Three PhD Studentships in Biomedical Engineering with Industrial Partners

Now Available in the Bates Group

Three PhD projects sponsored by leading international MedTech companies are now available in the Bates group for an October 2026 start. The industrial partners (Weinmann Medical and Fisher & Paykel Healthcare) will be actively involved in the projects, providing the students with invaluable experience of cutting-edge medical technology research, development and application. Brief project descriptions are provided below, interested students are encouraged to contact Prof. Bates (d.bates@warwick.ac.uk) directly for more details.

PhD Project 1: Digital Twins for Emergency Medicine (with Weinmann Medical)

This project will develop cohorts of digital twins for use in developing, validating and testing Weinmann's next-generation of ventilator technologies for emergency medicine scenarios. Digital twins will be created of intubated patients receiving pressure controlled mechanical ventilation [1], spontaneously breathing patients receiving non-invasive ventilation delivered via a facemask [2], and patients receiving CPR after Cardiac Arrest [3]. Digital twins will be developed as fully configurable Matlab code, with a well-defined user interface, and will run faster than real-time. The digital twins will be used to investigate a number of open research qustions, including (a) the potential for developing and validating closed-loop ventilation control modes, (b) whether patient data gathered in the field could allow the digital twins to identify patient characteristics that are relevant for therapy, (c) computational optimisation of current CPR protocols.

PhD Project 2: Digital Twins of patients receiving High Flow Nasal Cannula Therapy Warwick Industrial Fellowship (with Fisher & Paykel Healthcare)

High flow nasal cannula (HFNC) therapy, pioneered by Fisher & Paykel, delivers heated, humidified oxygen to patients at flow rates above 20 L/min and has become the first-line treatment for acute respiratory failure worldwide [4]. This project will develop digital twins [5,6] of patients suffering from exacerbations of chronic obstructive pulmonary disease (COPD) who are being treated with HFNC. We are collaborating with clinicians in Italy who are conducting clinical trials in this area and we will leverage their data to create digital twins of these patients, and use them to investigate potential benefits associated with (a) using bi-level (high/low) flow rates during inspiration/expiration (b) stratification of patients to identify sub-groups that would benefit most from different HFNC modalities, and (c) optimization of flow rates to individual patient characteristics.

PhD Project 3: A Machine Learning Based Clinical HFNC decision support system Warwick Industrial Fellowship (with Fisher & Paykel Healthcare)

Concerns around the possible negative consequences of delayed escalation of treatment are a significant factor inhibiting the use of High Flow Nasal Cannula Therapy among some clinicians. Using data from clinical collaborators around the world, this project will develop a user-friendly software tool, based on state-of-the-art machine learning models [7], that can predict the outcome of HFNC therapy in individual patients with higher accuracy than current clinical indices, early in their course of treatment [8,9]. This will increase confidence among clinicians that treating a patient with HFNC will lead to a positive outcome, and help them identify earlier patients who are failing on HFNC and need treatment escalation.

Key References:

[1] W. Joy, B. Albanese, D. Oakley, S. Mistry, Kateryna Nikulina, Andreas Schuppert, Gernot Marx, B. Brook, J.G. Hardman, J.G. Laffey, L. Rose, L. Camporota, T.E. Scott, D.G. Bates, and S. Saffaran, "Digital twins to evaluate the risk of ventilator induced lung injury during airway pressure release ventilation compared to pressure-controlled ventilation", Critical Care Medicine, 2025. pdf

[2] L. Weaver, H. Shamohammadi, S. Saffaran, R. Tonelli, M. Laviola, J.G. Laffey, L. Camporota, T.E. Scott, J.G. Hardman, E.M. Clini, and D.G. Bates, "Digital twins of acute hypoxic respiratory failure patients suggest a mechanistic basis for success and failure of non-invasive ventilation", Critical Care Medicine, 10.1097, 2024. pdf

[3] C. Daudre-Vignier, D.G. Bates, T.E. Scott, J.G. Hardman and M. Laviola, "Evaluating Current Guidelines for Cardiopulmonary Resuscitation using an Integrated Computational Model of the Cardiopulmonary System", Resuscitation, 2023. pdf

[4] H. Shamohammadi, L. Weaver, S. Saffaran, R. Tonelli, M. Laviola, J.G. Laffey, L. Camporota, T.E. Scott, J.G. Hardman, E. Clini, and D.G. Bates, "Airway pressures generated by high flow nasal cannula in patients with acute hypoxemic respiratory failure: A computational study", Respiratory Research, 2025. pdf

[5] H. Shamohammadi, S. Saffaran, R. Tonelli, V. Chiavieri, G. Grasselli, E. Clini, T. Mauri, and D.G. Bates, "Digital twins suggest a mechanistic basis for differing responses to increased flow rates during high-flow nasal cannula therapy", Intensive Care Medicine Experimental, 2025. pdf

[6] H. Shamohammadi, Sina Saffaran, D. Troxell, R. Tonelli, V. Chiavieri, G. Grasselli, D. Luca Grieco, S. Spadaro, A. Esquinas, E. Clini, T. Mauri, and D.G. Bates, "Digital Twins of Acute Hypoxemic Respiratory Failure and Sepsis Patients Suggest Potential Benefits of Bi-Level High Flow Nasal Cannula Therapy", Intensive Care Medicine, 2025. pdf

[7] H. Yu, S. Saffaran, A. Ali, C. Henry, N. Mustfa, A. Thomas, A. Rajhan, S. Isrhad, L. Weaver, R. Tonelli, L.S. Menga, Q. Zhang, M. Einollahzadeh Samadi, A. Schuppert, J.G. Laffey, L. Camporota, A.M. Esquinas, D.L. Grieco, M. Antonelli, L. Martins de Lima, L. Kawano-Dourado, I.S. Maia, A. Biasi Cavalcanti, E. Clini, T.E. Scott, and D.G. Bates, "In-Hospital Testing of NIVPredict - An AI Tool for Early Prediction of Non-Invasive Ventilation Outcome in Acute Respiratory Failure", Critical Care, 2026. pdf

[8] H. Yu, S. Saffaran, R. Tonelli, J.G. Laffey, A.M. Esquinas, L. Martins de Lima, L. Kawano-Dourado, I.S. Maia, A. Biasi Cavalcanti, E. Clini, and D.G. Bates, "Machine learning models compared with current clinical indices to predict the outcome of high flow nasal cannula therapy in acute hypoxemic respiratory failure", Critical Care, 2025. pdf

[9] H. Yu, S. Saffaran, R. Tonelli, J.G. Laffey, Q. Zhang, A.M. Esquinas, L. Martins de Lima, L. Kawano-Dourado, I.S. Maia, A.B. Cavalcanti, E.Clini, and D.G. Bates, "Evaluating the effect of heart and respiratory rate measurement errors on the ability to predict the outcome of high flow nasal cannula therapy: a multi-centre study", Critical Care, 2025. pdf