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Patient satisfaction in emergency department: Unveiling complex interactions by wearable sensors

Alessandro Stefanini[a,*], Davide Aloini[a], Peter Gloor[b], Federica Pochiero[a]

[a] Department of Energy, Systems, Territory and Construction Engineering, University of Pisa, Largo Lucio Lazzarino, 56122 Pisa, Italy
[b] Center for Collective Intelligence, MIT Sloan School of Management, Cambridge, MA 02139, USA

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ABSTRACT

We analyzed the interaction between patients and providers in the emergency department of a large university hospital using Sociometric Badges. Providers (doctors and nurses) were equipped with wearable sensors (Sociometric Badges), the badges measure body movements and speech energy with accelerometers, microphones, Bluetooth and infrared sensors.

Results show that patient satisfaction and service perceptions are greatly influenced by behavioral and network factors. Patients appreciate the physical closeness of the doctors and the providers' continuous monitoring of their health conditions. They also desire to be actively involved into the communication network with practitioners. In addition, patients perceive positively teams where doctors take the leadership of the communication network and ensure an effective team conversation.

1. Introduction

Patient satisfaction is a key measure of quality for healthcare organizations, assessed by health authorities and insurance companies alike to guarantee the satisfaction users of their health services (Berkowitz, 2016; Tsai, Orav, & Jha, 2015; Williams, 1994). Hospitals are constantly evaluated and, in some cases, remunerated based on metrics related to patient satisfaction (Roland & Dudley, 2015; Welch, 2010). Research shows that popularity and economic success of a hospital are directly related to positive patient experiences (Tsai et al., 2015).

Although it is essential to understand the determinants of patient satisfaction for improving hospital performance, investigating it is highly challenging due to the complex interaction dynamics between patients and medical staff that affect patient perceptions (Berkowitz, 2016; Sofaer & Firminger, 2005). Moreover, the dependence of patient perception on patient personality and culture, and the wide differences in care settings make such investigations even more complicated (Berkowitz, 2016; Sofaer & Firminger, 2005).

Patient satisfaction can be defined as the subjective perception of service quality derived from matching the expectations regarding the service with the actual experience and outcomes (Jain et al., 2017; Ross, Frommelt, Hazelwood, & Chang, 1987). Alongside the clinical outcome, which is at the core of health services, the relationship between patient and healthcare providers strongly influences the customer's perception of service performance and contributes to the service's value (Alrubaiee & Alkaa'ida, 2011; Ashill & Rod, 2011; Boquiren, Hack, Beaver, & Williamson, 2015; Ríos-Risquez & García-Izquierdo, 2016; Ware, Snyder, Wright, & Davies, 1983). Indeed, a good technical result does not always correspond to the overall satisfaction of the patient, while poor outcomes sometimes do not correspond to patient disappointment. Although the interpersonal relationship between patient and practitioners is recognized as a complex and important component of patient satisfaction (Boquiren et al., 2015; Sitzia & Wood, 1997) particularly in emergency medicine, investigating connections between technical and non-technical service performance is still an open issue and few researches addressed the topic quantitatively (Batbaatar, Dorjdagva, Luvsannyam, Savino, & Amenta, 2017).

In particular, researchers agree that both verbal and non-verbal interactions between practitioners and patient, and within medical teams might have a higher impact on patient satisfaction with respect to care effectiveness (e.g. Godil et al., 2013; Boquiren et al., 2015; Ríos-Risquez & García-Izquierdo, 2016). Indeed, past work has shown that verbal communication, non-verbal behaviors, and team network dynamics during diagnosis and treatments are among the principal determinants of the service experience (Batbaatar et al., 2017; Boquiren et al., 2015). An in-depth exploration of such determinants is therefore crucial for healthcare organizations to effectively support health service (re-)design and to improve healthcare provider behaviors. However, behavioral drivers affecting service delivery have been scarcely

* Corresponding author.
E-mail address: a.stefanini@ing.unipi.it (A. Stefanini).

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investigated and the resulting evidence is far from being conclusive (Batbaatar et al., 2017).

To fill this gap, this paper proposes a novel approach based on wearable sensors for investigating the practitioners' behaviors possibly influencing patient satisfaction. We therefore address the following Research Question:

RQ. How do providers' behaviors, expressed by verbal and non-verbal communication and team dynamics, affect patient satisfaction?

Specifically, this work empirically investigates the research question in the context of an Emergency Department, a very critical and still under investigated research setting for the healthcare system. Indeed, EDs have gained under pressure from national authorities and public opinion, e.g. public debate on excessive waiting time or misdiagnosis (Rebuge and Ferreira, 2012; Ganguly, Lawrence, & Prather, 2014; Van der Vaart, Vastag, & Wijngaard, 2011). This is also highlighted by the increasing attention paid by national health authorities to ED performance and to service levels offered to patients. As an addition, it is largely known the effect of EDs' performance on hospital reputation, since the ED is often the first department a patient visits and the first source of complaints for a hospital (Rehman & Ali, 2016; Trout, Magnusson, & Hedges, 2000).

The contribution of this work is related to the identification of the behavioral factors affecting service delivery through the use of direct and systematic measurements of human behaviors by wearable sensors. Specifically, the uniqueness of this study comes from an in-depth exploration of practitioners' behaviors and their effects on patient satisfaction during the ED service operations.

The case study reveals that patient satisfaction is greatly influenced by verbal communication, non-verbal behaviors, and team network dynamics. In particular, patients appreciate the physical closeness of the doctors and their role as leaders in the communication network during their stay in the ED. In addition, patients would like to be actively involved into the practitioners' communication and they welcome the staff's effort to continuously monitor their health condition.

The identification of such peculiar behavioral aspects influencing patient satisfaction, which are still absent in literature (Batbaatar et al., 2017), provides useful managerial implications for incorporating such complex factors into ED services by an appropriate re-design.

This research also provides important contributions from a methodological perspective by testing the suitability of wearable sensors (Carnevale, Huang, & Harms, 2018; Chaffin et al., 2017) for investigating human behaviors in real service settings. Therefore, the novelty of this paper also comes from applying an effective method for exploring determinants of customer satisfaction in the healthcare context where providers' behaviors significantly affect customers' experience and perception about service quality (Braun & Hadwich, 2016; Fitzsimmons, Fitzsimmons, & Bordoloi, 2008). In so doing, the proposed method overcomes the main limitations associated with self-report and direct observation, which are the typical approaches exploited for studying practitioners' behaviors and interactions with patients. Indeed, self-report methods introduce serious limitations regarding the subjectivity of judgments (different scales of perception for participants), the limited number of behavioral aspects analyzable, and the memory effect since such evaluations are not carried out in real-time (Pronin, 2007; Lepine, Piccolo, Jackson, Mathieu, & Saul, 2008; Ashill & Rod, 2011; Schmutz & Manser, 2013; Rosen, Dietz, Yang, Priebe, & Pronovost, 2014). On the other hand, while observational methods, as for instance direct observation and video analysis, may overcome memory effect and subjectivity (Morgan, Pullon, & McKinlay, 2015; Schmutz & Manser, 2013), they might introduce other limitations due to the influence of the observers, in particular their subjectivity in the standardization and the coding of behaviors (Barley, 1990; Blanch-Hartigan, Ruben, Hall, & Mast, 2018; Cunningham et al., 2012; Leonard-Barton, 1990). They are also very time consuming and raise serious privacy concerns (Rosen et al., 2014). Consequently, the researchers' opportunity to identify behavioral determinants of patient satisfaction through self-report and direct observation remains limited compared with employing wearable sensors.

The remainder of the paper is organized as follow. Section 2 describes the theoretical background. Section 3 presents the research methodology, while Section 4 introduces the case study. Next, Section 5 shows the results while Section 6 presents the discussion. Lastly, Section 7 draws the conclusions of the research and outlines future developments.

2. Theoretical background

2.1. Practitioner behaviors and patient satisfaction

Patient-practitioner relationships are multifaceted, subjective, and hard to analyze in a systematic way. Social network interactions among practitioners or between the medical team and the patient during the service delivery, leadership, coordination and collaboration attitude, completeness and consistency of information exchange, empathy for patient, and courtesy are just some of the many constituent variables which are at the basis of complex relational dynamics (Boquiren et al., 2015; Creswick, Westbrook, & Braithwaite, 2009; Gallan et al., 2019; LaVela & Gallan, 2014). Most of these factors are expressed through conscious and unconscious social "honest" signals (Pentland, 2008) in verbal and non-verbal communication during teamwork and dyadic interactions with patients. This communication allows providers an appropriate understanding of their patients' individual needs, and to build trust and understanding between practitioners and patients (Levinson, Lesser, & Epstein, 2010; Verlinde, De Laender, De Maesschalck, Deveugele, & Willems, 2012). In addition, since care is often provided by a team of practitioners, also communication between practitioners is essential for health service delivery.

Extant literature shows that individual and team behaviors may influence patient-practitioners relationship and patient perception of the quality of the health service (e.g., Stewart et al., 1999; Levinson et al., 2010; Pawlikowska, Zhang, Griffiths, van Dalen, & van der Vleuten, 2012; Quaschning, Körner, & Wirtz, 2013; Hall, Roter, Blanch-Hartigan, Mast, & Pitegoff, 2015; Ogbonnaya, Tillman, & Gonzalez, 2018). Such behaviors can be categorized in three main groups: verbal communication, non-verbal behaviors, and team network dynamics (Batbaatar et al., 2017; Blanch-Hartigan et al., 2018; Patterson et al., 2013). These behaviors might strongly influence patient satisfaction (Fig. 1). However, although practitioners' behaviors are recognized as critical success factors for the satisfaction of patients, few studies have systematically analyzed which behaviors really affect patient

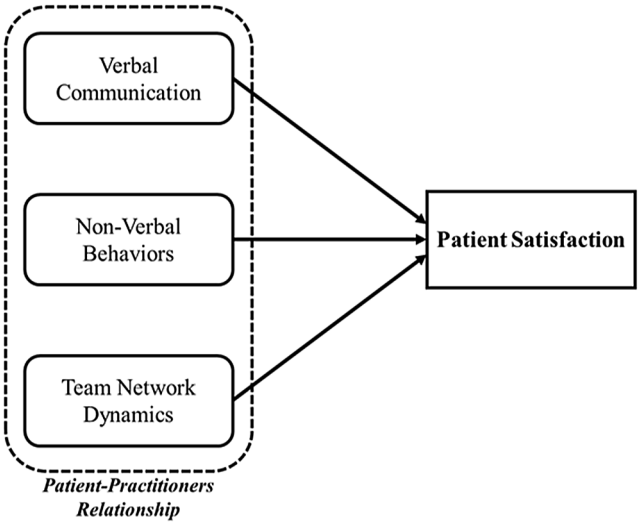

Fig. 1. Theoretical framework.

satisfaction (Batbaatar et al., 2017; Blanch-Hartigan et al., 2018; Patterson et al., 2013; Sabot, Wickremasinghe, Blanchet, Avan, & Schellenberg, 2017).

In the following subsections the fundamental influence of verbal communication, non-verbal behaviors, and team network dynamics on patient satisfaction are discussed.

2.1.1. Verbal communication

Verbal communication is the main means by which the doctor-patient relationship is developed and by which therapeutic goals are achieved (Detmar, Muller, Schornagel, Wever, & Aaronson, 2002; Dong, Butow, Costa, Dhillon, & Shields, 2014; Roter & Hall, 2006). Doctors need the right information to establish the diagnosis and treatment plan, while the patient needs to know and understand his/her diseases and to be psychologically reassured by the doctors (Ong, De Haes, Hoos, & Lammes, 1995). Both the doctors and patients alternate information-giving and information-seeking phases (Verlinde et al., 2012).

In addition, by supporting the information exchange for the care process, verbal communication establishes the interpersonal relationships between practitioners and the patient, to create the foundation for mutual understanding (Finney Rutten et al., 2015). The way and the mood in which information is transmitted to the patient, as well as the time devoted to explain and inform him/her, and the interaction mode, affect awareness of the patient about his/her health condition, the mutual relationships, and subsequent satisfaction for the medical care services provided (Boquiren et al., 2015; Levinson et al., 2010; Ong et al., 1995). Oral communication plays a fundamental role in developing empathy between patient and doctors, fostering patient trust in the care providers, contributing to build a “sense of safety” for patients (Alrubaiee & Alkaa'ida, 2011; Kim, Kaplowitz, & Johnston, 2004; Shieh, Wu, & Huang, 2010) and to decrease the physiological patient distress and anxiety (Stewart et al., 1999). Such aspects appear to be more relevant for clinical processes with greater diagnostic uncertainty, such as in the ED, where patients are greatly affected by negative feelings (Ríos-Risquez & García-Izquierdo, 2016).

On the contrary, inadequate communication between patient and practitioners may lead to patient dissatisfaction, despite positive and effective clinical outcomes (Ha & Longnecker, 2010; Williams, Weinman, & Dale, 1998). Therefore, verbal communication in the patient-provider relationship seems to emerge as a significant element of patient satisfaction that deserves to be further investigated.

2.1.2. Non-verbal behaviors

As well as verbal communication, non-verbal behaviors can significantly affect the relationship between patient and practitioners and, in turn, the patient’s perception of the care services provided (e.g., Bensing, 1991; Trout et al., 2000; Robinson, 2006; Pinto et al., 2012; Hall et al., 2015). Non-verbal behaviors include “communicative” actions and physical behaviors distinct from speech, such as facial expressions, gesturing, body posture, physical distance/proximity, positioning, eye contact, and physical activity. Patients are sensitive to behaviors that convey the emotional tone of interpersonal interaction (Larsen & Smith, 1981; Robinson, 2006), in particular in the most critical care units (e.g., EDs, Intensive Care Units, etc.) where patients and relatives feel stronger emotions such as fear, anxiety, and uncertainty (Chang, Carter, Suh, Kronish, & Edmondson, 2016; McColl-Kennedy et al., 2017; Ríos-Risquez & García-Izquierdo, 2016; Trout et al., 2000). Indeed, researchers claim that non-verbal behaviors contribute to a large extent (up to 80%) to communication between individuals and are especially relevant for socio-emotional exchanges (Mehrabian, 1968; Pawlikowska et al., 2012; Roter, Frankel, Hall, & Sluyter, 2006).

Recognizing the importance of such factors, researchers have tried to hypothesize and detect which non-verbal behaviors might most affect patient satisfaction. Interpersonal distance, eye contact, tone of voice, gestures and posture, facial expression, and physical contact (touch) seem to emerge as relevant factors for patient satisfaction from preliminary studies (Henry, Fuhrel-Forbis, Rogers, & Eggly, 2012; Kee, Khoo, Lim, & Koh, 2018; Marcinowicz, Konstantynowicz, & Godlewski, 2010). Non-verbal behaviors appear even to be able to influence the pain perceived by the patient (Ruben, Blanch-Hartigan, & Hall, 2017).

Aligned with these initial insights, Boissy et al. (2016) showed that training courses about communication skills (both verbal and non-verbal) for physicians improved patient satisfaction.

Hence, exploring patient-provider relationships and non-verbal behaviors as key drivers of patient satisfaction emerges as an important topic of research, particularly as there is little research available until now.

2.1.3. Team network dynamics

In parallel with verbal and non-verbal communication between patient and practitioners, team network dynamics are also very important for healthcare services (Rosen et al., 2018; Valentine, Nembhard, & Edmondson, 2015). Indeed, care services are often provided by teams rather than a single practitioner (e.g. emergency medicine, surgery, etc.) and, thus, interactions established in the team have a huge impact on team coordination and on outcomes in terms of care effectiveness, efficiency, and patient satisfaction (Kilner & Sheppard, 2010; Song et al., 2017). Thus, team network dynamics among healthcare providers affect the patient-provider relationship and become an important component of patient satisfaction (Mosadeghrad, 2014; O'leary, K. J., Sehgal, N. L., Terrell, G., Williams, M. V., & High Performance Teams and the Hospital of the Future Project Team, 2012; Rosen et al., 2018).

Accordingly, researchers have tried to explore the complex links between team interaction and health process outcomes using Social Network Analysis (SNA) and other network metrics (Bae, Nikolaev, Seo, & Castner, 2015; Gray et al., 2010; Sabot et al., 2017). Past results seem to support analysis of dynamic interactions affecting the quality of health services, such as the provider communication network, the emotions expressed during team conversations, the physical proximity and posture, and the physical activity (Bae et al., 2015; De Vries, Bakker-Pieper, & Oostenveld, 2010; Quaschning et al., 2013; Vogus & McClelland, 2016).

However, the difficulty in quantitatively measuring interactions and network dynamics still limits research on this topic to a few empirical studies (Bae et al., 2015; Sabot et al., 2017). This also increases the need for effective and innovative approaches for assessing team network dynamics during the work of health teams (Rosen et al., 2018).

3. Methodology

This research proposes a novel approach for evaluating healthcare providers’ behaviors (verbal communication, non-verbal communication, and team dynamics) during the delivery of the ED service, to discover drivers of patient satisfaction. Specifically, Sociometric Badges, wearable sensors developed by the MIT Media Lab (Olguín, Waber et al., 2009), are adopted to systematically obtain quantitative reliable behavioral measurements. The suitability of Sociometric Badges for monitoring behavioral variables and investigating complex network dynamics emerging from operational activities has been shown in previous research (Kim, McFee, Olguin, Waber, & Pentland, 2012), in particular in the healthcare domain (Bucuvalas et al., 2014; Olguin, Gloor et al., 2009; Yu et al., 2016). However, given the lack of empirical research on this topic, and particularly studies that directly evaluate ED provider practitioners’ behaviors using wearable sensors, an exploratory case study (Yin, 2017) was carried out.

Sociometric Badges are able to automatically and directly measure individual and collective behaviors, using four different sensors: accelerometer, microphone, Bluetooth, and IRDA (Kayhan et al., 2018; Olguín, Waber et al., 2009). It is possible to collect quantitative behavioral measures impossible to gather with surveys, interviews or direct

Table 1
Variables type.

Type of variable	Source	Measurements
Behavioral variables	*Sociometric Badges*	Behavioral variables evaluated for the ED team (network), for the patient, and for each practitioner starting from the sociometric detection
Patient satisfaction	*Questionnaires*	Overall patient satisfaction, care effectiveness, and team responsiveness measured through the questionnaire
Control variables	*Information systems*	Specific characteristic of each episode retrieved from ED information systems

observations. Sociometric Badges also guarantee privacy, an important issue in healthcare, by not recording the content of the conversation and not identifying the speaker by the sociometric data (Olguín, Waber et al., 2009). They are also less intrusive than a human observer limiting any social distortions to the data and potentially permitting the collection of more numerous behavioral aspects (Olguín, Waber et al., 2009; Rosen et al., 2014).

The methodology is structured in four main phases:

- *Research setup*. The aim of this phase is to define the research protocol and all the necessary settings for conducting the case study through the Sociometric Badges in the specific context. Firstly, a preliminary investigation of the ED is needed to outline all features related to the service, such as the department layout, the organization and physical distribution of medical staff in the ED, task allocation mechanism to practitioners, interactions with patients, how patients access the service, and finally, patient pathways within the ED. This information is relevant to define the main research settings (e.g. doctors and nurses involved in the investigation), to allow for the fine tuning of the Sociometric Badges, to select the sociometric variables to be considered, and to design the survey (questionnaires) for measuring patient perceptions about the ED service.
- *Data collection*. In this phase, all the necessary data for the study (i.e. behaviors, patient perceptions, and case characteristics) are collected. For each case, provider and patient behaviors are monitored using the Sociometric Badges. In order to get the data, practitioners and patients wore the tool for the entire duration of the service. Moreover, a questionnaire was submitted to the patient at the discharge from the ED. The questionnaire (Appendix A) asks for the patient's perceptions about the service received. Finally, patient data necessary for characterizing each case, such as triage registration time, discharge or hospitalization time, overall length of stay in the emergency department, emergency severity (severity class), sex, and age, are collected from the ED information system as control variables.
- *Pre-processing*. Sociometric data were pre-processed with the software provided by the supplier of the Sociometric Badge to check data correctness and to extract the features for the subsequent analysis phase (Kayhan et al., 2018). Specifically, behavioral variables and SNA metrics are estimated for each episode based on the sensor data. In addition, questionnaire data are aggregated into three different satisfaction indexes: Overall Satisfaction, Care Effectiveness, and Team Responsiveness. At the same time, the control variables are also evaluated for each case. A detailed description of adopted measures is provided in Section 3.1.
- *Data analysis*. In this phase, relationship between ED practitioners' behaviors and patient satisfaction are investigated by correlation and regression analysis. Pearson's correlation analysis allows identifying preliminary relationships between behavioral variables, measured by Sociometric Badges ("*individual and collective measures*" and "*network and SNA measures*" – see Section 3.1.1), and patient satisfaction ("*Overall satisfaction*", "*Care effectiveness*", and "*Team responsiveness*" – see Section 3.1.2), measured by the survey. Then, multiple linear regression (Kutner, Nachtsteim, Neter, & Li, 2004) is used to explore the potential determinants of patient satisfaction (for more detail about explorative investigations through regressions, see e.g. Draper & Smith, 1998; Kutner et al., 2004). Regression models were built with the behavioral variables ("*individual and collective measures*" and "*network and SNA measures*") as independent variables, while *Overall satisfaction*, *Care effectiveness*, and *Team Responsiveness* were introduced individually as dependent variables. Furthermore, to exclude potential confounding effects and to confirm the validity of findings, we controlled for five control variables (see Section 3.1.3).

Finally, feedback from experts, health managers and medical staff was collected in focus groups to confirm the interpretation of the results and to inspire additional implications from a managerial viewpoint.

3.1. Measurements

Variables can be divided in three different groups (Table 1): behavioral variables (independent variables); patient satisfaction (dependent variables); control variables.

3.1.1. Behavioral variables – Independent variables

Sociometric Badges recorded physical data about individual and collective behaviors of the ED team during the service delivery. Such behavioral measures, which characterize verbal behaviors, non-verbal behaviors, and team dynamics, were used as independent variables in the analysis phase.

Specifically, two classes of measures can be identified:

- *Individual & collective measures:* these measures record verbal and non-verbal behaviors (such as body/posture movements, speaking activity, and physical proximity) measured individually for providers and for patients, and collectively for the medical team (Kayhan et al., 2018).
- *Network & SNA measures:* these measures assess team dynamics occurring during the ED service. In particular, social network changes and mirroring are tracked for the overall medical team through network and SNA metrics (Borgatti & Halgin, 2011; Carpenter, Li, & Jiang, 2012; Cerqueti, Ferraro, & Iovanella, 2018; Cinelli, Ferraro, Iovanella, Lucci, & Schiraldi, 2017; Kayhan et al., 2018; Vermeulen & Pyka, 2017).

The complete list of measures is reported in Table 2 (*individual & collective measures*) and Table 3 (*network & SNA measures*).

3.1.2. Patient satisfaction – Dependent variables

Patient perceptions regarding the quality of service both in terms of outcome and service delivery quality are used as dependent variables. The measures of Overall Satisfaction, Care Effectiveness, and Team Responsiveness are survey-based and are defined consistently with the most recent literature (e.g. Boquiren et al., 2015; NHS Emergency Department Questionnaire, 2016). Appendix A reports full details about the measurement items and the questionnaire. Specifically, the following three metrics are used:

- *Overall satisfaction* – it measures the overall satisfaction related to the ED services (Appendix A – variables 1–8)
- *Care effectiveness* – it estimates the care effectiveness evaluating to

Table 2
Behavioral variables- individual and collective measures.

Variable	Description
Body movement activity	The level of physical activity measured by accelerometers' energy magnitude, higher values indicate higher body movement activity
Body movement consistency	The consistency of body movement ranges from 0 to 1, where 1 indicates no changes in activity levels, and 0 indicates the maximum amount of variation in activity levels in a defined period
Posture activity	The absolute angular velocity measured by accelerometers, higher values indicate higher posture activity which are often associated with walking activities in a defined period
Posture activity consistency	The consistency of posture activity ranges from 0 to 1, where 1 indicates no changes in activity levels, and 0 indicates the maximum amount of variation in activity levels
Speech profile speaking	The amount of time that the badge wearer is speaking while his/their interlocutor(-s) is/are not talking
Speech profile overlap	The amount of time that the badge wearer is speaking simultaneously to someone else
Speech participation	The proportion of active participation within the conversation by the badge holder
Turn-Taking	The number of changes of the person/people who is/are speaking during the conversation
Audio front	The audio recorded by the front microphone, the volume of others' voice
Audio back	The audio recorded by the back microphone, the volume of badge holder voice
Proximity Interactions	The amount of time that the badge wearer is within interaction-distance of each other badge (based on Bluetooth detections)

Table 3
Behavioral variables – network and SNA measures.

Variable	Description
Betweenness Centrality	Betweenness centrality of a node (in a network) is the share of all geodesic paths that pass through it (Borgatti, 2005). In this case, Betweenness Centrality of the team is the average of the betweenness centralities of all node on the proximity network of the practitioner team (for more details, see Wasserman & Faust, 1994)
Closeness Centrality	Closeness centrality of a node is the sum of graph-theoretic distances from all other nodes in the network, where the distance from a node to another is defined as the length of the shortest path from one to the other (Borgatti, 2005). In this case, Closeness Centrality of the team is the average of the closeness centralities of all node on the proximity network of the practitioner team (for more details, see Wasserman & Faust, 1994)
Degree Centrality	Degree centrality of a node (in a network) is the number of link/ties incident upon itself (number of paths of length one that emanate from a node). The degree centrality for each node is normalized respect to the total number of links present in the network (Borgatti, 2005). In this case, Degree Centrality of the team is the average of the degree centralities of all node on the proximity network of the practitioner team (for more details, see Wasserman & Faust, 1994)
Cohesion	Cohesion (of a network) is defined as the minimal number of node in a network that need to be removed to disconnect the group (Moody & White, 2003). In this case, Cohesion is evaluated on the proximity network of the practitioner team (for more details, see Wasserman & Faust, 1994)
Mirroring – (posture/ body movement/ audio front/ audio back)	Mirroring measurements assess the similarity of data series between members, estimated for posture, body movement, audio front, and audio back. It is theoretically based on the mirroring ("mirror neurons") theory (e.g., Rizzolatti & Craighero, 2004; Kohler et al., 2002; Chartrand & Bargh, 1999). Practically, the mirroring of the team was evaluated through the average (Network's average) and the deviation (Network's deviation) between members' network values separately assessed for posture, movement, audio front, and audio back (Kayhan et al., 2018). Thus, 8 metrics are considered (*Posture network's average*; *Posture network's deviation*; *Body movement network's average*; *Body movement network's deviation*; *Audio front network's average*; *Audio front network's deviation*; *Audio back network's average*; *Audio back network's deviation*). For more details, please see Kayhan et al., 2018

what extent the ED team was able to improve patient clinical condition and if he/she has received clear information about his/her health conditions and complete indications about the treatments to follow after discharge (Appendix A – variables 1–3)

– *Team responsiveness* – it evaluates the team responsiveness, assessing to what extent the ED team was able to promptly meet the patient's needs and to devote sufficient time for his/her treatments (Appendix A – variables 4–5)

3.1.3. Control variables

Individual patient characteristics (e.g., emergency severity, sex, age, and personality) and service process features (e.g., service times and ED team dimension) may strongly affect the patient service evaluations (see e.g., Boquiren et al., 2015; Berkowitz, 2016). Accordingly, to exclude potential confounding effects and influences deriving from specific episodes, five control variables were considered: overall Length Of Stay (LOS) in the ED, Patient sex, Patient age, number of team members (i.e. the number of practitioners participating to the ED team), and emergency severity (five-level severity classification). This data, which characterizes each ED episode, can be collected from the ED information systems.

4. Case study

The case study has been conducted in a large Italian Emergency Department. The ED is organized in "work cells" and each medical team is allocated to a single work cell including one or more patients. Hence each patient is associated to a specific team. Teams range from least two practitioners (doctor and nurse) to a maximum of four (doctor, nurse, specializing doctor and/or trainee nurse), they were continuously monitored during the service using the Sociometric Badges.

Data collection involved conscious patients including all emergency severity classifications except for "red codes" (life-threatening, immediate access to care). At the end of the stay in the ED, each patient filled out an anonymous questionnaire. In addition, data regarding specific characteristics of each patient episode was collected from the ED information system.

Data was gathered over a period of 4 months, following the methodology described in Section 3. After discarding incorrect registrations, the final dataset consisted of 90 episodes (patients) with 253 medical staff distinct recordings for a total of about 575 monitoring hours.

5. Results

5.1. Correlation analysis

To explore the potential relationship between behavioral variables (*individual & collective measures* and *network & SNA measures*) and patient satisfaction (*Overall Satisfaction, Care Effectiveness,* and *Team Responsiveness*) and get preliminary insight of the data, "Pearson's correlation" analysis was carried out using SPSS®. Appendix B shows the results obtained (Tables B1–B3). Only the independent variables that have a significant correlation with the dependent variables are displayed.

As shown by Tables B1–B3, there are no significant correlations (i.e. no p-value < 0.05) between the control variables (*Number of team members, Emergency Severity, Sex, Age, and Overall Length Of Stay*) and the dependent variables (*Overall Satisfaction, Care Effectiveness,* and *Team Responsiveness*). This seems to dismiss any potential effect of the control variables on the dependent variables. A full check of the influence of the control variables was carried out in the next phase of regression analysis.

5.2. Regression analysis

Three regression models were built using behavioral variables (*individual & collective measures* and *network & SNA measures*) as independent variables, with *Overall Satisfaction, Care Effectiveness,* and *Team Responsiveness* as the dependent variables.

Table 4 shows the regression model built with *Overall Satisfaction* as dependent variable. A relevant fraction of patients' overall satisfaction is predicted by two behavioral variables:

- *Doctor's posture activity*, which has a negative effect on *Overall Satisfaction*. The *Doctor's Posture Activity* is considered a proxy for measuring the walking activity of the doctor. A high rate of movement of the physicians seem having a negative influence on the patient satisfaction.
- *Mirroring audio front – network's deviation*. The deviation on the listening network has a negative effect on the *Overall Satisfaction*. This means that the overall satisfaction appears to be favored by a centralized speaking network.

The model in Table 4 is statistically significant with an *Adjusted R Square* of 0.360. All the variables included are highly significant (significance level below 0.01) and not collinear (Variance Inflation Factors – VIF very low) (O'brien, 2007).

Table 5 shows the regression model obtained with *Care Effectiveness* as dependent variable. Four behavioral variables have predictive power on *Care Effectiveness*:

- *Doctor's posture activity*, similarly to the first model, has a negative effect on *Care Effectiveness*.
- *Mirroring audio front – network's deviation*, similarly to the first model, has a negative effect on *Care Effectiveness*.
- *Patient's audio back* has a positive effect on *Care Effectiveness*. The perceived care effectiveness seems correlated with more speaking time of the patient.
- *Nurse's Body Movement Activity* has a positive effect on *Care Effectiveness*. Consequently, the perceived care effectiveness is correlated with a higher activity of nurse.

The model (Table 5) is statistically significant with *Adjusted R Square* of 0.441. All the variables included are significant and not collinear (VIF very low) (O'brien, 2007).

Table 6 shows the regression model with *Team Responsiveness* as dependent variable. Team responsiveness is predicted by two behavioral variables:

- *Doctor's posture activity*, similarly to the first model, has a negative effect on the perceived Team Responsiveness.
- *Doctor's speech overlap* has a negative effect on the perceived Team Responsiveness. Team Responsiveness decreases when the doctor speaks over the patient or other practitioners.

The model (Table 6) is statistically significant with *Adjusted R Square* of 0.386. All the variables included are highly significant (significance level far below 0.01) and not collinear (VIF very low) (O'brien, 2007).

To check for possible confounding effects and to confirm the

Table 4
Regression model for Overall Satisfaction. Column B reports the unstandardized coefficients; S.E. reports the standard errors (for coefficients); $B_{standardized}$ reports the standardized coefficients; t and Sig. report the t-value and 2 tailed p-value (null hypothesis test); VIF reports the Variance Inflation Factors.

Overall Satisfaction Model						
Variables	B	S.E.	$B_{standardized}$	t	Sig.	VIF
Doctor's Posture Activity	−0.427	0.071	−0.427	−3.331	0.002	1.051
Mirroring audio front – Network's deviation	−0.373	0.071	−0.373	−2.908	0.006	1.051
Constant	4.285	0.068	–	62.695	0.000	–

Table 6
Regression model for Team Responsiveness Column B reports the unstandardized coefficients; S.E. reports the standard errors (for coefficients); $B_{standardized}$ reports the standardized coefficients; t and Sig. report the t-value and 2 tailed p-value (null hypothesis test); VIF reports the Variance Inflation Factors.

Team Responsiveness Model						
Variables	B	S.E.	$B_{standardized}$	t	Sig.	VIF
Doctor's Posture Activity	−0.475	0.123	−0.475	−3.867	0.000	1.007
Doctor's speech overlap	−0.399	0.123	−0.399	−3.253	0.002	1.007
Constant	2.048E−15	0.121	–	0.000	1.000	–

Table 5
Regression model for Care Effectiveness. Column B reports the unstandardized coefficients; S.E. reports the standard errors (for coefficients); $B_{standardized}$ reports the standardized coefficients; t and Sig. report the t-value and 2 tailed p-value (null hypothesis test); VIF reports the Variance Inflation Factors.

Care Effectiveness Model						
Variables	B	S.E.	$B_{standardized}$	t	Sig.	VIF
Doctor's Posture Activity	−0.645	0.132	−0.645	−4.885	0.000	1.322
Mirroring audio front – Network's deviation	−0.383	0.119	−0.383	−3.211	0.003	1.080
Audio back – Patient	0.321	0.131	0.321	2.448	0.019	1.309
Nurse's Body Movement Activity	0.374	0.140	0.374	2.671	0.011	1.490
Constant	−3.982E−16	0.113	–	0.000	1.000	–

Table 7
Regression model for Overall Satisfaction with control variables. Column B reports the unstandardized coefficients; S.E. reports the standard errors (for coefficients); $B_{standardized}$ reports the standardized coefficients; t and Sig. report the t-value and 2 tailed p-value (null hypothesis test); VIF reports the Variance Inflation Factors.

Overall Satisfaction Model with control variables						
Variables	B	S.E.	$B_{standardized}$	t	Sig.	VIF
Doctor's Posture Activity	−0.469	0.126	−0.469	−3.484	0.002	1.051
Mirroring audio front – Network's deviation	−0.413	0.135	−0.413	−2.989	0.006	1.051
Overall Length Of Stay (LOS)	0.178	0.129	0.178	1.376	0.178	1.034
Sex	0.073	0.131	0.073	0.558	0.581	1.059
Age	−0.164	0.136	−0.164	−1.208	0.235	1.145
Team members' number	0.061	0.140	0.061	0.438	0.664	1.207
Emergency Severity	−0.024	0.135	−0.024	−0.174	0.863	1.131
Constant	2.467E−15	0.126	–	0.000	1.000	–

Table 8
Regression model for Care Effectiveness with control variables. Column B reports the unstandardized coefficients; S.E. reports the standard errors (for coefficients); $B_{standardized}$ reports the standardized coefficients; t and Sig. report the t-value and 2 tailed p-value (null hypothesis test); VIF reports the Variance Inflation Factors.

Care Effectiveness Model with control variables						
Variables	B	S.E.	$B_{standardized}$	t	Sig.	VIF
Doctor's Posture Activity	−0.645	0.132	−0.645	−4.885	0.000	1.375
Mirroring audio front – Network's deviation	−0.383	0.119	−0.383	−3.211	0.003	1.200
Audio back – Patient	0.321	0.131	0.321	2.448	0.021	1.525
Nurse's Body Movement Activity	0.374	0.140	0.374	2.671	0.019	1.676
Overall Length Of Stay (LOS)	0.108	0.122	0.108	0.889	0.381	1.051
Sex	−0.010	0.126	−0.010	−0.080	0.936	1.127
Age	−0.127	0.128	−0.127	−0.993	0.328	1.164
Team members' number	0.083	0.134	0.083	0.618	0.541	1.271
Emergency Severity	−0.136	0.134	−0.136	−1.017	0.317	1.275
Constant	−3.982E−16	0.113	–	0.000	1.000	–

validity of the three models obtained, we carried out two sets of tests with the control variables. The first test was to add the control variables to the regression models for *Overall Satisfaction*, *Care Effectiveness*, and *Team Responsiveness*. In all cases, the Adjusted R Square slightly dropped while the control variables are non-significant and the sociometric variables remain significant as shown by Tables 7–9. This result excludes potential confounding effects of the control variables on the three regression models. In a second test, we built regression models with only the control variables. All combinations of control variables were tested. No model with control variables was significant, ruling out any potential effect of the control variables on the dependent variables.

Table 9
Regression model for Team Responsiveness with control variables. Column B reports the unstandardized coefficients; S.E. reports the standard errors (for coefficients); $B_{standardized}$ reports the standardized coefficients; t and Sig. report the t-value and 2 tailed p-value (null hypothesis test); VIF reports the Variance Inflation Factors.

Team Responsiveness Model with control variables						
Variables	B	S.E.	$B_{standardized}$	t	Sig.	VIF
Doctor's Posture Activity	−0.506	0.134	−0.469	−3.484	0.002	1.097
Doctor's speech overlap	−0.447	0.139	−0.413	−2.989	0.006	1.191
Overall Length Of Stay (LOS)	0.058	0.129	0.178	1.376	0.178	1.031
Sex	0.001	0.131	0.073	0.558	0.581	1.058
Age	−0.081	0.136	−0.164	−1.208	0.235	1.154
Team members' number	0.125	0.140	0.061	0.438	0.664	1.254
Emergency Severity	−0.136	0.135	−0.024	−0.174	0.863	1.146
Constant	1.986E−15	0.126	–	0.000	1.000	–

6. Discussion

The subsequent case study discussion is structured in the three performance dimensions *Overall Satisfaction*, *Care Effectiveness*, and *Team Responsiveness*.

Empirical evidence shows that *Doctor's Posture Activity* and *Mirroring audio-Network's deviation* have a significant impact on *Overall Satisfaction* (Fig. 2).

Patient satisfaction appears positively influenced by steady attendance of the doctors in the emergency room, demonstrated by low doctor walking activity, and by the presence of a leader in the team communication network, who is able to coordinate the speaking network. This interpretation values doctor attendance during service delivery, suggesting that if the physician moves frequently out of the ED work cell, patients might perceive the doctor as less accessible, negatively affecting their sense of safety (Boquiren et al., 2015). In addition, the presence of a communication leader appears to assure completeness and consistency of the information exchange within the ED team and between team members and patients, leading to a positive perception of the service (Creswick et al., 2009; Rosen et al., 2018).

Regarding Care Effectiveness, *Doctor's posture activity*, *Mirroring audio-Network's deviation, Patient's audio back,* and *Nurse's body movement activity*

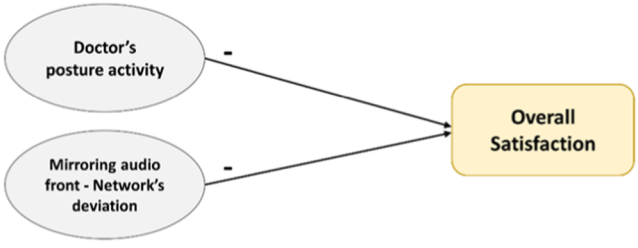

Fig. 2. Overall satisfaction model.

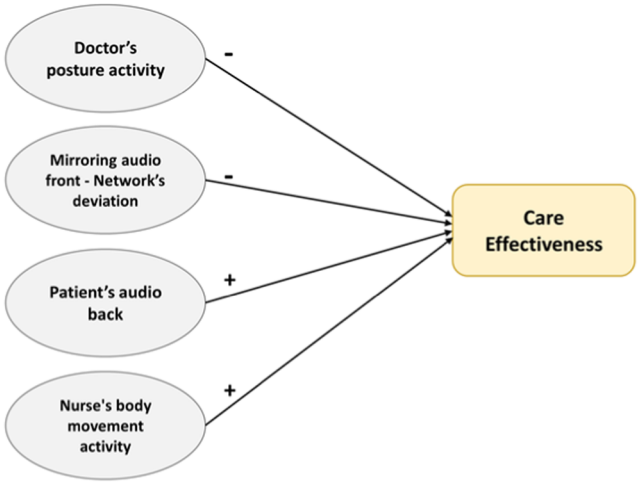

Fig. 3. Care effectiveness model.

have a significant impact on patient perceptions (Fig. 3).

Specifically, *Care Effectiveness* appears positively influenced by two additional factors with respect to *Overall Satisfaction*, i.e. patient listening, shown by *Patient's audio back*, and patient monitoring, measured by *Nurse's body movement activity*. A patient perceives higher care effectiveness if the medical team devotes more time to listening to him/her. Also, the *nurse's body movement activity* suggests a rise in *Care Effectiveness* if the nurses move more frequently within the work cell, this could be because patients assume that nurses are more actively taking care of them and committed to constantly checking their health conditions.

Aligned with previous evidence supporting the importance of putting the patient in the center in health services (Howarth & Haigh, 2007), our findings confirm that patients expect to be actively involved into the communication network to express their own perspectives and doubts to providers. They also appreciate staff members' efforts to continuously monitor their health condition (e.g. LaVela & Gallan, 2014; Finney Rutten et al., 2015; Boquiren et al., 2015). Indeed, listening, understanding, and responding to the patient provides valuable information that can help to better shape services and meet the individual needs of the patients (Howarth & Haigh, 2007).

Lastly, *Team Responsiveness* seems significantly influenced by *Doctor's Posture Activity* and *Doctor's speech overlap* (Fig. 4).

The continuous attendance of doctors in the emergency room, as shown by *doctor's walking activity*, and a limited overlap in speaking between the doctor and staff for service coordination, as revealed by *low doctor's speech overlap*, are appreciated by the patient. This finding suggests that, similarly to previous insights, the patient appreciates the presence of the doctor in the work cell. Otherwise, the team is perceived as less responsive to patient needs (Boquiren et al., 2015). Also, the doctor should avoid restricting the communication of the patient and other providers since this causes an ineffective communication (Saba et al., 2006; Squires, 2012).

Summarizing, five peculiar practitioners' behaviors are identified as relevant to influence patients' experience during the ED stay: Patients appreciate physical proximity of the doctors and the staff's efforts to continuously monitor their health conditions. Furthermore, they also desire to be actively integrated into the providers' communication. These three behavioral aspects support the principle of putting the patient in the center during ED service In addition, patients also perceive how the team interacts and team members coordinate, favoring teams where doctors lead the communication network and ensure effective team conversation.

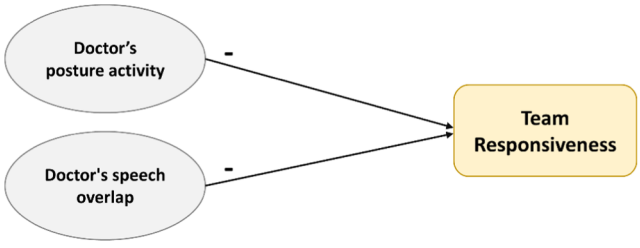

Fig. 4. Team responsiveness.

Finally, as shown by the regression models with control variables, the patients' judgment seems – surprisingly – not affected by the overall time spent in the ED.

7. Conclusion

This paper explores behavioral factors affecting patient satisfaction during ED stay. It investigates provider behaviors in the ED and analyses their influence on patient satisfaction exploring quantitative and systematic measurements of human interactions provided by innovative wearable sensors, the Sociometric Badges.

7.1. Theoretical and methodological contribution

The novelty of this research is twofold, on one hand we provide new empirical insights about healthcare provider behaviors that might affect patient satisfaction in an Emergency Department, on the other hand we apply a novel method, i.e. wearable sensor-based approach, that are more reliable and robust for the organizational analysis of complex environments. Indeed, to the best of our knowledge, this is the first time such a method has been applied to support systematic data collection of social interactions between patients and providers in the ED workplace and enable the quantitative analysis of actual behaviors.

Our findings disclose five behaviors as possible determinants of patient satisfaction during the ED stay. While they are aligned with theoretical propositions from past literature (e.g., Sitzia & Wood, 1997; Boquiren et al., 2015; Welch, 2010; Ríos-Risquez & García-Izquierdo, 2016), this is the first time such factors are empirically explored using automated tools. Specifically, patient evaluations seem to be influenced by verbal communication, non-verbal behaviors, and team network dynamics that can be framed in the wider debate in healthcare literature about patient centrality, service attendance, risk aversion, social interactions, leadership, collaboration attitude, and completeness/consistency of the information exchange in the communication networks (Boquiren et al., 2015; Creswick et al., 2009; Howarth & Haigh, 2007; LaVela & Gallan, 2014; Nugus & Braithwaite, 2010). The identified factors involve both doctors and nurses although the patients seem to attribute more relevance to doctors' behaviors. Moreover, while intensely monitored by health authorities, the overall throughput time appears not to significantly affect patient satisfaction.

Reported evidence also reinforce directions provided by previous authors (e.g. Fitzsimmons et al., 2008; Croson, Schultz, Siemsen, & Yeo, 2013) about the importance of including behavioral aspects in healthcare system analysis to provide managers with effective recommendations for service (re-)design and improvement.

From a methodological perspective, the case study shows the value of wearable sensors to monitor providers' interactions and retrieve data from complex service environment such as an ED. Indeed, such tools seems to overcome limits of previous measurement approaches for assessing individual and team behaviors based on self-report and direct observation methods (Batbaatar et al., 2017; Burtscher & Manser, 2012), which might be less effective for evaluating non-verbal behaviors and team network dynamics (Blanch-Hartigan et al., 2018; Patterson et al., 2013). Our findings confirm the reliability of the method and suggest it as a possible candidate to systematically analyze behaviors in other sophisticated socio-technical contexts. Accordingly, this research also provides a first contribution to the question of "how" to quantitatively investigate behavioral factors in complex service environments (Braun & Hadwich, 2016; Brocklesby, 2016; Croson et al., 2013).

7.2. Managerial implication, limitations and future developments

This study provides hospital managers with managerial insights for improving patient satisfaction and service perceptions. Specifically, visual contact seems to be important for patients; doctors should – if possible – stay closer to the patients. They should assume the role of communication leader during the service and assure the completeness and consistency of the information exchange within the ED team, while still letting the patient speak up. Also, it is recommendable to avoid cutting off the patient and other providers while speaking. Moreover, the team should pay attention to patient centrality during the service delivery, e.g. by frequently monitoring the patients' health conditions, by involving the patients in conversation, and by allowing them to express and clarify potential doubts.

Although it is challenging to control for all the determinants of such behaviors, these simple indications may support health managers for service re-design and may be useful for training ED staff about leadership, coordination, and collaboration skills (Boquiren et al., 2015; Leischnig & Kasper-Brauer, 2015; Levinson et al., 2010). For instance, the ED layout could be re-designed to increase the proximity of the doctor to the patients, or ED teams' configuration may be modified to avoid team dispersion and ineffective communication during the service delivery.

This research is not without limitations that point out directions for future research. The first limitation is due to the exploratory nature of the work. Drawing on a single case study, results might be affected by the particular context. This is a common issue for many behavioral studies that limits generalization (Tröster, Mehra, & van Knippenberg, 2014; Pons, Giroux, Mourali, & Zins, 2016). Besides, although findings are statistically significant, the sample size is quite limited. An extension of the sample in terms of number of investigated patients, teams, and possible repetition in other EDs would be valuable. Moreover, albeit the number of monitored variables and related indicators is high, the study is clearly not conclusive. Other significant, and perhaps relevant, metrics describing behavioral dynamics of ED practitioners, which were not caught by sociometric measures, might exist. In addition, the control variables considered might be not exhaustive, and thus it would be desirable to take in account a larger number of control variables (both individual and service characteristics) for future research.

As a suggestion for future research, it would be worthwhile to investigate behavioral variables more deeply to better understand motivations and causal relationships among providers' behaviors and their performance. In addition, this research could be replicated in different economic and cultural contexts to further test the investigated behavioral factors and potentially identify social differences in patient perceptions (Zhang, Beatty, & Walsh, 2008).

Appendix A

This appendix provides more details about the survey variables, the references used as source and the questions used in the questionnaire. The answers to the questionnaire are based on the Likert scale (five-item Likert scale).

	Survey Variable	References	Question
1	Providing information	Boquiren et al. (2015), Picker Institute Europe (2008) and NHS Emergency Department Questionnaire (2016)	Do you believe the ED practitioners have provided sufficient information about your health condition and medical treatments?
2	Treatment and care	Picker Institute Europe (2008)	Do you believe the ED practitioners have done adequate actions to improve your health conditions and to relief the pain?
3	Treatment information	Boquiren et al. (2015), Picker Institute Europe (2008) and NHS Emergency Department Questionnaire (2016)	Do you believe you received all the therapeutic indications to follow once you have left the ED? first aid?
4	Needs promptly satisfied/ Responsiveness	Picker Institute Europe (2008)	In case of necessity, did the medical staff promptly satisfy your needs?
5	Time devoted	NHS Emergency Department Questionnaire (2016)	Do you believe the practitioners have devoted enough time to you during the ED stay?
6	Patient trust and confidence	NHS Emergency Department Questionnaire (2016) and Picker Institute Europe (2008)	Do you believe the practitioners' behaviors have favored the establishment of a trusting relationship with you?
7	Concern, Friendliness, team collaboration	Boquiren et al. (2015)	Do you believe the practitioners' behaviors have created a positive and collaborative climate in the ED?
8	Satisfaction for the service	Boquiren et al. (2015), Picker Institute Europe (2008) and NHS Emergency Department Questionnaire (2016)	Are you satisfied about the services received by the ED?

Appendix B

See Tables B1–B3.

Table B1
Correlations between Overall Satisfaction, independent variables, and control variables.

	Overall Satisfaction	Posture activity – Doctor	Mirroring audio front – Network's deviation	Number of team members	Emergency Severity	Sex	Age	Overall Length Of Stay (LOS)
Overall Satisfaction	1	−0.509**	−0.439**	−0.180	0.023	−0.065	−0.147	−0.043
Doctor's Posture Activity	−0.509**	1	0.155	0.251	0.050	0.193	−0.065	0.175
Mirroring audio front-Network's deviation	−0.439**	0.155	1	0.391*	−0.080	0.143	0.008	0.079
Number of team members	−0.180	0.251	0.391*	1	0.064	0.205	0.076	0.254
Emergency Severity	0.023	0.050	−0.080	0.064	1	0.015	−0.326*	0.141
Sex	−0.065	0.193	0.143	0.205	0.015	1	0.133	−0.019
Age	−0.147	−0.065	0.008	0.076	−0.326*	0.133	1	0.024
Overall Length Of Stay (LOS)	−0.043	0.175	0.079	0.254	0.141	−0.019	0.024	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table B2
Correlations between care effectiveness, independent variables, and control variables.

	Care Effectiveness	Posture activity – Doctor	Mirroring audio front – Network's deviation	Audio back – Patient	Nurse's Body Movement Activity	Number of team members	Emergency Severity	Sex	Age	Overall Length Of Stay (LOS)
Care Effectiveness	1	−0.539**	−0.491**	0.060	0.126	−0.154	−0.022	−0.055	−0.051	−0.064
Doctor's Posture Activity	−0.539**	1	0.155	0.172	0.220	0.251	0.050	0.193	−0.065	0.175
Mirroring audio front-Network's deviation	−0.491**	0.155	1	0.045	−0.102	0.391*	−0.151	0.241	0.105	−0.048
Audio back – Patient	0.060	0.172	0.045	1	−0.033	−0.089	0.060	0.268	−0.120	0.101
Nurse's Body Movement Activity	0.126	0.220	−0.102	−0.033	1	−0.274	−0.172	−0.239	−0.251	−0.139
Number of team members	−0.154	0.251	0.391*	−0.089	−0.274	1	0.064	0.205	0.076	0.254
Emergency Severity	−0.022	0.050	−0.151	0.060	−0.172	0.064	1	0.015	−0.326*	0.141
Sex	−0.055	0.193	0.241	0.268	−0.239	0.205	0.015	1	0.133	0.019
Age	−0.051	−0.065	0.105	−0.120	−0.251	0.076	−0.326*	0.133	1	0.024
Overall Length Of Stay (LOS)	−0.064	0.175	0.048	0.101	−0.139	0.254	0.141	−0.019	0.024	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table B3
Correlations between team responsiveness, independent variables and control variables.

	Team Responsiveness	Posture activity – Doctor	Doctor's Speech Overlap	Number of team members	Emergency Severity	Sex	Age	Overall Length Of Stay (LOS)
Team Responsiveness	1	−0.509**	−0.420**	−0.180	0.023	−0.065	−0.147	−0.043
Doctor's Posture Activity	−0.509**	1	0.082	0.251	0.050	0.193	−0.065	0.175
Doctor's Speech Overlap	−0.420**	0.082	1	0.350*	−0.140	−0.017	0.035	0.147
Number of team members	−0.180	0.251	0.350*	1	0.064	0.205	0.076	0.254
Emergency Severity	0.023	0.050	−0.140	0.064	1	0.015	−0.326*	0.141
Sex	−0.065	0.193	−0.017	0.205	0.015	1	0.133	−0.019
Age	−0.147	−0.065	0.035	0.076	−0.326*	0.133	1	0.024
Overall Length Of Stay (LOS)	−0.043	0.175	0.147	0.254	0.141	−0.019	0.024	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

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