Nurses' voice: The role of hierarchy and leadership

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ABSTRACT

Purpose Voicing concerns and suggestions is crucial for preventing medical errors and improving patient safety. Research suggests that hierarchy in healthcare teams impairs open communication. Hierarchy, however, can vary with changing team composition, particularly during acute care situations where more senior persons join the team later on. The aim of our study was to investigate how changes in hierarchy and leadership were associated with nurses' voice frequency and nurses' time to voice during simulated acute care situations.

Methods Our sample consisted of 78 healthcare providers (i.e., nurses, residents, and consultants) who worked in 39 teams performing complex clinical scenarios in the context of interprofessional, simulation-based team training. Scenarios were videotaped and communication behaviour was coded using a systematic coding scheme. To test our hypotheses, multilevel regression analyses were conducted.

Findings Hierarchy and leadership had no significant effect on nurses' voice frequency. However, there were significant relationships between nurses' time to voice and both hierarchy (γ = 30.00, p = .002; 95% CI [12.43; 47.92]) as well as leadership (γ = 0.30, p = .001; 95% CI [0.12; 0.47]). These findings indicate that when more physicians are present and leadership is more centralized, more time passes until the first nurses' voice occurred.

Value This study specifies previous findings on the relationships between hierarchy, leadership, and nurses' voice. Our findings suggest that stronger hierarchy and more centralized leadership delay nurses' voice but do not affect the overall frequency of voice.

Keywords: communication, hierarchy, leadership, simulation training, voice

Article classification: Research paper

INTRODUCTION

In healthcare, voicing concerns and suggestions regarding work-related issues (i.e., voice; Morrison, 2014) is crucial to ensure patient safety and improve team performance (e.g., Pattni et al., 2019; Schwappach and Richard, 2018). Particularly in acute care situations (e.g., cardiac arrest, difficult airway), precise communication – including voice – is essential (e.g., Edmondson, 2003). Teams that deal with acute care situations are frequently characterised by varying team composition (Klein et al., 2006), that is, usually more senior persons join the team later on. Importantly, these changes also affect hierarchy and leadership in a team (e.g., Tschan et al., 2006), which in turn might affect members' voice behaviour. In healthcare, most studies have examined voice using surveys instead of observing actual team communication behaviour (Alingh et al., 2019; Martinez et al., 2017; Noort et al., 2019). This is problematic because attitudes towards voice in theory can vary from voice in practice: How participants think they *would* act (i.e., self-report) can differ from how they *actually* act (i.e., observation of behaviour during simulation scenario) in real teamwork situations (Argyris, 1980; Argyris and Schon, 1974).

Against this background, the current study investigated nurses' actual voice behaviour during simulation scenarios that included acute care situations. With regard to varying team composition in these situations, we were interested under which conditions nurses were more likely to voice concerns and suggestions towards their team members (e.g., residents or consultants). To address this question, we focussed on two factors that are often associated with changes in team composition: hierarchy and leadership.

Theoretical Background

Voice has been defined as "informal and discretionary communication by an employee of ideas, suggestions, concerns, information about problems, or opinions about work-related issues" (Morrison, 2014, p.174). Voicing concerns or suggestions contributes to preventing errors and is particularly important in acute care situations (Edmondson, 2003). In the literature

on voice in healthcare, the terms "speaking up", "upward voice", "safety voice", and "voice" have been used somewhat synonymously (e.g., Edmondson, 2003; Noort et al., 2019; Weiss et al., 2017). Moreover, nurses' voice behaviour has been defined as "nurses' safety voice" (e.g., Morrow et al., 2016). For the sake of simplicity, we chose to use the term "nurses' voice" throughout this article, which refers to utterances by nurses involving either suggestion-, problem-, opinion, or doubt-focused content (Farh and Chen, 2018; Morrison, 2014; Weiss et al., 2014).

Research has shown that team composition represents an important factor that influences interprofessional teamwork in healthcare (Xyrichis and Lowton, 2008). Team composition in healthcare often varies, particularly in acute care situations (Klein et al., 2006): New team members often join the team and affect the workflow, sometimes through their mere presence. Specifically, the presence of a person higher in hierarchy such as a consultant may affect teamwork and communication. Similarly, leadership roles can become ambiguous when team composition changes. As a result, it is not always clear which team member has the lead (Seelandt et al., 2017). Both factors – hierarchy as well as leadership – have been related to nurses' voice behaviour (e.g., Alingh et al., 2019; Klein et al., 2006).

With regard to hierarchy, research suggests that hierarchical structures and power dynamics in acute care teams function as a barrier for team members to openly voice concerns and suggestions (e.g., Morrow et al., 2016; Raemer et al., 2016; Weiss et al., 2017). Specifically, team members may be afraid to be rejected, punished, or criticised by the recipient of voice, who is usually a person in a formally higher-status position (Milliken and Lam, 2009; Morrison, 2014). In general, hierarchy in groups refers to vertical differences (i.e., power differences) between group members (e.g., Greer et al., 2018). Hierarchy in healthcare is linked to differences in clinical authority, for example, between nurses and physicians (Omura et al., 2017). In this context, negative effects of hierarchy are particularly noticeably in the case of nurses' voice towards a consultant, as nurses are often perceived as being "at the bottom of

hierarchy" whereas consultants are perceived as being "on top of the? hierarchy" (e.g., Weiss et al., 2017). Thus, hierarchical structures and power dynamics seem to be particularly relevant for the collaboration between nurses and physicians (e.g., Chattopadhyay et al., 2010). We were interested in how the presence vs. absence of physicians as an aspect of hierarchy affects nurses' voice.

With regard to leadership, research has shown that leadership behaviour affects voice in acute care situations (e.g., Farh and Chen, 2018; Nembhard and Edmondson, 2006; Weiss et al., 2018). Tschan and colleagues (2006) investigated leadership behaviour in acute care teams during simulation-based trainings that included changes in team composition. Their study highlighted the importance of two specific leadership behaviours: directive lead-taking (i.e., directing an immediate action) and structuring inquiry (i.e., questions by a new team member that ask for information relevant to the procedure). Moreover, research suggests that leadership in acute care teams is more successful when leadership is shared among team members (i.e., low leadership centralisation), that is, multiple team members execute leadership behaviour (Künzle et al., 2010). Combining these two aspects, we were interested in how leadership centralisation as a specific aspect of leadership would affect nurses' voice in acute care situations.

The majority of empirical studies on voice in healthcare have relied on self-reported rather than actual voice behaviour (e.g., Alingh et al., 2019; Kobayashi et al., 2006; Martinez et al., 2015; Schwappach and Gehring, 2014; Schwappach and Richard, 2018). Moreover, to examine antecedents as well as outcomes of voice behaviour, post-hoc reports have been treated as reliable data (Noort et al., 2019). While self-reports do provide valuable insight into the nature of voice in healthcare teams, solely relying on these data when studying team dynamics is problematic (Kolbe and Boos, 2019; Kozlowski, 2015). For one, individuals' espoused theories that reflect their theories comprising their beliefs, attitudes, or values, often mismatch their theory-in-use that are actually employed (Argyris and Schon, 1974). This mismatch

between how individuals think they *would* act and how they *actually* act is particularly prevalent with potentially embarrassing and threatening issues – which are involved in most voice situations (Argyris, 1980). Although research on espoused voice theories has revealed important insights into individuals' decision-making processes preceding voice (e.g., Detert and Edmondson, 2011; Morrison, 2014; Raemer et al., 2016), they do not offer insights into whether, when, and how individuals actually engage in voice behaviour .

The present study

We aimed to address these issues of voice research in healthcare. Specifically, we were interested in how hierarchy and leadership are associated with nurses' actual voice behaviour. We deliberately chose to examine nurses' voice behaviour because nurses' voice is crucial for team effectiveness and patient safety (Edmondson, 2003; Garon, 2012; Kolbe et al., 2012). Moreover, nursing as a profession has a strong moral and ethical imperative for patient advocacy that makes voice particularly important (Rainer, 2015).

We investigated nurses' voice behaviour during simulation-based training. As a result of varying team composition, changes in hierarchy and leadership emerged. The starting team, usually a pair of either two nurses or one nurse and one resident, was gradually complemented by further residents and consultants. This led to changes in the teams' formal hierarchy: The more residents or consultants were present, the stronger was the hierarchy in the team. In acute care teams, hierarchy has been suggested to prevent nurses' from voicing concerns and suggestions (e.g., Alingh et al., 2019; Milliken and Lam, 2009). For example, members are afraid to challenge the status quo or perceive a lack of power to act (Martinez et al., 2017; Milliken and Lam, 2009). Therefore, we assumed that the stronger hierarchy, the less frequently nurses engage in voice. Moreover, we expected that the stronger the hierarchy in a team, the more time passes until nurses engage in voice for the first time.

In the current study, we focus on *leadership centralisation* as one important aspect of leadership in healthcare team. Leadership centralisation refers to the frequency and distribution

of leadership behaviour (i.e., directive leadership and structuring inquiry) among team members. Recent findings showed that balance in team communication – i.e., multiple team member contributing to the pre-operative briefing – has positive effects (Su et al., 2017). Similarly, low leadership centralisation involves multiple team members performing leadership behaviour, which indicates a balanced team communication. This balance might create an atmosphere in which contributions are apparently welcome, including nurses' voice behaviour. By contrast, high leadership centralisation refers to a situation where a single team member calls the shots, which indicates unbalanced team communication. For this reason, we predicted that the lower leadership centralisation, the more nurses engage in voice. Moreover, we expected that in situations with lower leadership centralisation, less time passes until nurses engage in voice for the first time.

In sum, we formulated the following four hypotheses:

Hypothesis 1a: Nurses' voice will occur more frequently if hierarchy is low (i.e., fewer physicians are present).

Hypothesis 1b: Nurses' voice will occur more frequently if leadership centralisation is low.

Hypothesis 2a: Nurses' time to voice will decrease if hierarchy is low (i.e., fewer physicians are present).

Hypothesis 2b: Nurses' time to voice will decrease if leadership centralisation is low.

METHODS

Participants Our sample consisted of healthcare providers who were employed at a large University hospital (i.e., Institute of Anesthesiology and Institute of Intensive Care). For training purposes, participants completed a 1-day simulation-based training on improving both technical as well as teamwork skills in acute care situations in anaesthesia and intensive care. Participants were volunteers from these courses who provided written informed consent prior

to data collection. The overall study period included 12 days of training, with up to 11 participants per day. On each day, participants performed four complex simulation scenarios that lasted on average 12.3 minutes (*SD* = 3.1).

Apparatus and materials Trainings took place in the simulation centre, which was fully equipped as anaesthesia suite and allowed participants to carry out common anaesthesia and intensive care procedures including preparing the patient administrating medication, patient intubation, and patient monitoring. A full-sized simulation mannequin (SimMan3G®, Laerdal, Norway) was treated as a patient who can "speak" (i.e., simulation instructor in the control room) and render vital parameters (e.g., chest movements, heartrate, and pulse). Simulation scenarios were videotaped.

Simulation scenarios Scenario 1 involved the treatment of an instable atrial fibrillation. Scenario 2 involved a patient after a dorsal kyphoplasty in the post anaesthesia care unit with acute chest pain. Scenario 3 required the treatment of a postoperative delirium, and scenario 4 warranted a difficult airway management and reanimation. Scenarios were developed by simulation educators who had attended a simulation instructor course (Center for Medical Simulation, Boston, MA). Educators developed scenarios based on cases who had been reported at the internal critical incident reporting system, following a procedure described elsewhere (Schick et al., 2015). On each training day, scenarios were conducted in the same order (i.e., 1-4). To achieve optimal performance in each scenario, team members' actual voice was needed. Further descriptions of the scenarios and examples for voice events are portrayed in the Appendix.

Procedure In the beginning of each training day, participants completed a personal background questionnaire including demographic data such as age, gender, work experience, working area, and profession. Training was provided by simulation educators (i.e., 1 nurse, 2 physicians) with a special training in interprofessional healthcare simulation education. Participants were formally briefed in a standardised way and familiarised with the learning

objectives, expectation, ground rules of collaborative learning, facilities and technique (Rudolph et al., 2014). They participated in their respective role as nurse or physician. Prior to each simulation scenario, participants were asked to form a team for the initial patient contact, just as they would do it in their clinical work. The initial team was usually a pair of either two nurses or one nurse and one resident. One of the educators briefed them regarding the simulated case and, at the start of the scenario, acted as an embedded simulated person (e.g., emergency physician) who handed over the patient. After some time into the scenario, a critical event occurred (e.g., bradycardia, dyspnoea), which required the attendance of a consultant. At this point, one of the initial team members typically called for help. Responding to the call, a consultant entered the room to assist the initial team. Depending on the need of the team for further support, team composition shifted up to three times per scenario. After each scenario, the educators engaged the participants in a detailed debriefing which followed established debriefing approaches (Kolbe, Weiss, et al., 2013; Rudolph et al., 2007; Weiss et al., 2017). They used the video when appropriate. By the end of the training day, participants completed a final questionnaire including an evaluation of the training. However, this questionnaire was not relevant to the current study.

Measures

All measures were based on the video recordings of the scenarios, which were coded using INTERACT coding software (Mangold International GmbH, Arnstorf, Germany). Coding was performed by the first author.

Phases Based on video recordings, we defined each new team composition during a scenario as a distinct phase. A new phase (i.e., end of the previous phase) was coded, if someone of either equal (e.g., a second resident joins a team of two nurses and one resident) or higher (e.g., a consultant joins a team of two nurses and a resident) clinical authority entered the room, thereby affecting the team's hierarchy. In total, 81 phases were coded. On average, scenarios (N = 39) were segmented into 2.08 (SD = .93) phases.

Hierarchy Similar to Nembhard and Edmondson (2006), team members were assigned values for their respective clinical authority in the professional hierarchy. We chose values (i.e., nurse = 0, resident = 1, and consultant = 2) reflecting nurses as members with lower clinical authority, residents as members with higher clinical authority than nurses, but lower clinical authority than consultants, and consultants as members with the highest clinical authority (Chattopadhyay et al., 2010; Lingard et al., 2002; Weiss et al., 2017). This way each team composition was assigned a specific value for hierarchy. For example, if a team was composed of one nurse (0), one resident (1) and one consultant (2), the value for hierarchy was 3.

Leadership centralisation Following Tschan and colleagues (2006), we operationalised leadership behaviour during simulation scenarios using codes for directive leadership (i.e., "giving a direction for an immediate action"; p. 287) and structuring inquiry (i.e., "question asking for information relevant to the resuscitation procedure"; p. 287). To operationalise leadership centralisation, we calculated the variance of the total number of general leadership behaviour that was performed by team members for each phase (e.g., Su et al., 2017). Lower variances indicated that leadership centralisation in the team was low, as leadership behaviour was more evenly distributed among multiple team members. For example, consider a team composed of one consultant, two residents, and one nurse. If each of the team members engaged multiple times in leadership behaviour, leadership centralisation would be low (see table 1). By contrast, if the consultant exhibited the majority of leadership behaviour, leadership centralisation would be high (see table 1).

--- insert Table 1 about here ---

Nurses' voice frequency To assess nurses' natural voice behaviour, we utilized the modified version of the coding system Co-ACT (Kolbe, Burtscher, et al., 2013; Weiss et al., 2014), which was specifically developed to code the communication and coordination in acute

care teams. "Nurses voice" was coded when utterances involved either suggestion-, problem-, opinion, or doubt-focused content (Farh and Chen, 2018; Weiss et al., 2014). Frequency of nurses' voice was determined by aggregating nurses' voice occurrences for each phase.

Nurses' time to voice Nurses' time to voice was defined as time from the start of a phase (i.e., new team composition) until the moment when a nurse firstly voiced a suggestion, problem, opinion, or doubt towards his or her team members. In phases without nurses' voice occurrences (i.e., 28 of 81 phases), we used the overall duration of the phase as value for nurses' time to voice.

Control variables Because the study involved four different simulation scenarios (see above), we added the type of scenario as control variable in our model. Type of scenario was dummy coded such that scenario 1 served as reference category. Additionally, in analyses that predicted voice frequency, duration of phase (mean-centred) was added as control variable.

Interrater reliability To assess interrater reliability, four randomly selected videos (i.e., one for each of the four scenarios) representing 10.26 % of the data were coded by a second observer (i.e., trained graduate student). We found substantial agreement between raters for both leadership behaviour (Cohen's Kappa = 0.72) and nurses' voice behaviour (Cohen's Kappa = 0.83).

Analysis

To account for the hierarchical structure of our data (i.e., phases were nested in scenarios), we used multilevel regression modelling. We analysed the data with the packages *lme4* (Bates et al., 2016) and *multilevel* (Bliese, 2016) of the statistical software R (R Core Team, 2015). In the present study, 'level 1' refers to variables on the phase level (i.e., hierarchy, leadership centralisation, and phase duration) whereas 'level 2' refers to variables on the scenario level (i.e., type of scenario).

Our first hypothesis predicated that nurses' voice will occur more frequently if a) hierarchy is low and b) leadership centralisation is low. To determine whether the data

warranted a model with one or two levels of analysis, we calculated the Intra-Class-Correlations (ICCs) of the dependent variable voice frequency on the scenario level. An ICC from 10% on indicates that measures are not independent from their clusters (Lee, 2000). The respective ANOVA was significant, $F(38,42) = 3.268$, $p = .000$. Moreover, the ICC(1) of .522 indicated that variance between scenarios accounted for 52.2% of the total variance, implying that nurses' voice frequency values from different phases of the same scenario were not independent from each other. Consequently, we analysed our data using multilevel regression[1]. Moreover, we computed the variance inflation factor to assess multicollinearity between the 1-level predictors (i.e., hierarchy and leadership centralisation). VIF value was < 2 showing that collinearity was not a problem. Our multilevel regression models (i.e., random intercept models) were used to predict the dependent variable nurses' voice frequency from the mean-centred independent variables hierarchy and leadership centralisation (i.e., level 1 predictors). Our second hypothesis predicted that nurses' time to voice will be lower if a) hierarchy is low and b) leadership centralisation is low. To determine whether the data warranted a model with one or two levels of analysis, we calculated the Intra-Class-Correlations (ICCs) of the dependent variable nurses' time to voice on the scenario level. Although the respective ANOVA was not significant, $F(38,42) = 1.417$, $p = .14$, the ICC(1) = .167 indicates that variance between groups accounted for about 17% of the total variance, implying that nurses' time to voice values from different phases of the same scenario were not independent from each other. Consequently, we also used multilevel regression modelling for the second hypothesis.

RESULTS

Our final sample included 10 training days with a total of 78 participating healthcare providers: 36 nurses (26 women), 29 residents (10 women) and 13 consultants (4 women). Age

[1] As our outcome variable voice frequency represents counts, we also calculated multilevel models that considered data as poisson-distributed (Kabacoff, 2011). Results closely resemble those obtained from the multilevel models that treated data as normally-distributed. For ease of presentation, we only report findings of the multilevel model with the assumption of normally-distributed data.

(i.e., in years) was measured in categories: 24-29 (11 participants), 30-35 (23 participants), 36-41 (20 participants), 42-47 (9 participants), 48-53 (7 participants), >53 (6 participants) and not reported (2 participants). Work experience (i.e., in years) was also measured in categories: >2 (2 participants), 3-4 (10 participants), 5-6 (9 participants), 7-8 (10 participants), 9-10 (4 participants, >10 (41 participants), and not reported (2 participants). Descriptive statistics for all study variables are reported in table 2.

--- insert Table 2 about here ---

Results of the multilevel regression model predicting nurses' voice frequency and nurses' time to voice are reported in table 3 and table 4, respectively. We estimated the pseudo-R^2 for generalized mixed models (Nakagawa and Schielzeth, 2013), and we also calculated bootstrap confidence intervals (based on 5,000 resamples) for the parameter estimates.

--- insert Table 3 about here ---

--- insert Table 4 about here ---

We found no support for our first hypothesis: neither of the models revealed a significant relationship between hierarchy and nurses' voice frequency, nor between leadership centralisation and nurses' voice frequency. Model 1 (γ = -1.751, p = .041; 95% CI [-3.432; -0.064]) as well as model 2 (γ = -1.932, p = .024; 95% CI [-3.631; -0.310]) revealed a significant relationship between the control variable type of scenario and nurses' voice frequency. Nurses' voice frequency in scenario 4 (M = 1.29; SD = 1.32) was lower as compared to scenario 1 (M = 5.90; SD = 3.67).

In support of our second hypothesis, (i.e., nurses' time to voice will decrease if a) hierarchy is low and b) leadership centralisation is low), on level 1, model 1 (γ = 32.17, p =

.002; 95% CI [12.53; 51.12]), as well as model 2 (γ = 30.00, p = .002; 95% CI [12.43; 47.92]), revealed a significant relationship between hierarchy and nurses' time to voice, suggesting that the stronger the hierarchy in a team, the longer it took until the first nurses' voice occurred. Moreover, model 2 revealed a significant relationship (γ = 0.30, p = .001; 95% CI [0.12; 0.47]) between leadership centralisation and time to voice. The higher leadership centralisation during a phase, the more time passed until the first nurses' voice occurred. Type of scenario had no significant influence on the outcome variable nurses' time to voice.

DISCUSSION

In this study, we investigated how hierarchy and leadership were associated with nurses' actual voice behaviour during simulated acute care situations. As predicted, we found that nurses' voice occurred faster a) if hierarchy was lower (i.e., fewer physicians were present), and b) leadership was less centralized (i.e., more team members exhibiting leadership behaviour). Contrary to our expectation, nurses' voice frequency was not related to either hierarchy or leadership centralisation.

Implications for research and practice

The current study makes several contributions to research on leadership, hierarchy, and nurses' voice in acute care teams. First, our results suggest that the sole presence of a person with higher clinical authority, that is, a resident or consultant, is enough to delay nurses' voice. This finding extends previous research showing that hierarchical structures in acute care teams function as a barrier for nurses to openly communicate concerns and suggestions (e.g., Raemer et al., 2016) – at least in the start-up phase of a new team composition. Respect of perceived status differences, being afraid of challenging the status quo, or even norms of the organisation are possible reasons for nurses' initial reluctance to voice concerns (e.g., Li et al., 2018; Milliken and Lam, 2009). Supporting previous research, our findings indicate that the stronger the hierarchy, the more time nurses need to assess the situation until they feel safe enough to voice

their thoughts regarding work-related issues (e.g., Nembhard and Edmondson, 2006). This pattern can be problematic in situations which involve time-critical information-sharing and decision-making (Edmondson, 2003; Schmutz et al., 2015). Especially nurses, who typically experience the patient's treatment from early on – in contrast to consultants who join the team later – should feel comfortable to openly communicate concerns and suggestions, as they can have unique, important information regarding the patients' treatment (Nembhard and Edmondson, 2006). Yet, residents or consultants might not necessarily be aware of the potential impact of their presence on nurses' voice behaviour. Possibilities for structured, shared reflection during (oder "such as") simulation-based training and clinical debriefings might offer learning opportunities for all team members. For example, members with higher clinical authority (e.g., residents or consultants) might learn from members with less clinical authority (e.g., nurses) about the impact of their presence on nurses' voice. Another way to promote nurses' voice towards a senior medical leader could be his or her use of inclusive language, as Weiss and colleagues (2018) showed in their recent study. Additionally, senior medical leaders could behave more open to nurses' voice (e.g., Detert and Burris, 2007; Lebel, 2016) and respond adequately – even if not endorsing their suggestion – to foster subsequent nurses' voice (e.g., King et al., 2019). This way, nurses might be more likely to share their thoughts without being afraid to be rejected by the leader.

Second, our results suggest that more balanced leadership in a team might encourage nurses to voice their concerns and suggestions more quickly. As multiple team members (i.e., consultants, residents, and nurses) participate in shared leadership, the number of members who actually participate in team communication is higher and therefore, communication within the team is more balanced. When multiple team members participate in leadership, this can lead to a communication atmosphere that facilitates nurses' participation, including voice behaviour. In other words, low leadership centralisation might encourage nurses to contribute and thereby decreases the time to nurses' voice in an early stage of teamwork. Furthermore, shared

leadership might foster the development of a team mental model (Burtscher et al., 2011; Burtscher and Manser, 2012) that establishes contributions of each team member as a norm, decreasing nurses' time to voice. With regard to leadership styles, Farh and colleagues (2018) showed that particularly directive leadership promoted voice during preparation and action phases in surgical teams. In the current study, we focussed on directive leadership behaviour by suggesting that nurses' voice could be promoted, if directive leadership is distributed among multiple team members (i.e., low leadership centralisation).

Third, contrary to our expectations, we found that neither hierarchy nor leadership centralisation predicted nurses' voice frequency. As research via self-reports suggested that hierarchy prevents team members from openly voicing concerns and suggestions (Lyndon et al., 2012; Raemer et al., 2016), we expected hierarchy to reduce the number of times that nurses engage in actual voice behaviour. Our findings, however, suggests that hierarchy does not *actually* prevent nurses' voice in real team work situations per se, but merely delays the occurrence of nurses' voice. This extends and further specifies previous voice research. In addition, these findings demonstrate how voice research in healthcare might benefit from observing actual team interactions.

Limitations and future research

Our study has several limitations. First, data collection took place during simulation-based training. This could have affected team members' behaviour, because, despite effort for creating as much realism as possible, behaviour during simulations might differ from behaviour during actual acute care situations. For example, communication behaviour might have been affected because participants could have perceived simulation training as a psychological safer environment than their real work environment (e.g., Edmondson and Lei, 2014). Second, the order of the simulation scenarios was not randomized. This could be an alternative explanation for the effect of less nurses' voice frequency in the fourth scenario, compared to the first scenario, as participants might have been tired at the end of the training da*y.* Third, in the present

study, we operationalized hierarchy via *inter*-professional differences between nurses, residents, and consultants. However, *intra*-professional boundaries between nurses might also play a role, as hierarchical structures due to levels of seniority are suggested to potentially hinder collaborative working among nurses (Powell and Davies, 2012). Hierarchy within nursing might impact nurses' voice behaviour within and between professions: junior nurses might not voice concerns towards senior nurses and might be less likely to voice their concerns towards physicians than senior nurses.

Finally, our study was single centred, that is, data collection took place only in one organisation. Thus, we did not explicitly consider contextual factors such as an organisation's safety climate which might have influenced nurses' voice behaviour (Neal et al., 2000). Similarly, as we focussed on acute care situations, it would be worthwhile to investigate the effects of hierarchy and leadership on nurses' voice in less time-pressured contexts such as wards. Perceived time-pressure during a task has been suggested to affect voice behaviour (e.g., Bienefeld and Grote, 2012).

Up to now, there is a lack of studies investigating actual behaviour and dynamic interaction patterns in acute care teams. Future voice research should focus on behavioural observation to examine natural communication behaviour, for instance behaviour during simulated acute care situations as well as during real acute care situations (Kolbe and Boos, 2018). Our study demonstrated that studying actual voice behaviour can provide a new perspective on voice in healthcare teams that could barely be revealed by using self-reports.

Conclusion

This is the first study that systematically investigated the effects of hierarchy and leadership on actual nurses' voice behaviour. We show that hierarchy as well as leadership delay nurses' first voice, but not affect overall nurses' voice frequency. These findings indicate that both formal hierarchy in a team as well as team leaders' behaviour can affect nurses' voice. By investigating actual nurses' voice behaviour, the present study advances our understandings of

the dynamics of nurses' voice in acute care teams. Moreover, our study indicates that healthcare organisations could benefit from interventions that address leadership and hierarchy issues as this can contribute to improved team communication. For example, based on the findings of the current study, nurses could practice to voice concerns and suggestions in the presence of multiple senior medical leaders. We hope that our research will inspire additional research to facilitate the implementation of nurses' voice as an important component of safe and efficient patient care.

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APPENDIX

Scenario	Summary	Voice event
1	During the professors' ward round the patient develops an atrial fibrillation (AF). Initial Hf60 sinus, RR 123/77 mmHg, SpO2 97% with 4lO2, VHF 167/min, SpO2 goes off (i.e., the patient fiddles with himself), and the blood pressure stays the same (i.e., but decreases critically during the scenario).	The professor weighs the first and second voice events because he wants to know more about the patient and asks questions (e.g., "Did the patient have ever had AF?", "Were there thrombi in the transthoracic echocardiography?", "Does he have a cardiac pacemaker?", "Was there a cardiologist involved?", or "Why not?"). A voice event should be made by a team member towards the questioning but inactive professor, thus moving the team to necessary actions (e.g., cardioversion).
2	A contact-isolated patient is placed to the PACU shortly after dorsal kyphoplasty during the PACU "rush hour". The PACU nurses have got little time to prepare for isolation and the anaesthesiology registrar has to wait with the patient. During the interaction, the patient expresses chest pain – with slight ST changes (ST elevations) indicating a ST – elevation-myocardial-infarction (STEMI).	One of the team members was to bring the ST elevation clinic together to diagnose a heart attack and performs a voice event that leads the focus from the isolation to the current problem.
3	Following trepanation because of a chronic subdural hematoma, the patient has just been extubated and will be relocated to the ICU / PACU. The anaesthesiologist has been called on an emergency mission, a previously uninvolved doctor should carry out the transport. The patient is delirious and puts himself and others at risk.	Here, a meaningful brief handover should be called in by a voice event and the acutely threatening situation should be solved. The anaesthesiologist must perform a voice event against the order of the emergency mission.
4	A patient is transferred to the Intensive Care Unit (ICU) or Postoperative Anesthesia Care Unit (PACU) after 7 hours of uncomplicated surgery in the lower abdomen. The anaesthesiologist hands over the case and is called on the phone. Nurses will notice a bradypnea /dyspnoea, which will increase. It is caused by a relaxant overhang and can easily be treated. Depending on the speed of the team, bradypnea /hypopnea leads to hypoxemia, resulting in asystole and resuscitation.	A voice event of the nurses towards the anaesthetist should be placed in this scenario.