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Editorial

Hospitals and innovation: Introduction to the special section

1. Introduction: hospitals and current issues in innovation studies

Medical innovation is a complex phenomenon that results from the interplay of science, technology, medical practice and policy. It involves networked actors such as firms, universities, government agencies, patients and patient organisations, non-governmental organisations such as research charities, and healthcare personnel as well as the organisations which employ them (Morlacchi and Nelson, 2011; Powell et al., 1996). Only recently has this complex interplay been explicitly discussed in evolutionary models of innovation (Consoli and Mina, 2009; Nelson et al., 2011; Windrum and García-Goñi, 2008). Empirical studies have shown that medical innovation involves much more than the mere introduction of new medical services and products: the innovation processes are long, incremental and path-dependent, and they are strongly influenced by medical practice and developments in many different sectors, technologies and scientific disciplines (e.g. Garud et al., 2013; Morlacchi and Nelson, 2011; Rosenberg, 2009; Blume, 1992). Of particular prominence in medical innovation is the interaction between the clinic – representing clinical procedures, experience and expertise – and actors involved in development of new drugs and medical devices (Nelson et al., 2011).

Sophisticated investigations of specific medical treatments, services and technologies from an innovation perspective have emerged, confirming earlier studies from the sociology of science that emphasised how innovations are rooted in "hybrid individuals" who are involved in both medical practice and scientific research and who frequently work part-time or fully in hospitals (Ben-David, 1960; Metcalfe et al., 2005; Mina et al., 2007; Morlacchi and Nelson, 2011). It has been suggested that the competence bases of medical innovations are highly distributed and that they can be related to different "health innovation systems" which produce bundles of medical technologies and clinical services (Bonaccorsi 2010; Braun 1994; Consoli and Mina, 2009). In such systems, "research hospitals (...) are especially important institutions" because they facilitate diffusion of knowledge (tacit and codified), act as lead users and give practical feedback on new technologies, and constitute an organisational link between experimental and basic research (Consoli and Mina, 2009, p. 307; also Gelijns and Rosenberg, 1994). Hospitals are major users of innovations but they also contribute through the co-development of innovations. They adopt and adapt these, developing new services and processes in connection with implementation of new technologies. Hospitals can also generate service innovations, with or without support from external organisations (Hopkins, 2006). Finally, hospitals play an important role in production and circulation of knowledge within heath systems – also in connection to the use of new medical technologies, procedures and treatments, not least through their important role in the training of multiple kinds of medical and health staff in hospitals and in the wider health care system. As such, hospitals represent sites where all the different benefits from research may appear (Salter and Martin, 2001).

Hospitals are, in other words, organisations that play many essential roles in medical innovation: production and diffusion of knowledge, linking of practice with science and technology, use of and feedback on prototypes and concepts, and implementation of new medical routines, devices and procedures. All hospital outputs and services may be tied to innovation; in this special section we focus on medical innovations but emphasise that innovation in hospitals extends beyond the types that are covered in this issue (for example related to administrative systems and food and lodging for patients; see Djellal and Gallouj, 2005). It also must be emphasised that hospitals are not a uniform category of organisations; they range from large and research-intensive academic hospitals to general hospitals that offer medical services but which perform comparatively limited research. In this special section, the majority of papers discuss the role of the academic hospital – that is hospitals that perform medical services (sometimes with a particular emphasis on "advanced" or "complex" diseases) as well as research, education and other knowledge-generating activities.

If we look at the innovation literature, few authors focus on the role of hospitals in innovation. For example, investigations of biotechnology tend to focus solely on firms, universities or the linkages between these two types of actors, although the relevant products often are co-developed with hospitals and implemented in this setting. The literature on user-driven innovation has looked at the role of medical doctors as lead users in innovation in medical devices, but has usually not foregrounded the role of hospitals as such. Investigations into particular medical innovation trajectories address the complex interplay between actors in the generation of new and useful medical knowledge or medical tools, but have not made hospitals the specific topic of research either. This special section of *Research Policy* aims to fill this gap. Moreover, the papers contained within this issue discuss the role of hospitals in relation to three central issues when it comes to medical innovation.

First, there is a worry that the rate of medical innovation is slowing down. The efficiency of research and development (R&D)

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activities in the pharmaceutical industry has been declining for many years as measured by the number of approved drugs per R&D expenditure (Kola and Landis 2004; Scannell et al., 2012). It has been suggested that the underlying problems have to do with the wider perspectives on and organisation of R&D and innovation within healthcare but this is not yet sufficiently understood (Scannell et al., 2012). Also, high expectations with regard to new areas such as biotechnology and genetic engineering have so far not been realised; these areas seem to lead to fewer and less radical innovations than assumed by many advocates (Nightingale and Martin, 2004; Holdrege and Talbott, 2008). A broadening from the study of firms to studying the role of hospitals in more detail may help shed light on these findings and associated puzzles.

A particularly popular explanation for these productivity challenges is that there is a gap or disconnect between the fundamental research happening "at the laboratory bench" in universities, some academic hospitals and some firms, and the clinical activities happening "at the bedside" near the patients. The preferred solution seems to be *translational research initiatives*, whereby dedicated research and medical centres and programmes aim to "translate" basic research findings into practically and often commercially valuable applications (NIH, 2003; Cockburn, 2006; Drolet and Lorenzi, 2011; Morris et al., 2011). This is not an easy task, as the processes of basic medical research and clinical research and development are fundamentally different, with the former increasingly oriented at screening and testing molecular or gene level discoveries (Scannell et al., 2012). One example of novel translational solutions is Academic Drug Discovery Centres where studies have indicated that there are organisational and cognitive challenges related to the "bridging" process (Frye et al., 2011; Kirkegaard and Valentin, 2014; Tralau-Stewart et al., 2014). Translational research is a fairly new concept which deserves special attention in order to better understand medical innovation; hospitals are again central because they are an important partner in and often the location of translational research.

Second, there is an increasing interest in the role of the state in innovation and entrepreneurship beyond regulation and interventions in cases of "market failures" and "system failures" (Mazzucato, 2013). By active engagement in all phases of the innovation process, often under politically acceptable headings such as "national security", "orphan drugs", "rare diseases" or "grand challenges" more widely, governments not only ensure well-functioning markets but take high risks and help create technologies that constitute the foundation for completely new products, services and industries (*ibid.*). In most countries, health and care providers are predominantly public organisations, especially the larger and technologically advanced organisations such as hospitals. They are highly regulated and governed by a number of public agencies, they are related to many of the grand challenges such as obesity and an aging population, and may serve as particularly useful empirical sites for improved understanding of the multifaceted role of the state in innovation.

Third, there is a call for more studies of the problems and challenges of the innovation process, not least in the health and care context where the long-term and systemic nature of innovation is particularly prevalent (Consoli and Mina, 2009). Despite the popularity of the concept of innovation itself, the process of innovation is often characterised by failures, professional and organisational barriers, lack of diffusion and various "complexities" (Ferlie et al., 2005; Currie and White, 2012; Garud et al., 2013). Complexities are related to the co-evolutionary and path-dependent nature of the process, to the dependencies between actors, to the asynchronous and diachronous aspects of development trajectories, and to the cultural differences between groups, organisations and countries (Garud et al., 2013). Hospitals are increasingly expected to play diverse roles – generating health through provision of care, as well as wealth through supporting and generating innovation (Department of Health, 2011). With these roles hospitals face pressures to host research and be open to innovation, yet they also must deliver services of consistent quality, with ever higher expectations for efficient delivery, high regulatory burden and more stretched resources (Zerhouni, 2005). Ambitious policy interventions to bring together and align clinical and non-clinical stakeholders have been created (Soper et al., 2013). With their central position in medical innovation systems, hospitals are a key site to study how the challenges of complex multi-stakeholder innovation are being addressed, or may be addressed, in a difficult context of resource constraint and often competing missions.

2. Papers in the special section

The special section seeks to address these issues as well as contribute to a better explicit understanding of hospitals' innovation-oriented activities. It is based on a track organised at the EU-SPRI conference in Madrid in April 2013 and on a series of annual workshops on medical innovation (WOMI) started in Oslo in December 2013, followed by Gothenburg in 2014 and Valencia in 2015. The seven final articles represent different levels of analysis of hospitals and innovation. Three of them analyse micro-level processes of R&D and innovation focusing on the activities of individuals within hospitals: Ali and Gittelman (2016) look at patenting and licensing among personnel in two prominent U.S. academic medical centres over a 30-year period, Llopis and D'Este (2016) have conducted a survey among individuals in Spanish biomedical research networks to study participation in different forms of medical innovation, and Lander (2016) explores translational activities among healthcare professionals and researchers in a Canadian academic hospital setting. Two articles represent the organisational level. Miller and French (2016) have carried out a case study of a Canadian research hospital looking for entrepreneurial activities that combine "wealth" and "health" perspectives, while Thune and Mina (2016) provide a systematic literature review of the role of hospitals in the generation of innovations and propose a research agenda based on relational and co-evolutionary perspectives. Finally, two articles analyse the wider system in which hospitals are embedded. Gittelman (2016) analyses different research paradigms in biomedical research, especially related to genomics and clinical research, and discusses implications for hospitals and innovation. Kukk et al. (2016) analyse the wider institutional work required by actors who want to implement innovations, through a case study of the personalised cancer drug Herceptin®. The articles also represent different methodological approaches ranging from quantitative econometric analyses to case studies and use of historical data.

Ali and Gittelman (2016) distinguish between basic and clinical research and propose that these two modes of research may best be conceptualised as distinct research paradigms, where clinical research in particular is found within hospitals and entails contact with afflicted patients for research personnel that are often trained in both scientific and medical work. They note that in the U.S. in the last decades, priority has been given to the basic research paradigm with its emphasis on laboratory-based fundamental investigations of cause-effect relationships, and to translational attempts involving heterogeneous teams and large-scale data. Their empirical investigation of patenting and licensing in two academic medical centres shows a "clinician effect" when controlling for specialisation and other variables: inventions by teams of clinicians are more likely to be licensed to firms, while inventions by basic research teams or combined teams are less likely to be licensed unless the team leader has both a medical and PhD degree. The lack of an effect of translational teams is particularly surprising, because the