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Are gestures worth a thousand words? Verbal and nonverbal communication during robot-assisted surgery

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ABSTRACT

Communication breakdowns in the operating room (OR) have been linked to errors during surgery. Robot-assisted surgery (RAS), a new surgical technology, can lead to new challenges in communication owing to the remote location of the surgeon away from the patient and bedside assistants. Nevertheless, few studies have studied communication strategies during RAS. In this study, 11 robot-assisted radical prostatectomies were recorded and the interaction events between the surgeon and two bedside surgical team members were categorized by modality (verbal/nonverbal), topic, and pair (sender and receiver). Both verbal and nonverbal modalities were used by all pairs. The percentage of nonverbal interactions differed significantly by pair: 66% for the Surgeon-Physician Assistant, 50% for the Physician Assistant-Scrub Nurse, and 25% for the Surgeon-Scrub Nurse, indicating different communication strategies across pairs. In addition, there was a significant dependence between topic and the percentages of verbal and nonverbal events for all pairs. Strategies to improve team communication during RAS should take into account the use of verbal and nonverbal communication means and the variation in interaction strategies based on the topic of communication.

1. Introduction

1.1. Study of team communication in the operating room

The operating room (OR) is a high risk dynamic environment where non-technical surgical skills such as communication are critical to successful outcomes (Gillespie et al., 2010; Lingard et al., 2002; Roth et al., 2004). Communication breakdowns have been consistently linked to human error in surgery and healthcare (ElBardissi et al., 2007; Lingard et al., 2004; Nagpal and Moorthy, 2010; Nagpal et al., 2010; Sutcliffe et al., 2004; Wahr et al., 2013). Surgical teams present special challenges to communication since they deal with (a) inconsistent levels of team familiarity (i.e. the experience team members have working together), (b) overlapping but different expertise and roles among team members, (c) time constraints, and (d) hierarchical structures (Morrow and Fischer, 2013; Morrow et al., 2005; Sutcliffe et al., 2004).

Prior research regarding team communication within the OR has primarily focused on verbal communication. Nevertheless, a few studies have challenged the conception that effective communication can only be achieved verbally. Nonverbal means can support or even replace verbal exchanges especially for coordinating team actions (Segal, 1995). Theories of communication (e.g., common ground theory) state that people shape their interactions with others based on assumptions of their mutual knowledge and beliefs. In particular, multiple communication modes are important in creating common ground among team members. Additionally, the process of updating and improving common ground is affected by both the communication medium and the purpose of the interaction (Clark and Brennan, 1991).

Nonverbal modes of team communication, including gestures, visual gaze direction, body positions and movements, facial expressions and tool manipulations have been identified as critical to successful communication in other complex work domains (Argyle, 1972; Hutchins, 2006; Katz et al., 2006; Segal, 1995), but have received less

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attention in healthcare, particularly surgery (cf. Kolbe et al., 2014; Moore et al., 2010). In a recent systematic literature review that analyzed coding schemes for OR communication, none of the studies included nonverbal interactions (Tiferes et al., 2015).

1.2. Robot-assisted surgery

During Robot-Assisted Surgery (RAS), the surgeon sits at a console which is typically located away from the patient, without direct visual access to the patient and bedside members of the surgical team (Diana and Marescaux, 2015; Herron and Marohn, 2008). The surgeon manipulates controls at the console. These movements are reproduced by the robotic arms holding instruments within the patient, thus eliminating surgical tremor and allowing precise microsurgery (Spight et al., 2014). Robotic instrument changes are performed by other team members (i.e. the physician assistant or the scrub nurse) situated at the patient's side at the request of the surgeon. In addition, the physician assistant aids the surgeon by controlling laparoscopic instruments. A camera provides the surgeon with a view of the surgical field on a 3D viewer that is part of the console; the view can be magnified up to 10×. This video feed is reproduced on multiple (2D) screens throughout the OR allowing others on the surgical team to see what the surgeon is viewing. This shared view shows instrument movements (both the robotic instruments manipulated by the surgeon and the laparoscopic ones manipulated by the physician assistant), the camera view (with zoom level, horizontal and vertical position controlled by the surgeon; and changes in focus or camera insertion angle executed by the scrub nurse), and console display indicators (names of active robotic instruments and the camera insertion angle).

RAS provides advantages to surgeons in terms of improved visualization, precision, access to deep anatomical areas and may also lower stress and fatigue (Randell et al., 2016). However, it has also brought new challenges due to the more remote location of the surgeon, a reduced ability to maintain vision in the operative field, and the complexity of the robotic equipment (Catchpole et al., 2016; Randell et al., 2016).

Despite the importance of team communication in surgery, there is a lack of comprehensive analysis of team communication during RAS. Some studies have evaluated how RAS differs from laparoscopic surgeries in which the surgeon is located next to the OR table and the bed side assistants. Webster and Cao (2006) compared the steps to perform instrument changes with both technologies. RAS instrument changes seem to be more complex than in laparoscopic surgery; changes not only require more steps, but also that the team to be aware of the robot's operation mode at every stage. Cao and Taylor (2004) and Nyssen and Blavier (2010) compared the amount of team communication during laparoscopic versus RAS and both studies found more communication during the RAS. However, it is not clear if that disparity was due to the different technologies *per se* or the differences in experience the team had with each technology, which was different in Nyssen and Blavier (2010) and not reported in Cao and Taylor (2004). Nyssen and Blavier (2010) also found that the frequency of communications for some content categories ("orientation", "manipulation", "order", and "confirmations") was significantly higher for RAS than for laparoscopic surgeries. Again, however, we do not know whether these differences were influenced by the different technological demands, the differences in experience the team had with each technology, or both. Finally, Nyssen and Blavier (2010) studied the communication between the surgeon and one bed side assistant during RAS and suggested that greater levels of individual experience (measured as number of RAS performed) allowed for more implicit communication, however they do not describe what this implicit communication entailed. In summary, initial studies focused on differentiating the patterns of communication between robot-assisted and laparoscopic surgery (Cao and Taylor, 2004; Nyssen and Blavier, 2010; Webster and Cao, 2006), or real-time assessment of verbal communication during RAS (Cunningham et al., 2013; Nyssen and Blavier, 2010), but there are no studies that attempted to analyze verbal *and* nonverbal communications in RAS.

1.3. Study aims

In this study, we characterized team verbal and nonverbal interactions among the console surgeon, the physician assistant, and the scrub nurse in order to increase the knowledge of how surgical teams communicate during RAS. We hypothesized that team communication strategies (i.e., use of verbal vs. nonverbal means of communication) will be associated with the communicating pair and the topic of the interaction.

2. Materials and methods

2.1. Data collection

This research was conducted as part of an ongoing research initiative at a major cancer research hospital, the "Techno-fields" project. Techno-fields is intended to study and improve teamwork, communication, and other non-surgical skills in RAS, and supports audio- and video-recording of RAS cases using three ceiling-mounted cameras capturing views of personnel and their movements within the OR, recordings of the console video showing the view of the surgical field within the patient's body (to provide operative context) and up to eight audio tracks recorded by lapel microphones (Ahmad et al., 2016; Allers et al., 2016; Tiferes et al., 2016). As part of the ongoing project, recordings were made for cases in which all members of the surgical team and the patient had provided consent. Video and audio files were synchronized via the movie editing software, Adobe Premiere Pro CS6, resulting in four audiovisual streams per surgery. Noldus Observer XT 12 software was used to code the recordings. In addition to the recordings, time at the console (measured from the moment the surgeon sat at the console to start the procedure until he or she stood up at the end of the procedure) was noted.

2.2. Case and participant characteristics

For this study, recordings from 11 robot-assisted radical prostatectomies were analyzed. Surgeries were performed using Intuitive Surgical's da Vinci Si. Cases were selected to maximize the variability of team demographics concerning experience and inter-team familiarity levels for individuals comprising the surgical teams' "main triad" - the lead surgeon, the physician assistant (PA), and the primary scrub nurse (SN). These roles were the focus of research because they have a high degree of interaction during a case. Six surgeons (Ss), two PAs, and seven SNs participated in the 11 cases that we analyzed. Participants were surveyed regarding their years of experience in their role and the number of cases for which they had worked with other members of the team. Table 1 provides demographic information regarding participant experience. Table 2 shows familiarity levels among all the pair combinations present in each case. Note that for any given case, multiple individuals may have substituted for another in performing the team role (e.g., a second scrub nurse may have relieved the first scrub nurse).

Table 1
Number of participants by years of experience in the role.

	0-4 years	5-10 years	> 10 years
Surgeons	2	3	1
Physician Assistants	1	0	1
Scrub Nurses	4	1	2