Health care multidisciplinary teams: The sociotechnical approach for an integrated system-wide perspective

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Background: The current literature on the enabling conditions of multidisciplinary teams focuses on the singular dimensions of the organizations (i.e., human resources, clinical pathways, objects) without shedding light on to the way in which these organizational factors interact and mutually influence one another.

Purpose: Drawing on a system perspective of organizations, the authors analyze the organizational patterns that promote and support multidisciplinary teams and how they interrelate and interact to enforce the organization work system.

Methodology/Approach: The authors develop a modified sociotechnical system (STS) model to understand how the two dimensions of technical (devices/tools, layout/organization of space, core process standardization) and social (organizational structure, management of human resources and operations) can facilitate the implementation of multidisciplinary teams in health care. The study conducts an empirical analysis based on a sample of hospital adopters of transcatheter aortic valve implantation using the revised STS model.

Findings: The modified STS model applied to the case studies improves our understanding of the critical implementation factors of a multidisciplinary approach and the importance of coordinating radical changes in the technical and the social subsystems of health care organizations. The analysis informs that the multidisciplinary effort is not a sequential process and that the interplay between the two subsystems needs to be managed efficaciously as an integrated organizational whole to deliver the goals set.

Practice Implications: Hospital managers must place equal focus on the closely interrelated technical and social dimensions by investing in (a) shared layouts and spaces that cross the boundaries of the specialized health care units, (b) standardization of the core processes through the implementation of local clinical pathways, (c) structured knowledge management mechanisms, (d) the creation of clinical directorates, and (e) the design of a planning and budgeting system that integrates the multidisciplinary concept.

Key words: health care delivery processes, multidisciplinary teams, sociotechnical system, system-wide approach, technological innovation

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Multidisciplinary team-working is a complex process that brings together a group of diverse health care professionals to work and share their expertise, knowledge, and skills in order to deliver patient services (Mitchell, Parker, Giles, & Boyle, 2014; Nancarrow et al., 2013). Evidence shows that multidisciplinary teams play a significant role in generating a wide range of benefits, such as increased learning and development of people and institutions, better resource utilization, minimization of unnecessary costs, improvements in job performance and work quality, and more efficacious outcomes for patients and their families (Andreatta, 2010; Atwal & Caldwell, 2005). Consequently, well-coordinated collaboration within and across the medical professions is likely to be an increasingly important part of meeting contemporary health care challenges (Andreatta, 2010; McIntosh et al., 2014). Moreover, health care teams showed to be more complex than nonmedical teams, requiring more sophisticated knowledge of team dynamics and processes (Andreatta, 2010). This creates the need to devise managerial strategies that promote an interdependent collaborative approach among the professionals in the health care environment to maximize the benefits of multidisciplinary teams (Huckman & Pisano, 2006; Wholey et al., 2013).

The vast body of literature on the key enabling conditions of multidisciplinary team-working in the health care sector can be grouped into three main streams. The first focuses on human resource management, exploring the impact of organizational differences on the team learning rate (Edmondson, 2003; Pisano, Bohmer, & Edmondson, 2001) and demonstrating how an interdependent team leadership and an empowered team development, minimizing the impact of professional identity, can successfully frame the team learning process (Edmondson, 2003; Mitchell et al., 2014; Wholey et al., 2013). Other scholars found that relational coordination among cross-functional care provider groups, through relationships of shared goals, shared knowledge, and mutual respect, improved service performance (Gittell et al., 2000). The second stream identifies the powerful enabling tool of clinical pathways, which incorporate the implementation of guidelines and protocols into the core tasks and work processes of the professions in order to coordinate and promote a multidisciplinary approach in health care settings (Allen, 2009; Bragato & Jacobs, 2003), also in the event of increased uncertainty (Gittell, 2002). Finally, the third stream recognizes the role of objects and the organization of space where clinical procedure takes place (Barrett, Oborn, Orlikowski, & Yates, 2012; Nicolini, Mengis, & Swan, 2012) as key drivers in motivating and shaping cross-disciplinary collaboration and allowing participants to work across different types of boundaries.

Although the current literature offers many suggestions and implications, its main focus is on the singular dimensions of the organization and not on how these influence each other or how change management strategies need to be designed using an integrated organizational lens. To narrow this knowledge gap, the authors adopt a system perspective of organization to develop a modified sociotechnical system (STS) model and test it through the empirical analysis of multidisciplinary teams in health care settings. A description of this conceptual framework is given in the following section. The article then presents a multiple-case study analysis to identify (a) which of the model’s social and technical system patterns can better promote and support multidisciplinary teams and (b) how the social and technical systems interrelate and interact to implement the organization work system. The final sections discuss the findings of the analysis, informs practicing health care administrators and hospital managers about how to operationally apply the modified STS model, strengthens the extant knowledge base of the multidisciplinary approach, and points the way forward for future research.

## Conceptual Framework

Several organization theory scholars have investigated the role of the system perspective (Boulding, 1956; Von Bertalanffy, 1969) defined as the analysis and design of change processes that see the organization as a highly integrated system. Indeed, focusing exclusively on the single organizational subcomponents ignores the interaction between the diverse organizational dimensions and can be misleading, even counterproductive. The evidence provided by the health care management scholars shows that the adoption of a system-wide perspective is critical to understanding change and process innovation, be it the introduction of a new technology (Fitzgerald, Ferlie, Wood, & Hawkins, 2002; Sugarhood, Wherton, Procter, Hinder, & Greenhalgh, 2014) or the adoption of an innovative organizational model, for example, the lean approach (Mazzocato, Savage, Brommels, Aronsson, & Thor, 2010).

### The Sociotechnical System

The STS paradigm developed almost 60 years ago (Pasmore, Francis, Haldeman, & Shani, 1982; Shani, Grant, & Krishnan, 1992; Trist & Bamforth, 1951) has proved to be a particularly useful framework for assessing the system-wide implications of change and process innovation. The model considers each organization as a social subsystem of people and a technical subsystem of production process elements. The original technical subsystem model comprises the structures, tools, and knowledge needed to perform the work that produces products, whereas the social system brings into play the attitudes, beliefs, and relationships between individuals and among groups.
Regardless of type, each organization must align and ensure the compatibility of these two subsystems in order to produce a product or a service of value to the environmental subsystem (customers included) that also achieves market success. In other words, the concept underpinning the STS approach is the joint optimization of the technical and social subsystems that form the entire work system. There are two reasons that make the STS model particularly appropriate to analyze the organizational enabling conditions of health care multidisciplinary teams: (a) the fact that the integration of people and technology is a key driver of innovation and (b) the emphasis placed by the system-wide approach to process redesign on the importance of the human aspects. Health care organizations can be conceptualized as work systems in which people perform multiple tasks using various tools and technologies in a physical environment and under specific organizational conditions; those system interactions influence care processes and patient outcomes.

In devising the theoretical framework for this study, the authors modified the social and technical subsystems of the original STS model to factor in (a) the fundamental aspects that play a vital role in multidisciplinary team-working (i.e., human resources, clinical pathways, and objects) highlighted by the scientific literature discussed above and (b) the specific traits of the health care production processes when applying general organizational theoretical frameworks to the health care sector (Ackroyd, Hughes, & Soothill, 1989; Lega, Marsilio, & Villa, 2013). These specific traits include the long and diversified value chain of distinct organizational settings and environments, the presence of various stakeholders and subsystems with goals and expectations not always aligned, the adaptation of people and systems to local contingencies, the natural variability linked to the unpredictability of the demand and to the extremely high pace of product and process innovation, the relevant role of clinicians who tend to focus on maintaining the status quo and defending their professional autonomy as defined by the professional community, and the key role of knowledge creation and diffusion.

In the modified STS model, three key factors characterize the technical subsystem (Figure 1). Health care organizations adopt various types of devices/tools and technologies, such as medical devices and health IT, to improve care quality or safety or to reduce costs. The presence of different stakeholders with different expectations is a key factor when evaluating the introduction of a new technology: for example, suppliers and patients usually push for a fast introduction, managers and institutions are concerned about the overall economic sustainability, whereas the scientific community questions the appropriateness and the actual clinical improvement in comparison to the status quo. Second dimension regards layout/organization of space where the services are being delivered. Health care production processes are carried out in different spaces within and outside the hospital (e.g., operating rooms [ORs], hospital wards, outpatient clinics, rehabilitation centers). The higher number of processes of care that cut across different organizational settings (e.g., elderly and chronic patients care programs) spawn a series of interrelations and interdependencies between layouts that must necessarily be governed and given direction. Finally, core process standardization represents an important dimension of the technical subsystem. Core processes in health care delivery organizations consist of all diagnosis, treatment, and assistance activities done to patients. Evidence-based clinical guidelines inform health care professionals about caring for people with specific conditions. Defined as one of the most appropriate and effective ways to treat homogenous subgroups of patients, the accepted practice of clinical pathways translates the clinical guidelines into appropriate and effective organization core processes at the local level. It is extremely important to factor in local contingencies when implementing clinical pathways by holding in-depth discussions about the specific professional roles, the tasks involved, the decisions to be made, and the settings of each phase. Furthermore, a distinction must be made between natural variability (linked to the specificities of health care production processes) and artificial variability (usually caused by bad management and process malfunctions).

The social subsystem has three core dimensions as well (Figure 1). Organizational structure refers to the “hard” drivers of people management (Gareth, 2012), such as the formal assignment of roles and functions, the division of work between different units, and all the mechanisms that make the organization work, such as planning, budget and control systems, and reward systems. The design of
organizational structure in the health care sector is often complicated by the fact that the clinical professionals say that their job is to exclusively manage the patients and not deal with organizational performance, making them averse to organizational regulatory compliance. On the other side, human resource management includes the “soft” drivers such as the mechanisms and processes by which the organization generates and spreads knowledge to develop specific skills and competencies (e.g., leadership, teamwork, training; Gareth, 2012). The fast-paced changes in modern medicine and ongoing technological innovation assign a lead role to knowledge creation and diffusion in health care organizations. Finally, the operations management defined as the enabling mechanisms that support production processes. More specifically, operations management applied to health care means managing and optimizing the flow of goods and patients across the different hospital production units through scheduling and capacity planning, process design and execution, and information systems (Vissers & Beech, 2005).

The aim of the study is to investigate the robustness of the modified STS model and to identify which social and technical system patterns/tenets can better promote and support multidisciplinary teams in health care settings. The analysis also explores the interrelational dynamics to understand how the two subsystems interact to enforce the organization work system.

Methods

Research Design

To empirically investigate these propositions, the case study method has been adopted as deemed the most appropriate by the scholars to conduct an in-depth investigation of a contemporary phenomenon within its real-life context (Yin, 2014). Along with the other drivers of the multidisciplinary approach, the study examines the adoption of innovative medical technology as a typical primary engine of health care multidisciplinary team-working. The introduction of new technologies has a significant impact on health care organization work processes (Edmondson, Bohmer, & Pisano, 2001), disrupting the existing boundaries and routines that distinguish the several professional domains challenging organizational relationships and demanding new and alternative ways of interaction (Korica & Molloy, 2010). Several authors (Artwell, 1992; Orlowski, 2000), beginning with Barley’s (1986) pioneer work, underscore how a multidisciplinary approach to team-working can determine the implementation benefits of new technology. The transcatheter aortic valve implantation (TAVI) technology and procedure were identified by a focus group of 12 health care experts (industry representatives, policymakers, and scholars) as a typical case (Yin, 2014) of innovative medical technology that challenges routines and demands the efficacious implementation of a multidisciplinary team in clinical practice. TAVI is a highly technological, complex, and intensive procedure developed as a less invasive procedural alternative to surgical valve replacement for aortic stenosis in elderly or high-risk patients who are not suitable candidates for conventional open-heart surgery treatment (Feldman & DiSesa, 2014). TAVI implementation requires the hospital to create a well-organized multidisciplinary team, as set out in the most recent clinical guidelines issued by the relevant professional societies (Vahanian & Alfieri, 2013). Ideally, the multidisciplinary teams have broad expertise in structural and valvular heart disease, cardiovascular imaging, and post-procedure care and is composed of cardiac surgeons, cardiologists, radiologists, anesthesiologists, and trained nurses. The experts also recommend performing the procedure in a “hybrid” OR installed with the equipment and staff required for both image-guided catheter-based intervention and open-heart surgery (Vahanian & Alfieri, 2013). TAVI technology is an “interventionist” procedure, situated midway between the two specializations of cardiology and cardiac surgery, that is, it straddles the boundary but belongs to neither one nor the other. Traditionally, patients with heart valve problems are treated by cardiac surgeons, but the fact that TAVI is a catheter-based technology means that the skills of a cardiologist-interventionist are also needed. Moving the patients from the surgeon to the cardiologist in such a high-volume procedure poses at least two challenges: the technological and procedure-learning challenge for the cardiologists and the cardiac surgeons, and the organizational challenge whereby diverse professionals (cardiologists, cardio surgeons, anesthesiologists, and nurses) must learn and work together as a multidisciplinary team.

Data Collection and Analysis

The data were collected in 2012 from the Italian National Health Service (INHS) hospital-adopters of TAVI, that is, those using the TAVI procedure since it was introduced in Italy in 2007. In 2011, Italy performed 14.9% of total European implants, ranking second by TAVI take-up rate. In 2012, when the data were sourced, 80 hospitals across Italy had already completed a total of 1,855 TAVI procedures. The number of procedures varied significantly from hospital to hospital: More than 50 hospitals (62.5%) recorded less than 20 TAVI procedures, whereas 11 hospitals (13.5%) completed over 45 procedures. The results of a new technology or procedure have been widely shown to improve in step with the learning curve experience (Edmondson, Winslow, Bohmer, & Pisano, 2003) The international guidelines that specifically address TAVI suggest that, for a single hospital to achieve the optimal results, it needs to treat at least 40–50 cases per year. In
order to minimize any variations in technical competence driven by the volume of use, the authors focused exclusively on the 11 “strong adopters” of TAVI, starting with those hospitals that performed the most procedures. Consistent with replication logic (Yin, 2014), the analysis was halted at the theoretical saturation point with reasonable in-depth knowledge of the variance in technical and social dimensions previously identified in the model (Guest, Bunce, & Johnson, 2006). This selection process resulted in using the top four hospitals of the 11 short-listed health care facilities as case studies (Table 1).

The case study methodology relies on multiple sources of evidence with data that must converge and benefits from the prior development of theoretical propositions to guide the data collection and analysis (Yin, 2014). In order to understand the TAVI technology and procedure, the authors interviewed the industry representatives of the two medical device companies operating in the Italian market in 2012. A structured interview protocol of 38 open-ended questions split into sections according to the modified STS domains was then designed to obtain the relevant information from each health professional involved in the procedure; the questionnaire was subsequently tested in a pilot study with four professionals. A total of 27 interviews were held over a 6-month period with different staff at each hospital whose roles assigned them responsibility for key aspects of the TAVI procedure (Table 1). Two members of the research team were present at each interview: one of the three authors accompanied by their research assistant. Questions on factual issues aimed to get the multiple respondents at each site to give their diverse perspectives of the individual roles; the responses were then cross-checked to optimize data validity. The interviews were tape-recorded and transcribed verbatim (>400 pages of written material). A direct content analysis approach was used to analyze and codify the transcribed text (Hsieh & Shannon, 2005). The content analysis followed different steps. First, using the modified STS categories, the researchers identified key concepts or variables as initial coding categories. The three authors then independently reviewed the material and highlighted all text that initially appeared to refer to a key social or technical element. The next step entailed coding all the highlighted passages according to the predetermined categories. Text that eluded this coding scheme was given a new code. The researchers compared notes and reconciled any deviations from their initial coding and then used the consolidated checklist to independently code all the text and reach an acceptable level of reliability of the coding. The coded data set enabled the comparison of specific features across the four hospitals to facilitate cross-case analysis.

Findings

The modified STS model developed and applied by the authors to the case study analysis produced the following findings, also summarized in Table 2 (technical subsystem) and Table 3 (social subsystem).

Technical Subsystem

**Devices and tools.** The TAVI procedure replaces the diseased aortic valve by inserting a technologically innovative valve into the heart via catheter. This minimally invasive development has radically changed the management of aortic valve heart disease. The complex TAVI procedure involves many interlocking steps organized by each hospital in three main phases: (a) diagnostic testing and evaluation of the patient’s risk profile and eligibility for TAVI, (b) TAVI insertion, and (c) postsurgical recovery of patients in the intensive care unit (ICU) and regular floors. In the first phase, the patient undergoes
intensive medical examinations and tests (e.g., ulcer, chro-

Table 2

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Hospital 1</th>
<th>Hospital 2</th>
<th>Hospital 3</th>
<th>Hospital 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEVICE AND TOOLS</strong></td>
<td></td>
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<tr>
<td>Insertion procedure (%)</td>
<td>TR 70%</td>
<td>SG 30%</td>
<td>TR 75%</td>
<td>SG 25%</td>
</tr>
<tr>
<td><strong>LAYOUT AND SPACE</strong></td>
<td></td>
<td></td>
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<tr>
<td>a) Pretreatment diagnostic phase</td>
<td>Dedicated TAVI hemodynamic outpatient rooms</td>
<td>Specific slot for TAVI patient in the aortic stenosis outpatient room</td>
<td>Specific slot for TAVI patient in the hemodynamic outpatient rooms</td>
<td>Specific slot for TAVI patient in the hemodynamic outpatient rooms</td>
</tr>
<tr>
<td>b) Insertion procedure phase</td>
<td>Hemodynamic Cath Lab</td>
<td>Hybrid room</td>
<td>Hemodynamic Cath Lab</td>
<td>Hemodynamic Cath Lab</td>
</tr>
<tr>
<td>c) Postsurgical recovery</td>
<td>TAVI beds in ICU and in Cardiac Surgery ward</td>
<td>ICU and Cardiology ward beds</td>
<td>ICU and Cardiology ward beds</td>
<td>ICU and Cardiology ward beds</td>
</tr>
<tr>
<td><strong>PROCESS STANDARDIZATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAVI clinical pathway</td>
<td>Full definition and implementation</td>
<td>Definition and implementation only for the insertion procedure phase</td>
<td>No formalization</td>
<td>Full definition and implementation</td>
</tr>
</tbody>
</table>

Note. TR = transfemoral procedure; SG = surgical operation; OR = operating room; ICU = intensive care unit.

stenosis with a specific slot for TAVI patients. Hospitals 3 and 4 did not arrange specific facilities but assigned three afternoons per week for TAVI diagnosis and screening in the regular hemodynamic outpatient units. The TAVI-eligible patients then proceed to the next two phases according to the type of TAVI access treatment recommended. A "hybrid" OR furnished with the relative equipment and the medical staff qualified to conduct both image-guided catheter-based interventions and open-heart surgery is the preferred TAVI procedure setting indicated by the clinical standards (Vahanian & Alfieri, 2013). Of the three hospitals to assign a specific setting for the TAVI procedure, only Hospital 2 has a hybrid room. Hospital 1 divided its setting rooms according to the access route, using the hemodynamic Cath Lab for the transfemoral procedures and the cardiac OR for the surgical approach. Hospitals 3 and 4 assigned all TAVI procedures to the hemodynamic Cath Lab.

The decision of these two hospitals to use the hemodynamic Cath Lab for all TAVI procedures led the professionals involved to take conflicting positions. For example, a radiologist from Hospital 4 told us that the Cath Lab is too small to perform procedures such as TAVI, “the layout should be redesigned to reduce radiological exposure for both patients and operators.” Some cardiac surgeons’ statements indicate a sense of confusion and inconvenience (“Sometimes I feel like a fish out of water…”) and fear and danger (“what happens if something goes wrong?”). This has led the surgeons, anesthesiologists, and radiologists to argue in favor of the hybrid OR over the
Cath Lab, deeming the former a safer, larger, and more comfortable setting with fewer radiological protection problems. Cardiologists tend to take a more cautious stance, favoring the Cath Lab as a more appropriate setting for TAVI procedures. “Given the severe health budget restrictions that work against the better alternative of the hybrid room, the Cath Lab is the appropriate place for the TAVI procedures, in my view” (Cardiologist, Hospital 3). Moreover, a clear conflictual undertow emerged between the respondent nurses and technicians, whose jobs place them in the separate units of OR and Cath Lab. For example, “We have to compensate for the lack of expertise and skills of the technicians in charge of device preparation” (Nurse, Hospital 4). “Nurses act as if they are the only ones that know stuff and consider us pretty much useless” (Technician, Hospital 4). All posttreatment TAVI patients, without exception, must be admitted to the ICU, but Hospital 1 was the only one to allocate them specific ICU beds. The postsurgical recovery approaches to the management of TAVI ward logistics differed from one sample hospital to another. Hospitals 2 and 4 based their decisions on the settings in which to treat the patients on the recommended type of access route, sending those eligible for transfemoral procedures to the cardiology ward and hospitalizing the others in cardiac surgery wards. Hospital 3 admitted all TAVI patients to the cardiology ward. Hospital 1 was the only one to allocate four beds in the cardiac surgery ward to TAVI patients.

**Core process standardization.** The interviews indicated that each hospital’s clinical pathways standardized and formalized the core TAVI process steps described above to different degrees. Specifically, a full standard TAVI pathway integrating all three phases was defined and implemented by Hospitals 1 and 4, whereas Hospital 2 issued detailed guidelines for solely Phase 1 (patient assessment and access to the aortic valve decision-making process). Hence, Hospitals 1, 2, and 4 each invested significantly in defining, developing, and circulating guidelines and protocols for the appropriate TAVI clinical pathway and the main phases of the procedure. “Despite much talk about developing integrated clinical pathways [with the cardiology unit], only the TAVI treatment was successfully implemented” (Cardiac Surgeon, Hospital 1). The only one of the four not to adopt a specific and formalized TAVI pathway was Hospital 3.

**Social Subsystem**

**Organizational structure.** According to the latest clinical guidelines, TAVI technology is not the outright domain of either the cardiology unit or the cardiac surgery unit but of a well-organized multidisciplinary “heart team” qualified to manage the complex TAVI procedure exclusively. The four hospitals sampled therefore put together a multidisciplinary TAVI team of cardiac surgeons, cardiologists, radiologists, anesthesiologists, nurses, and technicians. However, the information gathered from the interviews shows that the TAVI team line-up varies from hospital to hospital with the medical staff assigned different roles in the three main TAVI procedural phases. All four hospitals scheduled TAVI meetings in which the cardiologists, cardiac surgeons, and anesthesiologists jointly assessed each patient’s diagnostic tests and other conditions for TAVI feasibility—rated according to the international clinical guidelines scores—and decided the best access route to insert the valve. Clinical standards recommend that both a cardiac surgeon and a cardiologist carry out specific procedural steps to support the actual insertion of the catheter at the selected access point during a TAVI procedure, regardless of the access route and the professional in charge of the catheter insertion. Nevertheless, each clinician is given a different role in the TAVI procedure according to the approaches deemed most appropriate by the professionals of each hospital. At Hospital 3, the TAVI cardiac surgeon and OR nurses are in charge of and actively involved in the “surgical” approaches but not in the transfemoral procedures, remaining outside the Cath Lab but on call for surgical “rescue” interventions. Hospital 1 has placed both a cardiac surgeon and a cardiologist in charge of all TAVI procedures supported by the TAVI heart team members. Hospital 4 tasks the cardiologist and the technicians with key roles in most transfemoral procedures. Hospital 2 places primarily a cardiac surgeon in charge of all TAVI procedures supported by the rest of the TAVI heart team. In terms of postsurgical recovery, the consensus of the respondents was that the TAVI patients require specific attention from both the cardiologist and the cardiac surgeon. Nevertheless, regardless of the setting in which the TAVI is performed, the TAVI patients are then transferred to the disciplinary teams of the wards to which they were originally admitted. Hospital 1 alone assigns the multidisciplinary TAVI heart team to care for patients through the entire duration of their hospital stay, even though their beds are physically located in the cardiac surgery ward. Departments (or clinical directorates) are intermediate organizational arrangements through which defined parts of larger hospital health services are managed. All of the hospitals analyzed, except for Hospital 3, established a multispecialty cardiothoracic and vascular clinical department that includes the cardiology and cardiac surgery units. These departments are in charge of clinical governance issues. In Hospitals 1 and 4, the introduction of the TAVI procedure was promoted personally by the head of department. The respondents all agreed that having a single department as the point of reference was of considerable support to TAVI team-working. “The departmental structure was highly influential in overcoming the resistance of the specialized units to collaboration in TAVI procedures” (Head of Cardiac Surgery, Hospital 2). The treatment costs of TAVI patients are sustained by both the cardiology and

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the cardiac surgery units involved in the procedure. However, the Diagnosis Related Group-based fee mechanism of the Italian NHS funding allocation system means that the treatment is paid to the organizational unit to which the patient has been formally assigned on admission to the hospital. This creates a tense environment in which the constant battle for patients (Cardiologist, Hospital 4) creates fear among the staff that “their patients will be stolen” (Cardiologist, Hospital 1).

**Human resource management.** The decision to adopt the TAVI procedure was driven by the efforts of the individual clinical leaders of each hospital. Hospital 1’s campaign was led by the Head of Cardiac Surgery, whereas Hospitals 2, 3, and 4’s were advocated by the Head of Cardiology. The TAVI leaders of Hospitals 1 and 2 got their colleagues actively involved in the project, as attested by several respondents. “I’m lucky to have Mr. X [Head of Cardiac Surgery] as a colleague; he’s not only highly competent, but also understands the value of innovative treatments” (Head of Cardiology, Hospital 2). “A key driver of the collaborative effort to implement TAVI was the [Head of the Cardiac Surgery Unit’s] ability to embrace innovation and its international standing” (Head of Cardiology, Hospital 1). However, that positive view is not shared by the cardiac surgeons of Hospitals 3 and 4. All four hospitals accompanied the TAVI implementation process with structured knowledge management mechanisms, guided primarily by the medical industry technology experts. However, this type of formal training has targeted specifically the cardiologists and cardiac surgeons, leaving the nurses, technicians, anesthesiologists, and cardiographists to “learn by doing.” The cardiologists and cardiac surgeons of Hospital 1 took it on themselves to design an internal training process for their nurses, technicians, anesthesiologists. Hospital 2 adopted a rotation system to increase the number of nurses qualified to assist TAVI patients. Hospital 3 issued specific TAVI training to just two Cath Lab nurses without organizing any form of knowledge transfer; the two TAVI-trained nurses are involved in all the TAVI procedures regardless of the approaches used. However, if neither of these trained nurses is on duty in the hospital, then an industry specialist has to be called in. Hospital 2’s internal training and specialization program involved also three echo-cardiographists who, after being trained to support TAVI diagnostic activities, were reassigned to the TAVI heart team from the diagnostic department, its capabilities deemed inadequate for the procedure. Hospital 4 invested the least, training exclusively the top professionals. Hospital 4’s anesthesiologist actually lamented the fact that “The cardiac surgeon had to get acquainted with non-invasive procedures while the

### Table 3

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Hospital 1</th>
<th>Hospital 2</th>
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<tbody>
<tr>
<td><strong>ORGANIZATIONAL STRUCTURE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) TAVI team structure</td>
<td></td>
<td></td>
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<tr>
<td>a.i) Patient eligibility evaluation (diagnosis)</td>
<td>TAVI meetings attended by cardiologists, cardiac surgeons, and anesthesiologists</td>
<td>TAVI meetings attended by cardiologists, cardiac surgeons, and anesthesiologists</td>
</tr>
<tr>
<td>a.ii) Insertion procedure and professional in charge of it</td>
<td>TR SG Both the cardiac surgeon and the cardiologist</td>
<td>“Hybrid” doctor in charge of all TAVI procedures Disciplinary team of the wards to which patients are admitted</td>
</tr>
<tr>
<td>a.iii) Postsurgical recovery</td>
<td>TAVI heart team</td>
<td></td>
</tr>
<tr>
<td>(b) Clinical department (including cardiac surgery and hemodynamic units)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>HUMAN RESOURCE MANAGEMENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) TAVI Leadership</td>
<td>Head of Cardiac Surgery</td>
<td>Head of Cardiology-Hemodynamics</td>
</tr>
<tr>
<td>b) Knowledge management and training</td>
<td>Structured knowledge management by industries</td>
<td>Structured knowledge management by industries + internal specialization of an “hybrid” doctor</td>
</tr>
<tr>
<td>b.i) Cardiologists and cardiac surgeons</td>
<td>Structured internal training process</td>
<td>Structured internal training process</td>
</tr>
<tr>
<td>b.ii) Other TAVI team members</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>OPERATIONS MANAGEMENT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adoption of TAVI specific operation management systems</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

*Note. TR = transfemoral intervention; SG = surgical operation.*
cardiologist had to learn to suture, which meant they had to receive specific industry training; on the other hand, we anesthesiologists members of the new TAVI procedure team have received no upskilling at all.

Moreover, the evidence shows that TAVI adoption can be a catalyst for upskilling the specialized doctors, providing them with training that blends the two specializations of cardiology and cardiac surgery into a cross-boundary role. In particular, Hospital 2 formally identified and trained the hybrid doctor.

The hybrid doctor is a TAVI procedure specialist trained to perform most of the TAVI procedures and for medically responsible for the TAVI patients. In this particular case, the hybrid doctor is a cardiac surgeon formerly assigned to the cardiac surgery unit but who worked mainly in the Cath Lab. “I’m a hybrid doctor: I’m a surgeon but 80% of my time is dedicated to TAVI procedures.” The hybrid nomenclature has entered the professional lexicon of Hospital 2’s TAVI staff with all respondents referring to him as the “hybrid doctor.” Hospital 1 also has assigned dedicated physicians to the TAVI procedure; in particular, the heads of cardiology and cardiac surgery have selected two doctors (one cardiologist and one cardiac surgeon) to receive training in this field, both of whom currently work full time on TAVI procedures.

**Operations management.** In each case, the need to use multiple professionals to handle different tasks in different settings meant that capacity planning management had to develop appropriate new tools and mechanisms. TAVI requires also well-functioning operations systems to support the primary clinical processes. The TAVI procedure poses at least three major challenges: (a) the simultaneous presence of different heart team members in the same setting, (b) longer OR/Cath Lab setup time and greater variations in surgical timing to accommodate the different technologies needed during TAVI insertion whereas the traditional procedures are managed independently by the single units, and (c) the patient’s need for specialized post-TAVI nursing assistance. This means that the hospitals need to invest in six key operational aspects: (a) beds management, (b) beds’ rounds, (c) physicians’ consultancies, (d) discharge process, (e) physicians and nurses’ shifts, and (f) scheduling of ORs. In order to redesign the operations and scheduling systems to facilitate the TAVI procedure, Hospitals 1 and 4 called on the support of the operations management office and the administrative department, respectively, whereas the change in the operations systems at Hospitals 2 and 3 was driven more by contingencies, which gave rise to operational problems such as OR overtime, ICU overcrowding, and disorganized hospital rounds,

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<td>None structured training – learning by doing No</td>
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**Main dimensions of the social system: Findings from the case studies**

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especially during the initial phase of TAVI implementation. At Hospital 4, the Head of Cardiothoracic was very clear in his praise of the role of the operations management office, which helped to expedite several operational details, thus saving the doctors from spending valuable time on matters that would otherwise have eaten into their medical schedule: “...indeed it was a pleasant surprise to see, for example, how efficiently the beds rounds had been organized so that the cardiologists and cardiac surgeons did not have to wait on each other to see the TAVI patients...” The Cardiac Surgeon at Hospital 1 stressed how vital it was to schedule the OR/Cath Lab procedures and to coordinate efficiently and effectively the OR/Cath Lab list and patient flow management efforts in the ICU and wards in order to avoid overcrowding and bed shortages.

### Discussion

The modified STS model shows that adopting a multidisciplinary team brings complex change management challenges to both the technical and social organizational subsystems. However, it is highly advisable to approach this as a sequential process given the need to effectively manage the interplay between both dimensions. Each of the four hospitals analyzed here has officially set up a multidisciplinary team to manage the new medical technology in accordance with the clinical guidelines. Nevertheless, the research findings clarify our understanding of the critical role of the modified tenets of the STS model and of the dynamics and interaction of the technical and the social subsystems in promoting and enabling such multidisciplinary teams. On the technical side, critical enabling conditions for multidisciplinary team-working include shared multispecialty spaces and facilities that do not belong to a specific clinical unit but are designed to meet specific patient needs (such as the TAVI screening, diagnostics and follow-up outpatient units, the hybrid and shared ORs, and the TAVI beds where patients receive care from the entire heart team). In fact, the cross-units innovated primarily by Hospitals 1 and 2 contribute fourfold to the multidisciplinary team-working by (a) maximizing coordination, team-learning, and knowledge-sharing; (b) improving the collaborative mentality, allowing practitioners to surpass traditional boundaries; (c) dispelling the negative perceptions of the many respondents who did “not feel at home”; and (d) enhancing the actual sharing and implementation of clinical pathways. The use of process standardization also underscores the mutual adjustment of the technical and social dimensions. The use of technical tools to formalize and standardize the core process phases (the clinical pathway) has made it easier to coordinate and integrate the interaction of the various health care professionals. In particular, many respondents considered the defining clinical pathway process an important driver of multidisciplinary team enforcement, because it strengthened the collaboration between the cardiologists and the cardiac surgeons. The case analysis shows that specific and intensive training and knowledge transfer is an enabling condition of the TAVI process and that it has to be applied to all members of the multidisciplinary heart team. The knowledge management mechanism was a significant help to further motivate the heart team. Hospitals 1 and 2 invested substantially to develop a specific training program that led them to create TAVI-specialized professionals (hybrid doctors, TAVI nurses, and TAVI cardiographers). These newly evolved professions are more likely to adopt an integrated and multidisciplinary approach given that these individuals (a) interact with other types of health care professionals, (b) take care of patients across shared and multidisciplinary wards, and (c) need to acquire additional skills in affinity with their specialization. Moreover, the operation management process adopted (attentive redesign of treatment scheduling systems) helped to ensure the efficacious management of the naturally high variability in TAVI procedure timing, space allocation, and the availability of the diverse members of multidisciplinary team and the specialized postsurgical nursing assistants. Finally, the study shows how the clinical department is an organizational structure that effectively unites the multidisciplinary teams in both the technical and the social subsystems because (a) it is a key factor in the development of clinical pathways and the entire knowledge-management process, (b) it can facilitate the creation of shared spaces and units that are primary enablers of multidisciplinary approaches and team-working, and (c) it can manage the expert leadership of the individual that has a profound influence on interprofessional team dynamics. It also reveals how Italy’s traditional NHS Diagnosis Related Group funding system was an unmovable boulder to an effective integrated multidisciplinary approach to care, practically igniting a turf war among medical staff who felt threatened by the potential loss of patients. However, this is a major issue and a bounded trait of the INHS that is beyond the jurisdiction of the hospital managers, themselves being subject to the constraints of the Italian legislative and regulatory framework.

### Practice Implications

The research offers valuable insights for practitioners tasked with managing the new medical technologies and the related multidisciplinary approaches. The empirical analysis shows that hospital administrators need to make a concerted effort across the entire technical (T) and social (S) spectrum to enable the multidisciplinary teams to work efficaciously. In particular, the evidence provided by the case study highlights four key factors critical to creating the
settings and optimizing the work and interaction of the multidisciplinary teams:

1. Hospital structural layout (T): (a) shared spaces facilitate knowledge creation and team-working (S), overriding the negativity of not “feeling at home” and (b) working in the same space eases process standardization and hence the implementation of clinical pathways (T).

2. The implementation of clinical pathways (T) optimizes the integration of clinical treatment, operations management, and patient interests and, as a key organizational methodology for team-working, is not only facilitated by the hospital’s structural layout (T) but also enforced by an organizational structure designed around clinical directorates (S).

3. Knowledge management is a key driver of multidisciplinary team-working (S). Instead of delegating this important aspect to the medical technology industry, the hospital managers need to design a formal training program that promotes a multidisciplinary culture among all the professionals involved. In addition, the findings show that the shared facilities (T) have the ability to maximize knowledge transfer among the different TAVI professionals.

4. Health care managers need to liaise more effectively with policymakers to design a more bundled payment system that links the funding to the entire patient care process and the multidisciplinary approach required by new medical technology. Furthermore, the managers need to start designing a planning and budgeting system (S) more oriented to the multidisciplinary approach in order to offset the negative impacts of the current health service funding system.

## Conclusions

There can be no question that multidisciplinary teams are a key factor in the design and delivery of health care delivery processes. The study integrates the main streams of literature on multidisciplinary teams with a system-wide framework to develop a modified STS model that is more tailored to investigating the work of the multidisciplinary teams and that opens up new research paths. The authors believe that the model provides a highly useful theoretical framework to guide the implementation of multidisciplinary teams for three reasons: (a) it recognizes the need to take a system-wide approach to the organization, (b) it identifies the diverse social and technical variables that need potential adjustment and realignment, and (c) it charts the direction and the interactions of these latter.

The implications of the study of multidisciplinary teams in relation to technological innovation in health care can be generalized to other sector dynamics that require team-working. One example is the increasing complexity of the skills and knowledge needed to provide comprehensive care to an ageing patient population with multiple chronic diseases (Greenhalgh et al., 2013; Wholey et al., 2014). The focus of this research is on organizational, social, and technical domains, but the study also has produced collateral evidence on the present INHS funding system that calls for the STS model to extend its scope to the organization’s institutional relationships with the strategic stakeholders and, therefore, points the future research agenda in that direction. A further suggestion for research is to quantitatively analyze the outcomes of adopting diverse factors of the modified STS for the management of multidisciplinary teams on organizational performance, for example, the impact of quality of care or length of stay (Gittell, 2002).

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## References


