Institution: Hartpury University		
Unit of Assessment: Sport and Exercise Sciences, Leisure and Tourism		
Title of case study: Improving performance and welfare for sport and race horses		
Period when the underpinning research was undertaken: 2014 - 2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Dr Kathryn Nankervis	Associate Professor	1999 to present
Dr Gillian Tabor	Senior Lecturer (Research)	2013 to present
Dr Jane Williams	Associate Professor	2015 to present
Dr John Fernandes	Lecturer (Research)	2017 to present
Period when the claimed impact occurred: 2014 to 2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

Equestrian sports, horseracing and leisure riding are popular worldwide. Water treadmill and physiotherapy interventions are increasingly being used within sport horse management to maintain musculoskeletal health, increasing competitive success and extending career longevity, however little standard guidance exists to inform their effective use. Research at Hartpury combined with over 15 years of practice, have been combined to develop evidence-based standards and guidance, which are informing industry practice. The standards and guidance are endorsed and promoted by international governing bodies for therapists and equestrian sports in the UK, and across the world. The application of this research has improved outcomes for equine athletes within British Equestrian's World-Class Programme leading to Olympic medal success, and informs the training of hundreds of sport horses and racehorses worldwide on a daily basis.

2. Underpinning research

Hartpury's Equine Therapy Centre has a long-standing reputation for providing high quality training and rehabilitation of sport and race horses and implementing innovative approaches that advance sector practice, in the UK and internationally. This case study identifies two areas of research, which have had a direct impact on guidance and practice: the use of water treadmill exercise and application of objective measures in veterinary physiotherapy within sport and racehorse management and training.

2.1 Equine Water Treadmill practice

Worldwide, there has been a dramatic increase in the use of equine water treadmills within the last 25 years but a global understanding of good practice guiding usage has been lacking. Hartpury installed the UK's first 'ground level' water treadmill in 1999. This unique design allowed the user to alter water depth within and between exercise sessions, which provided flexibility in designing and researching potential benefits of exercise protocols to improve sport horse performance and rehabilitation outcomes. Drawing on experience and research, Dr Nankervis and colleagues developed internal best practice guidelines that were implemented successfully across elite sport and racehorse clients, including within the training programmes of GBR Olympic Gold medallists in individual and team dressage prior to the London 2012 and Rio 2016 games.

An international survey was funded by the British Equestrian Federation's UK Sport Lottery supported World Class Programme to identify how existing users were employing water treadmill exercise for training and rehabilitation of sport horses. The results revealed a high number of relatively 'new' venues offering water treadmill exercise commercially, over a third of venues had less than 12 months experience with no formal training available for water treadmill operators [3.1]. The research also found that new users tended to experiment with the full capabilities of their water treadmills, combining high water with high speed [3.1], often with an incline. The research findings recognised this practice would be, at best, unlikely to

improve performance and could actually lead to unnecessary injury. An urgent need for the development and dissemination of best practice guidelines for water treadmill use was therefore evident.

The next step was a detailed study looking closely at differing practice. It compared the range of movement of the forelimbs and hindlimbs on a normal treadmill at 1.6 m/s with a water treadmill at 0.8 m/s (i.e. 'slow' treadmill belt speed) [3.2]. This study showed significant decreases in forelimb range of movement and significant increases in hindlimb range of movement as water depth increased. The range of movement of the forelimb on the water treadmill was significantly lower, and the range of movement of the hindlimb was significantly higher than on the normal treadmill. This information supported the need to exercise horses more slowly in water than at typical speeds used overland, to minimise the effects of drag on the forelimb and maximise the potential benefits for increased range of movement of the hindlimb [3.2]. This evidence established that '*slow*' exercise on water treadmills was beneficial for performance.

A further empirical study examined the effects of water depth on the movement of the back [3.3]. This study showed that water at a depth of the horse's knee (i.e., '*low*') was optimal for gaining lumbar flexion (desirable in sport horses) whilst avoiding extension in the thoracic spine (undesirable in sport horses). The conclusion was that high water (i.e., water above the level of the horse's knee) should be avoided for horses with 'kissing spines', a common back disorder in sport horses. The final step towards producing best practice guidelines was a review collating existing evidence [3.4], including findings from 3.2 and 3.3, to inform recommendations for the effective use of both treadmills and water treadmills within the training and rehabilitation of sport horses. In response to industry need [3.1] the 'Equine Water Treadmill Exercise: A Guide for Users' was released in 2020, which was informed by the existing evidence base [3.2, 3.3] and supported by experience in practice [3.4].

2.2 Outcome measures for Equine rehabilitation

Physiotherapy professional standards of practice state clinical reasoning and evidence-based practice should be used when selecting appropriate measures and tests for the assessment of neuro-musculoskeletal health, to promote sports performance, prevent injury, and to assess progress in rehabilitation programmes. In animal physiotherapy, no guidelines were available to assist practitioners with this approach in their practice.

Building on the approach used to develop the water treadmill guidelines, the Equestrian Performance Research Centre has led research to develop evidence-informed physiotherapy practice for use in the management and rehabilitation of sport and racehorses. To assess athlete status, physiotherapists should use objective, standardised and validated outcome measures. We surveyed animal physiotherapists to see if this approach was implemented in their practice in sport and leisure horses, and dogs. The results found this was not the case and that practitioners often used subjective assessment methods and outcome measures. We identified that limited outcome measures existed, which are time-efficient, inexpensive, and easy to use in practice and an urgent need for the development of clinical guidelines to support practice [3.5].

To understand what was required from the equine physiotherapy and rehabilitation industry specifically, consensus was gathered from experienced practitioners actively engaged in the management of sport horse health and performance across the world, including veterinarians, physiotherapists and equine researchers using a Delphi process [3.6]. This process agreed areas of assessment deemed essential to include in individual outcome measures, providing a basis for clinical assessment guidelines for horses and dogs engaged in sport. The reliability and validity of specific outcome measures have been supported by further studies undertaken at Hartpury. In 2020, this body of work underpinned the production of equine and canine assessment clinical guidelines validated by the Association of Chartered Physical and Animal Therapists (ACPAT) for use in practice, in competitive and companion animals.

3. References to the research

3.1. Tranquille, C.A., Tacey, J.B., Walker, V.A., **Nankervis, K.J.** and Murray, R.C., 2018. International Survey of Equine Water Treadmills - Why, When, and How? *Journal of Equine Veterinary Science*, *69*, pp.34-42. DOI: 10.1016/j.jevs.2018.05.220

3.2. **Nankervis, K.J.** and Lefrancois, K., 2018. A comparison of protraction-retraction of the distal limb during treadmill and water treadmill walking in horses. *Journal of Equine Veterinary Science*, *70*, pp.57-62. DOI: 10.1016/j.jevs.2018.08.005

3.3. **Nankervis, K.J.**, Finney, P. and Launder, L. (2015) Water depth modifies back kinematics of horses during water treadmill exercise. *Equine Veterinary Journal,* 48 (6) pp.732-736. DOI: 10.1111/evj.12519

3.4. **Nankervis**, K.J, Launder, E.J. and Murray, R.C. (2017) The use of treadmills within the rehabilitation of horses. *Journal of Equine Veterinary Science,* 53: pp.108-115. DOI: 10.1016/j.jevs.2017.01.010

3.5. **Tabor, G**., **Nankervis, K., Fernandes, J. and Williams, J**. 2020. Generation of domains for the equine musculoskeletal rehabilitation outcome score: Development by expert consensus. *Animals,* 10 (20): pp.203-217. DOI: 10.3390/ani10020203

3.6 Shakeshaft, A. and **Tabor, G.**, 2020. The Effect of a Physiotherapy Intervention on Thoracolumbar Posture in Horses. *Animals*, 10(11), pp.1977. DOI: 10.3390/ani10111977

4. Details of the impact

Hartpury's research presented in this case study has had a positive impact on the management and training of sport and race horses in three ways: developing best practice across industry, promoting success in equestrian sport, and through education and research-led teaching.

4.1 Developing best practice

Equine water treadmill practice: Hartpury combined with national and international partners from the UK, Germany, the Netherlands, Belgium, North America and China to establish The Hydrotherapy Working Group in 2019. The group consists of researchers, commercial equine hydrotherapy centres, equine veterinary surgeons and physiotherapists from the UK, Germany, the Netherlands, Belgium, North America and China. This group developed guidelines for water treadmill use, underpinned by Hartpury research, 'Equine Water Treadmill Exercise – A Guide for Users' with Nankervis as corresponding author [5.1]. These guidelines detail how water treadmills should, and should not be used, in the management and rehabilitation of sport horses. The guidelines are endorsed by British Equestrian and inform the use of water treadmills for horses on the British Equestrian World Class Programme [5.2], as well as being adopted as standard practice across equine therapy centres around the world [5.3].

In 2020, the Institute of Registered Veterinary and Animal Physiotherapists established an 'Institute of Equine Hydrotherapists' to set the standards for professionalism and clinical proficiency in equine hydrotherapy. The Institute advocate the use of the Hartpury guidelines as standard practice across the industry [5.3]. Practitioners recognise the value of applying our research-informed approach to their own practice, and use this the research to design protocols based on the '*low and slow'* methodology to generate a positive impact on horse health, performance and welfare [5.3]:

"*The research work has helped me educate staff with clear procedure guidelines, avoiding unnecessary injuries and getting the best results I can for my horses.*"

Grainne Ni Chaba-Byrne, Chair of the Institute of Equine Hydrotherapists [5.4].

Additionally the research [3.1-3.4] has been used to advise individual water treadmill users including leading racehorse trainers (e.g. Lucinda Russell), sports horse rehabilitation centres (e.g. Ivy Lodge, Northern Ireland and AK Equestrian, Netherlands), and major sport and race horse training venues (e.g. Conghua Training and Rehabilitation Centre, China). The research has also positively influenced how water treadmill manufacturers (Idots Aquatrainer, FMBs Therapy Systems, ECB Equine, Aqua Equine Treadmill Ltd.) support their clients to apply an evidence-informed approach to water treadmill use in practice:

"Our commercial customers are putting between 8 and 22 horses through their treadmills daily. The research work has helped my customers use their machines more effectively and safely. The 'Guide for Users' researched and published by Dr Kathryn Nankervis and Hartpury is included now in our handbook for all our customers."

(Serena Hickson, Managing Director FMBs Therapy systems [5.5]).

Supporting clinicians (veterinary surgeons and animal physiotherapists) in the management of sport and race horses: The research on outcomes measures has been used to assist veterinary surgeons' clinical decision-making informally individually, and formally via British Equine Veterinary Association CPD [5.3]. The equine water treadmill guidelines were also circulated to all UK equine veterinary surgeons via the British Equine Veterinary Association website to inform referral, and are supported by leading clinicians who use these with clients to enhance performance and within rehabilitation [5.3]. The video abstract for paper 3.3, explaining why high water should not be used for horses with back pain, or for dressage horses, is the most frequently viewed Equine Veterinary Journal video abstract: https://vimeo.com/267791535 (over 2,500 views).

*Evidence-based Assessment Guidelines for Equine Physiotherapy***:** In 2020, a working group consisting of experts from ACPAT and Hartpury researchers (Tabor and Allen) compiled physiotherapy clinical guidelines based on current best practice evidence and Hartpury research for use in the assessment of neuromuscular health and performance in horses and dogs. The UK national professional group for animal physiotherapists, ACPAT, recommend that the clinical guidelines are adopted in practice by all those involved in musculoskeletal care of sporting, leisure and companion animals including physiotherapists, veterinary surgeons and therapists [5.6]. The guidelines and underpinning studies have been disseminated via publications and meetings to international physiotherapy practitioner groups including the Danish and the Canadian Physiotherapy groups and the Australian Physiotherapy Association Animal group [5.7].

4.2 Supporting Olympic Success in Equestrian Sport

The *'low and slow'* water treadmill exercise protocol used within the Equine Therapy Centre at Hartpury University underpins professional practice in the Centre. In this REF period, hundreds of sport and race horses have been cared for using this protocol resulting in successful return to competition post injury and improved competitive success. In 2014, having achieved a World Record score of 94.3%, Charlotte Dujardin attributed her horse Valegro's fitness to twice weekly water treadmill sessions within the Equine Therapy Centre at Hartpury University [5.2]. The '*low and slow'* protocol we advocate has been applied to the training programmes of British, Irish, and Italian team horses, across dressage and eventing within Hartpury's Equine Therapy Centre, including that of Valegro, winner of Olympic Gold in Individual dressage in Rio 2016. The value of this contribution is recognised by British Equestrian [5.3]:

"The protocols developed as a result of work done by Hartpury University have been of great value in the training of horses on our Podium and Podium Potential Pathways, particularly in the preparation for major international competition, including those aiming for the Tokyo Olympics".

(Dr Robert Oulton, British Equestrian Squad Veterinarian [5.8]).

The much-publicised use of Hartpury's water treadmill enhancing performance within the GBR Dressage gold medal horses [5.6], stimulated widespread uptake of water treadmill exercise for training of elite dressage horses and wider equestrian disciplines:

"The equine water treadmill industry has grown 10-fold over the last 5-6 years. I truly believe this is down to new research coming out proving that water treadmills are not only a tool to be used for rehabilitation work post injury but also are very effective to support training with horses and ponies from many disciplines improving performance"

(Serena Hickson of FMBs Therapy Systems [5.5)].

4.3 Education and research-led training

Hartpury University is one of only two universities that runs an MSc programme for Chartered Physiotherapists who want to qualify as an animal physiotherapist, accredited by the Chartered Society of Physiotherapists. Successful completion enables registration as a professional practitioner with ACPAT and the Register of Animal Musculoskeletal Practitioners. The research presented across this case study is embedded into delivery, supporting the development of sound clinical reasoning and best practice approaches in equine therapy and rehabilitation, which students take with them into professional practice [5.9]. It is also integrated into animal and equine programmes across Level 3 to 7 (28 programmes; ~ 1000 students), enabling these students to enter the equestrian industry with a foundation of best practice in the management and training of sport and race horses. Our research also underpins equine hydrotherapy training courses around the world [5.10]:

"Based on the studies that Dr Nankervis conducted, we created an underwater treadmill course (the Aquatrainer Academy) for professional horse people in the Netherlands. The goals of this course are to increase the quality of the exercise on the treadmill, decrease the risks and increase the welfare of the horse".

(Morgan Lashley, Aquatrainer Academy, Netherlands [5.10]).

5. Sources to corroborate the impact

5.1: Equine Water Treadmill Exercise: A Guide for Users
5.2: Application of equine water treadmill research and protocols within British Equestrian and World Class and Podium Athletes
5.3: Examples of global endorsement of the Equine Water Treadmill Guidelines from the veterinary and equestrian industry
5.4: Testimonial Grainne Ni Chaba-Byrne, Chair of the Institute of Equine Hydrotherapists:
5.5: Testimonial Serena Hickson, FMBs Therapy Systems, United Kingdom
5.5: British Equine Veterinary Association Education Podcast:
https://equineveterinaryeducation.podbean.com/e/eve-podcast-no-24-september-2020-routine-equine-physiotherapy/
5.6: Testimonial Hannah Olivcer-Byrne, Chair, ACPAT, United Kingdom
5.7: Testimonial Lynne Harrison, Chair Animal Physiotherapy Group, Australian Physiotherapy Association
5.8 Testimonial Dr Robert Oulton, Team Veterinarian for the Para-Equestrian Dressage Team and Senior Veterinarian at Scott Dunn's Equine Clinic for British Equestrian, United Kingdom
5.9 Testimonial Suzanne Cottriall, Co-ordinator PgDip and MSc Veterinary Physiotherapy, University of Liverpool, United Kingdom
5.10 Testimonial Morgan Lashley DVM, Certified Equine Chiropractor, The Netherlands