dx100 eye tracking protocol, streamlined by findings of RESCUE-RACER to focus on tests with the greatest diagnostic efficacy, whilst expediting hospital implementation.

The new protocol will be supported by an adapted version of the freely available SCAT5 (ED-CAT). Recruitment to RESCUE-RTC will last for 12 months to capture seasonal variation, with a subset of 65 participants to be invited for follow-up in the acute injury period (1-4 weeks) to explore recovery, serially completing a Dx100 and ED-CAT examination, a shortened CANTAB protocol (cognitive function), and brain MRI (biological signatures of injury and recovery).





VIEW FROM THE GROUND:

DR YASUSHI AOYAMA

CHIEF MEDICAL OFFICER FOR RALLY JAPAN

“ I am the Chief Medical Officer of WRC Rally Japan, an event to be held this November, and I’ve been involved in motor sport for 25 years as a participant. As a doctor, I’ve been involved for nine years. I usually join the national rally championship as a stage doctor and sometimes visit circuit racing.

In Japan motor sport is in quite good circumstances for beginners to join.

Recently, Toyota motor company has put more emphasis on the grassroots motor sport like circuit racing and regional rally. Annual automobile sales total is five million, but manual transmission equipped vehicle is now only 1.5% of them, and some organisers began to consider two-pedal vehicle rally/ race for beginners. So far, not so many volunteer doctors are present at the scene, especially for grassroots events. We would like to improve this situation for to make motor sport safer.

In current Novel Coronavirus pandemic situation, we use online webinar and video tools to train in the rescue procedure.

If the conditions allow, we are planning to have a face-to-face training on site. It’s quite important for me to learn from another perspective, which is why I sometimes visit my local circuit venue. In the future, I’d like to work with expatriate doctors in foreign countries.

If I could change two things about local motor sport in Japan, the first would be to increase coverage for TV.

Recently, TV companies are broadcasting motor sports events not so frequently due to the payment for the rights, plus not many magazines for the enthusiasts to read. The effect good media has is much bigger than we thought, so more effective advertisement is necessary. The second is more doctors should attend the regional motor sport events to make it safer. To train the doctors and co-medicals, there also exists a cost problem. Additionally, if we have easy circuit access like Nürburgring track days, anyone can enter more easily and can enjoy the feel of motor sports.

One thing I have learned about the motor sport scene as a doctor is the similarities to disaster medical management, especially the rally rescue procedure.

It happens simultaneously and in difficult circumstances, which usually makes it difficult to access the site and collect the information. Correct simulation and good preparation are the best measures to be ready for that instance. Unfortunately, we are now in a pandemic and what we are doing now is to become a precious evidence for the future. We hope to proceed the WRC Rally Japan for this year and hope soon to rid the world of COVID-19 and make it safe again. ”

FEATURES

VISION ZERO

How a long-term strategy for road safety adopted by Sweden is helping reduce fatalities in world motor sport.



In 1997 the Swedish parliament adopted a new long-term approach towards road safety known as 'Vision Zero,' which was created with the underlying principle that no one should be killed or seriously injured through road accidents.

The simple objective was created with a philosophy and decision-making approach, which is that it is not acceptable for human mistakes to have fatal consequences. Since its introduction the number of road accident fatalities has decreased by 50 per-cent in the country, which has led to it gaining significant support in Europe and in some major cities throughout the United States including New York.

Recent statistics from the FIA show that the number of fatal accidents globally in motor sport has decreased consistently in the last 20 years, which is largely due to the progressive improvements to motor sport safety that have been introduced by the FIA Safety Department.

But now the FIA wants to go even further by employing the Vision Zero philosophy into its work in reducing the number of fatal accidents in amateur level motor sport, which account for 99 per-cent of fatalities worldwide. According to FIA President Jean Todt, the ambition is to ultimately achieve zero fatalities in motor sport worldwide.

"The underlying principle of Vision Zero is the same for both road and motor sport safety; every death is a tragedy and warrants action. And everything must be done to avoid injuries", says President Todt. "Death and injuries cannot be tolerated as an inevitable consequence of participating in motor sport."

FROM VISION TO ACTION

The Vision Zero initiative will incorporate Safety Envoys for each FIA region, who will provide



in-person safety support similar to the successful Rally Safety Task Force programme. These experts will work hand in hand with the National Sporting Authorities (ASNs) and organisers to identify risk factors associated with fatal and serious accidents, and offer support by implementing measures to avoid similar accidents in the future.

This support will work alongside the Serious Accident Study Group (SASG), which reviews all fatal motor sport accidents from around the world. These are submitted by ASNs through the World Accident Database, an online portal where FIA-appointed Incident Reporting Officers can enter information on serious accidents.

“DEATH CANNOT BE TOLERATED AS AN INEVITABLE ACTION OF MOTOR SPORT”

The most significant decline was seen on closed road events including rally, cross country, and hill climb, where lateral impacts or sideways collisions into solid objects are common. Both driver and co-driver deaths were reduced from 19 (combined) to 11 between 2015 and 2019, while circuit racing saw a steady decline from 10 to 7 in the same period. Other categories including drag and dirt oval events saw a significant decrease from 12 in 2016 to five in 2019.

These accidents studied by the SASG highlight the importance of undertaking a detailed investigation, to ensure that there is a clear understanding of the factors that led to the accident and identifying the appropriate solutions to prevent fatality.

ASNs will be given assistance with the investigation of fatal accidents in their country and support on introducing lasting safety improvements to mitigate the risk of similar accidents occurring in the future.

This will involve four key phases: the first being for the ASN to detect the fatality, then record and share the data with the FIA, which will then prompt an accident investigation to identify improvements. The FIA will assist the ASN with the implementation of safety improvements, then monitor the success of safety improvements and expand to other jurisdictions as appropriate.

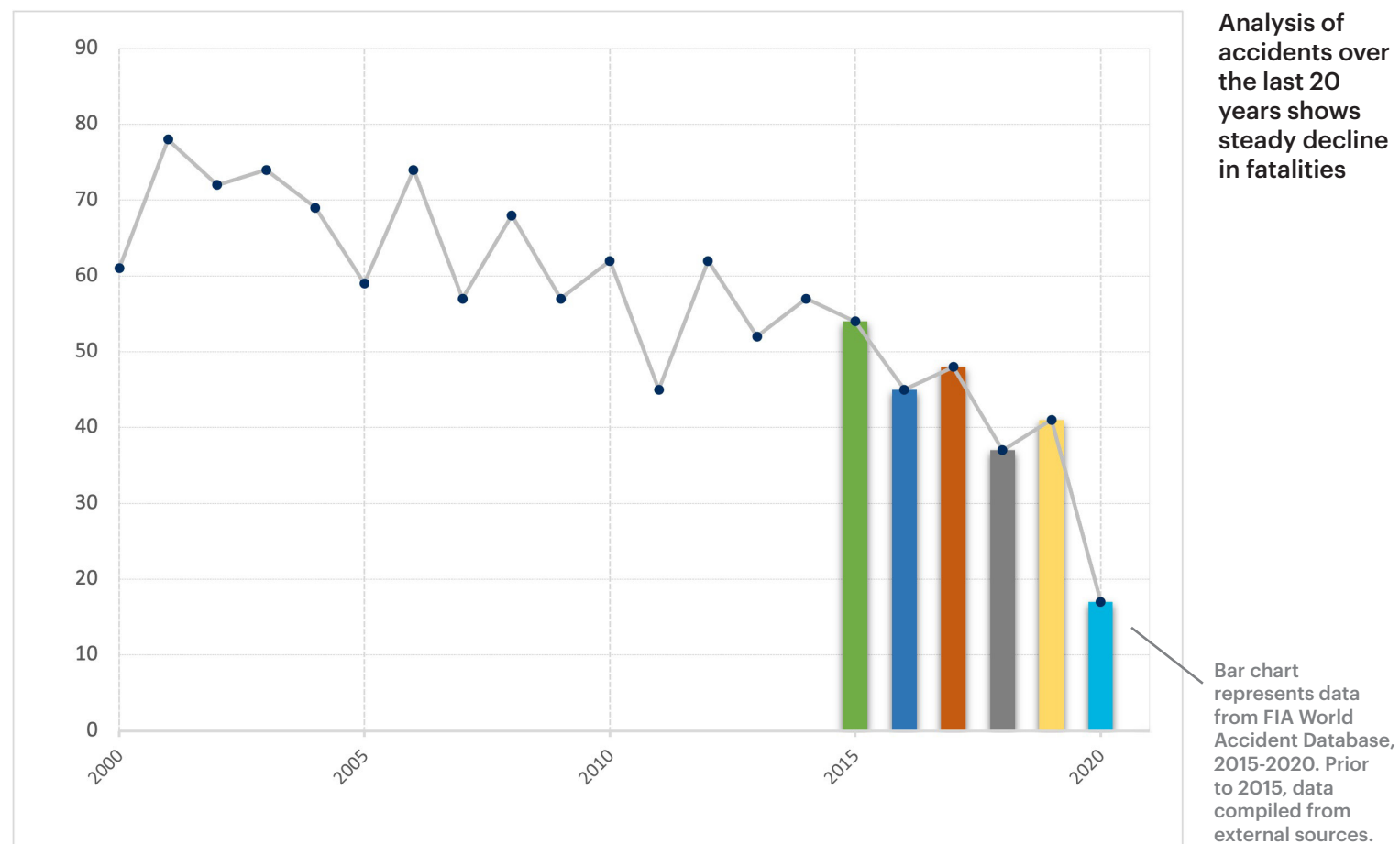
"This is a problem we need to fight together – 99 per-cent of fatal accidents are at amateur level, and it's a problem that's largely contained outside of professional motor sport," says

So far, the support programme has successfully been undertaken in Argentina in march this year, with a further four countries targeted by the end of 2021. The intent is to successfully share safety improvement information across all ASNs, to benefit the motor sport community as a whole.

SERIOUS ACCIDENT STUDY GROUP

Analysis of accidents in the World Accident Database over the last six years shows a steady decline of fatalities from 54 in 2015 to 41 in 2019. This dropped further to 17 in 2020, however this was mainly due to the cancellation of many motor sport events due to COVID-19.

MOTOR SPORT FATALITIES WORLDWIDE: 2000-2020



President Todt. "If we want to combat these tragedies, it is essential to collaborate with our ASNs that can have a real impact on the field."

DATA DRIVEN

One of the ways the FIA is helping ASNs is through the introduction of a new innovative low-cost Impact Data Recorder (IDR) which enables competitors at grassroots level motor sport to easily record data for accident analysis, but at the fraction of the cost of the Accident Data Recorders used in elite-level motor sport categories such as Formula One.

The novel device features no wires or mounting requirements, an internal battery life of two years, and works via Bluetooth by syncing with an app. It kicks into life once a car suffers an

impact above a minimum threshold and can record over 80 accidents during its lifetime.

The data generated by the IDR can then be viewed by the safety experts within the ASN, enabling them to make informed choices regarding their national technical and sporting regulations as well as safety equipment. Alternatively, the data could be sent to the FIA for analysis, following which the FIA will provide a data report to the ASN.

By taking this approach towards motor sport safety across all disciplines, the FIA is seeking to ensure that the racing and rally communities take responsibility for reducing serious injuries worldwide and in turn demonstrates the sport's positive impact towards society.

SIDE PROJECT

Accident statistics gathered through the World Accident Database are a powerful tool in the FIA's safety mission. The statistics show that, whilst rare, the most frequent type of serious accident in motor sport, which causes serious or fatal injury to the driver or co-driver, is a lateral impact into a tree during rallying.

To help ASNs and event organisers avoid such accidents, the FIA has launched the 2021 edition of the FIA Rally Safety Guidelines, which is now available on the FIA website in English, French, Spanish and German (Portuguese and Italian versions will be available shortly).

The guidelines gather the best practice that is currently applied at FIA World Rally Championship level in a format that can be used by rally organisers at regional and national level. There are also guidelines for Rally Safety Delegates and Rally Private Testing.

These FIA Rally Safety Guidelines are the culmination of an intensive period of detailed analysis and consultation regarding the safe running of rally events around the world.

They capture the latest best practice from the FIA World Rally Championship, making it relevant to regional and national level rallying. They outline expertise and guidance on all aspects of organising an event, including:

- The roles and responsibilities of officials
- The use of safety cars and the safety plan
- Areas of risk for spectators and competitors
- Special Stage selection and set-up
- Communication with marshals and spectators
- Handling incidents of varying severity from an organisational and medical perspective

The FIA is encouraging its Clubs, rally organisers, officials and volunteers to review these Guidelines and consider them a valuable resource to assist with the staging of rally events.



Rally guidelines have been updated for 2021



FATAL ACCIDENT STATISTICS (WORLDWIDE)

SUMMARY: 2020

TOTAL FATALITIES 17

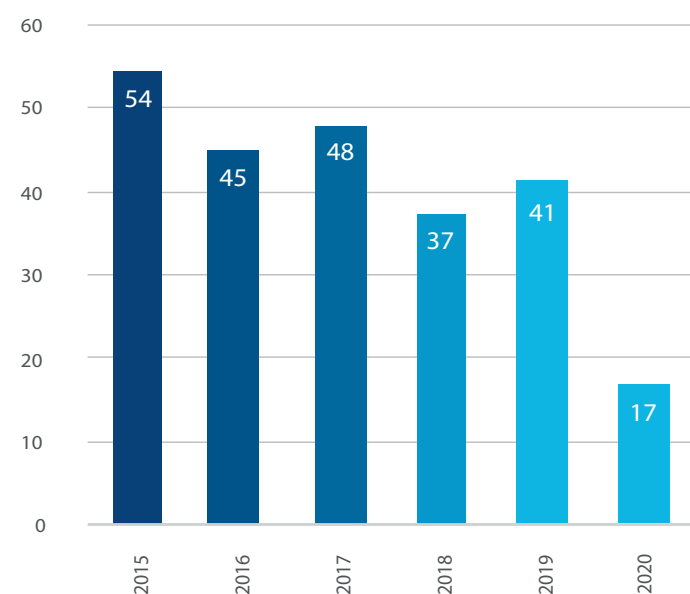
BY CATEGORY

CIRCUIT	CLOSED ROAD	OTHER
5	9	3

BY SANCTIONING BODY

FIA	ASN	NON-ASN
0	11	6

FATALITIES: 2015 - 2020

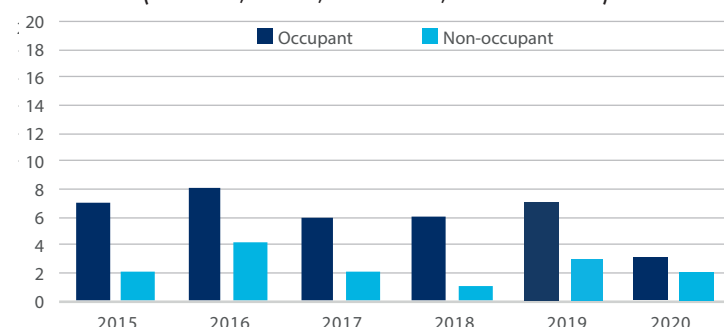


WORLD ACCIDENT DATABASE (WADB)

Motor sport accident data gathered through the World Accident Database is analysed and used to guide policy, allocate resource, prioritise research projects and identify systemic risks.

FATALITIES: CIRCUIT

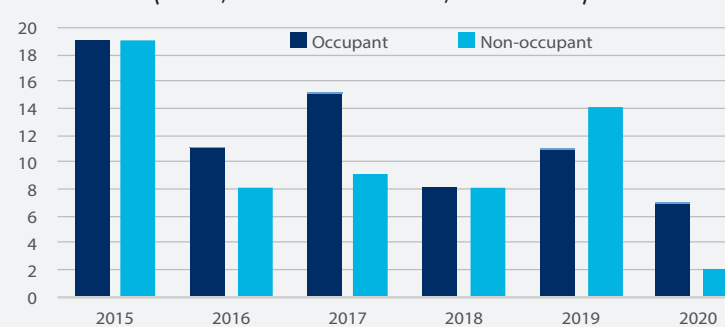
(CIRCUIT, OVAL, KARTING, RALLYCROSS)



	2015	2016	2017	2018	2019	2020
Occupant						
Driver	7	8	6	6	7	3
Co-driver						
Non-occupant						
Official	1	2	1	1	2	2
Team	0	0	0	0	0	0
Spectator	1	2	1	0	0	0
Media	0	0	0	0	1	0
Public	0	0	0	0	0	0

FATALITIES: CLOSED ROAD

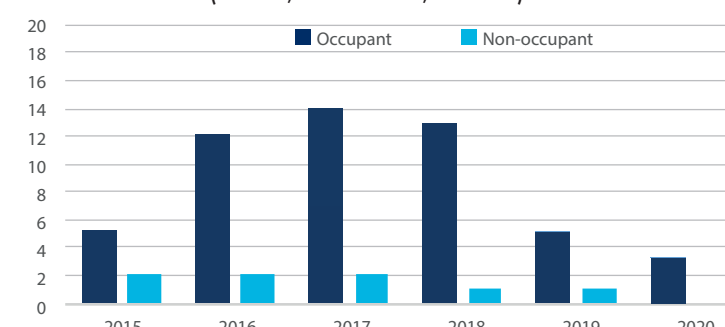
(RALLY, CROSS COUNTRY, HILL CLIMB)



	2015	2016	2017	2018	2019	2020
Occupant						
Driver	13	6	11	6	5	4
Co-driver	6	5	4	2	6	3
Non-occupant						
Official	0	0	2	1	1	0
Team	1	0	0	0	0	0
Spectator	18	6	7	5	9	2
Media	0	1	0	2	0	0
Public	0	1	0	0	4	0

FATALITIES: OTHER

(DRAG, DIRT OVAL, OTHER)



	2015	2016	2017	2018	2019	2020
Occupant						
Driver	5	12	13	13	5	3
Co-driver	0	0	1	0	0	0
Non-occupant						
Official	1	0	2	1	1	0
Team	1	2	0	0	0	0
Spectator	0	0	0	0	0	0
Media	0	0	0	0	0	0
Public	0	0	0	0	0	0

Last updated: 08.04.2021

DR PAUL REA

FIA HEAD OF MEDICAL AND RESCUE

Dr Paul Rea is a medical professional with over 20 years of experience in motor sport. He joins the FIA Safety Department having been heavily involved in motor sport rescue training and delivering medical briefings to rescue crews. *AUTO+ Medical* spoke to him about his experience and his ambitious plans for the future.

AUTO+ Medical: How did you get involved in motor sport?

Paul Rea: As a kid, way back in the mid 80s, a friend of my dad's used to compete at the Circuit of Ireland and we used to follow him on and off, and my earliest memories are going to rallies outside of Dublin with me and my dad to follow to follow him. After that, as years went by, I went into college and did mechanical engineering. I have always been fascinated by cars and by motor sport in general but I really got into motor sport in a big way when I went to Oxford University to study biomechanics. I competed in the British University Karting Championship while I was there and I was secretary to the motor drivers club in Oxford as well and got heavily involved with them in road rallies and karting. Over the years since then I did night navs and I was a co-driver for friends in rallies.

After university I worked as an engineer for a couple of years and then went back and did medicine as a mature student. Right through med school I was still involved in in motor sport with the clubs, and then did as many rallies as I could as a medical student as well. So I was an assistant to Stage Doctors and to Chief Medical Officers (CMO's) around Ireland and then as soon as I qualified I started jumping into loads of rallies. As an intern I did the Formula One TLS course in Silverstone. I have continued to be involved with the load of rallies all around Ireland and all the clubs around the country know me as I was doing between eight and 12 rallies a year.

A+M: What were your roles on these events?

PR: Initially a Stage Doctor on different rally stages, then as CMO for different rallies all around the country, and then beyond that I started getting more and more queries from Motorsport Ireland for licences, experts and for all sorts of different things. I started taking on the role unofficially as CMO and then got involved in the Safety Commission and the Medical Commission over the last few years. Then when COVID hit I jumped in to try and write the return to motor sport document last year as quickly as we could to try and get something started. I've been involved in it for so long at this stage that most of the competitors have my mobile number! I love the camaraderie and collegiality in motor sport. I like being involved





Rea worked as a stage doctor on rally stages in Ireland

professionally because it combines engineering, motor sport and sports medicine all into one thing. I also like it personally because I'm an out and out petrolhead - I rebuild classic cars in my spare time; I've got an old Lancia and a Triumph that I've rebuilt the engine in, and I've dismantled the suspension and gearbox.

A+M: When you saw the FIA was looking for someone with a multidisciplinary background, what did you think?

PR: I looked at it and thought "Gosh!" And then I showed it to my wife and she said "Yeah, absolutely!" I should point out my wife is from Switzerland, so that was an extra aspect to showing her the job. But when I looked at the job description, I very quickly realised I ticked every box and I said "Well, if I don't apply then I'll always regret it!" never thinking I would get it. But then I ended up having the interviews with Adam Baker and Professor Saillant, and a few more interviews

after that. Then I got word that I gotten the job so I was thrilled. It's something that when I looked back at the job description, I'd been doing myself in Ireland for a long, long time. Any accident I ever came across I always took pictures - with permission from competitors - of the car, of the scene, to see what happened and try and put it together. I talked to different people who've been involved like Dr Paul Trafford and a few other people over the years who I've known from Motorsport UK, but always kind of kept a close eye on predominantly grassroots rallying, in accidents that had happened and looking at the cars to see which way the car is deformed and seeing how people were injured and if there was anything better that could be done about it? So, when I saw the job description I realised I could put into practice the stuff I've been doing on my own for years.

A+M: Will you be planning to move to Switzerland as part of the role?

PR: That's the plan, my mother- and father-in-law live just outside Lausanne, so the plan is to be close to them. At the moment I'm still based in Dublin, but very soon the plan is to be based in Switzerland. For now, it's been an interesting one getting to know everybody via Zoom and having spent the last six weeks getting to know everybody, it would be nice to get to know them in an informal environment. And when COVID restrictions end to do the usual socialising that people do in an office environment.

A+M: What are your key objectives in this new role?

PR: Given my background from grassroots level up my targets really are principally to reduce the accidents in rallying. Circuit medicine and circuit safety has come a long way and, having cut my teeth in rallying, I'd love to be able to help make it safer and enjoyable for everybody. I want to try and reduce the fatal injuries and make the cars as safe as we possibly can along with the rest of the FIA Safety Department. Particularly from a grassroots level up, whilst always bearing in mind to try and keep it as cost-effective and as cost-efficient as possible. Also to try and figure out what actually happened in the car that caused a medical injury and to improve the car and improve people's awareness of the injuries so we see less of them in the future.

A+M: What are the main challenges to achieving this level at safety, especially at grassroots level?

“CIRCUIT MEDICINE AND CIRCUIT SAFETY HAS COME A LONG WAY”

PR: Cost is a major issue. There's always a challenge with any motor sport accident to try and minimise the amount of accidents that happen to start off with, but also from a competitor's perspective we don't want to be adding on unnecessary and overly expensive modifications to cars, particularly in a grassroots level. You want to keep all of the equipment as safe as possible, but as low cost as possible so that everyone uses it.

A+M: What is the main project you are working on at the moment?

PR: One of the main projects that the Medical Commission have tasked me with very early on is a virtual trauma centre network. Initially it's a computer system that will enable doctors all over the world to talk to each other. It'll act as a kind of a resource database for CMO's and for Deputy CMO's, but also for all doctors in motor sport all around the world. It's a database for all motor sport-related injuries and what we're hoping to do and we're hoping to create a Medical and Rescue Centre of Excellence that will be accessible to everybody. This means if we're giving lectures on a rescue topic or electric vehicle safety, we'd be able to upload it so that everybody can see it and equally they can share comments that anyone has on a social networking type the format. Another part of that project is if there's an accident, to link in with the trauma network. There are trauma hospitals associated with F1 events and World Rally Championship events all around the world, so there will be a follow up from a patient point of care perspective. The CMO or the doctor that's been involved with it can follow with the hospital what's going on, and link back in so that everybody's kept

informed about how everyone's getting on after an accident. It's a big project but one that will be definitely worthwhile for sharing medical information and for patient care after any motor sport accident.

A+M: There is also the COVID protocols that the FIA is involved in, is that something you have been thrown into?

PR: I'm taking over from Pau Mota as the COVID delegate for 2021. So I'm getting very familiar with the whole process and the COVID delegate notes for each event. I'm trying to get to know everybody as quickly as I can and adopt the same attitude that I've found in the past, which are that things are easier if you're approachable and if people can put a name to the face.

A+M: Do you think it be difficult because some circuits will want fans to come in and there will be different requirements for each venue you go to?

PR: I think that is going to be a challenge this year. From a team's perspective it should be more manageable this year because everybody's familiar with the protocols from last year. The other aspect to it as well is that the national guidelines from country to country have very much streamlined and are much more similar compared to last year because people have just had more time to get to grips with the guidelines. From an organiser's perspective, in terms of F1 and getting spectators, part and parcel of the sport is the spectators in the stands. But I think it has to be done in a safe manner that we don't risk everything. It's still going to be a challenge to bring spectators back into the sport, but we'll see how the vaccinations go on as the

“ ITS STILL GOING TO BE A CHALLENGE TO BRING SPECTATORS BACK ”

season progresses and see how national governments relax their guidelines.

A+M: Will personnel still be tested even if they have had a vaccination?

PR: For this year, yes. That is one thing that we were discussing in the COVID expert group that Appendix S doesn't change substantially this year, just for safety purposes more than anything else to ensure consistency throughout the season. That's not just for F1 but for every championship.



The COVID testing protocols will continue in F1 throughout the 2021 season

PHYSICAL EXAMINATION

Examining the unique and specific comfort adaptations that are required for different body sizes in race cars, particularly due to the physiological differences between women and men.



In the run up to every Formula One season you will often find videos of drivers having a seat fitting as they settle into their new car. For drivers this is an important exercise in comfort and can be key to them extracting the extra tenths they need to get pole or win a race.

For works manufacturers this process is all part of their bespoke design process. However when you are competing in a spec-series, drivers can often be limited in the number of areas they can change on the car to suit their comfort needs. In the case of Tatiana Calderon, during her single seater career she had to adapt a lot to the car throughout the season due to her different physique compared to her male counterparts.

“As a female we have 33 per-cent less muscle than men, so we have to train harder and I have to modify a lot of things in the car to be able to feel confident and comfortable. At the beginning it was difficult to understand where or which issues it was really, so for example I was lacking a lot of braking pressure at the beginning in single seaters, and they were telling me that it was maybe because I was not fit enough or strong enough.”

“I put a GoPro on my pedals, I’m a size 37 against the guys who have 43, so I was pressing the brake pedal with my toes and not with the good part of my feet. We built this platform to raise my feet, then once we did that there was no issue whatsoever. It took me a good year to find out what the issue was and there was no way I could modify it in a different way, so this platform we had to ask to be homologated within the car.”

SEATING PAINS

These modifications were present throughout Calderon’s career, particularly in the jump

“ I HAVE TO MODIFY A LOT OF THINGS IN THE CAR TO FEEL COMFORTABLE ”

from Formula 3 to Formula 2 where the cars are heavier and subsequently have heavier steering. For this Calderon had to work with her team to create a new steering wheel mould due to blisters that formed on her hands, which manifested into mobility issues in the cockpit.

“When you progress from F3 to F2 the steering wheel is heavy because we don’t have power steering like in F1, so I was getting cramps on my hands. I couldn’t talk on my radio because I had to push the button and I wasn’t able to shift up and press the button at the same time because the grip of the steering wheel was very, very thick,” says Calderon.

“I had to build these steering wheel moulds, and once we modified these moulds and put a thinner steering wheel on, the cramps disappeared, and I was able to really feel much more the car and I was not getting tired. I think maybe we need to have more flexibility with the things that we can modify for women to feel better.”

These issues of cockpit design and comfort are not anything new for motor sport, as former Race Engineer for the Audi World Endurance Championship team, Leena Gade, notes. When the safety regulations for closed-cockpit cars for extrication of drivers came into force, drivers who were shorter in height, such as Audi’s Alan McNish found that modifications needed to meet the regulations for the seat created issues around cockpit functionality.



Gade was part of Audi as a race engineer when they won Le Mans three times

“There were inserts that were put into the racing seats and Alan’s one was like a full seat that had to be put in and taken out,” recalls Gade. “That in itself created some issues, specifically with the functionality of his hands and his seatbelts. Some of these issues are not new and are in existence, so there should be some guidance within the technical commissions to help manufacturers of chassis to be able to design a car to accommodate this physique.”

Calderon also experienced a similar issue with homologated areas of the cockpit design during her F2 career, and believes

its important to have these compromises in design to compensate for the 33 per-cent less muscle mass that female drivers have compared to male drivers.

“I wanted a longer column for the steering wheel so I could steer and not hit my legs,” explains Calderon. “But these were not homologated because of the crash tests, so we had to study a lot my placement in the car and with the Halo it helped because you have to have the steering wheel much closer to you. But its important to have a little more flexibility in order for us to sit in the right position, to compensate for the less muscle

mass we have. It's super important to have 1cm or 2cm to sit in the right position, when you are trying to find the last few tenths."

PERFORMANCE GAINS

In the case of female drivers, their physiques and the relative proportions of the top half of their body to the bottom half of their body are completely different compared to male drivers, which means some of the pivot points for their legs and arms are slightly different.

Given that a lot of the requirements for single seater or sports car monocoques are set by the teams, Gade believes that there should be more of an understanding regarding driver physique particularly when it comes to female drivers.

"Those guidelines are in existence from a safety point of view which is incredibly important, but at times they can end up restricting where a driver ends up," says Gade. "In series that are not works-related or where there are works teams putting a lot of effort into designing cockpit areas for the drivers, there seems to be a slight lack of understanding in what is required for drivers to essentially drive a car efficiently and extracting performance from a car."

"I think we lack to some extent a little bit of guidance and guidelines from the way the technical regulations are written to accommodate different size drivers. To some extent perhaps the impetus of that or the requirement for that has been given over to the manufacturers of those different monocoques," adds Gade.

Alongside her work as President of the FIA GT Commission, Gade also works as a Vehicle Dynamics Manager for engineering company Multimatic. Recently they have produced the LMP2 chassis for the Mazda Daytona Prototype



Calderon had to adjust her pedals and steering column in F2 for comfort

Car (DPI) car, which Gade says is an example of how cars should be built to accommodate all types of driver shape and size.

"Space is at a premium in that car 100 per-cent, we have the opposite problem in that some of our taller drivers really do struggle to get into and out of the car,"

explains Gade. "There are specific points that are already defined by technical regs for where drivers placement needs to be inside the car, for example the height of the helmet from the top of the crossbar or the rollcage structure of the car, the distance from the front of the car or the

“ WE LACK GUIDANCE IN THE REGULATIONS TO ACCOMODATE DIFFERENT SIZED DRIVERS ”

steering area of the car to where the driver is."

"But shouldn't be a matter of male or female, it needs to accommodate the centiles of very small people to very large people, within reason there needs to be some specific points of where that would need to be. It's a bit more involved when you put those points in, because there has to be an evaluation of the number of drivers we have now that are involved in anything from single seaters to multi-driver championships but also for the physique of women."

This point is echoed by Calderon, who believes that chassis designers should have fitting days similar to F1 seat fits in the future so they have a better understanding of driver physique, as it could not only have an overall influence on driver performance but also be safer for drivers given her past experience.

"For safety we should in the future maybe have more flexibility to fit maybe a women in single seaters, this is something that I use every time I go to a race or to test every car and it has had a huge effect on my performance and on my training," says Calderon. "In the FIA Women in Motorsport commission we discussed these issues because we want the next generation to have a better understanding of what they need to change and for the designers to consider shorter and smaller people."

INSIDE THE... ASTON MARTIN F1 MEDICAL CAR

A look inside the new Aston Martin DBX Medical Car that is being used in Formula One this season.

Since 1996 the sole supplier of Safety and Medical Cars in Formula One has been Mercedes-Benz, but for 2021 that decades-long tradition will be broken as for the first time Aston Martin joins the fold.

The car maker will be supplying its Vantage model as the Safety Car while its first SUV, the DBX, will be the Medical Car, for 10 races this season. Powered by a twin-turbocharged 4.0-litre Mercedes-AMG V8 engine that produces 528bhp, the Medical Car will continue to be piloted by Alan van der Merwe and Dr Ian Roberts.

The DBX has been engineered at Aston Martin's UK headquarters in Gaydon, UK, and produces 700NM of torque, a 0-60 time of 4.3 seconds, and a top speed of 181mph.

The vehicle has undergone significant testing, including high-speed durability assessments and aggressive circuit driving at the Aston Martin facility at Silverstone, with both the Medical and Safety Car totting up almost 15,000km. It has also been tested in a dyno climate chamber to ensure they will perform in all race conditions.

On the following pages, Dr Roberts reveals what equipment goes inside the medical car for a Formula One race.





6. REAR FIRE EXTINGUISHER

A secondary fire extinguisher is located in the rear passenger seats for rapid response in the event of a fire.

1. REAR VIEW CAMERA

Situated above the track maps is a high-definition rear-view camera. Although shaped like a rear-view mirror, it is a screen.

2. CAR TRACKING AND CIRCUIT MAPS

Two large iPads are used to track all of the F1 cars and show the track status, including yellow flag sectors. The right-hand screen is dynamic, displaying data at all times wherever the medical car is on the circuit. The left-hand screen displays the same positional data but with an additional video overlay.

5. CENTRAL SCREEN:

Displays the Medical car's data and accesses its various modes and options.

4. RADIO AND INTERCOM VOLUME CONTROLS:

Two sets of controls, for the driver and co-driver, that also control the level of talk back to optimise the intercom audio.

3. RADIOS, BEACONS, LIGHTS AND SIREN CONTROL PANEL:

This bank of electronic switches controls a number of features. There are two digital radios on board, with the controls accessible to both driver and co-driver. The car electronics master switches can be seen below this panel (red and green)



8. TRAUMA BAG:

The main trauma bag contains the major resuscitation equipment. The equipment includes kit for advanced airway management (fibre-optic laryngoscope and tracheostomy) and intra-osseous cannulation, pelvic splinting, and monitoring. There is also a small ventilator along with resuscitation fluids and large dressings packs. Providing the immediate haemorrhage control, airway, ventilation and circulation management is the key purpose of this bag, and the contents are chosen to maximise that impact. All of the medical equipment is packaged into a small number of peli-cases, and travels in our air freight to all of the races.

9. SMALL TRAUMA BAG:

This is carried inside the car so it is immediately available at the incident. It holds a variety of emergency medical equipment, basic and advanced airways, a small suction device, a manual ventilator, two tourniquets, items for venous cannulation and even a small tool kit.

10. DEFIBRILLATOR:

There are many built-in safety mechanisms to ensure the electrical system can pose no threat to the driver, their team or rescuers. Electric shock is a small but a possible danger and can cause life threatening cardiac problems. We carry a defibrillator in case we need to respond to such a cardiac emergency.

11. EXTRICATION KIT:

All of the extrication teams carry a full range of equipment to remove a driver from their car, including the necessary straps and fixings for the extrication seat. This is a spare set just in case anything is missing or breaks.

7. WATER GEL BURNS DRESSINGS:

The pack contains ready to use dressings to cool burns. They can be deployed quickly to provide immediate relief and come in several sizes for different body areas.

12. PEOPLE:

We work alongside a doctor from the national team, who sits in one of the rear seats and who has the required trauma and resuscitation skills. They are chosen by their CMO, must be experienced in medicine as applied to motor sport and have a very good working knowledge of the type of event. They bring along their own medical equipment, including a cylinder of oxygen as we cannot carry this is our freight.

13. EXTINGUISHERS:

There are two large extinguishers in the trunk and smaller ones fixed inside the car, to "grab and go". We carry extinguishers to help in our primary purpose, which is to rescue the driver, rather than fight a car fire. They also enable us to have some immediate fire cover should we arrive at an incident before the Fire Marshals.

THE ROAD BACK:

KATHERINE LEGGE

The sportscar racer speaks to AUTO+ Medical about her recovery after a crash during pre-season testing at Paul Ricard last year.

During pre-season testing for the European Le Mans Series at Paul Ricard in July last year, Katherine Legge's Oreca-Gibson car left the circuit at the high-speed Signes corner at the end of the long straight. The car impacted the concrete barrier, causing big damage to the front of the car and trapping Legge in the wreckage. The session was immediately red flagged as rescue crews were dispatched, where it took them nearly an hour to extricate her.

After being transported to the circuit medical center, she was diagnosed with both legs broken and a broken left wrist. She was subsequently taken via helicopter to a nearby military hospital, where they performed surgery on her legs and wrist. The accident caused Legge to miss out on the rest of the 2020 season, with her returning to racing at this year's Daytona 24 Hours six months after the crash. **AUTO+ Medical** speaks to her about the injuries and recovery.

AUTO+ Medical: Can you talk me through what happened?

Katherine Legge: We're still not sure what caused the crash but from the data we could see that it wasn't car failure, and it wasn't driver error. I managed to hit the only concrete wall in the whole of Paul Ricard I think! It actually wasn't that fast an accident, it was relatively slow speeds compared to a lot of the accidents that we are used to seeing, but the car basically folded and trapped me inside. The console, the pedal box, everything folded up towards me, so my legs were actually beyond the pedals, the pedals were around my shin area and the steering wheel had come up. When you're gonna have a crash, you cross your arms on your chest which I did, then the steering wheel and the centre console hit me in the arm. I was trapped in the car for like an hour, but I didn't really have any pain and I didn't know what was broken, what wasn't broken. Within about half an hour there was 20 people surrounding the car trying to figure out how they were



going to cut me out. I don't actually know how they did it because I asked them to knock me out because I was freaking out from being trapped in the car for so long. Once they gave me an injection to send me to sleep, the next time I knew I woke up I was in the helicopter, butt naked on a cold slab coming into the hospital, and I tried to close my eyes and just go back to sleep because I was like "this sucks, this isn't cool!" I came around again in the MRI room where they did all the CAT scans, then later I woke up in the hospital bed.

A+M: What was the care like in the hospital?

KL: It was actually tricky because they didn't really speak much English, it was a military hospital close to the track called Hospital d'instruction des Armées. I was really lucky that my Dad was there because he usually comes to most of my races, but never to the tests, so he could help out too. When I woke up I was casted on both legs, not on my arm or my wrist because they didn't think that they were broken. In fact the report said that I broke an arm and a leg, but I didn't, I broke both legs and my arm. There's a tendon that runs down your wrist that's in a channel, and the tendon came out of that channel which ripped the tendon, so I have a scar there. That was actually one of the things that they were most worried about when I came back to the US, because once it's come out the channel and the tendon is loose, they put something over the channel to tie it back in. The doctors didn't really want to do anything invasive if it wasn't a problem.

A+M: Which bones did you break?

KL: I broke my left Tibia which snapped clean in half, it almost came out of the skin and was



Legge was airlifted to a nearby military hospital for treatment



“ I WAS TRAPPED IN THE CAR FOR AN HOUR, I DIDN'T KNOW WHAT WAS BROKEN ”

one of those compound fractures, but it pierced the underneath layers and is still bruised a little bit. My Fibula snapped in three different places, the left foot was broken in the second Metatarsal, and then my right ankle was broken. They were more worried about the right ankle because it's in a joint and they said that if anything goes wrong with the recovery of that, they would have to put in a plate and screws and I'd lose mobility. I had to really be careful with recovery on that one. The left leg they actually said I could walk on for two or three days after surgery, but when I tried, I thought "there's no way on God's green earth that there is any weight going on that leg right now!" because it hurts to begin with. When they did the surgery, it was very strange

the way they do it in France compared to England because they put me out in the operating theatre, so I saw the bright lights and the sterile environment and everything, which is kind of discombobulating. I think I'd rather go out before I go into the theatre.

A+M: What did they do to fix the broken bones?

KL: They put a rod down my Tibia and a screw at the top and the bottom to secure it. They didn't cast either leg because they said that it's better not to and it's also better to weight bear a little bit to get it to fix. They also didn't cast my right ankle, they put in a screw to hold it. I stayed in the hospital for like five days or so after that, I'm also a vegetarian so there wasn't so much that it could eat in the hospital, but they actually forced me some sardines when I got to the rehab place. But I just felt sick, like I get car sick sometimes and I just felt like that more than anything else; weak and sick. Then my Dad drove me six hours through France into the Pyrenees to go to 321 PERFORM, which was the recovery place with Xavier Feuillee, and then he took over my recovery. I stayed there for like three or four weeks and they took really good care of me, I had acupuncture and I went to the doctor for X rays. The recovery was really hard work because I was in there all day, every day. I literally had two days off after 10. My dad stayed with me for like the first week and then my fiancé came over from the US. I was really scared about flying back, because when you have both legs that you're not allowed to walk on and you're in an aeroplane, trying to get through the airport when you don't speak the language, it can be difficult. We got him over and because of

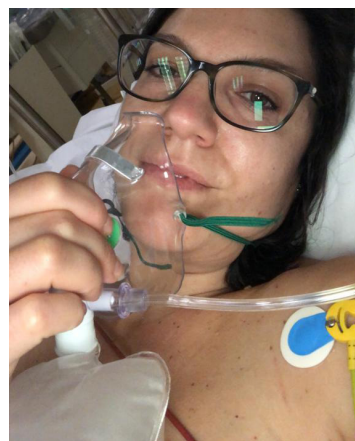
COVID his company let him work remotely in France, so when I was in the gym every day, he was billing the hours and I was going through the recovery to try and keep the muscle strength up. To try and retain muscles is really hard, so without the rehab at 321 PERFORM I would have been totally lost and the recovery would have taken a lot longer.

A+M: Were you still able to walk on both legs at this point?

KL: They would let me walk on my left leg with all the hardware in it but not my right ankle as they were worried about that one. I was actually in a wheelchair for another month after that. Even though I could have walked a lot earlier on my right ankle, they would not let me, they were worried about the screw pulling out or something reinjuring. I also just couldn't wait bear on the left leg early on.

A+M: Was there anyone else who helped you with recovery?

KL: Mark Webber ended up reaching out to me bless him, and said "Hey, I've been there, done that, got the T-shirt, so if you've got any questions..." and I just bombarded him with a million questions and his doctor as well actually who fixed him because I wasn't in England, and I wanted to know what I was going through was normal and what to expect. I really wanted to do Le Mans and I was pushing really hard to do it, but in hindsight it was the right decision not to because it would have been too soon. Mark was really helpful, and he's got an amazing memory of everything he went through. I didn't



Mark Webber helped Legge during her rehabilitation

“ I WANTED TO DO LE MANS, BUT IN HINDSIGHT IT WAS THE RIGHT DECISION NOT TO ”

know him before that, but he was super helpful and if anybody had the same injury again, I would definitely reach out to them and try and help them because it makes all the difference. Racing was a really small world and a tight knit community, so it's things like that which means so much. But I also think I was a bit too nervous about it, because Daytona was the first time, I was back in the car this year at the end of January, so it'd been six months and I was like, "Oh, is it going to hurt? Am I going to have any pain?"

A+M: What was it like when you finally got back into the car? Did they have to do any like special adjustments to your seat or anything?

KL: No nothing like that. I was mostly worried about my left leg, am I going to get ultimate brake pressure? Am I going to be able to stay in the brake pressure? Am I going to have the feel for modulation on

the brakes? Then I was thinking "okay, well, if not, then I can always revert to old school and do right foot braking" But it wasn't a problem. Then I was worried also about driver change, right? Because you have to jump in and out of the car, you knock your legs around, it's kind of brutal, but I trained pretty hard in the gym on the on the run up to it. After the first day I was like "Can I feel anything? Am I going to have pain? What am I going to do after the second session?" but in the end I was like "This is mega, I have nothing to worry about. I'm fine!" And did the whole 24 hours with no stress. As I said, I don't know how much of it was in my head or not. I think I could have possibly done Le Mans,

but I did not want to be not at peak and let everybody down. I think it was the right decision not to, but it was definitely a heart breaking one.

A+M: Anything else you wanted to add?

KL: Thanks to my Mom and Dad for helping me because things like cleaning your house or cooking and stuff that you can't do in a wheelchair, it's really hard. When you are in a wheelchair, you get a whole new respect for what those people go through. Luckily mine was only temporary, but it gives me shivers to think about, so kudos to people who have to deal with that on a daily basis. I think they must be the strongest people on the planet.



Legge did most of her rehabilitation in France at 321 PERFORM

SCIENTIFIC ARTICLE:

PHYSIOLOGICAL RESPONSES OF PROFESSIONAL & AMATEUR RACE CAR DRIVERS

Author: David P. Ferguson PhD ACSM-CEP, Michigan State University



Motor sport is a physically demanding sport that requires drivers to precisely maneuver a vehicle at a high rate of speed while being exposed to fatiguing gravitational forces, high cockpit temperatures, and vibrations. These physical stressors can cause a driver to make a mistake that could result in loss of lap time or worst-case scenario, a crash.

In order to reduce the incidence of fatigue from such physical stressors, drivers regularly engage in physical training to improve their skeletal muscle strength, body composition, aerobic capacity, and cognitive function. The Spartan Motorsport Performance Laboratory at Michigan State University has been conducting various research studies to document the physical stressors placed on drivers and developing training protocols to improve driver performance and safety. However, a unique aspect to motor sport is that in some series (primarily endurance sports car racing) professional and amateur drivers compete alongside each other.

In traditional “stick and ball sports” such as football, baseball and hockey athlete development and training is highly influenced by years of experience. For example, a fitness program for a 13 year-old football player may look completely different to that of a Premier League player. This is because both players have different stressors placed on them and therefore, different goals in training. In motor

“ PROFESSIONAL AND AMATEUR DRIVERS COMPETE TOGETHER IN MOTOR SPORT ”

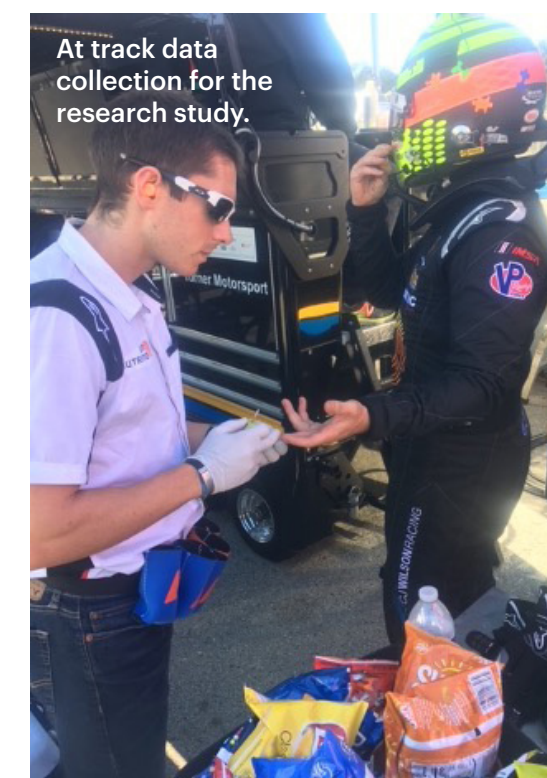
sport the stressors of driving the racecar are similar for the professional and amateur driver (e.g. they drive the same car). Thus, in order to best develop training protocols for professional and amateur drivers we first needed to document the physiological responses to racing in professional and amateur drivers.

We partnered with CJ Wilson Racing (now Gradient Racing) and Unit Nutrition during the 2017 IMSA Continental Tire SportsCar Challenge (CTSC) season. CTSC was ideal to investigate our research question because a single car was driven by a professional and amateur driver, meaning that the stressors to pilot the vehicle would be very similar if not identical. We first invited the drivers into the lab and evaluated their body composition, maximal aerobic capacity (VO2max) and skeletal muscle strength. We then monitored the team (consisting of 4 drivers/two cars) for physiological response to driving for the entire 2017 season.

During the season drivers wore a bio harness with various sensors that measured heart rate, skin temperature, core temperature, breathing rate and blood glucose. These measures allowed us to assess cardio metabolic differences between the professional and amateur drivers. Taken together, the laboratory and car measures allowed us to develop a detailed physiological profile for professional and amateur drivers.

The laboratory measures informed us that both professional and amateur drivers had

an aerobic capacity higher than the average population and that their percent body fat was less than the average population, imply that both groups of drivers could be considered “fit”. While those two variables were similar between the professionals and the amateurs, the professionals’ skeletal muscle could elicit higher power outputs and at a faster rate. This was an interesting observations as skeletal muscle plays a critical role in piloting the vehicle. Certainly, skeletal muscle must be strong and fatigue resistant to turn the steering wheel and modulate the brake pedal, but the trunk, back, neck and shoulder muscles must also hold the driver’s body in position while resisting gravitational forces. If the muscles



At track data collection for the research study.



Drivers and research staff that worked on the study.



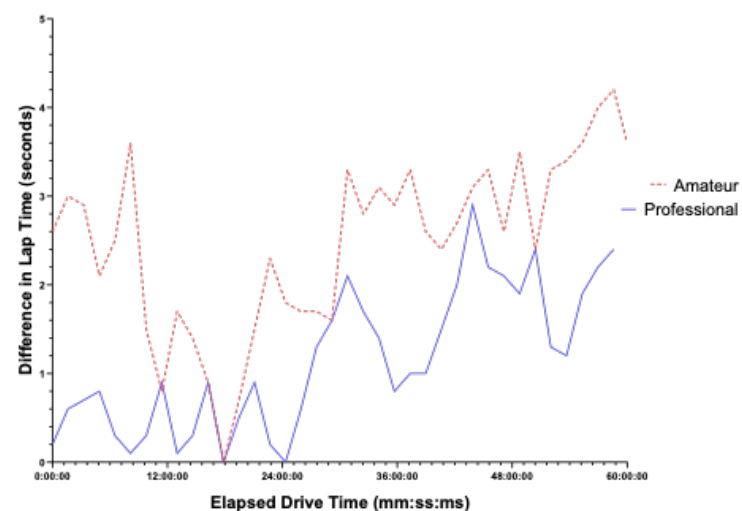
Race car driver being prepared for VO2max test in the Spartan Motorsport Performance Laboratory at Michigan State University.

fatigue the driver could “slump” in the seat and have difficulty keeping the car on the preferred racing line, which would result in longer lap times and potentially an on-track incident.

Indeed, we observed that the amateur drivers had longer lap times as compared to the professional drivers. Lap time is influenced by a variety of factors such as years of driving experience, car setup, and tire degradation, in addition to skeletal muscle power output. Yet, by evaluating identical race cars with similar setups we were able to parse out mechanisms by which driver physiology could influence lap time. The first thing we noticed was that lap time increased at a faster rate in the amateur drivers compared to the professional drivers; supporting our hypothesis that skeletal muscle fatigue was more pronounced in the amateur drivers. Associated with the sharp increase in lap times was the fact that the amateur drivers had higher heart rates and blood glucose levels as compared to the professionals.

During exercise heart rate and blood glucose increase to help fuel the working muscles, higher intensity exercise (e.g. the harder skeletal muscles are working) is associated with higher heart rates and blood glucose levels. Thus, these results tell us that the amateur drivers were having to “work harder” to pilot the vehicle and over time fatigue would increase lap time.

The next important piece of information we observed was that the amateur drivers lost more sweat in the race car as compared to the professional drivers. Initially, this was interesting because the temperature inside the cockpit was the same for both professional and amateur drivers and we

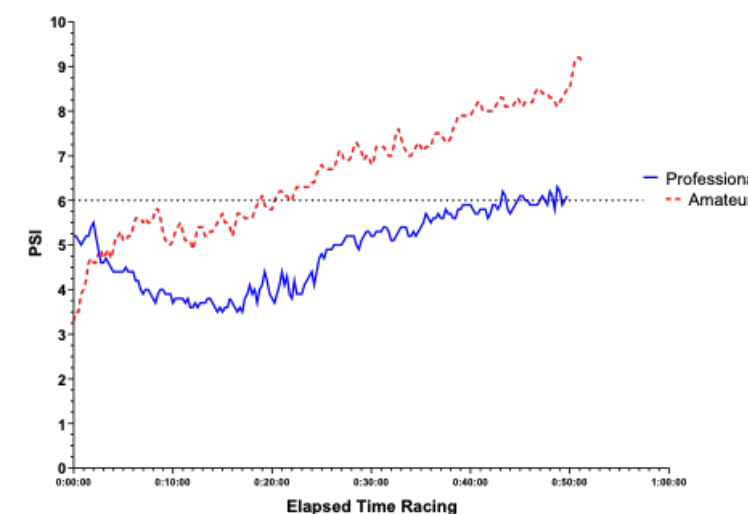


Over the course of a driving stint, the amateur driver had a larger increase in lap time as compared to the professional drivers. The data is presented as difference in lap time as compared to the optimal lap time on new warm tires.

would not expect such a drastic difference in sweat loss. However, what we discovered was that the amateur drivers did not consume fluid during the driving stint, while the professionals would consume 1 liter of fluid per hour.

When we integrated all the data together to calculate physiological strain index (PSI), we observed that the amateur drivers were more “strained” than the professional drivers. It is important to note that a PSI above 6 is considered the point at which performance loss occurs. For half the driving stint the amateurs will be above a PSI of 6, while the professionals remained below 6. The PSI response of the amateur drivers correlated with the increase in lap time.

In conclusion, our study showed that amateur drivers have a decreased ability to elicit skeletal muscle force production and do not consume fluid during driving stints. These observations result in amateur drivers having a higher physiological strain index (PSI) due to fatigue from the gravitational forces



The amateur drivers had a higher Physiological Strain Index (PSI) as compared to the professionals. Additionally, the amateur drivers exceeded a PSI of 6 which is associated with a loss in performance.

and cockpit temperatures that occur during racing. The manifestation of such fatigue increased the lap time of the amateur drivers.

The information gained from this study was crucial in helping us develop training plans for amateur drivers. Specifically, we instituted an educational session before deploying any fitness training. Many amateur drivers come from “sprint races” that are less than 30 minutes in length (not crucial to consume fluids) which means they do not get accustomed to drinking in the car. This behavior becomes detrimental once drivers begin competing in longer races. Therefore, we educated drivers on the importance of drinking during a race and encourage the race team to equip their vehicle with an easy to use drinking system.

While drivers must be cardiovascular fit and strong to be successful on track, our data indicates that amateur drivers have impairment in skeletal muscle strength, therefore, an initial fitness program should

prioritize strength development and power output. We recommend building strength based on the gravitational forces experienced by the driver, once the driver can efficiently resist those forces the fitness program can be expanded to include cardiovascular and other forms of training.

The amateur drivers in our study were receptive to the education/training plan and consistently engaged in the program. Over the last four years the on-track performance improved and in 2021 the amateur drivers that were in our study won their class at the 24 hours of Daytona. The ability to correlate physiological responses to racing with on track success is critical. Our study is one of 35 studies on race car driver physiology. In comparison there are 400 studies published each year on football players (American Soccer). The paucity of information on race car drivers is alarming because it limits the ability to develop evidence-based protocols to improve performance and safety. While our study has several limitations, such as small sample size, the ability to develop effective protocols based on driver physiology data is important and we encourage others in the field to continue to publish papers related to driver physiology. Our full study can be found in the 2020 issue of Research Quarterly for Exercise and Sport, with the citation being:

S. C. Barthel, T. M. Buckingham, C. E. Haft, J. E. Bechtolsheimer, T. A. Bechtolsheimer & D. P. Ferguson (2020): A Comparison of the Physiological Responses in Professional and Amateur Sports Car Racing Drivers, Research Quarterly for Exercise and Sport, DOI: 10.1080/02701367.2019.1690120

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