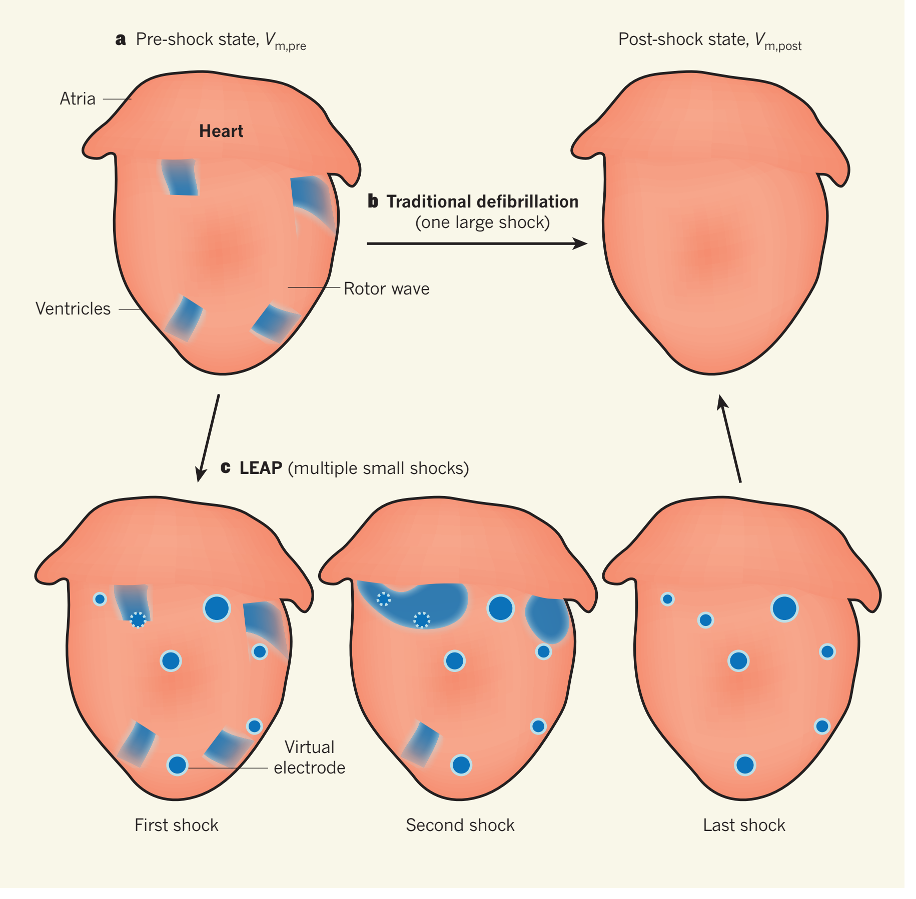

Figure 1 | Subtle defibrillation. a, During cardiac fibrillation, the pre-shock electrical state of the heart (the transmembrane potential throughout the heart; $V_{m,pre}$) features numerous unstable, electrical rotating waves (rotor waves). **b**, Traditional defibrillation works to rapidly bring the post-shock state ($V_{m,post}$) to resting levels by means of a single, large electrical shock. **c**, Luther *et al.*[3] describe low-energy antifibrillation pacing (LEAP), in which multiple low-strength shocks are applied to generate many virtual electrodes across the heart. These virtual electrodes excite the heart tissue, and the waves generated by each pulse of electricity propagate away from the electrodes, interacting with the rotor waves to eventually terminate fibrillation.

of the coronary vasculature. The branching structure was computed from polymer casts obtained from the same experiments. The authors propose that during a shock, the specific geometry (size, orientation and so on) of the blood-filled coronary vasculature, and its difference in electrical conductivity from that of the surrounding heart, lead to the formation of virtual electrodes throughout much of the heart. Indeed, Luther *et al.* show that shock strengths significantly lower than those required for traditional defibrillation can produce many virtual electrodes throughout the heart of beagle dogs, and that these electrodes generate numerous propagating waves without the need for multiple metal electrodes.

Through their *in vitro* and *in vivo* animal experiments, the researchers[3] show that the application of multiple, brief shocks significantly reduces the energy required for defibrillation by launching numerous propagating waves from many virtual electrodes across the heart (Fig. 1c). Surprisingly, the interval between the application of each low-energy antifibrillation pacing (LEAP) stimulus was longer than the average rotor period (underdrive pacing).

These intriguing findings lead to equally intriguing questions, an obvious one being whether this phenomenon will translate to humans. Moreover, the curious researcher might wonder whether even lower defibrillation energies — which are always desirable — could be used. However, there may be a theoretical minimum energy for various reasons, including the fact that a minimum electric field (around 1 volt per centimetre) is required to excite cardiac tissue[17]. In a given patient, the success of LEAP defibrillation will depend on the relationship of rotor-wave density and location and the spatial distribution and size of heterogeneities in tissue conductivity.

In light of Luther and co-workers' study, it seems prudent to factor coronary vasculature into whole-heart simulations of defibrillation. But deciding how to do this appropriately requires a detailed understanding of the geometry, conductivity and path of the electrical current near blood vessels. Such details can vary widely between individuals.

Although provocative, the new work[3,14] does not directly show the exact mechanism involved, nor does it outline the precise experimental pattern of virtual-electrode polarization resulting from vasculature-induced heterogeneities. Factors to explore include the effects of vessel shape and of vessel-wall and blood conductivities on the generation of virtual electrodes[18]. That said, it is exciting that LEAP can reduce the defibrillation threshold for both atrial and ventricular fibrillation *in vitro* and can terminate atrial fibrillation *in vivo* (by means of coil electrodes inside the heart). Indeed, LEAP is an important development showing that a significant decrease in the required shock strength results from a combination of dynamic control and the interaction of the electric field with the heart structure — purportedly, the coronary vasculature. ■

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CORRECTION

An erroneous Figure 1 appeared in the News & Views article "Materials science: Graphene moiré mystery solved?" by Allan H. MacDonald & Rafi Bistritzer (*Nature* **474,** 453–454; 2011), in that the lattices depicted were not honeycombs. The correct figure is now in place in the online version of the article.

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