

EDITORIAL



New technologies from bench to bedside – report from the Nordic association for clinical physics 2023 symposium

Stine Sofia Korreman^{a,b} , Claus Preibisch Behrens^{c,d} , Vibeke Nordmark Hansen^e , Jesper Thygesen^f 
and Thomas Lund Andersen^g 

^aDepartment of Clinical Medicine, Aarhus University, Aarhus, Denmark; ^bDanish Center for Particle Therapy, Aarhus University Hospital, Aarhus, Denmark; ^cDepartment of Oncology, Copenhagen University Hospital – Herlev and Gentofte, Copenhagen, Denmark; ^dDepartment of Health Technology, Technical University of Denmark, Lyngby, Denmark; ^eDepartment of Oncology, Copenhagen University Hospital, – Rigshospitalet, Copenhagen, Denmark; ^fDepartment of Clinical Engineering and Procurement, Central Denmark Region, Aarhus Denmark; ^gDepartment of Clinical Physiology & Nuclear Medicine, Rigshospitalet, Copenhagen, Denmark

ARTICLE HISTORY Received 16 September 2023; Accepted 18 September 2023

One of the most significant activities of the Nordic Association for Clinical Physics (NACP) is to arrange a triennial scientific symposium, which in 2023 took place in Reykjavik, Iceland, from March 30th to April 1st. The program of the symposium covered the major specialties of clinical medical physics under the common theme 'New technologies – from bench to bedside'. With 197 registered participants and 84 submitted abstracts, this was the largest (on-site) NACP symposium to date. The program was divided into plenary sessions with invited speakers, parallel sessions with both invited speakers and proffered papers, and finally parallel thematic workshop sessions. The thematic workshop session was a novel format, intended to engage all participants in active discussions on pertinent topics of relevance for present and/or future clinical practice. The themes of the workshops were dosimetry and artificial intelligence and they were preceded by plenary presentations on the two topics.

The symposium was visited by the board of the European Federation of Organisations of Medical Physics (EFOMP) who held their annual board meeting in Reykjavik at the symposium venue. A plenary presentation was given by the president of EFOMP, Paddy Gilligan (IR), on the development of new medical physics core curricula [1,2].

As a lead-in to the symposium theme, the first day featured a keynote address by Ane Appelt (UK) on 'Application of technologies in clinical practice – the physicists role' [3], followed by three plenary invited presentations featuring developmental technologies for imaging and radiotherapy in early stages (closer to the bench than to the bedside). Linda Knutsson (SE) presented recent advances in the clinical potential of quantitative MR, Jasper Nijkamp (DK) showed the first developments of a spectral micro-CT scanner for tumour imaging, and Crister Ceberg (SE) demonstrated translational research on high dose-rate electron flash therapy.

Of the submitted abstracts, 38 were featured as oral presentations in parallel sessions, and 37 as poster presentations in moderated poster walks.

The topical distribution of submitted abstracts to the NACP symposia has shifted somewhat over time. Compared to the NACP2020/21 symposium [4], there has been a notable increase in the number of abstracts relating to use of artificial intelligence, in all the fields of medical physics. This is not surprising as it reflects a general trend also seen in other medical physics conferences, such as the annual ESTRO and AAPM meetings. On the other hand, a decrease was observed in the number of abstracts related to proton therapy – likely a particularly large number of proton therapy abstracts was submitted in 2020/21 due to the then newly started proton therapy center in Denmark and the promise of several proton therapy centers in Norway. Adaptive radiotherapy and exploration of new treatment planning techniques remains in continuous development and has maintained a strong presence at the symposium. More detailed elaborations on the topics represented at the symposium are given in the sections below.

Artificial intelligence

Artificial intelligence (AI) is the subject of increasing interest in medical physics with multiple applications, as was already seen in the NACP2020/21 symposium [5, 6]. While still few applications are mature for routine clinical implementation, research and development is now aiming not only for technical solutions but also for clinical validation and schemes for practical and safe implementation.

At the NACP2023 symposium, AI in imaging and therapy was the topic of an invited plenary presentation by Irene Buvat (FR) [7], followed by three subsequent parallel thematic interactive workshops. AI was also the subject of a large number of submitted abstracts within all the medical

physics specialties. Deep learning is primarily used for auto-segmentation of structures in medical images, for radiation dose prediction, and for outcome prediction. In addition, AI has the potential to automate time consuming processes in treatment planning to improve efficiency in the clinical workflow, and to increase consistency of processes well-known to be prone to large interobserver variations such as delineation of organs at risk [8]. This may be useful not only in clinical practice, but also in retrospective studies, where more organs may be evaluated in a research setting. As training of AI models requires large amounts of data, focus is on the large patient groups including prostate cancer, head and neck cancer, and breast cancer. In Mikalsen et al. [9], deep learning based auto-segmentation for organs at risk in thorax and breast cancer is tested quantitatively and qualitatively in preparation for implementation in clinical practice. In Skarsø et al. [10], it is demonstrated that it is possible to use a large clinical data set for training a deep learning model for auto-segmentation of the heart in breast cancer patients. This eliminates the time-consuming task of creating a dedicated data set for model training and hence increases the practical feasibility of performing model training. The collection of large radiotherapy data sets is a key component in relation to harnessing data science developments in our field. In Krogh et al. [11], an infrastructure solution is presented for the multi-institutional collection and storage of DICOM data. The solution includes various tools for data curation and analysis, and it is under further development for support of for instance AI applications.

Treatment planning and adaptive therapy

Many aspects of treatment planning were in focus at NACP2023 presented both on posters and as proffered papers, continuing the trend from NACP2020/21 [12–14]. The focus on treatment planning has also led to several papers on the topic in the current *Acta Oncologica* issue. Two papers focus on issues related to treatment planning for lung cancer. Fjellanger et al. [15] report how they used multi-criteria optimization to improve knowledge-based automatic planning and implemented the solution in their clinic. Håkansson et al. [16] present a method to evaluate the dosimetric consequence of intra-fractional breath hold variability for patients treated in deep inspiration breath-hold. The method is based on a number of breath-hold CT scans and a splitting of the treatment plan into a number of sub-plans. Locoregional breast radiotherapy including the internal mammary nodes is in focus of the paper by Frengen et al. [17]. They present an automated treatment planning technique using non-coplanar arcs in order to lower the dose to organs at risk compared to a coplanar arc technique. Particularly doses to the contralateral lung and breast are reported to be lower while having superior target coverage compared to 3D-CRT. The latter two papers use the well-established procedure of deep inspiration breath-hold, which can nevertheless still be improved. Damkjær et al. [18] aim to provide a redesigned external gating surrogate with a reduced dosimetric footprint to avoid adverse skin reactions, in a

continuation of previous design efforts reported at NACP2020/21 [19].

Adaptive radiotherapy has gained much attention in recent years with new technological developments being implemented in clinical practice; e.g., MR- and CBCT based online adaptive systems. Patient specific dosimetry for adaptive radiotherapy was discussed in one of the workshops, while sessions included talks on adaptive RT for both proton- and photon radiotherapy. The great interest in online adaptive radiotherapy (oART) is reflected in two papers in the current issue of *Acta Oncologica*. Bak et al. [20] report that it is now standard at their institute to treat patients with vulvar carcinoma using CBCT-based oART. With oART they report better CTV coverage compared to standard IGRT opening up the possibility of reducing PTV margins. Reduction of margins is also in focus in the paper by Brennsæter et al. [21]. They report that it is safe to reduce the elective lymph node PTV margins for patients treated using CBCT-based oART for prostate cancer. Furthermore, patient-specific margins could be advantageous in reducing margins even more for patients with little intra-fractional motion with margin reductions leading to a potential reduction of dose to normal tissue. In a different direction, Schiavo et al. [22] explore hypoxia-based dose escalation in stereotactic body radiotherapy, with modeling of tumour control probability in different scenarios of tumour vasculature and resulting reoxygenation.

Proton therapy

Proton therapy was a very large topic at the NACP2020/21 [23,24], and is still an active research topic, reflecting the recent introduction of proton therapy in Denmark and soon also in Norway. At the NACP2023, the physics (range shifter and LET), the biology (RBE) and dose planning was addressed by different authors. The majority of abstracts related to dose planning, robustness and comparison of the proton plans versus photon plans, exploring the advantages of protons for specific tumor sites. Brincker et al. [25] investigate mediastinal lymphomas, where they have made a national multicentre trial on plan comparison. Here the photon plan varies significantly more than the corresponding proton plan, possibly reflecting the advantages of common training in proton planning. Rønde et al. [26] explores the advantages of proton therapy for testicular seminoma and paves the way for proton therapy for this group of patients.

Dosimetry

Dosimetry is a topic of continuous interest in all branches of medical physics, and at the NACP2023 symposium, it was featured in an invited plenary presentation by Eirik Malinen (NO), followed by three subsequent parallel thematic interactive workshops. As dosimetry is a basic topic of high interest for clinical practice, it generated an active participation during the workshops, with the largest participation under the subtopic of patient specific dosimetry.

From the Icelandic hosts of the conference, a study devising a new film based method for patient specific quality

assurance was presented, in which several calibration methods were compared for the novel Hyperarc radiotherapy delivery method [27].

The symposium concluded with a broad overview talk by Marcel van Herk (UK) on the translation of new technologies from early development to clinical implementation, including the history of development from the first electronic imaging devices to onboard cone-beam CT imaging equipment for image guided radiotherapy [28].

In summary, the NACP2023 symposium was very well attended by all three main medical physics specialties; Diagnostics (including radiology and MR), Nuclear Medicine, and Radiotherapy including both photon and proton therapy. The division of abstracts between the specialties likely reflects well the relative investments in research in the three disciplines, with 8% from diagnostics, 27% from nuclear medicine and 65% from radiotherapy.

It was a pleasure to have the NACP2023 symposium in Iceland. It is noteworthy that only three weeks prior to the symposium, the new Icelandic Society of Medical Physics was founded, and the successful symposium was an excellent demonstration of the dedication of the medical physicists engaged in this new society. We congratulate the local organizers on the great achievement of hosting such a successful event and on the establishment of The Icelandic Society of Medical Physics.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Stine Sofia Korreman  <http://orcid.org/0000-0002-3523-382X>
 Claus Preibisch Behrens  <http://orcid.org/0000-0002-0686-1421>
 Vibeke Nordmark Hansen  <http://orcid.org/0000-0003-2347-9977>
 Jesper Thygesen  <http://orcid.org/0000-0001-6187-3129>
 Thomas Lund Andersen  <http://orcid.org/0000-0002-2860-6317>

Data availability statement

Data used in this editorial are available upon request.

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