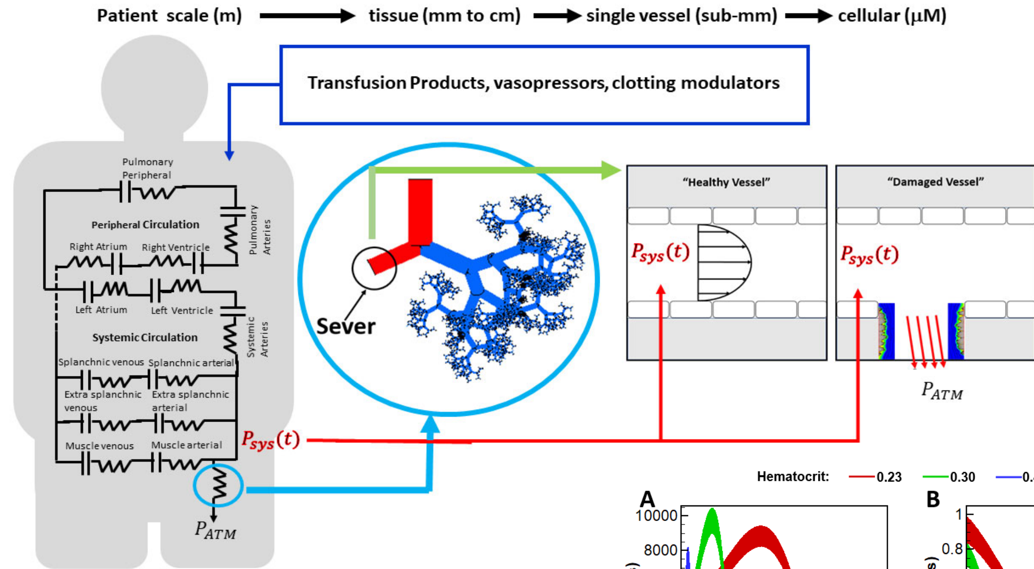
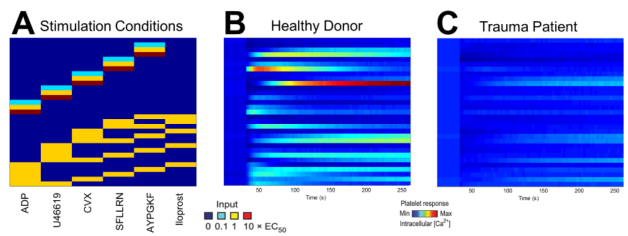
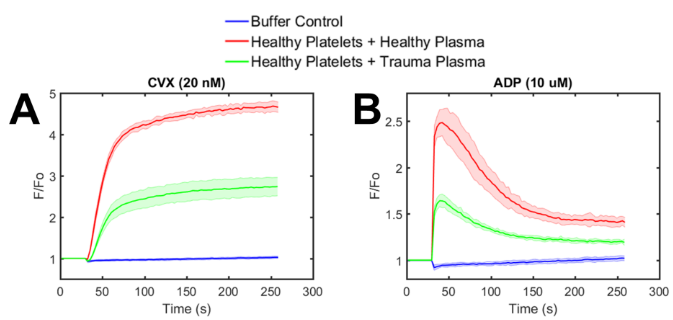
Multiscale Analysis of Trauma

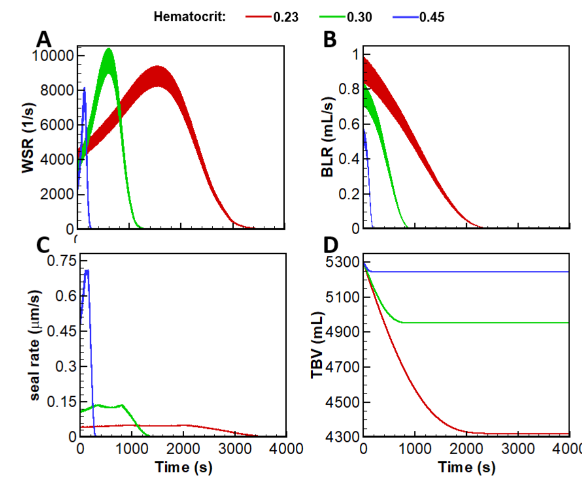
The model: The overall goal is to quantify metabolic responses to trauma, predict responses to physiological perturbations, and develop “on-the-fly” patient-specific strategies. This is done via experiment, whereby trauma patient blood is acquired at marked time-intervals post-injury to better stratify patient bleeding risks, prioritize biomarkers, and identify new opportunities for safer treatment options. This is also done via simulation where a multiscale model that accounts for changes in systemic circulation is linked to cellular responses to hemostasis over 6 orders of magnitude. The model consists of a global hemodynamic (GH) submodule that is represented as a closed-loop hydraulic circuit that includes 0-D, descriptions of the various components of the body, a bleeding branched vascular network (BVN) with a random distribution of cuts, and the single vessel scale for clot simulation. The global hemodynamic model includes the baroreflex response for modulating cardiovascular output. At all scales, models are constructed to match physiological conditions (B) before a wound occurs and the simulation predicts the expected outcome upon injury (C).

Inner-working Math: GH module consists of multiple, interacting 0-dimensional arterial and venous compartments arranged in series and parallel elastic pulsatile description of heart, and baroreflex control. Solved by system of ODE’s.
BVN module solves for pressure, flow, and shear distribution through the BVN via a modified Poiseuille flow equation.
Models coupled together via conservation of mass and momentum.
Change Current Practice: Important implications regarding resuscitation and transfusion strategies, i.e. effects of hemodilution.
End Users: Trauma surgeons, use to guide decision-making.









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