

# **RVNet(Work): A Collaborative Platform Advancing Right Heart Imaging and Innovation**

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The right heart plays a primary role in the overall ability to generate an adequate stroke volume and optimal cardiac output. The assessment of the right ventricle (RV) and right atrium (RA) is therefore important for diagnosis, monitoring, and guiding therapy across a range of acute and chronic cardio-pulmonary conditions. It also plays a vital role in the perioperative period, ensuring optimal outcomes after surgical and interventional procedures. Cardiac imaging plays a fundamental role into this assessment with the routine use of echocardiography, cardiac magnetic resonance imaging (cMRI) and computed tomography (CT). Our understanding of RV and RA structure and function has evolved significantly in tandem with the technological advancements of these imaging techniques. These developments are highlighted in the ever-growing evidence-based literature and have advanced our knowledge base but have also brought to the forefront the challenges associated with standardization, validity, reliability and translation into routine clinical assessment and decision making. Societal guideline documents aim to resolve some of these challenges as well as guide clinical application, but practice often remains heterogenous across departments, hospitals settings and geographical regions. Moreover, our understanding of reference values (normality) and disease does not fully encompass the rich diversity of the patient and/or cardio-pulmonary phenotypes.

The RVNet(Work) is a multi-disciplinary group of like-minded individuals who are equally intrigued and fascinated by the often-forgotten side of the heart. The group have come together to collaborate through shared writing, practice and research and to address some of these challenges. From inception in the Autumn of 2023, the group have met regularly to discuss the challenges and opportunities that we face as a clinical academic fraternity who utilise imaging for RV assessment. It is important to acknowledge that we are blessed with a plethora of literature to draw upon and to guide us going forward, however the current international status of clinical application including standardization and methodology

is not fully appreciated. Research is also needed to improve clinical and research standards for right heart assessment using multi-modality imaging

In view of this, one of the group's first endeavours was to distribute an international survey to gauge insight into the current knowledge, understanding and practical application of right heart imaging across healthcare and academic sectors. This survey was distributed via professional organisations, social media and personal networks. Concurrently, the group is working on a novel review article highlighting a roadmap from challenges to opportunities and from current to future application. These resources will inform the groups activity and will help to identify the challenges and opportunities that we face in the assessment of the right heart (see Figure 1).

This strategy has already highlighted several areas that require exploration and elucidation (presented below). These will feed into a collective wider collaboration to aid the writing of recommendations while targeting specific research questions focused on establishing validity and reliability as well as diagnostic and prognostic value.

### **Standardization of image acquisition**

The quality and standardised acquisition of image data is integral to providing reproducible, valid and clinically meaningful RV and RA data. It is therefore important to explore how this can be achieved to consider the unique geometry of the RV and RA using a multi-modality approach. This includes imaging windows and technical considerations for post-processing analysis. For example, through international guidelines we will help to recommend the inclusion of an RV-focused apical four-chamber view in standard examination protocols, as this is rarely implemented in clinical practice. Furthermore, normal values for RV dimensions are based on studies that have used different sectional planes, impacting on the true validity of these data. The interchangeability across different

techniques and modalities (e.g. direct comparison of transthoracic echocardiography, transoesophageal echocardiography and cMRI measurements) is an important consideration in various clinical settings and warrants further investigation.

### **Standardization of data analysis**

It is apparent that the methodology employed for data analysis of specific RV and RA structural and functional parameters can be variable. Accurate and standardised measurements are fundamentally important particularly in the presence of other inherent technical limitations. Specific examples include the timing and location of structural parameters and standardization of stroke volume, fractional area change, RV/RA volume and strain. The structural and functional relationships such as strain-area/volume are not fully understood. Developing clear protocols and definitions for these measurements by working with other cross-disciplinary groups and professional societies would help to facilitate integration of these novel aspects into research and clinical practice.

### **Standardization of interpretation and clinical decision making**

Many clinical decisions are based upon the magnitude of change and the grading of severity. These aspects are often challenging for the clinician (even when assuming accurate data acquisition and analysis). The RV is more susceptible to this ambiguity due to the known morphological and functional nuances. The ability to establish clinically meaningful thresholds for change and cut-offs for intervention are therefore paramount. An important part of clinical practice is based upon accurate longitudinal monitoring. Reference change values are determined by considering both analytic and biological variation of a measurement. Ongoing research supported by the RVNet(Work) will focus on establishing these reference changes for the right heart and will be essential for clinical practice to avoid

overcalling (or missing) clinically relevant change. In this regard, the prognostic value and ability to effectively triage will enhance availability and accessibility of these measures and ultimately improve patient management. In addition, defining clinically meaningful change in RV parameters and the potential role as surrogate endpoints in clinical trials is an essential component to this and further work should aim to explore these across a range of cardiopulmonary disease. Recent publications of this type have successfully demonstrated the importance in determining clinical trial endpoints and serve as real-world examples of what can (and should be) achieved.<sup>1,2</sup>

Our acknowledgement of cardiac adaptation relative to body size is well established however our understanding of allometric relationships and determining specific body size scalars is less clear. This issue is more apparent in the right heart where combinations of linear dimensions, areas and volumes are applied to a non-uniform geometry. Add the concept of proportionality and we reach an important level of insight that alongside scaling will help to drive more accurate size independent diagnostic and prognostic cut-offs.

### **Artificial intelligence (AI)**

The role of AI in medical imaging is fast-evolving and is improving the efficiency, diagnostic yield and predictive capacity. Artificial Intelligence is already being applied to the assessment of the right heart and will continue to evolve. This will aid our decision making but will also allow more complex structural and functional parameters, including strain-pressure-volume relationships, to be measured and utilised more easily. A standardized approach to integrating this technology into routine clinical practice requires a clear roadmap and we acknowledge the importance of collaborative work in this setting.

These overarching areas of work reflect the initial drive of the RVNet(Work), and provide a clear plan for ongoing projects. There are various potential solutions to address these issues (see Supplemental Table S1). Firstly the RVNet(Work) will aim to build the collaborations with international research groups to undertake quantitative and qualitative international research across 2D, 3D echocardiography, transoesophageal echocardiography and other imaging modalities. Establishing a discussion and data-sharing platform to promote communication and collaborative research with key stakeholders, including clinicians, professional societies, and industry partners is fundamental to this development. This can occur alongside the specific research from the group members and should involve the role of a dedicated RVNet(Work) core-lab to explore the impact of various factors on validity, reproducibility, clinically meaningful changes in RV parameters, and the role of machine learning and AI. Secondly, the group will create a collective effort to work with professional societies to support the integration of these research findings into clinical protocols, alongside the development and implementation of quality assurance procedures.

We would like to take this opportunity to acknowledge the importance of this initiative and the shared interest of the medical imaging community. If you require any further information regarding the group, please visit the following website <https://www.rvwork.net>. Here you will find details of the members, individual research publications, and their collective work.

**Conflicts of Interest:**

E.S. is an employee and a shareholder of AstraZeneca. D.A. has received honorarium and investigator research grant from Janssen. A.K. serves as Chief Medical Officer of Argus

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**References**

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## **Figure Titles and Legends**

**Figure 1** – The RVNet(Work) – issues pertaining to imaging of the right ventricle