



June 27, 2016

Anke Santens
Elf-Novemberlaan 4
8570 Vichte (Belgium)

RE: Anke Santens v. AG

EXPERT OPINION OF PROF. MICHAEL FREEMAN

Dear Sir or Madam,

I am been requested by Anke Santens to provide an expert opinion regarding a number of questions pertaining to her legal action.

My qualifications to provide opinions concerning the matters herein, particularly on issues of the causal relationship between trauma and injury, are as follows:

I am a doctor of medicine and an epidemiologist, and my fields of expertise are forensic medicine and forensic epidemiology, directed at the assessment of causation. For crash related causation assessments I have additional qualifications in the fields of crash reconstruction and injury biomechanics. I hold the following academic degrees: doctor of medicine (Med.Dr.), doctor of philosophy (Ph.D.) in epidemiology, doctor of chiropractic, master of public health (epidemiology and biostatistics), and bachelor of science in general science. In addition to my degreed education, I have completed a 2-year post-doctoral fellowship in forensic pathology at Umeå University in Sweden, and am a fellow of the pathology section of the American Academy of Forensic Sciences.

I serve as an Associate Professor of Forensic Epidemiology at Maastricht University, and a full Affiliate Professor of Epidemiology and Psychiatry at Oregon Health and Science University School of Medicine, in the Departments of Public Health and Preventive Medicine and Psychiatry, where I have taught courses for the past 15 years in forensic medicine, forensic epidemiology, and injury epidemiology. I also hold an appointment as an Adjunct Professor of Forensic Medicine and Epidemiology at the Institute of Forensic Medicine, Faculty of Health Sciences, Aarhus University, Aarhus, Denmark.

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I have been a crash reconstructionist since 1996, and have had ACTAR accreditation (the Accreditation Commission on Traffic Accident Reconstruction) since 2005. Over the past 20 years I have participated in the reconstruction of more than 2,000 crashes, including more than 300 fatalities. Since 1999 I have served as a vehicular homicide investigator for law enforcement (consultant to the state medical examiner and special deputy sheriff), and I am currently an affiliate medical examiner with the Allegheny County Medical Examiner's office.

I have more than 30 scientific publications pertaining to injury biomechanics, including a book for the Society of Automotive Engineering, and have taught injury biomechanics in a faculty peer-reviewed course at OHSU for the past 15 years. I have served as a consultant on injury biomechanics to state and federal government.

I serve as an associate editor or editorial board member of *OA Epidemiology*, the *Journal of Forensic Biomechanics*, *The Spine Journal*, *PM&R*, (the journal of the American Academy of Physical Medicine and Rehabilitation), the *Scandinavian Journal of Forensic Medicine*, the *International Research Journal of Medicine and Medical Sciences*, the *Egyptian Journal of Forensic Sciences*, the *Journal of Case Reports in Practice*, the *Austin Journal of Public Health & Epidemiology*, and the *Edorium Journal of Public Health*. I was the co-founder and co-editor in chief of the *Journal of Whiplash and Related Disorders*. I have published more than 170 scientific papers, abstracts, book chapters and books on topics that include traffic crash injuries, crash reconstruction, injury causation and injury biomechanics.

Relevant to the subject matter of this report, I have published a number of research articles, abstracts, and conference proceedings on the topic of post-traumatic spine pain, in particular, what is commonly called "whiplash" injury. My Ph.D. thesis was on chronic pain following whiplash trauma (1997). In the appendix of this report are a list of my peer-reviewed journal articles, books, thesis, and other publications on the topic of whiplash injury (>60). Further, I have served as the scientific chair and co-organizer of 6 international meetings on whiplash trauma (the International Whiplash Trauma Congress). The IWTC is the longest running medical and scientific educational program on whiplash in existence.

I have provided testimony in more than 300 civil and criminal trials in state and Federal courts throughout the United States, Canada, Australia, and in Sweden. Please see my CV for further details.

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Background facts

My understanding of the circumstances of the subject 2010 collision are as follows: Ms. Santens was traveling at approximately 50 km/h and a truck towing a trailer with a load of metal plates traveling in the opposite direction at approximately the same speed lost its load, resulting in some of the plates striking the left side and front of Ms. Santens' vehicle. She lost consciousness during the collision sequence, likely due to an impact between her head and the hard vehicle interior structures adjacent to her left (*i.e.* the window, window frame, B-pillar, seat belt guide).

It is my understanding that there is a dispute about whether or not the subject collision was the cause of Ms. Santens' post-crash symptoms, need for treatment, disability, and functional impairment.

In the following section of this report I have duplicated your questions in ***bold***, and provided a response below.

- 1. Both court experts concluded that whiplash leads to a 100 % disability for 1 week, 75 % disability for 2 weeks, 50 % disability for 2 weeks, 25 % disability for 2 weeks, 10 % disability for 2 weeks, 8 % disability for 9 months, a permanent disability of 3 % for whiplash and a permanent disability of 3 % for PTSD. Basically this implies I would have been fit for a part time job 3 weeks after the accident and fit for a full time job 2 months after the accident. Do you agree with both court experts that this is the typical evolution of a whiplash injury? Do you agree that a whiplash injury results in 3% disability / work incapacity?***

Response: The numbers cited by the Court experts are puzzling to me for several reasons. The first is that the injury described in the materials that I have reviewed is not a classic "whiplash" injury but rather a concussion secondary to a head impact inside the vehicle, with residual effects of a traumatic brain injury (TBI). The second reason is that the % of disability ranges given above do not have any basis in any scientific study that I have ever heard of. There have been more than 200 published scientific studies of long-term effects after whiplash trauma, including several of my own, and none of them reliably establish any assignment of disability at certain times that could be used as described above.

Further, if the experts are claiming that 3% of people are permanently disabled after whiplash trauma, then this means that 3 out of 100 people still cannot work after at least 1 year. Quite clearly, Ms. Santens is one of the 3 who are still disabled after a year (after 6 years, in fact).

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Statistics are never used to deny an observation, as rare events are no less real than common ones.

2. All court experts concluded that a whiplash / PTSD injury is fully healed after 1 year. The court experts claim causality between a low speed accident and long term injuries/symptoms can not be proven. Do you agree with the court experts?

Discussion: No, I do not agree because this assertion is contrary to the known science on the prognosis of whiplash injury. The most recent effort to study the recovery rate of injury following whiplash was published in 2010, and included a review of more than 200 papers on the recovery rate following whiplash injury.¹ The authors of the review stated:

"We found 226 articles related to course and prognostic factors in neck pain and its associated disorders.... the evidence suggests that approximately 50% of those with WAD (whiplash injury) will report neck pain symptoms 1 year after their injuries. Greater initial pain, more symptoms, and greater initial disability predicted slower recovery. Few factors related to the collision itself (for example, direction of the collision, headrest type) were prognostic..."

Clearly the court experts are incorrect in their assertion that injuries associated with whiplash trauma do not know become persisting injuries. Moreover, the claim that only 3% of injuries become permanent is flat wrong, and contradicted by virtually every prognosis study every published on the topic.

With regard to the prognosis of PTSD, I am unaware of any legitimate published research that sets a timeframe by when the condition must be considered resolved, and certainly nothing has ever been published that indicates that PTSD resolved in all cases after 1 year. This is also flat wrong.

3. All court experts deny that a whiplash injury can lead to a 100 % work incapacity. They call it a 'ridiculous injury' and they call the 100 % work incapacity we claim a 'ridiculous claim'. Do you agree?

Discussion: Again, I am puzzled by such a claim, which is obviously false and has no basis in any science or medicine. Disability is assessed individually, and never as the result of an assertion that recovery is "expected" for a particular injury. I'm not clear what would be "ridiculous" about

¹ Carroll LJ et al.. Course and prognostic factors for neck pain in whiplash-associated disorders (WAD): results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. J Manipulative Physiol Ther. 2009 Feb;32(2 Suppl):S97-S107.

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documenting that a patient cannot return to their normal duties after an injury. Such a patient would be identified by their actual status as determined by examination and functional capacity evaluation, not from a population-based statistic that has no applicability to an individual.

4. All court experts rule out the possibility that TBI can occur during a whiplash injury. The court experts claim causality between a low speed accident and TBI cannot be proven. Do you agree?

Discussion: Again I would point out that Ms. Santens' TBI was not caused by a "whiplash" trauma but rather by direct contact during the collision, which is clear from the biomechanical features of the collision. The court experts may not understand the biomechanical implications of your collision and what would have happened to your head during the collision sequence.

5. All court experts rule out the possibility that a spinal injury can occur during a whiplash injury. The court experts claim causality between a low speed accident and a spinal injury cannot be proven. Do you agree?

Discussion: No, I do not agree, and in fact, the assertion is rather absurd, given the thousands of publications on the topic of whiplash-related spinal injury, a topic on which I have published dozens of times in the scientific literature (see the list of publications in the Appendix of this report). Simply saying something does not make it so in the world of science.

6. All court experts state no structural brain injuries on MRI means there are no brain injuries at all. Do you agree?

Discussion: No, I do not agree, and the claim is contradicted by the literature on traumatic brain injury and the sensitivity of MRI to detect such injuries, going back to the 1990's, in fact.^{2,3,4} The lack of a positive MRI has virtually no meaning at all in the diagnosis of TBI, just as the lack of a fracture on an x-ray does not prove that a patient does not have back pain.

² Shenton ME et al. A review of magnetic resonance imaging and diffusion tensor imaging findings in mild traumatic brain injury. *Brain Imaging Behav.* 2012 Jun;6(2):137-92.

³ Bazarian JJ et al. DTI detects clinically important axonal damage after mild TBI: a pilot study. *J Neurotrauma.* 2007;24(9):1447–1459

⁴ Mittl RL et al. Prevalence of MR evidence of diffuse axonal injury in patients with mild head injury and normal head CT findings. *AJNR Am J Neuroradiol.* 1994;15(8):1583–1589.

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7. *We claim my headaches (unbearable for over 4 years; lessened when neurofeedback therapy started; never had a headache in my life before the accident) are a typical symptom of whiplash with TBI. The court experts claim causality between a low speed accident and headaches cannot be proven. Do you agree?*

Discussion: No, I do not agree. Headaches are the second most common feature of whiplash injury, after neck pain and stiffness. The topic has been studied extensively, and a search of the world's largest scientific publication database (called "Pubmed") using the terms "whiplash" and "headache" yielded 313 papers. Clearly, the court experts are unaware of what the scientific consensus is on the topic of post-traumatic headache and whiplash, as their conclusions are the opposite of what the science indicates. As far as the methodology for assessing cause and effect relationships in a medico-legal environment, see my answer below.

8. *The court concluded that 'causality can not be proven as the victim does not exactly remember the circumstances of the accident'. Do you agree?*

Discussion: No, I cannot agree with this conclusion. Peri-traumatic amnesia is a feature of concussion and it is reasonable for a concussed person to have an unclear recollection of some events. This in no way means that the injury did not occur.

A crash-related injury causation analysis for a specific individual is performed by assessing the risk of injury from the collision and comparing it to the probability that the injuries or conditions would have been present at the same point in time if the collision had not occurred. This is called a relative or comparative risk analysis, and also known as a "differential etiology" approach to causation, in which the single most probable cause is selected among all competing causes. The analysis is accomplished via the application of crash reconstruction, biomechanical, medical, and epidemiologic (risk assessment) principles.^{5,6,7,8} The methodology for assessing causation of spinal disk injury, chronic whiplash injury, and head injury following traffic crashes has been described in the peer-reviewed literature for many years.^{9,10,11}

⁵ Freeman MD, Zeegers M. Principles and applications of forensic epidemiology in the medicolegal setting. *Law, Probability, & Risk* 2015; doi:10.1093/lpr/mgv010.

⁶ Koehler S, Freeman MD. Forensic epidemiology; a methodology for investigating and quantifying specific causation. *Forens Sci Med Path* 2014 Jun;10(2):217-22

⁷ Freeman MD. Medicolegal causation analysis of a lumbar spine fracture following a low speed rear impact traffic crash. *J Case Rep Prac* 2015; 3(2): 23-29.

⁸ Freeman MD, Kohles SS. An Evaluation of Applied Biomechanics as an adjunct to systematic specific causation in forensic medicine. *Wien Med Wochenschr* 2011;161:1-11.

⁹ Freeman MD, Centeno CJ, Kohles SS. A systematic approach to clinical determinations of causation in symptomatic spinal disc injury following motor vehicle crash trauma. *PM R* 2009;1(10):951-6..

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The three fundamental elements of an injury causation analysis are as follows:

- 1) Whether the injury mechanism had the potential to cause the injury in question;
- 2) The degree of temporal proximity between the injury mechanism and the onset of the symptoms reasonably indicating the presence of the injury; and
- 3) Whether there is a more likely alternative explanation for the occurrence of the symptoms at the same point in time.

It is my understanding that Ms. Santens enjoyed normal health and was physically active prior to the subject 2010 collision events. It is unreasonable for the court experts or any other expert to suggest that she would have been completely disabled in the absence of the traumatic events induced by the crash, regardless of how rare the outcome may be deemed.

9. *I did not have visual wounds / bleeding on or from my head. The court experts conclude there can be no brain injury without a visible wound or head impact. Do you agree?*

Discussion: There is no such requirement. Concussion/ mild TBI can occur in the complete absence of head contact, and merely as a result of whipping motion of the head and its contents that can occur in some collisions. There is no scientific, medical, factual, or logical basis for the court experts to assert to the contrary.

The preceding opinions were given as reasonable medical and scientific certainties, and I certify them on my honor and conscience.

Very truly yours,



¹⁰ Freeman MD, Kohles SS. Application of the Bradford-Hill Criteria for Assessing Specific Causation in Post-Traumatic Headache. *Brain Inj Prof* 2011;8(1):26-8.

¹¹ Freeman MD, Kohles SS. Scientific and Legal Criteria for Evaluating Injury Causation Following Whiplash Trauma. *J Rehab Medicine* 2011;Suppl 50:20.

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Prof. Michael D. Freeman

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Department of Psychiatry, Oregon Health & Science University School of Medicine

Department of Forensic Medicine, Aarhus University

Appendix

Publications by Michael D Freeman pertaining to whiplash trauma and associated injury

1. **Freeman MD**. Medicolegal causation analysis of a lumbar spine fracture following a low speed rear impact traffic crash. *J Case Rep Prac* 2015; 3(2): 23-29.
2. Uhrenholt L, **Freeman MD**, Webb A, Pedersen M, Thorup-Boel LW. Fatal subarachnoid hemorrhage associated with internal carotid artery dissection resulting from whiplash trauma. *Forens Sci Med Path* 2015;11(4):564-9.
3. Westergren H, **Freeman MD**, Malmström E-M. The whiplash enigma: still searching for answers. *Scand J Pain* 2014; <http://dx.doi.org/10.1016/j.sjpain.2014.08.003>.
4. Nystrom NA, Champagne LP, **Freeman MD**, Blix E. Surgical fasciectomy of the trapezius muscle combined with neurolysis of the spinal accessory nerve; results and long-term follow-up in 30 consecutive cases of refractory chronic whiplash syndrome. *J Brachial Plexus and Peripheral Nerve Injury* 2010;5;7.
5. **Freeman MD**, Centeno CJ, Kohles SS. A systematic approach to clinical determinations of causation in symptomatic spinal disc injury following motor vehicle crash trauma. *PM R* 2009;1(10):951-6.
6. **Freeman MD**, Rosa S, Harshfield D, Smith F, Bennett R, Centeno CJ, Kornel E, Nystrom A, Heffez D, Kohles SS. A case-control study of cerebellar tonsillar ectopia and head/neck (whiplash) trauma. *Brain Injury* 2010;24(7-8):988-94.
7. **Freeman MD**, Nystrom A, Centeno C, Hand M. Chronic whiplash and central sensitization; do a trigger points play an important role in pain modulation? *J Brachial Plex Peripher Nerve Inj* 2009 Apr 23;4:2.
8. Centeno CJ, Elkins W, **Freeman M**, Elliott J, Sterling M, Katz E. Total Cervical Translation as a Function of Impact Vector as Measured by Flexion-Extension Radiography *Pain Physician* 2007 Sep;10(5):667-71.
9. Croft AC, **Freeman MD**. Correlating crash severity with injury risk, injury severity, and long-term symptoms in low velocity motor vehicle collisions. *Med Sci Monit* 2005 Oct;11(10):RA316-21. Epub 2005 Sep 26.
10. **Freeman MD**, Croft AC, Nicodemus CN, Centeno CJ, Welkins WL. Significant spinal injury resulting from low-level accelerations: A case series of roller coaster injuries. *Arch Phys Med Rehab* November 2005;86:2126-30.
11. **Freeman MD**, Croft AC, Rossignol AC, Elkins W. Chronic neck pain and whiplash: a case/control study of the relationship between acute whiplash injuries and chronic neck pain. *Pain Res Manag* 2006;11(2):79-83.
12. Centeno CJ, **Freeman MD**, Welkins WL. A review of the literature refuting the concept of minor impact soft tissue injury. *Pain Res Manag* 2005;10(2):71-4.
13. **Freeman MD**, Olson D. Hemifacial tic following a low-speed motor vehicle crash. *J Whiplash Rel Dis* 2004;3(1).
14. Croft AC, Haneline MT, **Freeman MD**. Low speed frontal crashes and low speed rear crashes: is there a differential risk for injury? *Annu Proc Assoc Adv Automot Med.* 2002;46:79-91.

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15. Croft AC, Herring P, **Freeman MD**, Haneline MT: The neck injury criterion (NIC): future considerations. *Accid Anal Prev* 2002;34(2):247-55.
16. **Freeman MD**, Croft AC, Rossignol AM, Weaver DS, Reiser M. A review and methodologic critique of the literature refuting whiplash syndrome. *Spine* 1999;24(1):86-98.
17. **Freeman MD**, Croft AC, Rossignol AM. Whiplash Associated Disorders (WAD) - Redefining Whiplash and its Management" by the Quebec Task Force: A Critical Evaluation. *Spine* 1998;23(9):1043-9.
18. Croft AC, Herring P, **Freeman MD**, Centeno C, Haneline MT, Baric JJ: Late (chronic) whiplash injury. Public health perspectives amidst a controversial literature. *JACA* 40(8):26-32, 2003.
19. **Freeman MD**. The epidemiology of acute and chronic whiplash injury in the U.S. Proceedings of HWS-Distorsion (Schleudetrauma) & Leichte Traumatische, Hirnverletzung. Invaliditat und Berufliche Reintegration. Basel, Switzerland. June 29-30, 2000.
20. **Freeman MD**. Meta-analysis of whiplash prognosis studies. Proceedings of Whiplash 2000, Bath, England. May 16-18, 2000. pp 102-24.
21. **Freeman MD**, Croft AC, Reiser M. Die epidemiologie des Schleudertraumas - wo liegt die Schelle Zur Verletzung? (The epidemiology of whiplash - is there a reliable threshold for whiplash injury?) *HWS-Distortion (Schleudetrauma) & Leichte Traumatische, Hirnverletzung*. Edited by Ettlin TM and Mürner J. June 25-6, 1998:99-118.
22. **Freeman MD**. *A study of chronic neck pain and whiplash injuries*. Thesis for completion of Doctor of Philosophy degree, Oregon State University. *UMI Dissertation services*, Ann Arbor, MI. 1998:9820108.
23. Nordhoff L, **Freeman MD**, Siegmund GP. *Human Subject Crash Testing: Innovations and Advances*. Society of Automotive Engineers, Detroit MI 2007
24. **Freeman MD**. Cervical Sprain and Strain. Medscape. Updated April, 2016. Available at: <http://emedicine.medscape.com/>.
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26. Hunter OK, **Freeman MD**. Cervical Sprain and Strain. eMedicine from WebMD. Updated July 15, 2009. Available at: <http://emedicine.medscape.com/article/306176-overview>.
27. **Freeman MD**. Forensic considerations in the mild traumatic brain injury case. In: Mild
28. **Freeman MD**, Nordoff LS. Crash Injury Thresholds, (Ch. 14) in Nordhoff LS. Motor vehicle collision injuries: Biomechanics, diagnosis & management. Jones and Bartlett Publishing, Boston MA 2005.
29. **Freeman MD**, Croft AC. The Controversy over Late Whiplash: Are Chronic Symptoms after Whiplash Real? in: Whiplash Injuries Edited by M. Szpalski and R. Gunzburg. Lippencott-Raven. September 1997
30. **Freeman MD**. Biomechanical, Mechanical, and Epidemiologic Characteristics of Low Speed Rear Impact Collisions. *Proceedings of 67th Annual Meeting of the American Academy of Forensic Sciences* 2015 Feb 16-21: Orlando, FL. D11:517-8.
31. **Freeman MD**, Uhrenholt L. Investigation of a disputed mechanism of diffuse axonal injury following a low speed frontal crash. *Proceedings of 66th Annual Meeting of the American Academy of Forensic Sciences* 2014 Feb 17-22: Seattle (WA). 1984:367-8.
32. Uhrenholt L, Webb A, Pedersen M, Christensen HW, **Freeman MD**. Does whiplash trauma result in

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somatic injury. *Scand J Forens Med* (2012;18(1):121

33. Uhrenholt L, **Freeman M**. How microscopy can explain traffic crash-related cervical spine injury. 2011. Poster session presented at Årsmøde i Dansk Selskab for Retsmedicin og Dansk Selskab for Ulykkes- og Skadeforebyggelse [The Danish Traffic Medicine Society of the Danish Society for Forensic Medicine] November 3-5, 2011] Grenå, Denmark.
34. Nystrom NA, **Freeman MD**. "Trigger Point" Surgery for Soft Tissue Pain in Chronic Whiplash Syndrome. *J Rehab Medicine* 2011;Suppl 50:27.
35. **Freeman MD**, Kohles SS. Scientific and Legal Criteria for Evaluating Injury Causation Following Whiplash Trauma. *J Rehab Medicine* 2011;Suppl 50:20.
36. **Freeman MD**, Centeno CJ. "Whiplash-Associated Disorders [WAD]" – the persisting lexicon of a failed venture. *J Rehab Medicine* 2011;Suppl 50:6-7
37. Nystrom A, **Freeman MD**. Central sensitization is a reversible response to focal soft-tissue neck pain in chronic whiplash. *2010 American Academy of Orthopedic Surgeons Annual Meeting* March 9-13, 2010, New Orleans, LA.
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55. Centeno CJ, **Freeman M**. Re: Are smooth pursuit eye movements altered in chronic whiplash-associated disorders? A cross-sectional study. *Clin Rehabil* 2008 Apr;22(4):377-8.
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