DCS publications on PubMed: July 1, 2021 - December 31, 2021

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Methodology. Searches were made in PubMed constraining the search period between July 1, 2021 and December 31, 2021. These were later processed for readability but no records were otherwise added or removed. In the preparation of this file, the following searches have been executed:

- diffuse correlation spectroscopy

Diffuse correlation spectroscopy beyond the water peak enabled by cross-correlation of the signals from InGaAs/InP single photon detectors.

Robinson M, Renna M, Ozana N, Peruch A, Carp S, Sakadzic S, Blackwell M, Aull B, Richardson J, Franceschini MA.

IEEE Trans Biomed Eng. 2021 Nov 30;PP.

doi: 10.1109/TBME.2021.3131353. Online ahead of print.

OBJECTIVE: Diffuse correlation spectroscopy (DCS) is an optical technique that allows for the non-invasive measurement of blood flow. Recent work has shown that utilizing longer wavelengths beyond the traditional NIR range provides a significant improvement to signal-to-noise ratio (SNR). However, current detectors both sensitive to longer wavelengths and suitable for clinical applications (InGaAs/InP SPADs) suffer from suboptimal afterpulsing and dark noise characteristics. To overcome these barriers, we introduce a cross correlation method to more accurately recover blood flow information using InGaAs/InP SPADs. METHODS: Two InGaAs/InP SPAD detectors were used for during in vitro and in vivo DCS measurements. Cross correlation of the photon streams from each detector was performed to calculate the correlation function. Detector operating parameters were varied to determine parameters which maximized measurement SNR. State-space modeling was performed to determine the detector characteristics at each operating point. RESULTS: Evaluation of detector characteristics was performed across the range of operating conditions. Modeling the effects of the detector noise on the correlation function provided a method to correct the distortion of the correlation curve, yielding accurate recovery of flow information as confirmed by a reference detector. CONCLUSION: Through a combination of cross-correlation of the signals from two detectors, model-based characterization of detector response, and optimization of detector operating parameters, the method allows for the accurate estimation of the true blood flow index. SIGNIFICANCE: This work presents a method by which DCS can be performed at longer NIR wavelengths with existing detector technology, taking advantage of the increased SNR.

Optimization of time domain diffuse correlation spectroscopy parameters for measuring brain blood flow.

Mazumder D, Wu MM, Ozana N, Tamborini D, Franceschini MA, Carp SA.

Neurophotonics. 2021 Jul;8(3):035005.

doi: 10.1117/1.NPh.8.3.035005. Epub 2021 Aug 12.

Significance: Time domain diffuse correlation spectroscopy (TD-DCS) can offer increased sensitivity to cerebral hemodynamics and reduced contamination from extracerebral layers by differentiating photons based on their travel time in tissue. We have developed rigorous simulation and evaluation procedures to determine the optimal time gate parameters for monitoring cerebral perfusion considering instrumentation characteristics and realistic measurement noise. Aim: We simulate TD-DCS cerebral perfusion monitoring performance for different instrument response functions (IRFs) in the presence of realistic experimental noise and evaluate metrics of sensitivity to brain blood flow, signal-to-noise ratio (SNR), and ability to reject the influence of extracerebral blood flow across a variety of time gates to determine optimal operating parameters. Approach: Light propagation was modeled on an MRI-derived human head geometry using Monte Carlo simulations for 765- and 1064-nm excitation wavelengths. We use a virtual probe with a source-detector separation of 1cm placed in the pre-frontal region. Performance metrics described above were evaluated to determine optimal time gate(s) for different IRFs. Validation of simulation noise estimates was done with experiments conducted on an intralipid-based liquid phantom. Results: We find that TD-DCS performance strongly depends on the system IRF. Among Gaussian pulse shapes, 300 ps pulse length appears to offer the best performance, at wide gates (500ps and larger) with start times 400 and 600ps after the peak of the TPSF at 765 and 1064nm, respectively, for a 1-s integration time at photon detection rates seen experimentally (600 kcps at 765nm and 4Mcps at 1064nm). Conclusions: Our work shows that optimal time gates satisfy competing requirements for sufficient sensitivity and sufficient SNR. The achievable performance is further impacted by system IRF with 300 ps quasi-Gaussian pulse obtained using electro-optic laser shaping providing the best results.

Quantification of perfusion and metabolism in an autism mouse model assessed by diffuse correlation spectroscopy and near-infrared spectroscopy.

Rinehart B, Poon CS, Sunar U.

J Biophotonics. 2021 Nov;14(11):e202000454.
doi: 10.1002/jbio.202000454. Epub 2021 Aug 9.

There is a need for quantitative biomarkers for early diagnosis of autism. Cerebral blood flow and oxidative metabolism parameters may show superior contrasts for improved characterization. Diffuse correlation spectroscopy (DCS) has been shown to be reliable method to obtain cerebral blood flow contrast in animals and humans. Thus, in this study, we evaluated the combination of DCS and fNIRS in an established autism mouse model. Our results indicate that autistic group had significantly (P=.001) lower (40%) blood flow (1.16 0.26) 10-8 cm2 /s), and significantly (P=.015) lower (70%) oxidative metabolism (52.4 16.6 mol/100 g/min) compared to control group ([1.93 0.74] 10-8 cm2 /s, 177.2 45.8 mol/100 g/min, respectively). These results suggest that the combination of DCS and fNIRS can provide hemodynamic and metabolic contrasts for in vivo assessment of autism pathological conditions noninvasively.

Diffuse Optical Spectroscopy Assessment of Resting Oxygen Metabolism in the Leg Musculature.

Boebinger SE, Brothers RO, Bong S, Sanders B, McCracken C, Ting LH, Buckley EM.

Metabolites. 2021 Jul 29;11(8):496.
doi: 10.3390/metabo11080496.

We lack reliable methods to continuously assess localized, resting-state muscle activity that are comparable across individuals. Near-infrared spectroscopy (NIRS) provides a low-cost, non-invasive means to assess localized, resting-state muscle oxygen metabolism during venous or arterial occlusions (VO2VO and VO2AO, respectively). However, this technique is not suitable for continuous monitoring, and its utility is limited to those who can tolerate occlusions. Combining NIRS with diffuse correlated spectroscopy (DCS) enables continuous measurement of an index of muscle oxygen metabolism (VO2i). Despite the lack of previous validation, VO2i is employed as a measure of oxygen metabolism in the muscle. Here we characterized measurement repeatability and compared VO2i with VO2VO and VO2AO in the medial gastrocnemius (MG) in 9 healthy adults. Intra-participant repeatability of VO2i, VO2VO, and VO2AO were excellent. VO2i was not significantly correlated with VO2AO (p = 0.15) nor VO2VO (p = 0.55). This lack of correlation suggests that the variability in the calibration coefficient between VO2i and VO2AO/VO2VO in the MG is substantial across participants. Thus, it is preferable to calibrate VO2i prior to every monitoring session. Important future work is needed to compare VO2i against gold standard modalities such as positron emission tomography or magnetic resonance imaging.

Superconducting nanowire single-photon sensing of cerebral blood flow.

Ozana N, Zavriyev AI, Mazumder D, Robinson M, Kaya K, Blackwell M, Carp SA, Franceschini MA.
Neurophotonics. 2021 Jul;8(3):035006.
doi: 10.1117/1.NPh.8.3.035006. Epub 2021 Aug 19.

Significance: The ability of diffuse correlation spectroscopy (DCS) to measure cerebral blood flow (CBF) in humans is hindered by the low signal-to-noise ratio (SNR) of the method. This limits the high acquisition rates needed to resolve dynamic flow changes and to optimally filter out large pulsatile oscillations and prevents the use of large source-detector separations (=3 cm), which are needed to achieve adequate brain sensitivity in most adult subjects. Aim: To substantially improve SNR, we have built a DCS device that operates at 1064nm and uses superconducting nanowire single-photon detectors (SNSPD). Approach: We compared the performances of the SNSPD-DCS in humans with respect to a typical DCS system operating at 850nm and using silicon single-photon avalanche diode detectors. Results: At a 25-mm separation, we detected 136 times more photons and achieved an SNR gain of 168 on the forehead of 11 subjects using the SNSPD-DCS as compared to typical DCS. At this separation, the SNSPD-DCS is able to detect a clean pulsatile flow signal at 20Hz in all subjects. With the SNSPD-DCS, we also performed measurements at 35mm, showing a lower scalp sensitivity of 316% with respect to the 488% scalp sensitivity at 25mm for both the 850 and 1064nm systems. Furthermore, we demonstrated blood flow responses to breath holding and hyperventilation tasks. Conclusions: While current commercial SNSPDs are expensive, bulky, and loud, they may allow for more robust measures of non-invasive cerebral perfusion in an intensive care setting.

Cerebral Blood Flow of the Neonatal Brain after Hypoxic-Ischemic Injury.

Tierradentro-Garca LO(#), Saade-Lemus S(#), Freeman C, Kirschen M, Huang H, Vossough A, Hwang M.
Am J Perinatol. 2021 Jul 5.
doi: 10.1055/s-0041-1731278. Online ahead of print.

OBJECTIVE: Hypoxic-ischemic encephalopathy (HIE) in infants can have long-term adverse neurodevelopmental effects and markedly reduce quality of life. Both the initial hypoperfusion and the subsequent rapid reperfusion can cause deleterious effects in brain tissue. Cerebral blood flow (CBF) assessment in newborns with HIE can help detect abnormalities in brain perfusion to guide therapy and prognosticate patient outcomes. STUDY DESIGN: The review will provide an overview of the pathophysiological implications of CBF derangements in neonatal HIE, current and emerging techniques for CBF quantification, and the potential to utilize CBF as a physiologic target in managing neonates with acute HIE. CONCLUSION: The alterations of CBF in infants during hypoxia-ischemia have been studied by using different neuroimaging techniques, including nitrous oxide and xenon clearance, transcranial Doppler ultrasonography, contrast-enhanced ultrasound, arterial spin labeling MRI, 18F-FDG positron emission tomography, near-infrared spectroscopy (NIRS), functional NIRS, and diffuse correlation spectroscopy. Consensus is lacking regarding the clinical significance of CBF estimations detected by these different modalities. Heterogeneity in the imaging modality used, regional versus global estimations of CBF, time for the scan, and variables impacting brain perfusion and cohort clinical characteristics should be considered when translating the

findings described in the literature to routine practice and implementation of therapeutic interventions. KEY POINTS: Hypoxic ischemic injury in infants can result in adverse long-term neurologic sequelae.. Cerebral blood flow is a useful biomarker in neonatal hypoxic-ischemic injury.. Imaging modality, variables affecting cerebral blood flow, and patient characteristics affect cerebral blood flow assessment..

Impact of cutaneous blood flow on NIR-DCS measures of skeletal muscle blood flow index.

Bartlett MF, Akins JD, Oneglia AP, Brothers RM, Wilkes D, Nelson MD.

J Appl Physiol (1985). 2021 Sep 1;131(3):914-926.

doi: 10.1152/japplphysiol.00337.2021. Epub 2021 Jul 15.

Near-infrared diffuse correlation spectroscopy (NIR-DCS) is an optical technique for estimating relative changes in skeletal muscle perfusion during exercise but may be affected by changes in cutaneous blood flow, as photons emitted by the laser must first pass through the skin. Accordingly, the purpose of this investigation was to examine how increased cutaneous blood flow affects NIR-DCS blood flow index (BFI) at rest and during exercise using a passive whole body heating protocol that increases cutaneous, but not skeletal muscle, perfusion in the uncovered limb. BFI and cutaneous perfusion (laser-Doppler flowmetry) were assessed in 15 healthy young subjects before (e.g., rest) and during 5 min of moderate-intensity handgrip exercise in normothermic conditions and after cutaneous blood flow was elevated via whole body heating. Hyperthermia significantly increased both cutaneous perfusion (7.3-fold; P = 0.001) and NIR-DCS BFI (4.5-fold; P = 0.001). Although relative BFI (i.e., fold-change above baseline) exhibited a typical exponential increase in muscle perfusion during normothermic exercise (2.81 0.95), there was almost no change in BFI during hyperthermic exercise (1.43 0.44). A subset of eight subjects were subsequently treated with intradermal injection of botulinum toxin-A (Botox) to block heating-induced elevations in cutaneous blood flow, which 1) nearly abolished the hyperthermia-induced increase in BFI and 2) restored BFI kinetics during hyperthermic exercise to values that were not different from normothermic exercise (P = 0.091). Collectively, our results demonstrate that cutaneous blood flow can have a substantial, detrimental impact on NIR-DCS estimates of skeletal muscle perfusion and highlight the need for technical and/or pharmacological advancements to overcome this issue moving forward.NEW & NOTEWORTHY We used passive whole body heat stress, in combination with local intradermal botulinum toxin type A treatment, to experimentally manipulate cutaneous blood flow and investigate its impact on NIR-DCS measures of skeletal muscle BFI at rest and during exercise. Collectively, the results show that cutaneous blood flow, which was augmented in response to passive whole body heat stress, markedly affects NIR-DCS-derived BFI, such that the BFI signal becomes dominated by changes in cutaneous red blood cell flux.

Measuring neuronal activity with diffuse correlation spectroscopy: a theoretical investigation.

Cheng X, Sie EJ, Naufel S, Boas DA, Marsili F.

Neurophotonics. 2021 Jul;8(3):035004.

doi: 10.1117/1.NPh.8.3.035004. Epub 2021 Aug 5.

Significance: Diffuse correlation spectroscopy (DCS) measures cerebral blood flow non-invasively. Variations in blood flow can be used to detect neuronal activities, but its peak has a latency of a few seconds, which is slow for real-time monitoring. Neuronal cells also deform during activation, which, in principle, can be utilized to detect neuronal activity on fast timescales (within 100ms) using DCS. Aims: We aim to characterize DCS signal variation quantified as the change of the decay time of the speckle intensity autocorrelation function during neuronal activation on both fast (within 100ms) and slow (100ms to seconds) timescales. Approach: We extensively modeled the variations in the DCS signal that are expected

to arise from neuronal activation using Monte Carlo simulations, including the impacts of neuronal cell motion, vessel wall dilation, and blood flow changes. Results: We found that neuronal cell motion induces a DCS signal variation of 10-5 . We also estimated the contrast and number of channels required to detect hemodynamic signals at different time delays. Conclusions: From this extensive analysis, we do not expect to detect neuronal cell motion using DCS in the near future based on current technology trends. However, multi-channel DCS will be able to detect hemodynamic response with sub-second latency, which is interesting for brain-computer interfaces.

Performance assessment of laser sources for time-domain diffuse correlation spectroscopy.

Samaei S, Colombo L, Borycki D, Pagliazzi M, Durduran T, Sawosz P, Wojtkiewicz S, Contini D, Torricelli A, Pifferi A, Liebert A.

Biomed Opt Express. 2021 Aug 2;12(9):5351-5367.
doi: 10.1364/BOE.432363. eCollection 2021 Sep 1.

Time-domain diffuse correlation spectroscopy (TD-DCS) is an emerging optical technique that enables noninvasive measurement of microvascular blood flow with photon path-length resolution. In TD-DCS, a picosecond pulsed laser with a long coherence length, adequate illumination power, and narrow instrument response function (IRF) is required, and satisfying all these features is challenging. To this purpose, in this study we characterized the performance of three different laser sources for TD-DCS. First, the sources were evaluated based on their emission spectrum and IRF. Then, we compared the signal-to-noise ratio and the sensitivity to velocity changes of scattering particles in a series of phantom measurements. We also compared the results for in vivo measurements, performing an arterial occlusion protocol on the forearm of three adult subjects. Overall, each laser has the potential to be successfully used both for laboratory and clinical applications. However, we found that the effects caused by the IRF are more significant than the effect of a limited temporal coherence.

Extraction of tissue optical property and blood flow from speckle contrast diffuse correlation tomography (scDCT) measurements.

Zhao M, Huang C, Mazdeyasna S, Yu G.

Biomed Opt Express. 2021 Sep 1;12(9):5894-5908.
doi: 10.1364/BOE.429890. eCollection 2021 Sep 1.

Measurement of blood flow in tissue provides vital information for the diagnosis and therapeutic monitoring of various vascular diseases. A noncontact, camera-based, near-infrared speckle contrast diffuse correlation tomography (scDCT) technique has been recently developed for 3D imaging of blood flow index (aDB) distributions in deep tissues up to a centimeter. A limitation with the continuous-wave scDCT measurement of blood flow is the assumption of constant and homogenous tissue absorption coefficient (a). The present study took the advantage of rapid, high-density, noncontact scDCT measurements of both light intensities and diffuse speckle contrast at multiple source-detector distances and developed two-step fitting algorithms for extracting both a and aDB. The new algorithms were tested in tissue-simulating phantoms with known optical properties and human forearms. Measurement results were compared against established near-infrared spectroscopy (NIRS) and diffuse correlation spectroscopy (DCS) techniques. The accuracies of our new fitting algorithms with scDCT measurements in phantoms (up to 16% errors) and forearms (up to 23% errors) are comparable to relevant study results (up to 25% errors). Knowledge of a not only improved the accuracy in calculating aDB but also provided the potential for quantifying tissue blood oxygenation via spectral measurements. A multiple-wavelength scDCT system with new algorithms is currently developing to fit multi-wavelength and multi-distance data for 3D imaging of both blood flow and oxygenation distributions in deep tissues.

Microvascular blood flow changes of the abductor pollicis brevis muscle during sustained static exercise.

Giovannella M, Urtane E, Zanoletti M, Karadeniz U, Rubins U, Weigel UM, Marcinkevics Z, Durduran T.

Biomed Opt Express. 2021 Jun 18;12(7):4235-4248.
doi: 10.1364/BOE.427885. eCollection 2021 Jul 1.

A practical assessment of the general health and microvascular function of the palm muscle, abductor pollicis brevis (APB), is important for the diagnosis of different conditions. In this study, we have developed a protocol and a probe to study microvascular blood flow using near-infrared diffuse correlation spectroscopy (DCS) in APB during and after thumb abduction at 55% of maximum voluntary contraction (MVC). Near-infrared time resolved spectroscopy (TRS) was also used to characterize the baseline optical and hemodynamic properties. Thirteen (n=13) subjects were enrolled and subdivided in low MVC (N=6, MVC<2.3 kg) and high MVC (N=7, MVC=2.3 kg) groups. After ruling out significant changes in the systemic physiology that influence the muscle hemodynamics, we have observed that the high MVC group showed a 56% and 36% decrease in the blood flow during exercise, with respect to baseline, in the long and short source-detector (SD) separations (p=0.031 for both). No statistical differences were shown for the low MVC group (p=1 for short and p=0.15 for long SD). These results suggest that the mechanical occlusion, due to increased intramuscular pressure, exceeded the vasodilation elicited by the higher metabolic demand. Also, blood flow changes during thumb contraction negatively correlated (R=-0.7, p<0.01) with the absolute force applied by each subject. Furthermore, after the exercise, muscular blood flow increased significantly immediately after thumb contractions in both high and low MVC groups, with respect to the recorded values during the exercise (p=0.031). An increase of 251% (200%) was found for the long (short) SD in the low MVC group. The high MVC groups showed a significant 90% increase in blood flow only after 80 s from the start of the protocol. For both low and high MVC groups, blood flow recovered to baseline values within 160 s from starting the exercise. In conclusion, DCS allows the study of the response of a small muscle to static exercise and can be potentially used in multiple clinical conditions scenarios for assessing microvascular health.

Association of Ongoing Cerebral Oxygen Extraction During Deep Hypothermic Circulatory Arrest With Postoperative Brain Injury.

Lynch JM, Mavroudis CD, Ko TS, Jacobwitz M, Busch DR, Xiao R, Nicolson SC, Montenegro LM, Gaynor JW, Yodh AG, Licht DJ.

Semin Thorac Cardiovasc Surg. 2021 Sep 8:S1043-0679(21)00405-6.
doi: 10.1053/j.semtcvs.2021.08.026. Online ahead of print.

Cardiac surgery utilizing circulatory arrest is most commonly performed under deep hypothermia (18C) to suppress tissue oxygen demand and provide neuroprotection during operative circulatory arrest. Studies investigating the effects of deep hypothermic circulatory arrest (DHCA) on neurodevelopmental outcomes of patients with congenital heart disease give conflicting results. Here, we address these issues by quantifying changes in cerebral oxygen saturation, blood flow, and oxygen metabolism in neonates during DHCA and investigating the association of these changes with postoperative brain injury. Neonates with critical congenital heart disease undergoing DHCA were recruited for continuous intraoperative monitoring of cerebral oxygen saturation (ScO2) and an index of cerebral blood flow (CBFi) using 2 noninvasive optical techniques, diffuse optical spectroscopy (DOS) and diffuse correlation spectroscopy (DCS). Pre- and postoperative brain magnetic resonance imaging (MRI) was performed to detect white matter injury (WMI). Fifteen neonates were studied, and 11/15 underwent brain MRI. During DHCA, ScO2 decreased exponentially in time with a median decay rate of -0.04 min-1. This decay rate was highly variable between subjects. Subjects who had larger decreases in ScO2 during DHCA were more likely to have postoperative WMI (P=0.02). Cerebral oxygen extraction persists during DHCA and varies widely from patient-to-patient.

Patients with a higher degree of oxygen extraction during DHCA were more likely to show new WMI in postoperative MRI. These findings suggest cerebral oxygen extraction should be monitored during DHCA to identify patients at risk for hypoxic-ischemic injury, and that current commercial cerebral oximeters may underestimate cerebral oxygen extraction.

Optical Detection of Intracranial Pressure and Perfusion Changes in Neonates With Hydrocephalus.

Flanders TM, Lang SS, Ko TS, Andersen KN, Jahnavi J, Flibotte JJ, Licht DJ, Tasian GE, Sotardi ST, Yodh AG, Lynch JM, Kennedy BC, Storm PB, White BR, Heuer GG, Baker WB.

J Pediatr. 2021 Sep;236:54-61.e1.

doi: 10.1016/j.jpeds.2021.05.024. Epub 2021 May 15.

OBJECTIVE: To demonstrate that a novel noninvasive index of intracranial pressure (ICP) derived from diffuse optics-based techniques is associated with intracranial hypertension. STUDY DESIGN: We compared noninvasive and invasive ICP measurements in infants with hydrocephalus. Infants born term and preterm were eligible for inclusion if clinically determined to require cerebrospinal fluid (CSF) diversion. Ventricular size was assessed preoperatively via ultrasound measurement of the fronto-occipital (FOR) and frontotemporal (FTHR) horn ratios. Invasive ICP was obtained at the time of surgical intervention with a manometer. Intracranial hypertension was defined as invasive ICP =15mmHg. Diffuse optical measurements of cerebral perfusion, oxygen extraction, and noninvasive ICP were performed preoperatively, intraoperatively, and postoperatively. Optical and ultrasound measures were compared with invasive ICP measurements, and their change in values after CSF diversion were obtained. RESULTS: We included 39 infants, 23 with intracranial hypertension. No group difference in ventricular size was found by FOR (P=.93) or FTHR (P=.76). Infants with intracranial hypertension had significantly higher noninvasive ICP (P=.02) and oxygen extraction fraction (OEF) (P=.01) compared with infants without intracranial hypertension. Increased cerebral blood flow (P=.005) and improved OEF (P<.001) after CSF diversion were observed only in infants with intracranial hypertension. CONCLUSIONS: Noninvasive diffuse optical measures (including a noninvasive ICP index) were associated withintracranial hypertension. The findings suggest that impaired perfusion from intracranial hypertension was independentof ventricular size. Hemodynamic evidence of the benefits of CSF diversion was seen in infants with intracranial hypertension. Noninvasive optical techniques hold promise for aiding the assessment of CSF diversion timing.

Accuracy of diffuse correlation spectroscopy measurements of cerebral blood flow when using a three-layer analytical model.

Zhao H, Sathialingam E, Buckley EM.

Biomed Opt Express. 2021 Oct 27;12(11):7149-7161.

doi: 10.1364/BOE.438303. eCollection 2021 Nov 1.

Diffuse correlation spectroscopy (DCS) is a non-invasive optical technology for the assessment of an index of cerebral blood flow (CBFi). Analytical methods that model the head as a three-layered medium (i.e., scalp, skull, brain) are becoming more commonly used to minimize the contribution of extracerebral layers to the measured DCS signal in adult cerebral blood flow studies. However, these models rely on a priori knowledge of layer optical properties and thicknesses. Errors in these values can lead to errors in the estimation of CBFi, although the magnitude of this influence has not been rigorously characterized. Herein, we investigate the accuracy of measuring cerebral blood flow with a three-layer model when errors in layer optical properties or thicknesses are present. Through a series of in silico experiments, we demonstrate that CBFi is highly sensitive to errors in brain optical properties and skull and scalp thicknesses. Relative changes in CBFi are less sensitive to optical properties but are influenced by errors in layer thickness. Thus, when using the three-layer model, accurate estimation of scalp and skull thickness are required for

reliable results.

Fast diffuse correlation spectroscopy with a low-cost, fiber-less embedded diode laser.

Biswas A, Moka S, Muller A, Parthasarathy AB.

Biomed Opt Express. 2021 Oct 4;12(11):6686-6700.
doi: 10.1364/BOE.435136. eCollection 2021 Nov 1.

Diffuse correlation spectroscopy (DCS), a popular optical technique for fast noninvasive measurement of blood flow, is commonly implemented using expensive fiber-coupled long coherence length laser systems. Here, we report the development of a portable and fiber-less approach that can be used as a low-cost alternative to illuminate tissue in DCS instruments. We validate the accuracy and noise characteristics of the fiber-less DCS laser source, by comparisons against traditional DCS light sources, with experiments on controlled tissue-simulating phantoms and in humans.

Quantification of blood flow index in diffuse correlation spectroscopy using long short-term memory architecture.

Li Z, Ge Q, Feng J, Jia K, Zhao J.

Biomed Opt Express. 2021 Jun 15;12(7):4131-4146.
doi: 10.1364/BOE.423777. eCollection 2021 Jul 1.

Diffuse correlation spectroscopy (DCS) is a noninvasive technique that derives blood flow information from measurements of the temporal intensity fluctuations of multiply scattered light. Blood flow index (BFI) and especially its variation was demonstrated to be approximately proportional to absolute blood flow. We investigated and assessed the utility of a long short-term memory (LSTM) architecture for quantification of BFI in DCS. Phantom and in vivo experiments were established to measure normalized intensity autocorrelation function data. Improved accuracy and faster computational time were gained by the proposed LSTM architecture. The results support the notion of using proposed LSTM architecture for quantification of BFI in DCS. This approach would be especially useful for continuous real-time monitoring of blood flow.

The future of noninvasive neonatal brain assessment: the measure of cerebral blood flow by diffuse correlation spectroscopy in combination with near-infrared spectroscopy oximetry.

Ferrari M, Quaresima V.

J Perinatol. 2021 Nov;41(11):2690-2691.
doi: 10.1038/s41372-021-00996-w. Epub 2021 Mar 1.

DOI: 10.1038/s41372-021-00996-w PMID: 33649445

Simulation of statistically accurate time-integrated dynamic speckle patterns in biomedical optics.

James E, Powell S, Munro P.

Opt Lett. 2021 Sep 1;46(17):4390-4393.
doi: 10.1364/OL.435812.

The simulation of statistically accurate time-integrated dynamic speckle patterns using a physics-based model that accounts for spatially varying sample properties is yet to be presented in biomedical optics. In this Letter, we propose a solution to this important problem based on the Karhunen-Love expansion of the

electric field and apply our method to the formalisms of both laser speckle contrast imaging and diffuse correlation spectroscopy. We validate our technique against solutions for speckle contrast for different forms of homogeneous field and also show that our method can readily be extended to cases with spatially varying sample properties.

Noninvasive Optical Monitoring of Cerebral Blood Flow and EEG Spectral Responses after Severe Traumatic Brain Injury: A Case Report.

Poon CS, Rinehart B, Langri DS, Rambo TM, Miller AJ, Foreman B, Sunar U.

Brain Sci. 2021 Aug 20;11(8):1093.
doi: 10.3390/brainsci11081093.

Survivors of severe brain injury may require care in a neurointensive care unit (neuro-ICU), where the brain is vulnerable to secondary brain injury. Thus, there is a need for noninvasive, bedside, continuous cerebral blood flow monitoring approaches in the neuro-ICU. Our goal is to address this need through combined measurements of EEG and functional optical spectroscopy (EEG-Optical) instrumentation and analysis to provide a complementary fusion of data about brain activity and function. We utilized the diffuse correlation spectroscopy method for assessing cerebral blood flow at the neuro-ICU in a patient with traumatic brain injury. The present case demonstrates the feasibility of continuous recording of noninvasive cerebral blood flow transients that correlated well with the gold-standard invasive measurements and with the frequency content changes in the EEG data.

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