From Keyboard to Clinic: Computational Trials of Regenerative Therapy Safety in the Human Heart

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WHY we are interested

One UK heart attack hospital admission every 5 minutes[1]
Heart attacks cause irreparable scarring of the affected tissue
Coronary heart disease costs the NHS £1,500,000,000 per year[2]
Computational trials are a fast and precise tool to ethically investigate new treatments
Stem cell injection may renew the damaged heart

Stem cell injection can improve cardiac function, however, the stem cells are immature and might disturb the heart’s rhythm: is it safe?

HOW we do it

Computer simulations are routinely used to test new inventions and their safety across many sectors
Cardiac digital twins are virtual copies of human hearts, constructed from real patient data
We simulate stem cell injection in the scarred human heart to investigate potential side effects

WHAT we found

To guide clinical delivery, our mechanistic investigations showed:
1) Healed heart attack scars promote stem cells to produce extra beats
2) Early after a heart attack following break out into chaotic rhythm is favoured

CHAOTIC RHYTHM

Premature Stem Cell Beat
Regular Heartbeats

Simulated ECG
before after heart attack

MECHANISTIC INVESTIGATION OF CHAOTIC ACTIVITY

Likelihood of premature stem cell beats
Early Healing Scarred Heart attack stage

Likelihood to break into chaotic rhythm
Early Healing Scarred Heart attack stage

IMPACT

Efficient and safe exploration of optimal delivery strategies, such as injection location and cell dose
Large-scale investigations of safety in individual patients and different disease characteristics
Systematic drug discovery and design to improve therapy safety whilst maintaining efficacy

Our modelling and simulation framework can be used for safety and efficacy evaluations to advance therapy development, delivery and mitigation of safety concerns

References

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