THE MOST IMPORTAN PUBLICATIONS FOR THE SKIN CONDUCTANCE MONITOR:

REVIEW PAPERS OF CLINICAL UTILITY:

1. Storm H. Changes in Skin Conductance as a tool to monitor nociceptive stimulation and pain. Current Opinion in Anaesthesiology 2008, 21:796–804

VALIDATION OF THE TECHNOLOGY ON VOLENTERS:

1. Gjerstad AC, Storm H, Wallin G. Evaluation of the skin conductance method by using microneurographi, abstract, ISAP, Chicago 06. Presentation sympathetic nervous system

2. Dubé AA, Duquette M, Roy M, Lepore F, Duncan G, Rainville P.
Brain activity associated with the electrodermal reactivity to acute heat pain. Neuroimage 2009 Mar 1;45(1):169-80

3.Burton AR, Birznieks I, Spaak J, Henderson LA, MaceWeld LG. .Effects of deep and superfcial experimentally induced acute pain on skin sympathetic nerve activity in human subjects. Exp Brain Res (2009) 195:317–324

4. Luis R, Storm H. Department of Paediatric Research and Department of Anaesthesiology, The National Hospital, Oslo. Measuring of stress and pain responses on voluntary adult persons after a burning injury by visual analogue scale, blood pressure, heart rate and skin conductance variables, Abstract;IASP 2002.

5. Kunimoto M, Kirno K, Elam M, Karlsson T, Wallin BG. Neuro-effector characteristics of sweat glands in the human hand activated by irregular stimuli. Acta Physiol Scand 1992;146:261-269.

6. Hagbarth KE, Hallin RG, Hongell A, Torebjørk HE, Wallin BG. General Characteristics of sympathetic activity in human skin nerves. Acta Physiol Scand 1971;84:164-176

7. Wallin BG, Sundløf G, Delius W. The effect of carotid sinus nerve stimulations on muscle and skin nerve sympathetic activity in man. Plugers Arch 1975;358:101-110.

8. Macefield VG, Wallin BG. The discharge behaviour of single sympathetic outflow in normotensive human sweat glands. J Auton Nerv Syst 1996;14:277-286.

9. Bini G, Hagbarth KE, Hynninen P, Wallin BG. Thermoregulatory and rythmgenerating mechanisms govering the sudomotor and vasoconstrictor outflow in human cutaneous nerves. J Physiol 1980:306:537-552.

10. Tranel D, Damasio H. Neuroanatomical correlates of electrodermal skin

conductance responses. Psychophysiology 1994;31:427-438.

11. Edelberg R. Electrical properties of the skin. In: Brown CC (eds), Methods in Psychophysiology. Williams & Wilkins, Baltimore, 1967:1-59.

12. Christie MJ. Electrodermal activity in the 1980's: a review. J. R. Soc Med 1981;74:616-22.

13. Fredrikson M, Furmark T, Olsson MA, Fischer H, Andersson J, Långstrom B. Functional neuroanatomical correlates of electrodermal activity: A positron emission tomographic study. Psychophysiology, 35 (1998), 179-185.

14. Patterson JC, Ungerleider LG, Bandettini PA. Task-dependent functional brain activity correlation with skin conductance changes: an fMRI study. NeuroImage 2002, 17, 1797-1806.

DEVELOPMENT OF SOFTWARE PROGRAM:

1. Storm H, Fremming A, Ødegaard S, Martinsen Ø, Mørkrid L. A software analysis program for spontaneous and stimulated skin conductance activity. Clinical Neurophysiology 2000;111:1989-1998.

2. Storm H. The development of a software analysis program for analysing spontaneous skin conductance activity in preterm infants, Clinical Neurophysiology 2001(112):1562-1568.

PAIN AND OTHER STIMULI IN INFANTS AND CHILDREN:

1. Storm H. Skin conductance activity and the stress response from heel stick in premature infants. Archives of Disease in Childhood 2000;83(2):F143-F147.

2. Storm H. Development of emotional sweating in the preterm infant measured by skin conductance, Early Human Development 62(2001)149-158.

3. Hellerud BC, Storm H. Skin conductance and arousal during tactile and nociceptive stimulation in relation to postnatal age of preterm and term infants. Early Human Development 70(2002)35-46.

4. Storm HS, Fremming A. Effectiveness of oral sucrose and food intake on pain response in preterm infants measured by changes in skin conductance activity, heart rate, crying time and behavioural state, Acta Paediatrica Scandinavia 2002(91):555-560.

5. Storm H, Vandvik IH, A pilot study of how spontaneous skin conductance changes may be used as a method to measure the effect of hypnosis. mai 2000, Oslo, poster J. of Psychosomatic Research 2000(48) p 276.

6. Storm H, Østberg BC. A pilot study of spontaneous and stimulated skin conductance changes in a patient suffering from anorexia, foredrag. J. of Psychosomatic Research 2000(48) p 230.

7. Hernes K, Mørkrid L, Fremming A, Ødegaard S, Martinsen Ø, Storm H. Skin conductance activity during the first year of life, Pediatric Research 2002;52(6):837-843.

8. Eriksson M, Storm H, Fremming A, Schollin J. Skin conductance compared to a combined behavioural and physiological pain measure in newborn infants. Acta Paediatrica 2008 Jan;97(1):27-30. Epub 2007 Dec 3. PMID: 18052991 (PubMed)

9. Denise Harrison, Linda Johnston, Suzanne Boyce, Peter Loughnan, Hanne Storm, Peter Dargaville, Skin conductance as a measure of pain and stress in hospitalised infants, Early Human development 2006;82:603-8.

10. Roeggen I, Denise Harrison, Hanne Storm. Skin conductance variability between and within hospitalised infants at rest. Early Hum Dev. 2011 Jan;87(1):37-42. Epub 2010 Oct 30.

11. Kim Kopenhaver Haidet, PhD, CNNP1, Cherie Adkins, PhD(c), RN1, Sarah Rebstock, PhD, MD2, Arash Salavitabar, BS2
Elizabeth J. Susman, PhD1, Sheila G.West, PhD1, Charles Palmer, MB, ChB2, & Hanne Storm3, MD, PhD Measures of Stress Vulnerability in LBW Infants: An Integrative Biobehavioral Approach to Stress Reactivity Measurement, Abstract Gravens conference 2007.

12. Salavitabar A, Haidet K, Adkins C, Palmer C, Storm H. Preterm Infants Physiological and Behavioural responses to sound stimuli in the neonatal Intensive care Units. PAS, Honolulu; 4458- Neonatology, on 5/4/08, 11-3, published Advances in Neonatal Care Febr 2010.

13. Munster JMA, Simonsson L, Sindelar R. Skin conductance (SC) measurements as pain assessment in newborn infants born 22-27 gestational weeks (GW) at different postnatal age. E-PAS2009:5505.77, Early Human Development 88 (2012) 21–26.

14. Luís Pereira-da-Silva [1,2], Ivete Monteiro [1], Sandra Gomes [1], Patrícia Rodrigues [1], Daniel Virella [1], Micaela Serelha [1], Hanne Storm [3] Skin conductance indices discriminate nociceptive responses to acute
stimuli from different heel prick procedures in infants. The Journal of Maternal-Fetal and Neonatal Medicine, 2012; 25(6): 796–801.

15. Rosana Tristão, José Alfredo Lacerda de Jesus, Storm H, Heart rate, oxygen saturation and skin conductance: a comparison study of acute pain in Brazilian newborns. Conf Proc IEEE Eng Med Biol Soc. 2011;2011:1875-9. doi: 10.1109/IEMBS.2011.6090532.

16. N Kandamany, E Hayden, JF Murphy. National Maternity Hospital Holles Street, Dublin, Ireland. ROP Screening and Stress in Preterm Infants. EPAS 2010 Poster.

17. Ham J. Tronick E. A procedure for the measurement of infant skin conductance and its initial validation using clap induced startle. Dev Psycho Biol 2008;50:626-631.

18. Storm H, PAIN ASSESSMENT IN NEONATES, Published by IGI Global http://igi-global.com/AuthorsEditors/AuthorEditorResources/CallForBookChapters/CallForChapterDetails.aspx?CallForContentId=02f37e9d-dfc7-4596-9a47-cadff82a5a9c.

19. Cresi, Castagno, Storm, Silvesto, Minero,Savino COMBINED ESOPHAGEAL INTRALUMINAL IMPEDANCE PH AND SKIN CONDUCTANCE MONITORING TO DETECT DISCOMFORT IN GERD INFANTS" was recently published in *PLOS ONE* and is available online at http://dx.plos.org/10.1371/journal.pone.0043476.

20. Chapter in book. Monitoraggio del dolore postoperatorio nei pazienti pediatrici
M. Astuto, G. Arena, M. Sardo, P. Murabito, H. Storm.
in Govern inico e medicina perioperatoria Springer- Verlag Italia 2012
ISBN 978-88-470o cl
-2792-3 eISBN 978-88-470-2793-30 DOI 10.1007/978-88-470-2793-0

21. Munsters J, Wallström L, Ågren J, Norsted T, Sindelar R. Skin conductance measurements as pain assessment in newborn infants born at 22–27 weeks gestational age at different postnatal age. Early Hum Dev. 2012 Jan;88(1):21-6.

22. Storm H. The Capability of Skin Conductance to Monitor Pain Compared to Other Physiological Pain Assessment Tools in Children and Neonates. Pediat Therapeut 2013, 3:4.

23. Savino F, Vagliano L, Ceratto S, Viviani F, Miniero R, Ricceri F. Pain assessment in children undergoing venipuncture: the Wong–Baker faces scale versus skin conductance fluctuations. PeerJ 2013;1:e37; DOI 10.7717/peerj.37.

24. Rosa T. Scaramuzzo, Maddalena Faraoni, Elisa Polica, Valeria Pagani, Elena Vagli & Antonio Boldrini (2013) Skin conductance variations compared to ABC scale for pain evaluation in newborns, The Journal of Maternal-Fetal & Neonatal Medicine, 26:14, 1399-1403,

25. Macko J1, Moravcikova D, Kantor L, Kotikova M, Humpolicek P. Skin conductance as a marker of pain in infants of different gestational age. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2014 Dec;158(4):591-5. doi: 10.5507/bp.2013.066. Epub 2013 Oct 2.

26. Beken S, Hirfanog IM, Gucuyener K, Ergenekon E, Turan O, Unal S, Altuntas N¸ Kazancı E, Kulal F, Turkyılmaz C, Atalay Y, Cerebral Hemodynamic Changes and Pain Perception During Venipuncture: Is Glucose Really Effective? Journal of Child Neurology 2014, Vol. 29(5) 617-622.

27. Baleine J, Milési C, Mesnage R, Novais ARB, Combes C, Durand S, Cambonie G. Intubation in the delivery room: Experience with nasal midazolam. Early Human Development 90 (2014) 39–43.

28. Karpe J1, Misiołek A, Daszkiewicz A, Misiołek H.Objective assessment of pain-related stress in mechanically ventilated newborns based on skin conductance fluctuations. Anaesthesiol Intensive Ther. 2013 Jul-Sep;45(3):134-7. doi: 10.5603/AIT.2013.0028.

29. Hoffman K1, Bromster T, Hakansson S, van den Berg J. Monitoring of pain and stress in an infant with asphyxia during induced hypothermia: a case report. Adv Neonatal Care. 2013 Aug;13(4):252-61. doi: 10.1097/ANC.0b013e31829d8baf.

30. Tristão RM1, Garcia NV, de Jesus JA, Tomaz C. COMFORT behaviour scale and skin conductance activity: what are they really measuring? Acta Paediatr. 2013 Sep;102(9):e402-6. doi: 10.1111/apa.12325. Epub 2013 Jul 10.

31. Dalal PG1, Doheny KK, Klick L, Britcher S, Rebstock S, Bezinover D, Palmer C, Berlin C, Postula M, Kong L, Janicki PK. Analysis of acute pain scores and skin conductance measurements in infants. Early Hum Dev. 2013 Mar;89(3):153-8. doi: 10.1016/j.earlhumdev.2012.09.008. Epub 2012 Oct 6.

32.. Lene Tandle Lyngstad*, Bente Silnes Tandberg*, Hanne Storm** MD, PhD, Birgitte Lenes Ekeberg*, Atle Moen, MD, PhD*. Does skin-to-skin contact reduce stress during diaper change in preterm infants? Stress during change of diapers in preterm infants and the effect of kangaroo mother care. Early Hum Dev. 2014 Apr;90(4):169-72.

33. José Alfredo Lacerda de Jesus. Hanne Storm Adson Ferreira da Rocha and Rosana Maria Tristão. Skin Conductance and Behavioral Pain Scales in Newborn Infants. Psychology & Neuroscience 2015 American Psychological Association 2015, Vol. 8, No. 2, 203–210.

34. Zeiner V, Storm H, Kopenhaver Doheny K. Preterm Infants' Biological and Behavioral Stress Responses to Nurse Handling in the NICU. J Matern Fetal Neonatal Med. 2015 Oct 6:1-6.

35. Nakstad B, Nordheim T, Hovde H, Storm H. Skin Conductance changes differ between painful stimuli and general hypoxia different from peripheral oxygen saturation. Abstract EAPS 2014.

36. Robin van der Lee1,3,4 & Liesbeth JM Groot Jebbink1 & Thea HM van Herpen2 & Esther J d'Haens1 & Josette Bierhuizen1 & Richard A van Lingen1. Feasibility of monitoring stress using skin conduction measurements during intubation of newborns. Eur J Pediatr (2016) 175:237–243.

37. Christiana N. Oji-Mmuo, Eric J. Michael, Jacqueline McLatchy, Mary M. Lewis, Julie E. Becker, Kim Kopenhaver Doheny (kdoheny@hmc.psu.edu). Skin conductance at baseline and postheel lance reflects sympathetic activation in neonatal opiate withdrawal. Acta Pædiatrica. Published by John Wiley & Sons Ltd 2016 105, pp. e99–e106 e99.

ANAESTHESIA:

1.Storm H, Myre K, Rostrup M, Stokland O, Ræder J. Skin conductance correlates with perioperative stress, Acta Anesthesiol Scand 2002;46:887-895.

2. Storm H, Shafiei M, Myre K, Ræder J. Palmar skin conductance compared to a developed stress score and to noxious and awakening stimuli on patients in anaesthesia. Acta Anaesthesiology Scand 2005:49(6):798-803.

3. E. W. Jensen[1], M. Jospin[1], P. Gambus[2], G. Martinez[2], B. Rodriguez[3], H. Litvan[4]. Monitoring skin conductance during general anaesthesia for detection of nociception. S-206 http://www.iars.org/abstracts/abstracts80.shtm

4. Gjerstad AC, Storm H, Hagen R, Huiku M, Quigstad E, Ræder J. Comparison of Skin Conductance with Entropy during tetanic stimulation, surgery and emergence from general anaesthesia, Acta Anaesthesia Scan 2007; 8-15.

5. Gjerstad AC, Storm H, Hagen R, Huiku M, Qvigstad E, Ræder J. Skin conducatance or entropy for detection of non-noxious stimulation during different clinical levels of sedation. Acta Anaesthesiol Scand 2007;51:1-7.

6. Thomas Ledowski, Hanne Storm et al. Skin conductance monitoring compared with bispectral index monitoring to assess emergence from general anaesthesia using sevoflurane and remifentanil. British Journal of Anaesthesia 2006;97:187-91.

7. Thomas Ledowski, Hanne Storm et al. Skin conductance monitoring compared with Bispectral Index to assess emergence from total i.v. anaesthesia using propofol and remifentanil. British Journal of Aneaesthesia 2006; 97(6):817-821.

8. Røeggen I, Storm H, Raeder J. Will detection of sympathetic activation with sweating and altered skin conductance from noxious stimulation be attenuated by atropine? - a pilot studyof the Pain-detector device. Abstract. International Society for Anaesthetic Pharmacology 2006: Poster 31.

9. Storm H[1], Røeggen I[1], Støen R[2], Qvigstad E[2], Klepstad P[3], Skorpen F[3], Ræder J[2] Rikshospitalet University Hospital[1] and Ullevaal University Hospital[2], University of Oslo, St. Olav Trondheim Regional Hospital, University of Trondheim [3], Norway.
Number of skin conductance fluctuations increased differently from BIS during tetanic stimuli. Increasing doses of remifentanil attenuated the skin conductance response. Abstract and oral presentation. Award for best clinical usability method. Society for technology in Anesthesia, Orlando, Florida jan 2007

10. H Storm*, T Ledowski**, R Støen***, A Fremming*, E Qvigstad***, I I Røeggen* and J Ræder***, *Rikshospitalet University Hospital, Oslo, Norway; **Department of Anaesthesia and Pain Medicine, Royal Perth Hospital, Perth, Australia; ***Ullevål University Hospital**, Oslo, Norway. Do parameters of skin conductance reflect both arousal and noxious stimuli during awakening after total intravenous anesthesia? Abstract, American Society for Anesthesiology, San Francisco, Oct 07.

11. H. Storm1, R. Støen5, P. Klepstad3, F. Skorpen2, E. Qvigstad4 and J. Ræder4 Nociceptive stimuli responses at different levels of general anaesthesia and genetic variability. Acta Anaesthesiol Scand 2013; 57: 89–99

12. Sarbourdin N, Armaou M, Louvet N et al.Pain monitoring in anesthetized children: first assessment of skin conductance and analgesianociception index at different infusion rates

of remifentanil. Pediatr Anesth 2013; 23: 149–155.

13. Storm H. “Pain monitoring in anesthetized children: first assessment of skin conductance and analgesia-nociception index at different infusion rates of remifentanil”, recommended preset values for the skin conductance equipment was not used. Pediatric Anesthesia 23 (2013) 760–763.
14. Nada Sabourdin,Michel Arnaout, Nicolas Louvet, Marie-Laurence Guye, Federica Piana, Isabelle Constant. Response to: PAN-2013-0130 – ‘Pain monitoring in anesthetized children: first assessment of skin conductance and analgesia-nociception index at different infusion rates of remifentanil’, recommended preset values for the skin conductance equipment was not used. Pediatric Anesthesia. 2013 (23);10: 962.

INTENSIVE CARE UNITS:

1. Gjerstad AC, Wagner K, Henrichsen T, Storm H. Skin Conductance Versus the Modified COMFORT Sedation Score as a Measured of Discomfort in Artificially Ventilated Children. Abstract ESA 2002, *Pediatrics* 2008;122;e848-e853.

2. Gunther A, Sackey P, Karolinsk hospital, Storm H. Skin conductance changes in intensive care patients. Critical Care 2013, 17:R51.

3. Solana MJ,Lopez-Herce J, Fernandez S, Gonzalez,R, Urbano J, Lopez J, Bellon JM. Assessment of pain in critically ill children. Is cutaneous conductance a Reliable tool? Journal of Critical Care 30 (2015);481–485.

4. www.kib.ki.se “Skin conductance variability and stressful exposures in critical care” (Thesis from Anders Gunther MD.PhD)

5. Svalebjørg M, Storm H, Olsen RB, Bugge JF. Measurement of skin conductance responses can detect procedural pain in the preoperative setting, Submitted Acta Scand 2016.

6. Gunther A. Hansen JO, Sackey P, Storm H, Bernhardsson J, Sundin Ø, Bjärtå A. Measuring pain – a validation of physiological and self-rated measurements, and an investigation of the relationship between them. Submitted ESICM LIVES 2016.

7. Hansen J.O, Storm H, Boglino-Hörlin A, Le Guen M, Gayat E, Fischler M. Skin conductance as a pain assessment tool during chest tube removal: an observational study. Submitted Eur J Pain 2016.

POSTOPERATIVE PAIN, ADULTS AND CHILDREN

1. Thomas Ledowski, Hanne Storm et al. Monitoring of skin conductance to assess postoperative pain intensity. British Journal of Anaesthesia 2006;97(6):862-5.

2. Ledowski T, Bromilow J, Wu J, Paech MJ, Storm H, Schug SA. The assessment of postoperative pain by monitoring skin conductance: results of a prospective study, Anaesthesia. 2007 Oct;62(10):989-93

3. Hullett B, Chambers N, Preuss J, Zamudio I, Lange J, Pascoe E, Ledowski T, Monitoring Electrical Skin Conductance A Tool for the Assessment of Postoperative Pain in Children? Anesthesiology 2009; 111:513–7

4. Ledowski T, Preuss J, Schug SA. The effects of neostigmine and glycopyrrolate on skin conductance as a measure of pain, Eur J Anaesthesiol. 2009 Sep;26(9):777-81.

5. Strehle EM1, Gray WK. Comparison of skin conductance measurements and subjective pain scores in children with minor injuries. Acta Paediatr. 2013 Nov;102(11):e502-6. doi: 10.1111/apa.12382. Epub 2013 Aug 30

6. Rocco Rago, Paolo Miccoli, Hanne Storm, Francesco Forfori, Francesca Franceschini, Jacopo Belfiore. The Skin Conductance Algesimeter validated with the Numerical Rating Scale Postoperatively in Patients treated with Classical Music. Journal of Anesthesia and Surgery Journal ISSN: 2377-1364; 2015(3):1-5.

CHRONIC PAIN

Semih Gungor, Bhumika Rana, Kara Fields, James J. Bae, Lauren Mount, Valeria Buschiazzo, Hanne Storm. Changes in the skin conductance monitor as an endpoint for sympathetic nerve blocks. Abstract ISAP Nice 2015, submitted paper PainMedicine.

PAIN THRESHOLD

Wallstrom T, Hellgren C, Akerud H, Wiberg-Itzel E. Skin conductance activity in post-term pregnancies. J Matern Fetal Neonatal Med. 2015 Nov;28(16):1912-6.

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