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Teamwork, Clinician Well-Being & Patient Safety in Hospital Care

An integrative approach towards a better understanding of interrelations and causal dependencies

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1. INTRODUCTION

The integration of the topics of teamwork, clinician well-being and patient safety was the main objective of this dissertation. The quotes below, taken from a survey that was part of this project, provide an insight into clinicians'[1] thoughts and attitudes towards those central topics.

"I feel that within critical care teams, there is always some sort of competition, a need to mark territory, to gain the trust of others and to prove oneself. This environment stresses me."

"The level of safety depends a lot on the quality of collaboration between co-workers."

"Many residents cover up their lack of knowledge and force me [a nurse] to exceed my competencies in order to keep the patient safe."

"As soon as the workload increases, management of safety culture becomes secondary."

"It would be useful to implement trainings that support the staff psychologically and that provide the opportunity to use tools and strategies to improve teamwork and safety."

"It is because of the team climate that I am still able to work in this great profession after nine years."[2]

The quotes demonstrate what is stressful and what can be a resource, and they illustrate clinician's ideas on how these constructs interact. The topics of teamwork, clinician well-being and patient safety seem to resonate amongst nurses and physicians: they are central aspects of their daily work life and they contribute to making hospitals a beneficial place for patients and clinicians alike.

The quotes may reflect individual perceptions, yet they are supported by empirical studies that demonstrate that the healthcare setting can be harmful for its inhabitants. The

[1] I will use the term "clinicians" to refer to nurses and physicians throughout this dissertation.
[2] All quotes translated from German, French, and Italian by the author.

work of clinicians is physically and emotionally demanding. Long shifts, a high workload that needs to be managed with fewer personnel resources, patients with increasingly complex conditions, few rewards, little appreciation and interpersonal conflicts are just a few stressors (Allen & Holland, 2014; Arakawa, Kanoya, & Sato, 2011; Griffiths et al., 2014; 2014; Tanner, Bamberg, Kozak, Kersten, & Nienhaus, 2015). It is not surprising that the quality of patient care can suffer under such working conditions (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aiken et al., 2014; Van Bogaert, Kowalski, Weeks, Van Heusden, & Clarke, 2013). Patients may be given the wrong medication in the wrong dose, hygiene standards may be disregarded, or important treatments may be forgotten (Kalisch, Tschannen, & Lee, 2012; Ottestad, Boulet, & Lighthall, 2007; Squires, Tourangeau, Laschinger, & Doran, 2010; Zander, Dobler, Baumler, & Busse, 2014).

Patient care tasks are predominantly carried out by teams: nurses work together on ward for a shift, and their contributions to care are complemented by physicians who see the patients. Other specialists, such as pharmacists, radiologists or physical therapists may contribute their expertise during a patient's hospital stay. Interprofessional teamwork is particularly important in settings where patients' conditions are critical and the environment is less predictable, such as intensive care (Moyen, Camiré, & Stelfox, 2008; Myhren, Ekeberg, & Stokland, 2013).

Low clinician well-being and decreased patient safety pose considerable problems in the healthcare setting (Aiken et al., 2012; de Vries, Ramrattan, Smorenburg, Gouma, & Boermeester, 2008, Estryn-Behar et al., 2011). The quotes above illustrate that teamwork can be a stressor or a resource for clinicians, *and* it can contribute to or hinder safe patient care. High-quality teamwork may thus have the capacity improve clinician well-being and patient safety simultaneously. Previous studies have investigated cross-sectional relationships between either two of the three constructs teamwork, clinician well-being, and patient safety, but not addressed them in conjunction or longitudinally (e.g. Davenport et al., 2007; Wilkins et al., 2008). The overall purpose of this dissertation was thus to integrate teamwork, clinician well-being, and patient safety in the hospital setting by developing a theory-based framework connecting all three constructs, and to explore (causal) interrelations between them.

This dissertation is structured as follows: Chapter 1 defines teamwork, clinician well-being and patient safety; illustrates their importance in the healthcare setting;

provides a theoretical background to connect these constructs; outlines the specific research aims and summarizes the studies that were part of this dissertation. Chapters 2 to 4 comprise these studies. They contribute to the overall purpose of this dissertation via **A) a systematic literature review** on the state of research regarding relationships between teamwork, clinician well-being and patient safety; **B) a cross-sectional study** on clinician burnout and objective patient safety; and **C) a longitudinal study** that explored causal relationships between interprofessional teamwork, clinician burnout and patient safety. Chapter 5 contains additional analyses that complement the results of chapters 2 to 4. Finally, chapter 6 summarizes and integrates the results of chapters 2 to 5 and discusses limitations, practical and theoretical implications, and points out avenues for future research.

Theoretical foundations

This section introduces the central constructs of this dissertation, namely, teamwork, well-being and safety, by providing definitions and explaining the theoretical background. Of course, these constructs are not unique to the healthcare context, and considerable research activity has been dedicated to them in other organizational settings (e.g., Alarcon, 2011; Bienefeld & Grote, 2013; Nahrgang, Morgeson, & Hofmann, 2011; Zohar & Polachek, 2014). However, they have been transferred to the healthcare context rather recently despite their significance. As will be discussed below, the hospital environment possesses some unique features that may have delayed the adaptation and investigation of these constructs.

Patient safety

Patient safety is an important indicator of hospital performance. It can be defined as 'the avoidance, prevention and amelioration of adverse outcomes or injuries stemming from the process of healthcare' (Vincent, 2012, p. 4). Kristensen, Mainz, and Bartels (2007) add a temporal perspective to this definition by stressing that efforts to improve patient safety must be continuous, and that the improvement of patient safety depends on an organization's willingness to learn. Adverse outcomes or adverse events are undesired

incidents occurring during the care process, and preventable adverse events are those that do not arise from the patient's condition, but as a result of human error or a flawed system (de Vries et al., 2008; Kristensen et al., 2007). They occur quite frequently – studies estimate that about 5 to 11% of patients are affected by at least one, and that 50 to 70% of adverse events could have been prevented (de Vries et al., 2008; Soop, Fryksmark, Köster, & Haglund, 2009; Vincent, Neale, & Woloshynowych, 2001; Zegers et al., 2009). De Vries et al. (2008) estimate that 7% of adverse events results in lasting harm, and another 7% are fatal. However, even if patients suffer no lasting physical damages, adverse events are associated with psychological costs such as psychological trauma, patient's loss of trust in the system, and emotional distress of clinicians involved in adverse events (Duclos et al., 2005; Rassin, Kanti, & Silner, 2005). In addition, patient safety incidents have considerable financial impact: on average, they prolong hospital stays by 8 to 10 days and cost an estimated extra 3900 euros (Ehsani, Jackson, & Duckett, 2006; Vincent et al., 2001).

Patient safety is a complex issue, because hospitals have to maintain a balance between a high level of standardization and allowing for the necessary flexibility to respond to non-routine events (Amalberti, Vincent, Auroy, & de Saint Maurice, 2006). Thus, there is no one patient safety indicator that is representative of the entire system. Generally, authors distinguish between process and outcome patient safety indicators (Garrouste-Orgeas et al., 2012). Process indicators are errors or lapses that occur during treatment, such as medication errors, wrong choice of treatment, or skipping crucial steps during a procedure. Outcome indicators provide information on the general level of safety and include hospital-acquired infections or standardized mortality ratios (Garrouste-Orgeas et al., 2012). Data on these indicators may be collected via the review of records, observations or self-reports by clinicians (or patients). Self-reports may tap into a very specific aspect of safety, or be a global rating that covers aspects not captured with a single indicator taken from patients' records. However, self-reports may be biased by individual preferences, whereas record reviews are considered more objective (Garrouste-Orgeas et al., 2012).

The magnitude of patient safety incidents has been realized relatively late. In 1999 the Institute of Medicine (IOM) launched a report that brought the issue of patient safety to attention (Cohn, Corrigan, & Donaldson, 1999). Since then, progress to solve this

problem has been relatively slow (Ovretveit, 2009; Travaglia & Braithwaite, 2009). A 'blaming culture' existed in many hospitals, which accused individual clinicians for their inadequate skills and neglect (Reason, 2000). This culture prevented hospitals from analyzing errors to learn how to prevent them in the future. It is in process to be replaced by a systemic approach that considers individual mistakes as multi-causal and thus as an expression of a faulty system that is inadequately suited to human cognition and behavior (Cohn, Corrigan, & Donaldson, 1999; Reason, 2000). It is this systemic approach that this dissertation taps in to by investigating patient safety in conjunction with teamwork and clinician well-being.

Clinician well-being

Employee well-being is a generic term that encompasses a plethora of psychological and physiological states. It may be considered a result of the interplay between individual and organizational factors, and is consequently intertwined with numerous variables in the occupational context, such as job demands, autonomy, social support, conflict, turnover or sick leave (Harter, Schmidt, & Keyes, 2003; Kuoppala, Lamminpää, & Husman, 2008; Wright & Cropanzano, 2000).

This is also true for the healthcare setting (e.g., Bruyneel, Van den Heede, Diya, Aiken, & Sermeus, 2009; Van Bogaert et al., 2013), which due to its unpredictable and changing environment generates numerous stressors that are associated with reduced well-being in many clinicians (Montgomery, Panagopoulou, Kehoe, & Valkanos, 2011; Montgomery, 2007; Reader, Cuthbertson, & Decruyenaere, 2008). Studies report burnout rates from 30 to 50 percent; depending on the country, they may be as high as 78 percent (e.g., Aiken et al., 2012; Estryn-Behar et al., 2011; Poncet et al., 2007). The effects of the healthcare environment *on* clinician well-being have been well documented for the nursing profession in recent years – a gap exists with regard to physician well-being (for an overview, see Jennings, 2008). In contrast, the effects *of* reduced clinician well-being on patient safety are less well known.

This lack of knowledge may be attributed to cultural aspects associated with the nursing and medical professions (Hall, 2005). In nursing culture, it seems to be acceptable to voice concerns over the impact of work stress; however, nurses do not see opportunities to change these circumstances (Berland, Natvig, & Gundersen, 2008). Thus,

nurses may admit to stress and reduced well-being, but they are required to possess the resources necessary for patient care regardless (Berland et al., 2008). In contrast, physicians view themselves as far less susceptible to the effects of stress and fatigue as nurses. They prefer to be seen as cool-headed and able to perform despite long work hours and sleep loss. Admitting to being susceptible to workplace stressors, being exhausted, or even mentally ill, is still considered a taboo (Wallace, 2012; Wallace & Lemaire, 2009). This culture is also fostered at the organizational level. The reduction in performance after being awake for 17 hours is comparable to a blood alcohol level of .05% – the legal driving limit in many countries – and thus constitutes a safety hazard (Williamson & Feyer, 2000). Yet it is still argued that such work hours are essential in medical training, because they enable residents to closely follow patients' trajectories through the hospital and thus to meet their learning goals (Lewis, 2003).

These above rationale illustrates that reduced well-being constitutes a considerable problem in the healthcare context, with associated negative effects on the organization and the individual (e.g., van Beuzekom, Akerboom, Boer, & Dahan, 2013; Van Bogaert et al., 2014). However, many studies are missing a theoretical model that explains the development of well-being, which can lead to a confusion of terms and definitions.

In this dissertation, the focus lies on clinician's occupational psychological well-being, i.e., a state of well-being (or lack thereof) that is induced by work-related factors. It is based on the stress and coping theory by Lazarus and Folkman (1984), who propose that stress is a process which develops based on the interplay between individual and environment. Environmental factors, like high workload or restructuring of the workplace, are not stressful per se, but may be evaluated as such by the individual. The evaluation is thus dependent on personal attributes. Whether the individual appraises a potential stressor as a threat, irrelevant or a challenge has consequences for the response (Lazarus & Folkman, 1984; Lepine, Podsakoff, & Lepine, 2005). Both threats and challenges evoke short term responses, such as changes in affect and behaviors. Threats furthermore induce coping mechanisms, such as increased effort or devaluation of work. Long-term negative consequences, such as prolonged strain, may be the outcome. Challenge stressors, on the other hand, may have rather positive outcomes if they are successfully coped with. The above definition of well-being thus encompasses both negative facets, such as burnout, acute and chronic strain, and positive facets, such as

general mental health or work engagement. It furthermore covers affective, cognitive, and behavioral component of well-being (Van Horn, Taris, Schaufeli, & Schreurs, 2004). For instance, the concept of work engagement includes positive attitudes towards one's work (affect), assigning high value to one's job (cognition) and increased effort (behavior).

Teams and teamwork

Working conditions in the healthcare setting may be demanding for individuals, but teams are generally well suited to respond to these demands (Baker, Day, & Salas, 2006). Teams are often used when tasks are complex and non-routine (Bishop & Mahajan, 2005; Levi, 2014). Particularly in acute care settings such as intensive care units, quick responses are often necessary as a patient's condition may change rapidly (Begun & Kaissi, 2004). In hospitals, various professions and specializations are needed for the delivery of healthcare: anesthetists, surgeons, and scrub nurses performing an operation; a physician in a hospital ward devises a treatment plan, nurses provide care, and physical therapists mobilize patient after an operation.[3] These tasks are too complex to be carried out by a single individual – teams consist of *at least two individuals*. A defining characteristic of teams that sets them apart from other groups is thus *interdependency*: team members possess *specialized roles and knowledge*, and they *interact* with each other to reach a *common goal* (Kozlowski & Ilgen, 2006). Teams are *embedded in and interact with an organizational system*: a patient may undergo treatment provided by several teams in different departments, such as radiology, the operating theatre, and the orthopedic ward (Kozlowski & Ilgen, 2006). Finally, the goals teams pursue are *relevant for the organization*: they contribute to the provision of healthcare (Cannon-Bowers & Salas, 1998; Kozlowski & Bell, 2003; Kozlowski & Ilgen, 2006).

How do these teams combine individual expertise to accomplish their goals? Scholars generally agree that technical skills, or task-related activities – i.e., competencies that are inherent to one's profession – are not sufficient for effective teamwork (Cannon-Bowers & Salas, 1998; Marks, Mathieu, & Zaccaro, 2001). Cannon-Bowers and Salas (1998) make the distinction between teamwork-related knowledge, skills, and attitudes (KSA's). For instance, team members are required to have a certain amount of knowledge

[3] This dissertation project focused on nurses and physicians, but of course other healthcare professionals, such as midwives, pharmacists, or physical therapists may be part of the team as well.

about the roles and expertise of other team members (also called transactive memory systems), and they need to have a shared understanding about the completion of procedures (i.e., shared mental models). Furthermore, team members need to demonstrate certain non-technical or team skills, such as adaptation to new situations, re-distribution of tasks, or communication of important information to other team members. Finally, positive attitudes facilitate teamwork. Examples are a sense of cohesion – i.e., team members' motivation to remain in the group –, and a high level of team efficacy – i.e., the shared belief that the team possesses the capabilities to reach its goal.

Kozlowski and Ilgen (2006) distinguish between cognitive, interpersonal (attitudinal, motivational), and behavioral (action) processes. Apart from team mental models and transactive memory systems, they name team learning and team climate as important cognitive processes. Team learning is defined as the acquisition of team-related skills and competencies through interaction, whereas team climate refers to a shared cognition of team values and rules. Team interpersonal processes cover concepts such as team cohesion and efficacy, but also team-level affective states, motivation, and conflict. Examples of behavioral processes are cooperation, communication, and coordination – i.e., the general contributions to the team goal (as opposed to social loafing), the ability to talk to team members about goals and how to get there, and the ability to organize team members' actions into meaningful sequences.

Marks et al. (2001) distinguish between action, transition, and interpersonal processes. Action processes refer to coordinative and leadership behaviors directly related to achieving the goal, whereas transition processes comprise the evaluation of past and the planning of next steps. Interpersonal processes refer to social interactions that create a pleasant atmosphere in the team, thus facilitating transition and action processes.

The above descriptions of effective teamwork use different terminologies, but they all combine a cognitive (team mental models, transactive memory systems), a behavioral (coordination, communication) and an interpersonal (cohesion, conflict) domain in their respective definitions. These domains are not mutually exclusive. For instance, Marks et al. (2001) emphasize team *behaviors* such as active conflict management, but that does not exclude the existence of underlying team cognitions and perceptions. Conversely, interpersonal team aspects may be described as shared perceptions by Cannon-Bowers and Salas (1998) and Kozlowski and Ilgen (2006), but they do not deny that these

perceptions may manifest in actual behaviors. To summarize, effective teamwork manifests itself in team behaviors. Underlying cognitions are essential to execute these behaviors, and interpersonal aspects facilitate development of shared cognitions and execution of team behaviors.

However, teams in healthcare face specific challenges. The notion that 'a team of experts does not make an expert team' (Burke, Salas, Wilson-Donnelly, & Priest, 2004, p. i97), i.e., that technical skills or knowledge are not sufficient to provide quality healthcare, and that teamwork requires training (Leonard, 2004; Salas, Dana, Sims, Klein, & Burke, 2003), has been adopted relatively late by healthcare organizations, compared to other high-risk organizations such as aviation (Ramanujam & Rousseau, 2006). Within the domain of teamwork, team processes that are clearly related to goal accomplishment, such as coordination of activities, have since been acknowledged as important for patient safety (Pronovost, 2013; Salas et al., 2003). In contrast, the contribution of subliminal interpersonal aspects, such as a team climate that encourages clinicians to speak up, are far less clear, as will be discussed in study A. Hierarchical structures and cultural differences between healthcare professions may contribute to the devaluation of (interpersonal) teamwork (Hall, 2005; Rosenstein & O'Daniel, 2005). Furthermore, teams in hospitals are complex entities. In contrast to many other organizational settings, where teams may work on a project for the duration of several months or years, healthcare teams are relatively short-lived: they work together for the duration of an operation or a shift and then dissolve. These teams are often built from a pool of clinicians that are acquainted with each other, but changing team constellations require them to constantly adapt to an environment that is far less predictable than other industries (Begun & Kaissi, 2004; Edmondson, 2012; West & Lyubovnikova, 2013). Moreover, the overall goal – improving the patient's health – is not achieved before the team dissolves. Instead, multiple teams contribute to this overall goal, thus requiring additional coordination. Lastly, team learning, which is considered an important aspect of teamwork by many scholars, especially in an unpredictable environment, may be impeded by changing team constellations (Vashdi, Bamberger, & Erez, 2013).

This section provided the theoretical foundations for teamwork, clinician well-being and patient safety, and described specific challenges associated with them in healthcare

organizations. The next section introduces the theoretical models which illustrate the hypothesized interrelations between them.

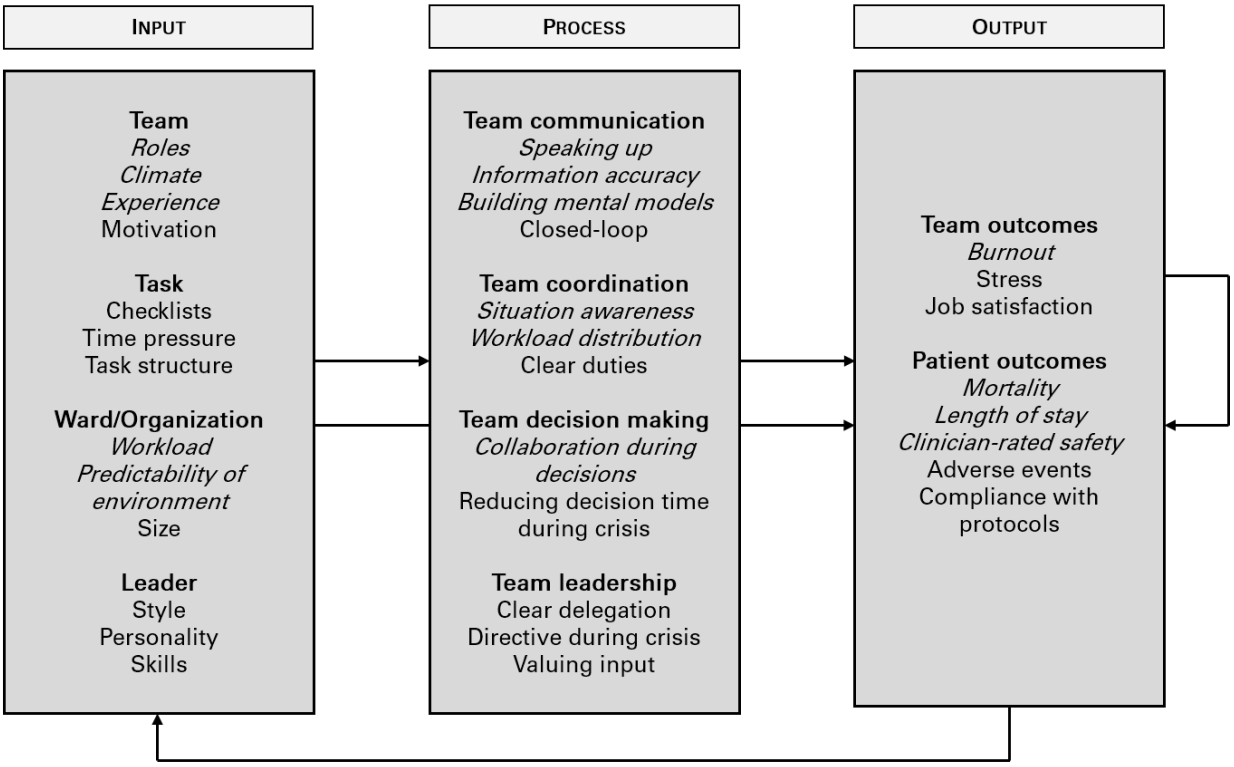
Connecting teamwork, clinician well-being and patient safety

Three theoretical frameworks provide the background for the integration of teamwork, clinician well-being, and patient safety. In this dissertation, the Input-Process-Output (IPO) framework by McGrath (1964) serves as a template to structure these constructs. In addition, we draw from the job demands-resources model (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001) and the conservation of resources theory (COR; Hobfoll, 1989, 2002) to illustrate the linkages between teamwork, clinician well-being and patient safety.

The IPO framework by McGrath (1964) originates from systems analysis and is intended to explain *group* processes. Characteristics of the group and the task, such as experience, attitudes, or the structure of the task, are considered inputs to group processes. Interactions between group members constitute the actual teamwork described above – for instance, making decisions about the distribution of work. These group processes generate output, such as the resuscitation of a patient. The IPO framework suggests linear, causal processes and has consequently been criticized for being too static and simplistic. It does not include feedback loops from output to input, take into account temporal processes of group development, or explain multiple, parallel group processes. These limitations have been addressed by later alterations and extensions (Burke, Stagl, Salas, Pierce, & Kendall, 2006; Ilgen, Hollenbeck, Johnson, & Jundt, 2005; Marks et al., 2001; Reader, Flin, Mearns, & Cuthbertson, 2009), two of which will be addressed in more detail below.

Based on a literature review, Reader et al. (2009) applied the IPO framework to healthcare *teams*. They extended it to include concepts of relevance in the ICU setting, the majority of which are depicted in figure 1. The extended framework in figure 1 furthermore acknowledges that team outputs may feed back into future team inputs, thus assuming cyclical instead of linear relationships. For the purposes of this dissertation, it has been extended to cover the topics explicitly or implicitly addressed in studies B and C (in italics). The framework also acknowledges the significance of the other two constructs investigated by linking team outcomes (e.g., burnout) and patient outcomes (e.g.,

Figure 1
IPO framework adapted from McGrath (1964) & Reader et al. (2009)



Note. Topics addressed in this dissertation are in italics.

mortality). In addition, it suggests that the effects of team inputs (e.g., professional role) may be directly associated with outputs (e.g., burnout), rather than via team processes.

Within the IPO framework, Marks et al. (2001) focus on teams, specifically, on temporal development of team processes by questioning the linear input-process-output chain. They differentiate between action phases (e.g., coordination, backup behaviors, monitoring) and transition phases (e.g., goal setting, strategy development), both of which have specific inputs, processes, and outputs. Actions and transition phases alternate, the output of one phase thus feeding into the next. In addition, several chains of action and transition phases may occur simultaneously. For instance, an anesthetist monitors a patient's vital signs whilst a surgeon, a resident, and a nurse perform an operation. Every now and again the surgeon may adjust the strategy or monitor the resident's progress. Furthermore, Marks et al. (2001) emphasize the importance of interpersonal team processes. Interpersonal processes are considered the foundation for effective teamwork and as such can take place during action and transition phases. For instance, negative

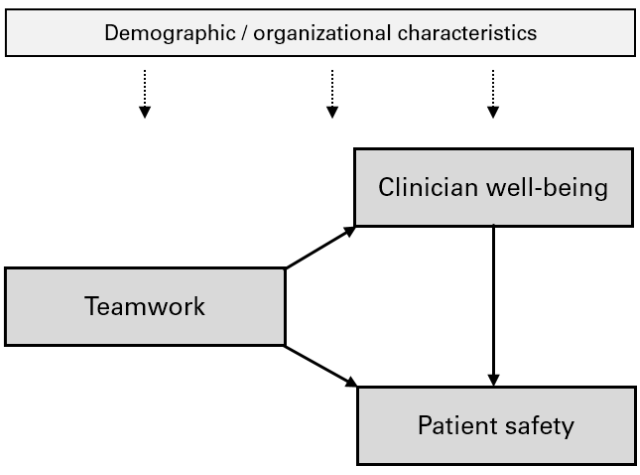
comments about team members' skill level may impair their confidence, team cohesion and, eventually, team performance.

Finally, COR theory (Hobfoll, 1989, 2002) and the JD-R model (Demerouti et al., 2001) provide a rationale for the hypothesized linkages between teamwork, clinician well-being and patient safety. According to COR, individuals are motivated to maintain and accumulate resources. Resources may be anything of value to the individual – objects, personality attributes, or characteristics of the environment. Strain or reduced well-being occurs if the individual is threatened with loss of resources, if he or she actually loses them, or if an expected gain of resources does not occur.

The JD-R model differentiates between job resources and job demands. Job demands are "physical, social, or organizational aspects of the job that require sustained physical or mental effort" (Demerouti et al., 2001, p. 501) and thus have the capacity to reduce the individual's well-being. Job resources, on the other hand, "refer to those physical, social, or organizational aspects of the job" (Demerouti et al., 2001, p. 501) that either aid completion of tasks, mitigate the effects of high job demands, or support personal growth. Lack of job resources may also result in reduced well-being.

Based on the theoretical foundations described above, the conceptual framework shown in figure 2 was developed. It depicts the a priori assumptions concerning the relationships between teamwork, clinician well-being, and patient safety. Depending on its quality, teamwork can be a demand *or* a resource that can increase or decrease both clinician well-being and patient safety: disrespectful, dismissive communication within the team may prevent individuals from fully contributing to the task at hand, and ineffective coordination may increase individual workload and thus increase error probability and reduce well-being. On the other hand, positive interpersonal interactions may result in a positive team climate. Effective communication and coordination is likely to reduce individual workload, thus reducing the probability of errors

Figure 2
Conceptual framework



and strain on the individual. In addition, the framework proposes a connection between clinician well-being and patient safety. Reduced clinician well-being occurs if clinicians' resources are depleted, and their cognitive functioning may suffer (Deligkaris, Panagopoulou, Montgomery, & Masoura, 2014; Park & Kim, 2013). As a consequence, their capability to fulfil job-related duties may be impaired, which is thought to have a negative effect on patient safety (Park & Kim, 2013). Finally, the effect of demographic and organizational characteristics, such as professional experience or workload on teamwork, clinician well-being, and patient safety is accounted for.

The underlying idea of this framework is that teamwork may have a simultaneous effect on clinician well-being and patient safety. As teamwork is the predominant form of work distribution in hospitals, intervening to improve it may be an efficient means to increase both clinician well-being and patient safety. Research findings from other organizational settings show that teamwork is associated with well-being or safety and thus lending support to the above assumptions (e.g., Burke, Wilson, & Salas, 2003; van Mierlo, Rutte, Seinen, & Kompier, 2001). However, as established earlier, the healthcare setting possesses some unique characteristics and faces specific challenges, and improvement of patient safety and clinician well-being are central and urgent goals for hospitals. As will be outlined below, existing research suffers from some conceptual and methodological limitations. Thus, investigations of teamwork, clinician well-being, and patient safety need to be conducted based on theory and in a manner that is meaningful to the healthcare setting.

Summary of studies and research objectives

This dissertation includes three empirical studies that address different research questions contributing to the overall objective of integrating teamwork, clinician well-being and patient safety (for a summary, see table 1). Additional analyses were conducted to complement the findings of these studies.

The main purposes of **Study A** were to establish an overview of the current state of research on relationships between teamwork, clinician well-being and patient safety, and to develop a framework that combines these constructs. Contributions to this area of

research have been made by different disciplines, such as psychology, nursing sciences, medicine, and human factors. Thus, scholars approach this research area with the methodology and research questions specific to their discipline, but there is a lack of exchange with regard to the respective research outputs between the disciplines. In order to bring contributions from the different disciplines together, we conducted a systematic review that aimed to identify studies published between 2000 and 2012 investigating quantitative relationships between teamwork, clinician well-being and patient safety. Specifically, we were interested in underlying theories and definitions, study design and types of analysis, and strength of statistical relationships.

The 80 studies included in the review confirmed that previous research had addressed relationships between either two of the three constructs, but none had integrated all three. Based on the studies and psychological theory, we expanded the conceptual framework depicted in figure 2 by providing a more detailed rationale for the hypothesized relationships between teamwork, clinician well-being, and patient safety, and by identifying research trends, gaps and strengths. The most prominent gaps were a lack of theoretical foundation and vague definitions of key constructs, statistical analyses that did not match data complexity, missing investigation of objective patient safety indicators, measures of unclear validity, absence of a multi-dimensional and interprofessional conceptualization of teamwork, and a lack of knowledge regarding causal relationships. Specifically, observational studies, which comprised about 50 percent of reviewed studies, investigated the impact of cognitions and behaviors in interprofessional teams on immediate safety outcomes, such as errors. In contrast, survey studies (50%) investigated predominantly mono-professional samples (a majority being nurses) and focused on interpersonal teamwork and subjectively rated patient safety. **Additional analyses D** updated the systematic review to 2015 and revealed that some of the gaps described above have since been addressed by researchers.

Based on the research gaps identified in study A, further research objectives were defined to address these gaps via **studies B** and **C**. Data were collected from interprofessional teams consisting of altogether 2100 nurses and physicians who worked on 55 Swiss intensive care units via an online survey consisting of previously validated measures, and from the units' record system.

The main objective of **study B** was to address the lack of knowledge regarding objective patient safety. It investigated relationships between clinician burnout and patient safety via a cross-sectional design. In addition, demographic and organizational characteristics as illustrated in figure 2 were included. Data were analyzed using hierarchical (multilevel) regression. Analyses revealed that emotional exhaustion predicted standardized mortality ratios, but not length of stay. The main finding was that emotional exhaustion predicted standardized mortality ratios but not length of stay. However, workload was associated with increased length of stay. In addition, low burnout, trainee status and being a physician were associated with higher safety perceptions. **Additional analyses E** complemented this study by investigating the effect of teamwork on objective patient safety. Analyses revealed that cognitive-behavioral teamwork, but not interpersonal teamwork predicted standardized mortality ratios.

Lastly, **study C** tested the framework depicted in figure 2 via a three-wave longitudinal design. Its main objective was to investigate causal relationships between teamwork, clinician well-being, *and* patient safety. In addition, it employed a multi-dimensional conceptualization of teamwork by differentiating between interpersonal and cognitive-behavioral aspects, including the quality of teamwork between nurses and physicians. Cross-lagged structural equation modeling revealed that emotional exhaustion predicted interpersonal teamwork. Interpersonal and cognitive-behavioral teamwork mutually reinforced each other. Finally, cognitive-behavioral teamwork predicted clinician-rated patient safety. **Additional analyses F** repeated the analyses of study C with an alternative measure of cognitive-behavioral teamwork.

Table 1
Overview of empirical studies and additional analyses included in dissertation

	Study title	Publication Status	Main objectives	Main outcomes	PhD candidate's contribution
Main studies					
A	Integrating teamwork, clinician well-being and patient safety – development of a conceptual framework based on a systematic review (Welp & Manser)	Under review at *BMC Health Services Research*	Assessment of the current state of research, identification of research gaps and strengths, provision of a theory-based framework to combine all three constructs	Teamwork, clinician well-being and patient safety have not been investigated via an integrative approach. Research on these topics suffers from considerable conceptual and methodological limitations	Substantial contribution to conception & design, data collection, analysis, interpretation, draft and revision of the manuscript
B	Emotional exhaustion and workload predict clinician-rated and objective patient safety (Welp, Meier, Manser, 2015)	Published in *Frontiers in Psychology*	Investigation of the association between clinician burnout and objective patient safety	Emotional exhaustion predicts standardized mortality ratios, but not length of stay	Substantial contribution to conception & design, data collection, analysis, interpretation, draft and revision of the manuscript
C	The interplay between teamwork, burnout, and patient safety – a longitudinal study (Welp, Meier, & Manser)	To be submitted to *Critical Care Medicine*	Examination of causal relationships between teamwork, clinician burnout and patient safety	Emotional exhaustion predicts interpersonal teamwork. Interpersonal and cognitive-behavioral teamwork mutually reinforce each other Cognitive-behavioral teamwork predicts patient safety	Substantial contribution to conception & design, data collection, analysis, interpretation, draft of the manuscript
Additional analyses – based on studies A, B, & C, respectively					
D	Updating the systematic review	-	Update of the systematic review (study A)	Gaps identified in study A have since been addressed with the exception of interprofessional teamwork	Substantial contribution to conception & design. Sole contributor to analysis & interpretation
E	Investigating teamwork and objective patient safety	-	Investigation of the relationship between teamwork and objective patient safety	Cognitive-behavioral teamwork, but not interpersonal teamwork is associated with standardized mortality ratios.	Substantial contribution to conception & design. Sole contributor to analysis & interpretation
F	Taking "safety" out of the safety organizing scale	-	Validation of the relationship between cognitive-behavioral teamwork and patient safety of study C	Safety-related items in the cognitive-behavioral teamwork measure do not affect the relationship to patient safety	Substantial contribution to conception & design. Sole contributor to analysis & interpretation

2. STUDY A

Integrating Teamwork, Clinician Well-Being and Patient Safety – Development of a Conceptual Framework Based on a Systematic Review

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Abstract

Background: There is growing evidence that teamwork in hospitals is related to both patient outcomes and clinician psychological well-being. Furthermore, clinician well-being is associated with patient safety. Despite considerable research activity, only few studies included all three constructs, and their interrelations have not yet been investigated systematically. To advance our understanding of these potentially complex interrelations we propose an integrative framework taking into account current evidence and research gaps identified in a systematic review.

Methods: We conducted a literature search in six major databases. Inclusion criteria were: peer reviewed papers published between 2000 and 2012 investigating a statistical relationship between at least two of the three constructs teamwork, patient safety, and clinician well-being. Methodological quality was assessed using a standardized rating system and relevant data, such as instruments, analyses and outcomes were extracted and qualitatively appraised.

Results: The 80 studies included in this review were highly diverse regarding quality, methodology and outcomes. We found support for the existence of the singular links between teamwork, well-being and patient safety. However, we identified several conceptual and methodological limitations. The main barrier to advancing our understanding of the causal relationships between teamwork, clinician well-being and patient safety is the lack of an integrative, theory-based, and methodologically thorough approach investigating the three constructs simultaneously and longitudinally. Based on psychological theory and our findings, we developed an integrative framework that addresses these limitations and proposes mechanisms by these constructs which might be linked.

Conclusion: Knowledge on the mechanisms underlying the relationships between these constructs helps to identify avenues for future research and to develop multi-professional practice interventions aimed at benefiting clinicians and patients by using the synergies between teamwork, clinician psychological well-being and patient safety.

Keywords: teamwork, clinician well-being, patient safety, framework, systematic review

Competing interests: None for all authors.

Author's contributions: AW designed the study, conducted the literature search, analyzed and interpreted the data and wrote the manuscript. TM substantially contributed to the design of the study, aided in data interpretation and reviewed and substantially contributed to the writing of the manuscript.

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BACKGROUND

Patient safety is an important indicator of hospitals' organizational performance. Approximately 10% of patients suffer adverse events and half of those are deemed preventable.[1] Patient safety has been defined as the absence of preventable adverse events – events that are a consequence of healthcare interventions and not the patients' condition.[2] Healthcare is predominantly provided by teams – two or more people with specialized roles and responsibilities interacting with the shared goal of patient care.[3] Consequently, in addition to medical competence, effective teamwork is critical for safe patient care.[4-7] This includes both observable team behaviors and clinicians' perceptions of interpersonal team processes. For example, reports of better coordination or team psychological safety have been linked to fewer medical errors and better patient outcomes such as length of stay.[8-10] Also, specific team *behaviors*, for example leadership, information sharing or decision making and team properties (e.g., shared mental models) were found to be associated with performance indicators such as decision and execution latency or protocol adherence.[11, 5, 12]

Teamwork is also an important predictor of another indicator of hospitals' organizational performance: the well-being of healthcare providers.[13, 14] Reduced well-being or psychological strain may develop as an immediate or long-term response to stressors[15] and is highly prevalent in healthcare workers.[16, 17] Teamwork may constitute such a stressor. For instance, dysfunctional inter-professional teamwork predicts increased acute and chronic clinician strain.[18, 19] However, effective teamwork may protect from the effects of work stress, since positive perceptions of teamwork are associated with enhanced psychological well-being indicators such as increased mental health in nurses and physicians.[20, 21]

Lastly, clinician well-being and patient safety are interrelated. Reduced clinician psychological well-being is associated with objective and subjective patient safety indicators such as mortality ratios, clinician-rated safety and reported errors.[13, 22, 23] Highly strained clinicians might thus pose a threat to patient safety. Vice versa, patient

safety incidents are stressors that may lead to decreased clinician well-being: clinicians report increased emotional distress following medical error.[24]

Studies investigating associations between teamwork, clinician well-being and patient safety originate from very different strands of research – medical, nursing, and psychology. So far, the evidence that they generated has not been brought together for systematic evaluation. While this research showed that relationships exist between construct pairings of teamwork, clinician psychological well-being and patient safety, all three of them have rarely been investigated simultaneously. Moreover, the *mechanisms* underlying the relationships between either two – and potentially all three – constructs are largely unknown.

To overcome this research gap, we aimed to provide an overview of the current state of research on relationships between at least two of the three constructs of teamwork, clinician psychological well-being, and patient safety. In a systematic review we summarized theoretical foundations, sample, methodology, and empirical findings, and evaluated overall study quality. Based on the findings of the systematic review, we developed a conceptual framework integrating the three constructs. Specifically, we propose theoretically informed causal relationships between the constructs, describe focal points of past research, and identify gaps in the current knowledge. The framework is intended to serve as a blueprint both for future studies and for team-based interventions intended to benefit clinicians' well-being and patients' safety.

METHOD

Definition of central constructs

Teamwork

The definition of teamwork was based on the model by Marks and colleagues, which includes transition (planning, goal formulation), action (coordination, monitoring), and interpersonal processes (conflict management, motivation, or team members' perceptions

thereof (e.g. team climate).[25] Thus, studies comparing the effects of team-based work to other forms of work organization were excluded. Leadership was included if it was clearly directed at the team level, excluding studies examining dyadic or organizational leadership processes. Studies assessing inter-team processes were excluded, because we were interested in how working *within* a team relates to patient safety and clinician well-being.

Clinician psychological well-being

Our aim was to identify studies investigating both positive and negative aspects subsumed under psychological well-being.[26-28] We included studies investigating general or work-related psychological or physiological strain as an individual's short- or long-term perception of or response to stressors.[15] Studies examining fatigue were included if direct measures of fatigue were used rather than being inferred from external indicators such as shift duration. General or work-related positive outcomes such as work engagement were included. Studies examining personality traits or psychopathological disorders were excluded. Long-term chronic somatic disorders such as lower back pain were excluded, as it is often unclear whether these conditions are caused by continuous psychological strain or physical activities.

Patient safety

Patient safety was defined as "the avoidance, prevention, and amelioration of adverse outcomes or injuries stemming from the process of healthcare".[29] We included studies covering variables that could directly affect a patient's health status (i.e. reported or observed errors, key actions not being performed), as well as subjective patient safety ratings and objective morbidity-mortality-data. Studies assessing quality of patient care or using safety climate as a substitute outcome measure were excluded.

Search strategy

We searched six databases (Medline, PsycArticles, PsycInfo, Psyndex, ScienceDirect, and Web of Knowledge) to identify relevant literature. Two of the three keywords TEAMWORK, PATIENT SAFETY, WELL-BEING were combined with AND. The

results were then combined with OR. In order to receive both relevant and manageable results, we applied a number of strategies (e.g. MeSH/thesaurus terms, related terms, alternative spellings, truncations or plural forms, and adjacency terms). Further inclusion criteria were: peer-reviewed journal articles, published in English between January 2000 and December 2012, referring to hospital context. Studies sampling practicing nurses or physicians were included. If multiple publications were based on the same dataset, we either selected the paper that was first published or reported the most extensive data analysis. Finally, we hand-searched reference lists of the selected articles and systematic reviews identified in our initial search.

Screening and selection procedure

All references were independently screened by two raters (AW and either MD, SS, or JV). The title and abstract were scanned at the first stage. Studies investigating at least two of the three constructs (teamwork, patient safety, clinician well-being) in a hospital setting were included. At the second stage, studies reporting a statistical relationship between at least two of the relevant constructs, which clearly described measurement methods and were published in peer-reviewed journals, were included. Disagreements between raters at the first screening stage led to inclusion, whereas disagreements at the second stage were resolved by consensus discussion.

Quality rating

To systematically assess study quality, we combined and slightly adapted existing systems (see appendix).[30, 31] Ratings were based on a maximum of 19 items (not all items were applicable for all studies) covering topics such as validity of measures or statistical analyses. Items were rated as 0 = major limitations/not applicable/not mentioned, 0.5 = some limitations, or 1 = fulfilled. Two raters (AW and MD) independently evaluated study quality and resolved disagreements through discussion.

Data extraction

Study setting, study design, method of data collection, data analysis, and study outcomes were extracted from the selected studies. If results were described in sufficient detail but effect sizes were not reported, we calculated them according to convention[32, 33] to judge whether a statistically significant relationship was large enough to infer practical implications.[34] In some studies, these variables may have been analyzed within a larger context (e.g. nurse working environment), however, only relationships between the variables of interest to this review are reported.

Framework development

Based on the results of our systematic review, the framework development followed two stages. First, we formulated hypotheses regarding the causal relationships between teamwork, clinician well-being and patient safety based on psychological theory, the theoretical foundations and findings of the reviewed studies. Second, we examined measures, samples, and definitions of teamwork, well-being and patient safety to detect trends and shortcomings in current research.

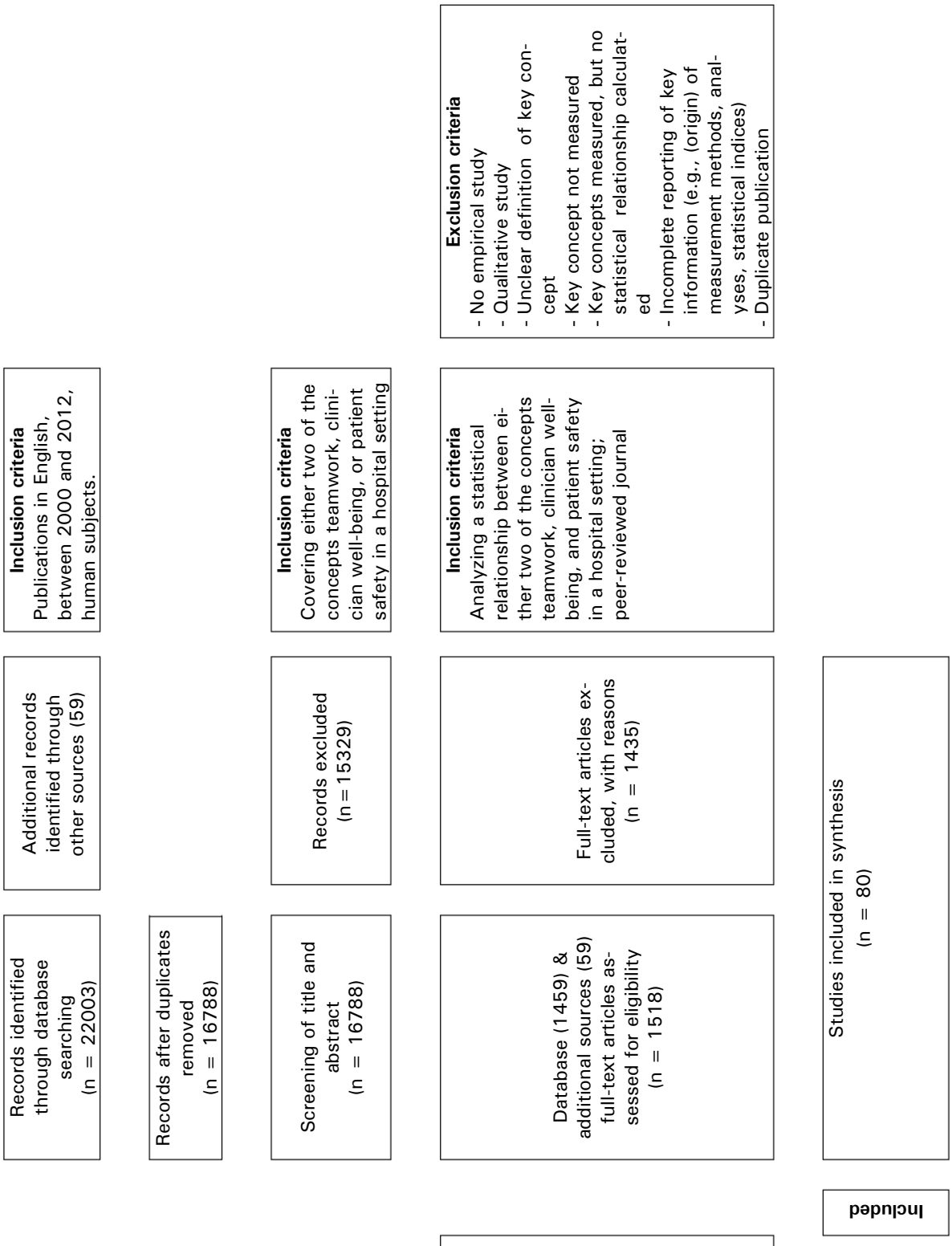
RESULTS

The database search from 2000 to 2012 yielded 22003 results. After removing duplicates, 16788 remained. Following title and abstract screening, the full text of 1518 publications was retrieved. Examining full-texts and hand-searching reference lists led to the inclusion of 80 publications (see figure 1). Of these, 18 investigated relationships between teamwork and well-being, 39 between teamwork and patient safety, 19 between well-being and patient safety, and four covered all three constructs.

Quality rating

Quality of the selected studies ranged from medium (35 studies) to high (45 studies; see tables 1 to 4). Average study quality was similar across the three constructs teamwork, well-being and patient safety (i.e. 10.8 for teamwork/patient safety (*SD* = 2.02), 10.9 for well-being/patient safety (*SD* = 1.73), 10.9 for teamwork/well-being (*SD* = 1.63), and 10.9 (*SD* = 1.81) for teamwork/well-being/patient safety). While low quality studies were identified in this review, they were excluded at an early stage because the methodological description was insufficient for data extraction and assessment of quality (see figure 1).

Figure 1: *Systematic search method and inclusion/exclusion criteria*



Relationships between teamwork and clinician psychological well-being

Design & sample

All studies examining relationships between teamwork and well-being used cross-sectional self-report designs, with one study adding a pre-post-shift diary design. Of these 18 studies, 13 surveyed nurses (table 1),[35-38, 20, 18, 39-43, 19, 44] one physicians,[21] one midwives[45] and three included a mixed sample.[46-48]

Measures

Teamwork was most often operationalized with the nurse-physician-relations subscale of the Nursing Work Index Revised (NWI-R).[49, 38, 18, 46, 39, 41, 43, 47, 19, 44] Well-being was frequently assessed with the Maslach Burnout Inventory (MBI).[50, 35, 38-43, 47, 19, 44]

Findings

Although causal relationships could not be established in the reviewed studies, most authors assumed that teamwork, a variable inherent to the working context, influences the individuals' *general* well-being, rather than well-being influencing teamwork. Two studies focused on *acute* strain,[18, 46] one of which showed that it negatively predicted team behaviors such as closed-loop communication or backup behavior.[46] Some studies examined the larger clinical work context without formulating assumptions about the specific relationships between teamwork and well-being, the respective findings thus being a by-product of the larger study context rather than a focus of investigation..[45] Across all studies, 35 significant relationships were reported. Overall, findings indicate that clinicians perceiving higher quality of teamwork also reported higher well-being or less strain. Effect sizes ranged from small (β = -12.85; f^2 = 0.13) to large (r = -.47, see table 1).

Table 1

Relationships between teamwork and clinician well-being

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
Bobbio et al., 2012[35]	Mediation of relationship between empowering leadership/organizational support and burnout by trust in leader/organization	no	273 nurses, general hospital, Italy	Cross-sectional self-report questionnaire	Team leadership: Empowering leadership scale[*] Well-being: Maslach Burnout Inventory (MBI)[*]	Path analysis	1) Satisfactory model fit 2) Trust in leader mediates relationship leading by example and emotional exhaustion 3) Trust in leader mediates relationship between showing concern/ interacting with the team and a) emotional exhaustion b) cynicism 4) Trust in organization mediates relationship between informing and a) emotional exhaustion and b) cynicism 5) No mediation effects for reduced professional efficacy	1) χ^2 (18) = 21.27, p = 0.27, χ^2/df = 1.18, RMSEA = 0.03, CFI = 1.00, SRMR = 0.02 Indirect effects: 2) β = -0.04, p < 0.05 3a) β = -0.23, p < 0.001 3b) β = -0.15, p < 0.001 4a) β = -0.03, p < 0.05 4b) β = -0.04, p < 0.02 5) NS	11.5 (16)
Bratt et al., 2000[36]	Relationships between nurse/unit characteristics, work environment and job satisfaction	no	1973 nurses, 70 pediatric intensive care units, 65 pediatric hospitals, USA/ Canada	Cross-sectional self-report questionnaire	Teamwork: a) Group cohesion: Group Judgment Scale b) Nurse-physician collaboration: Collaboration and Satisfaction about Care Decisions[*] Well-being: Job Stress Scale[*]	Pearson's correlation	Job stress is negatively correlated with 1) group cohesion 2) nurse-physician collaboration	1) r = -0.43, p < 0.001 2) r = -0.37, p < 0.001	9.5 (16)
Brunetto et al., 2011[37]	Relationships between supervisor-subordinate relationship, teamwork, role ambiguity and well-being	yes	1138 nurses, 3 public and 7 private urban and regional hospitals, Australia	Cross-sectional self-report questionnaire	Teamwork: Nurses' Satisfaction with Teamwork Scale Well-being: Perception of Well-being Scale (self-developed)	Pearson's correlation	Positive correlation between nurses' satisfaction with teamwork and well-being	Public sector: r = 0.35, p < 0.001 Private sector: r = 0.39, p < 0.001	9.5 (16)
Bruyneel et al., 2009[38]	Relationship between nurse working environment and nurse-perceived outcomes	no	179 nurses, 12 units, 5 acute care hospitals, Belgium	Cross-sectional self-report questionnaire	Teamwork: Nursing Work Index-Revised (NWI-R)[*] subscale *Nurse-Physician-Relations*	Multivariate logistic regression	Nurse-physician relations are not associated with emotional exhaustion	NS	11.5 (16)

Table 1

Relationships between teamwork and clinician well-being

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
					Well-being: MBI*				
Budge et al., 2003[20]	Relationships between nurses' work characteristics, work relationships and health	no	225 nurses, general hospitals, New Zealand	Cross-sectional self-report questionnaire	Teamwork: Nurse-Physician-Relations Scale* Well-being: Short-Form Health Survey (SF-36)* subscales *mental health* and *vitality*	Pearson's correlation	Positive correlation between nurse-physician relations and 1) mental health 2) vitality	1) $r = 0.29$, $p < 0.001$ 2) $r = 0.36$, $p < 0.001$	12.5 (16)
Gabriel et al 2011[18]	Collegial nurse-physician relations and psychological resilience moderate relationships between task accomplishment satisfaction and pre-/postshift affect	no	57 nurses, USA	Cross-sectional pen-and-paper diary-report	Teamwork: Nurse-Physician-Relations Scale* Well-being: Affect scale, psychological resilience based upon Connor–Davidson Resilience Scale (CD-RISC)*	Pearson's correlation, multilevel modeling	1) Nurse-physician relations are a) negatively correlated with preshift negative affect b) positively correlated with preshift positive affect 2) No correlations between nurse-physician-relations and psychological resilience 3) Nurse-physician relations a) negatively predict postshift negative affect b) positively predict postshift positive affect	1a) $r = 0.30$, $p < 0.05$ 1b) $r = 0.33$, $p < 0.05$ 2) NS 3a) $\gamma = -0.13$, $p < 0.01$ 3b) $\gamma = 0.2$, $p < 0.01$	12 (16)
Gevers et al., 2010[46]	Relationship between acute/chronic job demands and acute job strain and relationship between the latter and individual teamwork behavior	yes	48 nurses, nursing students and physicians, emergency department, The Netherlands	Cross-sectional self-report questionnaire	Teamwork and well-being: self-developed items adapted from existing measures	(Hierarchical) linear regression	1) Acute a) cognitive strains b) emotional strains separately negatively predict individual teamwork behavior c) whereas physical strains do not 2) When all three predictors are analyzed simultaneously, only acute emotional strains remain significant	1a) $\beta = -0.35$, $p < 0.01$, $R^2 = 0.18$, $[f^2 = 0.22]^{\dagger\ddagger}$ 1b) $\beta = -0.44$, $p < 0.001$, $R^2 = 0.25$, $[f^2 = 0.33]^{\dagger\ddagger}$ 1c) NS 2) $\beta = -0.36$, $p < 0.05$, $R^2 = 0.26$, $[f^2 = 0.35]^{\dagger\ddagger}$, emotional & physical strains: NS	13 (16)
Gunnarsdottir et al., 2009[39]	Relationships between nurses' work environment and work outcomes	no	695 nurses, various specialties, university hospital, Iceland	Cross-sectional self-report questionnaire	Teamwork: Nurse-Physician-Relations Scale* Well-being: Emotional Exhaustion*	(Hierarchical) linear regression	1) Nurse-physician relations are negatively associated with emotional exhaustion 2) Upon inclusion of four additional predictors, this association becomes non-significant	1) $\beta = -2.38$, $p < 0.001$, []† 2) NS	12.5 (16)

Table 1

Relationships between teamwork and clinician well-being

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
Kanai-Pak et al., 2008[40]	Relationships between nurses' work environment and work outcomes	yes	5956 nurses, various specialties, 19 hospitals, Japan	Cross-sectional self-report questionnaire	Teamwork: Nurse-Physician-Relations Scale[*] Well-being: Emotional Exhaustion[*]	Multivariate logistic regression	Lower nurse-physician relations are associated with higher risk for emotional exhaustion	Adj. OR = 1.35, $p < 0.05$	10.5 (16)
Klopper et al., 2012[41]	Relationships between nurses' work environment, job satisfaction and burnout	no	935 nurses, ICU, 62 hospitals, South Africa	Cross-sectional self-report questionnaire	Teamwork: Nurse-Physician-Relations Scale[*] Well-being: MBI[*]	Spearman's rank correlation	1) Negative correlation between nurse–physician relations and a) emotional exhaustion b) depersonalization 2) Positive correlation between nurse–physician relations and personal accomplishment	1a) ρ = -0.255, $p < 0.01$ 1b) ρ = -0.193, $p < 0.01$ 2) ρ = 0.199, $p < 0.01$	8.5 (16)
Lehmann-Willenbrock et al., 2012[42]	Mediation of relationships between appreciation of age diversity and nurse Well-being/team commitment by co-worker trust	yes	138 nurses, 1 hospital, Germany	Cross-sectional self-report questionnaire	Teamwork: Team commitment scale Well-being: Workplace Irritation Scale[*]	Pearson's correlation	Negative correlation between team commitment and irritation	$r = -0.33$, $p < 0.01$	12.5 (16)
Rafferty et al., 2001[43]	Relationship between interdisciplinary teamwork and nurse autonomy on patient and nurse outcomes and nurse assessed quality of care	yes	5006 nurses, 32 hospitals, UK	Cross sectional self-report questionnaire	Teamwork: Items referring to teamwork on unit derived from NWI-R[*] Well-being: MBI[*]	Pearson's correlation	Negative correlation between teamwork and burnout	$r = -0.219$, $p < 0.001$	6.5 (16)
Raftopoulus et al., 2011[45]	Relationships between safety and teamwork climate and stress	no	106 midwives, public maternity units, Cyprus	Cross-sectional self-report questionnaire	Teamwork: Safety Attitudes Questionnaire (SAQ)[*] subscale *teamwork climate* Well-being: job exhaustion, occupational stress (1 item each)	Backward stepwise linear regression	1) Job exhaustion negatively predicts teamwork climate (14 predictors altogether) 2) No association between teamwork and occupational stress	1) β = -12.85, $p = 0.046$, $R^2 = 0.117$, [$f^2 = 0.13$][†‡] 2) NS	10 (16)
Rathert et al., 2012[47]	Mediation of relationship between nurses' work envi-	no	272 nurses & other medical care	Cross-sectional self-report	Teamwork: 4 items from Agency for Healthcare Research	Path analysis	1) Negative association between teamwork and emotional exhaustion within larger path model	1) β = -0.19, $p < 0.01$ 2) GFI = 0.99, AGFI = 0.92, NNFI = 0.97,	11.5 (16)

Table 1

Relationships between teamwork and clinician well-being

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	ronment and workarounds by emotional exhaustion		providers, acute care hospital, North America	questionnaire	and Quality (AHRQ) Patient Safety Culture Survey[*] Well-being: Emotional Exhaustion[*]		2) Good final model fit	RMSEA = 0.06, χ^2 = 11.81 (*df* = 6)	
So et al., 2011[48]	Cultural differences in relationships between team structure, job design, and Well-being	yes	470 nurses & other medical care providers, acute hospitals, China & UK	Cross-sectional self-report questionnaire	Teamwork: items about team structure (roles, objectives, cooperation, performance reflection) Well-being: items about perceived work stress	Path analysis	Negative association between team structure and work stress within larger path model 1) in the UK sample 2) but not in the Chinese sample 3) Good overall model fit	1) β = -0.18, $p < 0.05$, $R^2_{\text{all stress predictors}}$ = 0.302 2) NS 3) χ^2 = 787.94 (*df* = 246, $p = 0.05$), CFI = 0.91, NNFI = 0.91, RMSEA = 0.071, 90%CI 0.065 - 0.076	12.5 (16)
Sutinen et al., 2005[21]	Relationships between health, work and social characteristics and retirement attitudes	no	447 physicians, several hospitals, Finland	Cross-sectional self-report questionnaire	Teamwork: Team Climate Inventory (TCI)[*] Well-being: General Health Questionnaire (GHQ-12)[*]	Pearson's correlation	Negative correlation between teamwork and minor psychiatric morbidity	r = -0.12, $p < 0.05$	10.5 (16)
Van Bogaert et al., 2009[44]	Mediation of relationships between nurse work environment and nurse job outcomes and quality of care by burnout	no	401 nurses, medical, 31 units, general and university hospital, Belgium	Cross-sectional self-report questionnaire	Teamwork: Nurse-Physician-Relations Scale[*] Well-being: MBI[*]	Pearson's correlation Path analysis	1) Negative correlation between nurse-physician relationship and a) depersonalization b) personal accomplishment 2) Within path model: negative association between nurse-physician relationship and emotional exhaustion 3) Adequate overall model fit	1a) r = 0.155, $p < 0.05$ 1b) r = -0.115, $p < 0.01$ 2) β = -0.19 3) χ^2 = 548.1, *df* = 313, $p < 0.001$, CFI = 0.906, IFI = 0.903, RMSEA = 0.43	11.5 (16)
Van Bogaert et al., 2010[19]	Relationships between nurse work environment, nurse job outcomes, quality of care, and burnout	no	546 nurses, 42 units, general and university hospitals, Belgium	Cross-sectional self-report questionnaire	Teamwork: Nurse-Physician-Relations Scale[*] Well-being: MBI[*]	Linear mixed effects multilevel model	1) Positive association between nurse-physician relationship and personal accomplishment 2) Negative association between nurse-physician relationship and a) emotional exhaustion b) depersonalization	1) β = 1.98, $p < 0.0001$ 2a) β = -3.79, $p < 0.0001$ 2b) β = -1.09, $p < 0.05$	11.5 (16)

Notes: We report not only significant but also non-significant relationships between predictor and outcome variables of interest in this review as hypothesized in the reviewed studies; even if not explicitly stated in the original publication.

[*] validated instrument; [†] effect sizes calculated by authors, calculation not possible if brackets empty; [‡] Cohen's f^2 based on R^2 instead of ΔR^2 ; [§] in brackets: maximal possible score.

Relationships between teamwork and patient safety

Design & sample

Studies examining relationships between teamwork and patient safety were very diverse regarding study design, construct operationalization, setting, data collection methods and strength of statistical relationships (see table 2). Of 39 studies, 22 employed video- or live-observation of nurses and physicians in real or simulated clinical situations (table 2a).[5, 12, 51-58, 11, 6, 59-68] Three studies utilized cross-sectional designs with self-report questionnaires (table 2b).[69, 8, 70] Another 14 studies employed mixed-method designs (e.g. record reviews or observations plus questionnaires, tables 2b and c).[71-76, 10, 77, 9, 78-82] These 14 studies included one intervention study[75] and four with longitudinal aspects,[75, 76, 8, 79] the two latter of which found evidence that teamwork predicted later patient safety.

Measures

The studies using questionnaires surveyed either nurses[76, 77, 69, 70, 78-80] or a mixed sample.[74, 10, 9, 81, 82] They focused on perceptions of various teamwork aspects such as safety organizing, team climate or nurse-physician relations. Observational studies, in contrast, analyzed actual team processes of teams usually consisting of nurses, physicians (and other healthcare professionals) with the exception of three studies.[11, 60, 65]

The NOTECHS tool[83] and its adaptations to various clinical settings was the most frequently cited system to assess teamwork in observational studies.[52-54, 6, 59, 60, 71, 72, 66] Questionnaire studies employed a variety of instruments covering different behavioral or socio-emotional teamwork aspects. Patient safety was assessed using subjective ratings[69, 8, 70, 82] and indicators based on hospital records[71, 72, 64, 65, 74-77, 9, 78-81] and observational data.[5, 12, 51-55, 57, 56, 58, 11, 6, 59, 60, 71-73, 63, 67, 68] Observational studies often used execution of key treatment actions as a proxy measure for patient safety.[55, 58, 11, 60, 73, 63] Only one study utilized both objective and subjective patient safety indicators.[10]

Findings

Overall, findings were rather inconsistent for the relationship between teamwork and patient safety. All authors assumed teamwork to positively influence patient safety. However, some studies revealed negative relationships suggesting that better teamwork was associated with lower patient safety.[52, 11, 71, 72, 64, 66, 74, 10] Also, studies investigating links between teamwork and objective patient safety indicators were frequently unable to identify significant relationships. For example, two studies used a sample of clinicians surveyed with a teamwork questionnaire to examine associations with objective and subjective patient safety indicators.[78, 70] While no association between teamwork and preventable adverse events extracted from hospital records was found,[78] the effect was significant when using the frequency of these events reported by head nurses.[70] Overall, 92 significant associations were identified and effect sizes ranged from small (r = -.08) to large (r = -.66, tables 2a and 2b).

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
a) observational studies									
Burtscher et al., 2010[51]	Relationships between coordination activities and team performance under differing situational demands	yes	19 anesthetists and 14 anesthesia nurses, 40 cases, teaching hospital, Switzerland	Video observation of anesthesia induction	Teamwork: observation system used for coding coordination activities & clinical work Patient safety: team performance (self-developed checklist)	Paired-sample t-test	1) Compared to low-performing teams, high-performing teams increase task management during non-routine events 2) No changes in information management during non-routine events	1) $t(20) = -2.75$, $p < 0.05$, []† 2) NS	13.5 (15)
Burtscher et al., 2011[12]	Relationships between adaptive team coordination during non-routine events and clinical performance during anesthesia induction	yes	15 anesthesia teams (1 resident, 1 nurse), teaching hospital, Switzerland	Video observation of simulated anesthesia induction	Teamwork: team coordination (structured observation)* Patient safety: decisions and execution latency (expert rating)	Pearson's correlation	1) Information management is a) negatively correlated with decision latency b) but not with execution latency 2) No correlations between task management and a) decision latency b) execution latency	1a) $r = -0.49$, $p = 0.003$ 1b) NS 2a) NS 2b) NS	12.5 (15)
Burtscher et al., 2011[5]	Team mental model properties moderate link between monitoring behaviors and performance in anesthesia induction	yes	31 teams (1 anesthesia resident, 1 anesthesia nurse), teaching hospital, Switzerland	Video observation of simulated anesthesia induction	Teamwork: Team mental model similarity and accuracy (concept mapping), monitoring behavior (structured observation*) Patient safety: adherence to anesthesia induction protocol (structured observation*)	Multiple hierarchical regression	1) Teams with similar mental models perform well irrespective of team monitoring level; teams with dissimilar mental models only perform well when team monitoring is low 2) Team mental model similarity is only related to performance when team mental model accuracy is also high 3) Team performance is high when either team or system monitoring is high and the other is low 4) Mental model accuracy does not moderate relationship between systems monitoring and performance	1) $\beta = 0.36$, $p = 0.04$, $\Delta R^2 = 0.13$, [$f^2 = 0.21$]† 2) $\beta = 0.42$, $p = 0.02$, $\Delta R^2 = 0.17$, [$f^2 = 0.12$]† 3) $\beta = -0.36$, $p = 0.04$, $\Delta R^2 = 0.12$, [$f^2 = 0.28$]† 4) NS	14 (15)
Catchpole et al., 2007[54]	Relationships between non-technical	yes	42 operations (24 pediatric,	Live & video observation	Teamwork: non-technical skills (NOTECHS*)	Multiple linear regres-	Non-technical skills negatively predict 1) minor problems but not 2) intraoperative performance or	1) $B = -3.3$, $t = -2.2$, $p = 0.035$, []† 2) NS	8 (15)

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Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	skills and adverse events in the OR		18 orthopedic), 2 hospitals, UK		Patient safety: Adverse events: minor problems, intraoperative performance, operating time	sion	3) operating time	3) NS	
Catchpole et al., 2008[52]	Relationships between non-technical skills and errors in the OR	yes	54 surgeons, anesthetists, and nurses, 48 operations (26 laparoscopic cholecystectomies, 22 carotid endarterectomies), 1 hospital, UK	Live observation of operation	Teamwork: NOTECHS* Patient safety: errors in surgical technique (observation clinical human reliability assessment technique), other procedural problems and errors (checklist), operating time	Multiple linear regression	1a) Surgical leadership and management negatively predicts operating time, b) whereas anesthetic leadership and management in carotid endarterectomy positively predicts operating time (2 predictors) 2) nursing leadership and management negatively predict other procedural problems and errors (2 predictors) b) whereas nursing leadership and management in carotid endarterectomy positively predicts operating time (2 predictors) 3) surgical situation awareness negatively predicts errors in surgical techniques (3 predictors) b) whereas surgical situation awareness in carotid endarterectomy positively predicts operating time (3 predictors) 4) Teamwork dimensions a) leadership and management b) teamwork and cooperation c) problem solving and decision making d) situation awareness are not associated with patient safety dimensions e) errors in surgical technique f) other procedural problems and error g) operating time	1a) β = -0.187, p = 0.023 1b) β = -0.81587, p < 0.001, R^2 = 0.717, [f^2 = 2.533]†‡ 2a) β = -0.381, p = 0.012 2b) β = 0.405, p = 0.008, R^2 = 0.689, [f^2 = 2.215]†‡ 3a) β = -0.713, p < 0.001 3b) β = 1.968, p < 0.001, R^2 = 0.189, [f^2 = 0.233]†‡ 4ae-dg) 9 non-significant associations	9 (15)
Catchpole et al., 2008[53]	Relationships between non-technical skills and	yes	Physicians and nurses, 44 operations (24	Live & video observation	Teamwork: NOTECHS* Patient safety: errors & threats	Spearman's rank correla-	1) Positive correlation between non-technical skills and a) safety threats b) operative duration	1a) ρ = 0.584, p < 0.005 1b) ρ = 0.581, p < 0.005	10 (15)

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Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	safety threats, errors, and operative duration		pediatric, 20 orthopedic), 2 hospitals, UK		(checklists and free observations)	tion	c) but not technical errors in pediatric surgery 2) No correlations between non-technical skills and a) safety threats b) operating time c) technical errors in orthopedic surgery	1c) NS 2a) NS 2b) NS 2c) NS	
Kolbe et al., 2012[55]	Relationships between speaking up and technical team performance/team interaction	no	31 anesthesia teams (1 nurse, 1 resident), teaching hospital, Switzerland	Video observation of simulated anesthesia induction	Teamwork: Coding scheme for (non-) verbal team interactions Patient safety: technical team performance (adherence to checklist of standard anesthesia induction and target values)	Hierarchical linear regression	1) Technical team performance is predicted by nurses' levels of speaking up 2) but not by residents' levels of speaking up	1) $\beta = 0.43$, $p = 0.017$, $R^2 = 0.18$, $[f^2 = 0.22]^{\dagger\ddagger}$ (2 predictors) 2) NS (3 predictors)	14 (15)
Kuenzle et al., 2010[57]	Relationship between shared leadership and anesthesia team performance under high and low task load	yes	12 anesthesia teams (1 resident, 1 nurse), teaching hospital, Switzerland	Video observation of simulated anesthesia induction	Teamwork: Coding scheme for content-oriented and structuring leadership behavior Patient safety: performance (reaction time after non-routine event)	ANOVA	1a) No differences in shared leadership behaviors of high-performing teams between nurses and residents b) during high- and low task load situations 2a) Residents show more leadership behaviors than nurses in low performing teams b) independent of task load	1a) $F(1, 20) = 0.00$, $p = 0.971$, $\eta^2 = 0.000$ 1b) Interaction: NS 2a) $F(1, 20) = 7.14$, $p = 0.015$, $\eta^2 = 0.263$ 2b) Interaction: NS	12.5 (15)
Kuenzle et al., 2010[56]	Relationship between shared leadership and anesthesia team performance under high and low task load	yes	12 anesthesia teams (1 resident, 1 nurse), 1 hospital, Switzerland	Video observation of simulated anesthesia induction	Teamwork: structuring and content oriented leadership: structured observation Patient safety: performance (speed of correct management after non-routine event (= high task load))	Spearman's rank correlation Kruskal-Wallis-test	1) Under high task load team performance and a) structuring and b) content-oriented leadership are not correlated 2) Under low task load, team performance and a) structuring, b) but not content-oriented leadership are negatively correlated 3) Interaction of leadership behavior and	1a) NS 1b) NS 2a) $\rho = -0.56$, $p < 0.05$ 2b) NS 3) NS	12 (15)

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Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
							team experience is not associated with team performance		
Lubbert et al., 2009[58]	Relationship between team organization and treatment errors	yes	378 video registrations of patients treated in the emergency room, 1 hospital, The Netherlands	Video observation	Teamwork & patient safety: Self-developed checklist measuring adherence to advanced trauma life support (ATLS) guidelines	t-test	1) Errors in team organization dimension *evident leadership* are associated with more deviations from treatment protocol, whereas 2) errors in team organization dimension *effective leadership* are not	1) p = 0.01 (no other indicators reported) 2) NS	6 (15)
Manser et al., 2009[11]	Relationships between different coordination patterns and team performance	yes	46 anesthesia residents, 23 teams, USA	Video observation of simulated anesthesia emergency	Teamwork: self-developed coding scheme for coordination Patient safety: clinical performance (adherence to malignant hyperthermia treatment guidelines)	Hierarchical regression analysis	1) Time spent on coordination dimensions a) task management b) but not information management c) or coordination via work environment negatively predicts performance (4 predictors altogether) 2) Time spent on task management categories a) task distribution b) but not planning c) clarification d) initiating action e) or assistance negatively predicts performance (6 predictors altogether) 3) Time spent on information management categories a) situation assessment b) but not information transfer c) decision making d) or feedback/acknowledgement negatively predicts performance (5 predictors altogether)	1a) β = -0.466, p < 0.01, ΔR^2 = 0.243, [f^2 = 0.32]† 1b) NS 1c) NS 2a) β = -0.539, p < 0.01, ΔR^2 = 0.340, [f^2 = 0.52]† 2b) NS 2c) NS 2d) NS 2e) NS 3a) β = 0.569, p < 0.05, ΔR^2 = 0.227, [f^2 = 0.29]† 3b) NS 3c) NS 3d) NS	11.5 (15)
McCulloch et al., 2009[6]	Relationships between non-technical skills and	yes	54 surgeons, anesthetists and nurses,	Uncontrolled pre-post-training Live observa-	Teamwork: NOTECHS* Patient safety: technical errors	Spearman's rank correla-	1) Negative correlation between a) overall non-technical skills and technical errors b) especially for surgical sub-team	1a) ρ = -0.215, p = 0.024 1b) ρ = -0.236, p = 0.013	11.5 (18)

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Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	technical errors		48 observations before and 55 observations after training, teaching hospital, UK	tions of operations	(Observation Clinical Human Reliability Assessment, OCHRA)*	tion	2) Negative correlation between a) situational awareness and technical errors b) especially for surgical sub-team	2a) ρ = -0.300, p = 0.001 2b) ρ = -0.436, p < 0.0001	
Mishra et al., 2008[59]	Relationships between non-technical skills and technical errors	yes	26 observations (nurses, surgeons, anesthetists), teaching hospital, UK	Live observation of operation	Teamwork: NOTECHS* Patient safety: OCHRA*	Spearman's rank correlation	1) No correlation between technical errors and a) leadership & management b) teamwork & cooperation c) problem-solving and decision-making in the d) overall team, or e) surgeon f) anesthetists g) and nurses subgroup 2) Negative correlation between situation awareness and technical errors for a) overall team b) surgeon subgroup c) but not anesthetists d) and nurses subgroup	1ad) NS 1ae) NS 1af) NS 1ag) NS 1bd) NS 1be) NS 1bf) NS 1bg) NS 1cd) NS 1ce) NS 1cf) NS 1cg) NS 2a) ρ = -0.505, p = 0.009 2b) ρ = -0.718, p = 0.001 2c) NS 2d) NS	10 (15)
Ottestad et al., 2007[60]	Development and psychometric testing of tool to measure resuscitative skills and to compare interns and teams regarding ideal management of septic	no	23 observations (ICU residents), USA	Video observation of emergency simulation	Teamwork: NOTECHS* Patient safety: Adherence to Surviving Sepsis Campaign Guidelines	Pearson's correlation	Positive correlation between non-technical skills and team sepsis management	r = 0.4, p = 0.05	7.5 (15)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	shock								
Schraagen et al., 2011[71]	Relationships between non-routine events, teamwork and patient outcomes	yes	1 pediatric cardiac surgery team, 40 operations, The Netherlands	Cross-sectional self-report questionnaire, live observation of operations, record review	Teamwork: observation tool derived from NOTECHS*, ANTS*, NOTSS*, and OTAS* Patient safety: 30-day postsurgical complications, operating time	Pearson's correlation, ANOVA	1) Positive correlation between non-technical skills and a) operating time b) but not postsurgical complications 2) Explicit coordination of anesthetists is associated with higher levels of postsurgical complications	1a) $r = 0.45$, $p < 0.05$ 1b) NS 2) $M_{uncomplicated} = 12.88$, $M_{minor\ complications} = 21.55$, []† $M_{major\ complications} = 16.40$, $F(2,36) = 4.78$, $p < 0.01$, []†	10 (16)
Schraagen et al., 2011[72]	Relationships between non-routine events, teamwork and patient outcomes	yes	1 pediatric cardiac surgery team, 40 operations, The Netherlands	Cross-sectional self-report questionnaire, live observation of operations, record review	Teamwork: NOTECHS* Patient safety: 30-day postsurgical complications	Pearson's correlation, ANOVA	*Teamwork and cooperation* is associated with higher levels of postsurgical complications	$M_{uncomplicated} = 3.19$, $M_{minor\ complications} = 3.44$, $M_{major\ morbidity} = 3.28$, $F(2,36) = 3.85$, $p < 0.05$, $\eta^2 = 0.18$	8.5 (16)
Siassakos et al., 2010[73]	Relationships between individual team members' knowledge, skills, and attitudes and team performance	no	19 teams (physicians and midwives), 6 maternity units, UK	Video observation of obstetric emergency simulation, self-report questionnaire	Teamwork: SAQ subscale team climate* Patient safety: team performance (magnesium administration)	Kendall's rank correlation	No correlation between teamwork climate and performance	NS	8 (16)
Siassakos et al., 2011[62]	Relationships between teamwork skills and behaviors and team performance in emergency situations	yes	47 teams (2 physicians and 4 midwives each), 6 maternity units, UK	Video observation	Teamwork: Team analytical tool* Patient safety: performing key actions	Kendall's rank correlation	1) Positive correlation between speed of magnesium administration and a) skills b) behavior c) and overall teamwork 2) Negative correlation between time needed to put patient in recovery position and a) skills b) behavior c) but not overall teamwork 3) Negative correlation between time	1a) $\tau = 0.54$, $p < 0.001$ 1b) $\tau = 0.41$, $p = 0.001$ 1c) $\tau = 0.51$, $p < 0.001$ 2a) $\tau = -0.29$, $p = 0.012$ 2b) $\tau = -0.25$, $p = 0.026$ 2c) NS 3a) $\tau = -0.39$, $p <$	8.5 (15)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
							needed to administer O^2 and a) skills b) behavior c) and overall teamwork 4) Negative correlation between time needed to sample blood and a) skills b) behavior c) and overall teamwork	0.001 3b) $\tau = -0.28$, $p = 0.014$ 3c) $\tau = -0.41$, $p < 0.001$ 4a) $\tau = -0.35$, $p = 0.002$ 4b) $\tau = -0.35$, $p = 0.002$ 4c) $\tau = -0.35$, $p < 0.002$	
Siassakos et al., 2011[61]	Relationships between teamwork and clinical efficiency in emergency situations	yes	114 physicians and nurses, 19 teams, 6 maternity units, UK	Video observation	Teamwork: self-developed observation system Patient safety: performing key action (speed of magnesium administration)	Kendall's rank correlation	1) Positive correlation between closed-loop communication and clinical efficiency 2) Positive correlation between unambiguous communication and clinical efficiency 3) No correlations between clinical efficiency and a) SBAR communication style b) team coordination c) situational awareness d) leadership style e) supportive language f) task support by senior clinician	1) $\tau = 0.46$, $p = 0.022$ 2) $\tau = 0.53$, $p = 0.004$ 3a) NS 3b) NS 3c) NS 3d) NS 3e) NS 3f) NS	8 (15)
Thomas et al., 2006[63]	Relationship between teamwork and quality of care	yes	118 teams (physicians, nurses, respiratory therapists), resuscitation room, teaching hospital, USA	Video observation of neonatal resuscitation	Teamwork: Frequency of different teamwork behaviors Patient safety: Neonatal Resuscitation Program (NRP) Guidelines	Spearman's rank correlation	1) Negative correlation between team communication and a) overall quality of resuscitation, b) non-compliance with all NRP steps, and c) non-compliance during preparation and initial steps 2) Negative correlation between team management and a) noncompliance with all NRP steps, and b) noncompliance during preparation and initial steps but not c) overall quality of resuscitation, 3) Negative correlation between team leadership and a) overall quality of resuscitation, but not with	1a) $\rho = -0.236$, $p = 0.007$ 1b) $\rho = -0.214$, $p = 0.014$ 1c) $\rho = -0.230$, $p = 0.008$ 2a) $\rho = -0.201$, $p = 0.021$ 2b) $\rho = -0.252$, $p = 0.003$ 2c) NS 3a) $\rho = -0.288$, $p < 0.001$ 3b) NS 3c) NS	9.5 (15)

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Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
							b) noncompliance with all NRP steps, and with c) non-compliance during preparation and initial steps		
Tschan et al., 2006[64]	Relationships between directive leadership, structuring inquiry and performance regarding different phases	yes	109 clinicians (nurses, residents, senior physicians), 21 teams, ICU, university hospital, Switzerland	Video observation and transcription of emergency simulation	Teamwork: directive leadership and structuring inquiry Patient safety: clinical performance (key actions, hands-on time)	Pearson's correlation	1) Phase 1 (nurses only): positive correlation between performance and a) directive leadership and b) structuring inquiry 2) Phase 2 (residents and nurses): positive correlation between performance and a) resident directive leadership during first 30 seconds, no correlation between performance and b) resident directive leadership per second c) resident structuring inquiry per second d) resident structuring inquiry during first 30 seconds 3) Phase 3 (nurses, residents, senior physicians): positive correlation between performance and a) senior physician structuring inquiry, no correlation between performance and b) resident structuring inquiry c) senior physician d) resident directive leadership	1a) $r = 0.445$, $p < 0.05$ 1b) $r = 0.216$, $p < 0.05$ 2a) $r = 0.522$, $p < 0.05$ 2b) NS 2c) NS 2d) NS 3a) $r = 0.428$, $p < 0.01$ 3b) NS 3c) NS 3d) NS	11.5 (15)
Tschan et al., 2009[65]	Relationships between team communication and perceptual biases of individuals and accuracy of diagnosis	yes	53 physicians, 20 teams, university hospital, Switzerland	Video observation of handover simulation	Teamwork: coding of communication and behavior Patient safety: diagnostic performance	ANOVA	1) Groups considering more diagnostic information are not more likely to find the correct diagnosis 2) Groups showing a) more explicit reasoning b) more talking to the room are more likely to find the correct diagnosis	1) NS 2a) $F(2, 15) = 5.750$, $p = 0.014$ 2b) $\chi^2 = 8.598$, $df = 2$, $p = 0.007$	11 (15)
Westli et al., 2010[66]	Relationship between teamwork skills/shared mental mod-	yes	27 trauma teams, Norway	Video observation of emergency simulations	Teamwork: ANTS* and Anti-Air Teamwork Observation Measure (ATOM)	Pearson's correlation	1) Negative correlation between supporting behavior and performing key actions 2) Negative correlation between poor coordination and medical management 3) Positive correlation between infor-	1) $r = -0.37$, $p < 0.05$ 2) $r = -0.36$, $p < 0.05$ 3) $r = 0.34$, $p <$	10.5 (15)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	els and clinical performance				Patient safety: Team global medical management, key actions of trauma management		mation exchange and medical management 4) Negative correlation between poor situational awareness and performing key actions 5) Positive correlation between providing information and medical management 6a-u) 21 non-significant correlations between teamwork and patient safety variables	0.05 4) r = -0.40, p < 0.05 5) r = 0.51, p < 0.01 6a-u) NS	
Wiegmann et al., 2007[67]	Relationship between (teamwork-related) surgical flow disruptions and surgical error	yes	31 cardiac operations, 1 hospital, USA	Live observation of operation	Teamwork: teamwork-related surgical flow disruptions Patient safety: surgical errors	Multiple regression	Teamwork-related surgical flow disruptions positively predict surgical errors	β = 0.692, p < 0.001, adj. R^2 = 0.553, [f^2 = 1.24][†‡] (5 predictors altogether)	11 (15)
Williams et al., 2010[68]	Relationships between teamwork behaviors and resuscitation errors	yes	12 resuscitation teams, NICU, teaching hospital, USA	Video observation of resuscitation	Teamwork: frequency of different teamwork behaviors Patient safety: Neonatal Resuscitation Program (NRP) Guidelines	Spearman's rank correlation, generalized linear mixed model (GLM)	1) Negative correlation between vigilance and NRP errors 2) No correlation between workload management and NRP errors 3) NRP errors are associated with a) more assertions before the error b) less teaching after the error 4) No associations between NRP errors and a) information sharing before error b) information sharing after error c) inquiry before error d) inquiry after error e) assertion after error f) teaching before error	1) ρ = -0.62, p = 0.031 2) NS 3a) OR = 1.44, p = 0.008, 95%CI 1.10 - 1.89 3b) OR = 0.59, p = 0.028, 95%CI 0.37 - 0.94 4a) NS 4b) NS 4c) NS 4d) NS 4e) NS 4f) NS	10 (15)
b) survey studies									
Brewer, 2006[74]	Relationships between culture, team	yes	430 nurses, physicians and other	Cross-sectional self-report questionnaire,	Teamwork: Positive team processes: Relational	Pearson's correla-	1) Positive intra-team processes correlate positively with a) length of stay b) but not with patient falls	1a) r = 0.59, p < 0.05 1b) NS	10 (16)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	characteristics/processes and patient safety/hospital financial performance		medical care providers, 16 surgical units, 4 acute care hospitals, USA	record review	Coordination Scale[*] Negative team processes scale Patient safety: patient falls (incident reporting system), length of stay (hospital records)	tion	2) No correlation between negative team processes and a) length of stay b) patient falls	2a) NS 2b) NS	
Chan et al., 2011[75]	Validity of a team-based tool to assess success of a team-based intervention to reduce central line associated blood stream infections (CLABSI)	no	46 ICUs, 35 hospitals, USA	Secondary analyses of longitudinal RCT, self-report questionnaire, record review	Teamwork: Team check-up tool (TCT) Patient safety: Central line associated bloodstream infections (CLABSI)	Cox regression	No association between teamwork and duration to reach zero CLABSI's after intervention	NS	10 (19)
Chang & Mark, 2009[76]	Antecedents (teamwork, nurse & patient factors) of severe and non-severe medication errors	yes	1 671 nurses, 279 units, 146 hospitals, USA	Longitudinal self-report questionnaire, record review	Teamwork: Relational Coordination Scale[*] Patient safety: medication errors (hospital incident reports)	Generalized estimating equations (GEE)	Relational coordination predicts neither 1) severe nor 2) non-severe medication errors	1) NS 2) NS	9 (16)
Edmondson, 2004[10]	Relationship between team/organizational characteristics, team leadership and medication errors	yes	159 nurses, physicians and pharmacists, 8 hospitals, USA	Cross-sectional self-report questionnaire, record review	Teamwork: Team/organizational characteristics and team leadership (self-developed questionnaire) Patient safety: medication error (hospital incident reports & self-	Spearman's rank correlation	Positive correlation between 1) nurse manager coaching 2) nurse manager direction setting and 3) unit relationship quality and a) detected and b) intercepted medication errors but not with c) non-preventable drug complications	1a) $\rho = 0.74$, $p < 0.03$ 1b) $\rho = 0.71$, $p < 0.03$ 1c) NS 2a) $\rho = 0.74$, $p < 0.03$ 2b) $\rho = 0.83$, $p < 0.03$ 2c) NS	11 (16)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
					reported)			3a) ρ = 0.74, p < 0.03 3b) ρ = 0.76, p < 0.03 3c) NS	
Fasolino et al., 2012[77]	Relationships between nurse characteristics, nurse practice environment, team member effectiveness and medication error	yes	163 nurses, 11 surgical units, 1 hospital, USA	Cross-sectional self-report questionnaire, record review	Teamwork: team member effectiveness survey Patient safety: medication errors (hospital incident reports)	Spearman's rank correlation	Team member effectiveness is positively correlated with medication error	ρ = 0.19, p < 0.01	12 (16)
Hoffer Gittell et al., 2000[9]	Relationship between relational coordination and quality of care/length of stay	yes	338 physicians, nurses, and other medical care providers, 9 hospitals, USA	Cross-sectional self-report questionnaire, record review	Teamwork: Relational Coordination Scale[*] Patient safety: Length of stay	Hierarchical linear regression	Relational coordination is associated with decreased length of stay	B = 53.77, p < 0.001, []†	13 (16)
Kalisch & Lee, 2010[69]	Relationship between teamwork and missed nursing care	yes	2216 nurses, 40 acute care units, 4 hospitals, USA	Cross-sectional self-report questionnaire	Nursing Teamwork Survey[*] MISSCARE Survey[*]	Pearson's correlation Multiple linear regression	1) Negative correlation between missed nursing care and a) trust b) team orientation c) backup behavior d) shared mental model e) team leadership 2) After controlling for various covariates, overall teamwork scores negatively predict missed nursing care	1a) r = -0.31, p < 0.01 1b) r = -0.28, p < 0.01 1c) r = -0.31, p < 0.01 1d) r = -0.32, p < 0.01 1e) r = -0.29, p < 0.01 2) B = -0.254, p < 0.001, ΔR^2 = 10.9, [f^2 = 0.124]†	12.5 (16)
Leroy et al., 2012[8]	Mediation and moderation relationships	yes	580 nurses and head nurses, 4	Longitudinal self-report questionnaire	Teamwork: Team Psychological Safety Scale[*]	Path analysis	1) Good overall model fit 2) Within path model, team psychological safety at time 1 positively predicts treat-	1) χ^2 = 6.72, p = 0.03, SRMR = 0.07, RMSEA = 0.02, CFI	14 (16)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	between leader behavioral integrity for safety, team psychological safety, team priority of safety, and treatment errors		hospitals, Belgium		Patient Safety: head nurses' reports of treatment errors		ment errors at time 2	= 0.98 2) β = 0.28, p = 0.02	
Manojlovich et al., 2007[70]	Relationships between perceived work environments, nurse-physician communication and patient outcomes	yes	462 nurses, 25 ICUs, 8 hospitals, USA	Cross-sectional self-report questionnaire	Teamwork: parts of ICU Nurse-Physician Questionnaire[*] Patient safety: nurse-reported adverse events (medication errors, ventilator-associated pneumonia, catheter-associated sepsis)	Random intercept multilevel models	Nurse-physician communication negatively predicts 1) ventilator-associated pneumonia 2) catheter-associated sepsis and 3) medication errors	1) B = -0.045, p < 0.05, R^2 = 0.09, [f^2 = 0.1][†‡] (7 predictors altogether) 2) B = -0.049, p < 0.05, R^2 = 0.14, [f^2 = 0.16][†‡] (7 predictors altogether) 3) B = -0.047, p < 0.01, R^2 = 0.11, [f^2 = 0.12][†‡] (7 predictors altogether)	
Manojlovich et al., 2009[78]	Relationship between nurse-physician communication and patient outcomes	yes	462 nurses, 25 ICUs, 8 hospitals, USA	Cross-sectional self-report questionnaire, record review	Teamwork: ICU Nurse-Physician Questionnaire[*] Patient safety: adverse outcomes ventilator-associated pneumonia, bloodstream infections, and pressure ulcers	Pearson's correlation	No correlation between nurse-physician communication subscales 1) timeliness 2) accuracy 3) openness and 4) understanding and patient safety indicators a) ventilator-associated pneumonia b) bloodstream infections and c) pressure ulcers	1a-4c) 12 non-significant associations	11 (16)
Taylor et al., 2012[79]	Relationships between safety climate, teamwork and patient adverse events	no	Nurses in 29 units, 1 hospital, USA	Cross-sectional & longitudinal self-report questionnaire, record review	Teamwork: SAQ subscale team climate[*] Patient safety: patient falls & injuries, deep vein thrombosis and	Multilevel logistic regression	Positive team climate is associated with 1) fewer decubitus ulcers, but not 2) less patient falls & injuries or 3) pulmonary embolisms and deep vein thrombosis one year later	1) OR = 0.56, 95%CI 0.30 - 0.82, p < 0.01 2) NS 3) NS	13.5 (16)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
					pulmonary embolism records				
Vogus et al., 2007[80]	Moderation of relationship between team safety organizing behaviors and medication errors by trust in manager and existence of care pathways	yes	1033 nurses & 78 nurse managers, 78 units, 10 acute-care hospitals, USA	Cross-sectional self-report questionnaire, record review	Teamwork: Safety Organizing Scale (SOS)[*] Trust in manager: 2 items Care pathways: 1 item Patient safety: medication errors (number of errors reported to unit's incident reporting system up to 6 months after survey data collection)	Multilevel Poisson regression	1) Safety organizing negatively predicts medication errors 2) Trust in manager has no impact on reporting of medication errors when level of safety organizing is high. When safety organizing is low and trust in manager is high, more errors are reported 3) Use of care pathways has no impact on reporting of medication errors when safety organizing is low. When safety organizing is high and care pathways are extensively used, fewer errors are reported	1) β = -0.29, p < 0.01, 95%CI -0.57 to -0.01 2) β = -0.68, p < 0.001, 95%CI -1.03 to -0.32 3) β = -0.82, p < 0.001, 95%CI -1.31 to -0.33	13 (16)
Wheelan et al., 2003[81]	Relationship between teamwork and patient mortality	yes	349 healthcare providers, 17 ICUs, 9 hospitals, USA	Cross-sectional self-report questionnaire, record review	Teamwork: Group Development Questionnaire[*] Patient safety: Standardized mortality rates	Pearson's correlation	Level of group development correlates negatively with mortality rates	r = -0.66, p = 0.004	12 (16)
Yun et al., 2005[82]	Moderation of relationship between contingent leadership and team effectiveness by severity of patient trauma and team experience	yes	91 members of trauma resuscitation teams, 1 hospital, USA	Cross-sectional self-report questionnaire, scenario method	Teamwork & patient safety: Team Effectiveness Scale[*], Team leadership, severity of trauma and team experience manipulated across scenarios	General linear model (GLM)	1) Interaction of leadership/severity of injury: Team effectiveness dimension *quality healthcare* is high when patient was not severely injured/leadership is empowering or patient was severely injured/leadership was directive 2) Interaction of leadership/team experience: quality healthcare is highest when leadership is empowering, independent of team experience 3) 3-way-interaction: quality healthcare is highest when team is experienced and leadership is empowering, independent of patient condition. When team is inexperienced, quality healthcare is highest when leadership is empowering and patient is	1) Severely injured patient: $M_{\text{directive leaders}}$ = 3.06, 95%CI 2.83 - 3.27, $M_{\text{empowering leaders}}$ = 2.72, 95%CI 2.50 - 2.95. Non-severely injured patient: $M_{\text{empowering leaders}}$ = 3.91, 95%CI 3.69 - 4.13, $M_{\text{directive leaders}}$ = 2.16, 95%CI 1.94 - 2.38, F = 119.48, p < 0.01, η^2 = 0.26. 2) Experienced team: $M_{\text{empowering leadership}}$ =	14.5 (16)

Table 2

Relationships between teamwork and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
							not severely injured, or when leadership is directive and patient is severely injured	3.65, 95%CI 3.42 - 3.82, $M_{directive\ leadership}$ = 2.48, 95%CI 2.25 - 2.70. Inexperienced team: $M_{empowering\ leadership}$ = 2.99, 95%CI 2.76 - 3.21, $M_{directive\ leadership}$ = 2.74, 95%CI 2.51 - 2.96, F = 23.19, p < 0.01, η^2 = 0.06. 3) Inexperienced team/ severely injured patient: $M_{directive\ leadership}$ = 3.19, 95%CI 2.89 - 3.49, $M_{empowering\ leadership}$ = 2.13, 95%CI 1.82 - 2.44. Inexperienced team/non-severely injured patient: $M_{empowering\ leadership}$ = 3.85, 95%CI 3.57 - 4.12, $M_{directive\ leadership}$ = 2.28, 95%CI 2.00 - 2.56, F = 7.31, p < 0.01, η^2 = 0.04.	

Notes: We report not only significant but also non-significant relationships between predictor and outcome variables of interest in this review as hypothesized in the reviewed studies; even if not explicitly stated in the original publication.

[*] validated instrument; [†] effect sizes calculated by authors, calculation not possible if brackets empty; [‡] Cohen's f^2 based on R^2 instead of ΔR^2 ; [§] in brackets: maximal possible score.

Relationships between clinician psychological well-being and patient safety

Design & sample

The majority of the 19 studies examining relationships between clinician well-being and patient safety (table 3) targeted either nurses[85, 86, 22, 87-90, 14] *or* physicians,[91-95, 84, 96-98, 23] with only one study using a mixed sample.[13] Fifteen studies employed a cross-sectional design[85, 86, 91, 92, 22, 94, 95, 88, 13, 84, 89, 96, 97, 90, 14] and four used a longitudinal design.[93, 87, 98, 23]

Measures

The MBI[50] was the instrument used most frequently to assess psychological well-being.[91, 22, 93, 13, 84, 89, 96, 97, 90] Patient safety was measured using a variety of self-report measures,[85, 86, 92, 22, 87, 95, 88, 84, 89, 96, 97, 90, 14, 98, 23] with only three studies using objective data such as mortality rates.[91, 94, 13]

Findings

Authors followed two lines of reasoning when studying the well-being/patient safety relationship: Some assumed that committing an error (equaling reduced patient safety) induces (emotional) distress in clinicians,[87, 13, 84, 90] while the majority of researchers theorized that high strain causes employees' performance to suffer, thus being detrimental to patient safety.[85, 86, 91, 92, 22, 93-95, 88, 89, 96-98, 23] Empirical evidence, both cross-sectional and longitudinal, lends support to both perspectives.[90, 23] Overall, results were mixed. For the 58 significant relationships, effect sizes ranged from small (OR = 1.09) to large (OR = 8.3, see table 3).

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
Arakawa et al., 2011[85]	Relationships between nurses' work, health, and lifestyle characteristics and medical errors and incidents	yes	6445 nurses, 99 hospitals, Japan	Cross sectional self-report questionnaire	Well-being: SF-36 scales *mental health* and *vitality** Patient safety: Number of incidents and errors during the previous 6 months	Logistic regression	No association between 1) mental health 2) vitality and medical errors and incidents	1) NS 2) NS	9 (16)
Arimura et al., 2010[86]	Relationships between work characteristics, sleepiness, mental health state and self-reported medical errors	yes	454 nurses, 2 general hospitals, Japan	Cross sectional self-report questionnaire	Well-being: GHQ-28*, daytime sleepiness (Epworth sleepiness scale) Patient safety: medical errors during past month	Multiple logistic regression	1) Poorer mental health is associated with higher occurrence of medical errors 2) Daytime sleepiness is not associated with higher occurrence of medical errors	1) OR = 1.1, $p < 0.05$, 95%CI 1.0 - 1.1 2) NS (8 predictors altogether)	10.5 (16)
Fahrenkopf et al., 2008[91]	Relationships between depression, burnout, and medication errors	yes	123 residents, 3 pediatric hospitals, USA	Cross-sectional self-report questionnaire, record review	Well-being: MBI* Patient safety: medical errors (self-report & chart reviews)	Cluster adj. Poisson analysis, Fisher's exact test	1) Burnt out residents perceive their number of errors to be higher than residents who are not burnt out 2) Burnt out residents are more likely to attribute errors to sleep deprivation 3) No significant differences in error rates detected in chart reviews between both groups	1) $M_{\text{high burnout}} = 2.3$, $M_{\text{low burnout}} = 1.0$, $p = 0.002$ 2) 29% vs. 10%, $p = 0.05$ 3) NS []†	8 (16)
Halbesleben et al., 2008[22]	Relationships between nurse burnout and patient safety perceptions /reporting behavior	yes	148 nurses, 1 hospital, USA	Cross sectional self-report questionnaire	Well-being: Emotional Exhaustion and Depersonalization* Patient safety: AHRQ Patient Safety Culture Survey* & frequency of incident reports	Multiple linear regression	1) Emotional exhaustion and depersonalization predict patient safety dimensions a) safety grade b) safety perception c) near-miss reporting frequency 2a) Emotional exhaustion and b) depersonalization do not predict patient safety dimen-	1a) $\beta_{\text{exhaustion}} = -0.40$, $p < 0.01$, $\beta_{\text{depersonlization}} = -0.16$, $p < 0.05$, $R^2 = 0.22$, [$f^2 = 0.28$]†‡ 1b) $\beta_{\text{exhaustion}} = -0.84$, $p < 0.001$, $\beta_{\text{depersonlization}} = -0.26$, $p < 0.05$, $R^2 = 0.36$, [$f^2 = 0.56$]†‡ 1c) $\beta_{\text{exhaustion}} = -0.14$, $p < 0.05$, $\beta_{\text{depersonlization}} = -0.36$, $p < 0.01$, $R^2 = 0.18$, [$f^2 = 0.22$]†‡ 2a) NS	13.5 (16)

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
							sion event reports	2b) NS	
Halbesleben & Rathert, 2008[92]	Relationship between physician burnout and patient satisfaction and patient recovery time after hospital discharge	yes	178 patient and physician dyads, 1 hospital, USA	Cross-sectional self-report questionnaire	Well-being: MBI*, patients' perception of physician depersonlization Patient safety: recovery time: 1-item patient self-report	Path analysis, Pearson's correlation	1) Good overall model fit 2) Positive correlation between patient recovery time and a) depersonalization b) but not emotional exhaustion c) or personal accomplishment 3) Positive correlation between patients' perception of physician depersonalization and recovery time 4) No correlation between physician emotional exhaustion and recovery time	1) GFI = 0.99, CFI = 1.00, NNFI = 1.02, AIC = -2.98, BIC = -8.45, RMSEA = 0.00 2a) $r = 0.44$, $p < 0.05$ 2b) NS 2c) NS 3) $r = 0.32$, $p < 0.05$ 4) NS	12 (16)
Hayashino et al., 2012[93]	Hope moderates relationship between distress and medical errors	yes	836 physicians, Japan	Longitudinal self-report questionnaire	Well-being: MBI* (time 1) Medical errors: self-report (time 2)	Poisson regression	High scores in 1) emotional exhaustion 2) depersonalization and low scores in 3) personal accomplishment at time 1 are associated with medical errors at time 2	1) IRR = 2.34, $p < 0.0001$ 2) IRR = 2.72, $p < 0.0001$ 3) IRR = 0.62, $p = 0.001$	9.5 (16)
Hunziker et al., 2012[94]	Influence of self-reported, biochemical and physiological stress on cardiopulmonary resuscitation (CPR) performance	yes	28 residents, teaching hospital, Switzerland	Self-report questionnaire, video observation of simulated resuscitation	Well-being: Stress/overload index (self-report; blood cortisol, heart rate) Patient safety: performance (time until CPR is started and hands-on time)	Multiple linear regression	1) Stress/overload negatively predicts a) time to start CPR b) but not hands-on-time during resuscitation 2) Heart rate negatively predicts a) hands-on-time b) time to start CPR during resuscitation 3a) Cortisol level and b) heart rate variability do not predict c) hands-on-time and d) time to start CPR 4) The difference of	1a) $\beta/B = 12.01$, 95%CI 0.65 - 23.36, $p = 0.04$ 1b) NS 2a) $\beta/B = 2.22$, 95%CI 0.53 - 3.92, $p = 0.015$ 2b) $\beta/B = -0.78$, 95%CI 1.44 to -0.11, $p = 0.027$ 3ac) NS 3ad) NS 3bc) NS 3bd) NS 4ad) NS 4ae) NS 4bd) NS 4be) NS 4cd) NS	12.5 (15)

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
							a) stress/overload b) cortisol level c) heart rate variability before to during resuscitation do not predict d) hands-on-time or e) time to start CPR 5) The difference of heart rate before to during resuscitation predicts a) hands-on-time and b) time to start CPR	4ce) NS 5a) β/*B* = 2.73, 95%CI 0.48 - 4.99, *p* = 0.022 5b) β/*B* = −1.12, 95%CI -1.91 to -0.33, *p* = 0.01 (no information regarding standardization of coefficients)	
Jones et al., 2012[87]	Effect of incident seriousness and work-based support on negative positive affect	yes	171 nurses, 4 hospitals, UK	Cross-sectional & longitudinal between & within-person design, diary study	Well-being: Positive & Negative Affect Scale (PANAS) and mood diary entries* Patient safety: nurse-reported incidents	Random-effects multilevel model	1) Interaction of incident occurrence and seriousness leads to elevated negative affect during remainder of shift 2a) Incident occurrence b) but not incident seriousness lead to reduced positive affect during remainder of shift	1) β = 0.07, *z* = 3.5, *p* < 0.005 2a) β = -2.39, *z* = 1.99, *p* < 0.05 2b) NS	13 (16)
Klein et al., 2010[95]	Relationship between burnout and self-reported quality of care	yes	1311 surgeons, 489 hospitals, Germany	Cross sectional self-report questionnaire	Well-being: Copenhagen Burnout Inventory (CBI*) Patient safety: Quality of care: frequency of diagnostic and therapeutic errors (Chirurgisches Qualitatssiegel survey CQS)	Multivariate logistic regression	1) Burnout is associated with a) lower quality of diagnosis/therapy b) more diagnostic errors c) more therapeutic errors among males 2) Unclear association of burnout with a) lower quality of diagnosis/therapy b) more diagnostic errors c) more therapeutic errors among females	1a) OR = 1.71, 95%CI 1.10 - 2.64 1b) OR = 1.94, 95%CI 1.35 - 2.79 1c) OR = 2.56, 95%CI 1.66 - 3.96 2a-c) contradictory information regarding significance in text and table	10.5 (16)

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
Maiden et al., 2011[88]	Relationship between moral distress, compassion fatigue, and causes of medication errors	yes	205 nurses, ICU, USA	Cross sectional self-report questionnaire, focus group	Well-being: Moral distress scale* Compassion fatigue: Professional Quality of Life Scale* Patient safety: Medication Administration Error Survey*	Pearson's correlation	1) Positive correlation between moral distress is positively correlated with a) transcription related medication errors and b) physician communication related medication errors c) but not with medication packaging d) pharmacy processes 2) Compassion fatigue is positively correlated with a) transcription related medication errors but not with medication error due to b) physician communication c) medication packaging d) pharmacy processes	1a) $r = 0.20$, $p = 0.05$ 1b) $r = 0.24$, $p = 0.01$ 1c) NS 1d) NS 2a) $r = 0.15$, $p = 0.05$ 2b) NS 2c) NS 2d) NS	9 (16)
Merlani et al., 2011[13]	Relationships between hospital, patient, and clinician characteristics and burnout/stress	yes	3052 physicians, nurses, and nurse-assistants, 74 ICUs, Switzerland	Cross-sectional self-report questionnaire, record review	Well-being: MBI*, 1 stress item Patient safety: mortality rates and length of stay (unit records)	Multivariate logistic regression	1) Mortality is associated with higher level of burnout 2) Length of stay is not associated with burnout	1) OR = 1.060, $p = 0.04$, 95%CI 1.003 - 1.120 2) NS	12.5 (16)
Prins et al., 2009[84]	Relationships between self-reported errors, burnout, and engagement	yes	2115 residents, The Netherlands	Cross-sectional self-report questionnaire	Well-being: Utrecht Burnout Scale (UBOS)*, Utrecht Work Engagement Scale (UWES)* Patient safety: medical errors	Pearson's correlation	1) Errors due to wrong actions/inexperience a) are positively correlated with emotional exhaustion b) depersonalization c) and negatively correlated with personal accomplishment 2) Errors due to wrong actions/inexperience are not correlated with	1a) $r = 0.20$, $p < 0.001$ 1b) $r = 0.29$, $p < 0.001$ 1c) $r = -0.05$, $p < 0.001$ 2a) NS 2b) NS 2c) NS 3a) $r = 0.43$, $p < 0.001$ 3b) $r = 0.42$, $p < 0.001$ 3c) $r = -0.08$, $p < 0.001$ 4a) $r = -0.23$, $p < 0.001$	10.5 (16)

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
							d) vigor e) dedication f) absorption 3) Errors due to lack of time a) are positively correlated with emotional exhaustion b) depersonalization c) and negatively correlated with personal accomplishment 4) Errors due to lack of time are negatively correlated with a) vigor b) dedication c) absorption	4b) r = -0.24, $p < 0.001$ 4c) r = -0.11, $p < 0.001$	
Ramanujam et al., 2008[89]	Relationship between nurses' work characteristics, burnout, and patient safety	yes	430 nurses, 2 hospitals, USA	Cross sectional self-report questionnaire	Well-being: Not described, although it can be deducted from the paper that the MBI* was used Patient safety: nurses' safety perception	Path analysis	1) Unsatisfactory initial model fit statistics, final model statistics not reported 2) Positive association between depersonalization and perceived patient safety 3) No association between emotional exhaustion and perceived patient safety	1) χ^2 = 1100.60, df = 455, χ^2/df = 2.419, CFI = 0.876, RMSEA = 0.058 2) β = 0.189, $p < 0.001$ 3) NS	8.5 (16)
Shanafelt et al., 2002[97]	Prevalence of burnout in medical residents and the relationship to self-reported patient care practices	yes	115 internal medicine residents, USA	Cross sectional self-report questionnaire	Well-being: MBI* Patient safety: self-developed patient care practices measure	Stepwise logistic regression	1) Overall burnout score is associated with higher levels of a) monthly b) weekly suboptimal patient care practices 2) Depersonalization is associated with higher levels of a) monthly b) weekly suboptimal patient care practices 3) No associations between a) emotional exhaustion b) personal accomplishment and	1a) OR = 8.3, $p < 0.001$, 95%CI 2.6 - 26.5 1b) OR = 4.0, p = 0.036, 95%CI 1.1 - 14.2 2a) OR = 5.8, $p < 0.001$, 95%CI 2.2 - 15.4 2b) OR = 2.8, p = 0.041, 95%CI 1.1 - 7.7 3ac) NS 3ad) NS 3bc) NS 3bd) NS	10.5 (16)

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
							c) monthly d) weekly suboptimal patient care practices		
Shanafelt et al., 2010[96]	Relationship between burnout, quality of life, depression and perceived major medical errors	yes	7905 surgeons, USA	Cross sectional self-report questionnaire	Well-being: MBI* Patient safety: medical errors	Logistic regression	1a) Emotional exhaustion and b) depersonalization are associated with higher odds of reporting an error 2) Personal accomplishment is associated with lower odds of reporting an error	1a) OR = 1.048, $p < 0.0001$, 95%CI 1.042 - 1.055 1b) OR = 1.109, $p < 0.0001$, 95%CI 1.096 - 1.122 2) OR = 0.965, $p < 0.0001$, 95%CI 0.955 - 0.975	9 (16)
Squires et al., 2010[90]	Relationships between nurse leadership, work environment, safety climate, and nurse and patient outcomes	no	600 acute care nurses, USA	Cross sectional self-report questionnaire	Well-being: Emotional Exhaustion* Patient safety: medication errors and ulcers	Path analysis	1) Very good final model fit 2) No association between pressure ulcers and emotional exhaustion 3) Positive association between medication errors and emotional exhaustion	1) $\chi^2 = 217.6$, $p < 0.001$, SRMR = 0.054, CFI = 0.947, RMSEA = 0.047, PCLOSE = 0.67 2) NS 3) $\beta = 0.14$, $p < 0.05$	12 (16)
Teng et al., 2010[14]	Interactions between time pressure and burnout on patient safety	yes	458 nurses, 90 units, 2 medical centers, Taiwan	Cross sectional self-report questionnaire	Well-being: MBI* Patient safety: frequency of adverse events scale	Multiple linear regression	1) Burnout negatively predicts adverse events 2) The interaction of burnout and time pressure negatively predict adverse events	1) $\beta = -0.25$, $p = 0.00$ 2) $\beta = -0.08$, $p = 0.03$ $R^2 = 0.06$ $[f^2 = 0.06]^{\dagger\ddagger}$ (7 predictors altogether)	13 (16)
West et al., 2006[98]	Relationships between distress, quality of life and medical errors	yes	184 internal medicine residents, teaching hospital, USA	Longitudinal cohort study, self-report questionnaire	Well-being: MBI*, fatigue and sleepiness: 2 items Patient safety: medical errors	Generalized estimation equations (GEE)	1) Higher levels of a) emotional exhaustion b) depersonalization are associated with major medical errors in the c) previous d) following 3 months 2) Lower levels of personal accomplishment are associated with higher levels of major medical error in the a) previous	1ac) PE = 4.58, $p = 0.002$ 1bc) PE = 2.45, $p = 0.002$ 1ad) OR = 1.07, $p = < 0.001$, 95%CI 1.03 - 1.12 1bd) OR = 1.10, $p = 0.001$, 95%CI 1.04 - 1.16 2a) PE = -2.59, $p = 0.002$ 2b) OR = 0.93, $p = 0.02$, 95%CI 0.88 - 0.99	12 (16)

Table 3

Relationships between well-being and patient safety

Study	Topic	Primary topic	Sample & setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score §
							b) following 3 months		
West et al., 2009[23]	Relationships between fatigue, distress, and medical errors	yes	380 internal medicine residents, teaching hospital, USA	Longitudinal cohort study, self-report questionnaire	Well-being: MBI*, fatigue and sleepiness: 2 items Patient safety: medical errors	Generalized estimation equations (GEE)	Higher levels of 1) sleepiness 2) fatigue 3) emotional exhaustion 4) depersonalization 5) lower levels of personal accomplishment are associated with subsequent medical errors	1) OR = 1.10, p = 0.002, 95%CI 1.03 - 1.16 2) OR = 1.14, $p < 0.001$, 95%CI 1.08 - 1.21 3) OR = 1.06, $p < 0.001$, 95%CI 1.04 - 1.08 4) OR = 1.09, $p < 0.001$, 95%CI 1.05 - 1.12 5) OR = 0.94, $p < 0.001$, 95%CI 0.92 - 0.97	13 (16)

Notes: We report not only significant but also non-significant relationships between predictor and outcome variables of interest in this review as hypothesized in the reviewed studies; even if not explicitly stated in the original publication.

* validated instrument; † effect sizes calculated by authors, calculation not possible if brackets empty; ‡ Cohen's f^2 based on R^2 instead of ΔR^2 ; § in brackets: maximal possible score.

Relationships between teamwork, clinician psychological well-being and patient safety

Design & sample

Four of the 80 reviewed studies examined teamwork, well-being and patient safety (table 4), two of which sampled nurses only.[101, 103] All studies were cross-sectional self-report studies, with study 77 using risk-adjusted morbidity and mortality rates as objective patient safety indicators.

Measures

Half of the studies used the nurse-physician-relations scale[49] to assess teamwork, and (parts of) the MBI[50] or its emotional exhaustion subscale to measure well-being.[101, 102]

Findings

One study proposed a model with the teamwork variable psychological safety[104] serving as a mediator between work environment and work engagement, commitment, and patient safety.[102] However, this mediation effect was statistically non-significant. Another study found a partial mediation between nursing work environment (including nurse-physician relations) and adverse events via burnout. Two studies covered teamwork, well-being and patient safety amongst other aspects of the (nursing) work environment, but did not analyze the variables simultaneously, and reported mixed results. Effect sizes of the 11 significant relationships ranged from small (r = 0.13) to medium (r = 0.39).

Table 4

Relationships between teamwork, clinician well-being and patient safety

Study	Topic	Primary topic	Sample & Setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
Davenport et al., 2007[100]	Relationships between team and safety climate, working conditions, emotional exhaustion and patient morbidity/mortality	yes	6083 surgical team members, 52 hospitals, USA	Cross-sectional self-report questionnaire, record review	Teamwork: SAQ subscale team climate*, levels of communication and collaboration Well-being: Emotional Exhaustion* Patient safety: risk adjusted 30-day morbidity/mortality	Spearman's rank correlation	1) Negative association between patient morbidity and a) clinician's communication with attending doctors b) but not with clinician's communication with residents c) nurses d) other healthcare providers 2) No associations between team climate and a) mortality b) morbidity 3) No associations between emotional exhaustion and a) mortality b) morbidity	1a) ρ = -0.38, $p < 0.01$ 1b) NS 1c) NS 1d) NS 2a) NS 2b) NS 3a) NS 3b) NS	11.5 (16)
Laschinger & Leiter, 2006[101]	Mediation of relationship between nursing work environment and patient safety outcomes by burnout	yes	8597 nurses, acute care hospitals, Canada	Cross-sectional self- report questionnaire	Teamwork: Nurse-Physician-Relations Scale* Well-being: MBI* Patient safety: adverse events scale	Path analysis	1) Good overall model fit 2) Nurse-physician-relations and a) emotional exhaustion b) depersonalization c) adverse events are negatively correlated d) personal accomplishment are positively correlated 3) Adverse events and a) emotional exhaustion b) depersonalization are positively correlated c) personal accomplishment are negatively correlated (only results from correlation matrix are reported)	1) χ^2 = 16 438.19, *df* = 1.344, CFI = 0.908, IFI = 0.908, RMSEA = 0.037 2a) r = -0.f22, p = <0.01 2b) r = -0.16, p = <0.01 2c) r = -0.14, p = <0.01 2d) r = 0.13, p = <0.01 3a) r = 0.30, p = <0.01 3b) r = 0.34, p = <0.01 3c) r = -0.22, p = <0.01	10.5 (16)
Rathert et al., 2009[102]	Mediation of relationships between	no	306 nurses and other clinical care	Cross-sectional self-report questionnaire	Teamwork: Psychological Safety Scale*	Path analysis	1) Good overall model fit 2) Psychological safety does not mediate relationship	1) RMSEA = 0.06, NNFI = 0.92, CFI = 0.93 2a) NS	10.5 (16)

Table 4

Relationships between teamwork, clinician well-being and patient safety

Study	Topic	Primary topic	Sample & Setting	Design & data collection methods	Assessment of variables	Analyses	Findings	Outcomes & effect sizes	Quality score[§]
	work environment and work engagement, commitment and patient safety by psychological safety		providers, acute care hospital, USA		Well-being: Work engagement scale Patient safety: scale adapted from AHRQ Patient Safety Culture Survey		between work environment and a) patient safety b) work engagement 3) Positive correlation between patient safety and a) work engagement b) psychological safety 4) No correlation between psychological safety and work engagement	2b) NS 3a) $r = 0.14$, $p > 0.013$ 3b) $r = 0.39$, $p < 0.01$ 4) NS	
Wilkins et al., 2008[103]	Relationships between nurses' work environment, health status and medication errors	no	4379 nurses, Canada	Cross-sectional self-report, phone interviews	Teamwork: Nurse-Physician-Relations Scale[*] Well-being: mental health (1 item) Patient safety: medication error (1 item)	Logistic regression	1) Lower levels of nurse-physician relations are associated with more medication errors 2) Mental health status is not associated with medication errors	1) OR = 1.6, 95%CI 1.1 - 2.3, $p < 0.05$ 2) NS	11 (16)

Notes: We report not only significant but also non-significant relationships between predictor and outcome variables of interest in this review as hypothesized in the reviewed studies; even if not explicitly stated in the original publication.

[*] validated instrument; [†] effect sizes calculated by authors, calculation not possible if brackets empty; [‡] Cohen's f^2 based on R^2 instead of ΔR^2 ; [§] in brackets: maximal possible score.

Integrative framework

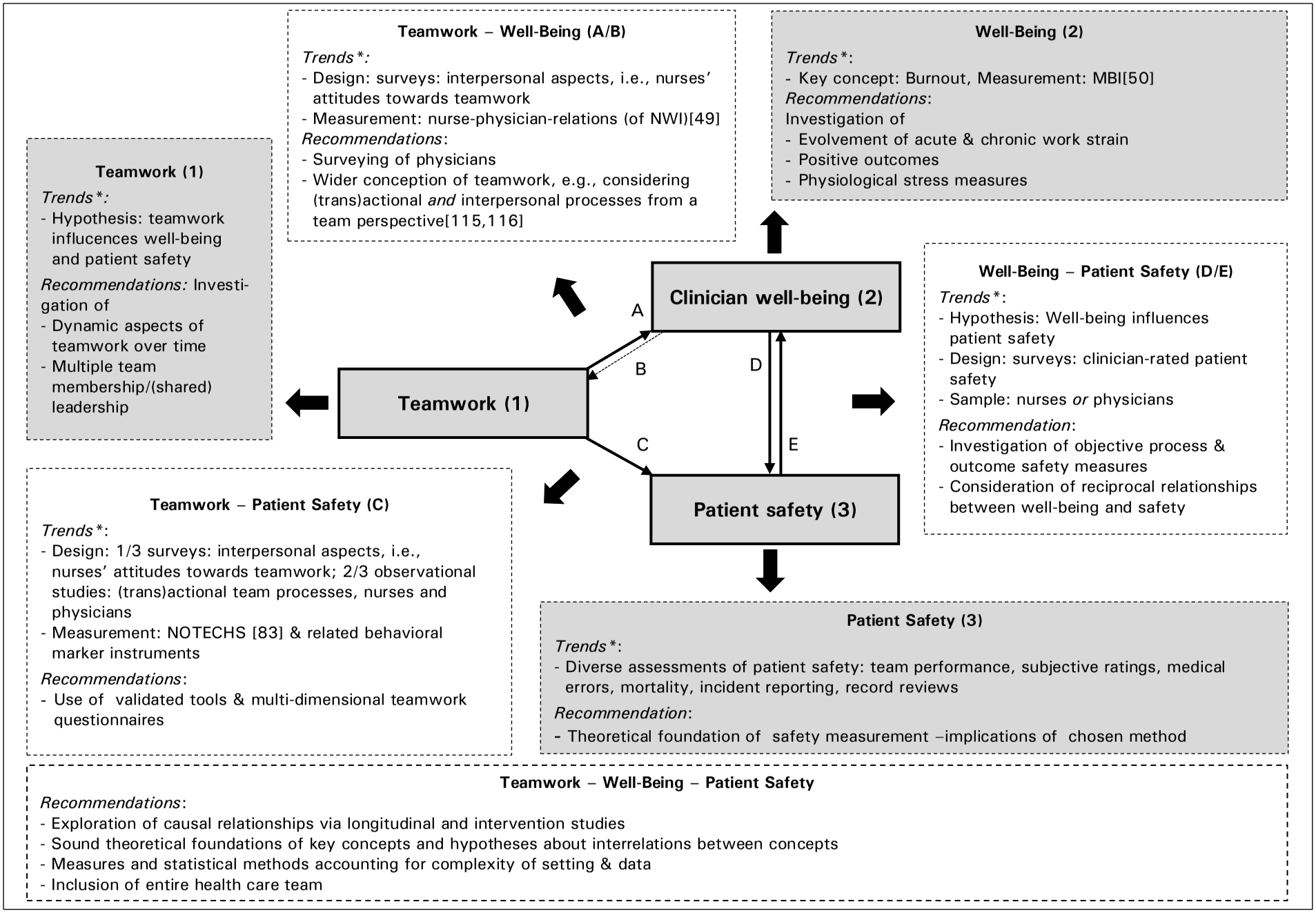
We combined psychological models of team performance and work stress with the findings and theoretical assumptions of this review to formulate specific hypotheses regarding the relationships between teamwork, clinician well-being and patient safety (figure 2).

Drawing from the job demands-resources model,[105] we propose that teamwork can be a demand as well as a resource. A team in which actions are not well-coordinated, goals are not communicated and employee's input to patient care is not welcomed by fellow team members may be demanding for its members and thus directly decrease the team's ability to provide safe patient care (figure 2, arrow C).[104, 10, 102, 106, 107, 11, 108] Simultaneously, ineffective teamwork may lead to decreased clinician well-being. According to the conservation of resources theory, decreased well-being can develop if there is an imbalance between resource investment and resource gain.[109, 47, 92, 22] Ineffective teamwork, as a lack of resource, can lead to a higher individual workload or emotional distress, thereby decreasing well-being.[47, 48]

Poor well-being, in turn, may decrease clinicians' ability to provide safe care (arrow D), because clinicians' physical and mental resources are depleted[110], cognitive functioning may suffer and they may not be able to exhibit safe working behaviors.[111, 112] The effects of decreased clinician well-being might also be reflected in the team, because distressed team members may not be able to execute relevant team behaviors as effectively; arrow B).[46]

In contrast, if teamwork quality is high, teamwork may act as a resource supporting clinicians to provide safe patient care (e.g., shared team mental models, backup behaviors, high psychological safety encouraging clinicians to speak up; arrow C).[55, 102, 10, 104, 106, 113] Effective teamwork helps to balance workload, prevent errors, and provide social support in a demanding work environment,[114, 108] and may also lead to lower strain levels arrow A), thereby indirectly supplying clinicians with resources needed for safe patient care (arrow D).[39, 47]

Figure 2: *Integrative framework*



Notes. *as identified in this review

From the reviewed studies, it is not clear whether patient safety influences well-being or vice versa. Clinicians with reduced well-being may not be able to care for patients as safely and effectively due to depletion of resources.[23] Conversely, being involved in an adverse event may lead to guilt and emotional stress potentially compromising psychological well-being in the short- or long-term.[24] Given the existing evidence, we hypothesize that well-being and patient safety are tightly coupled: Tangible patient safety incidents are likely to cause short-term emotional distress in clinicians[90] and chronic strain.[24] Chronic strain may also develop due to demanding working conditions which may decrease clinicians' motivation and efficiency, which could lead to reduced patient safety in the long run; arrows D and E).[23]

Gaps and trends in current research

Current gaps and recommendations based on the reviewed studies are summarized in figure 2. We found that a holistic approach taking account of the complexity of teams in healthcare organizations was missing, especially in survey studies. In addition to focusing on the individual professions *within* the team, the entire multi-professional team should be included. Potential multiple team membership covering transition, action, and interpersonal teamwork processes, and adoption of a temporal rather than static perspective should be considered.[115, 116] For example, correlating teamwork behaviors and patient safety indicators over an entire shift is not sufficient to gain an understanding of how they are linked. Instead, changes during the course of a shift or a specific task together with other influencing factors such as disturbances or interruptions need to be taken into account.[64, 117] As our review was set in the hospital context, a large part of the reviewed studies linked teamwork and patient safety to *work-related* indicators of well-being, such as burnout, which includes both negative (emotional exhaustion and depersonalization) and positive (personal accomplishment) aspects. Future approaches should consider reciprocal relationships between well-being and patient safety, and broaden the assessment of well-being to acute strain, physiological stress indicators or positive outcomes such as work engagement.[118]

With respect to patient safety, there is a clear need to consider how teamwork and well-being interact in impacting on objective safety indicators. This also includes ensuring independence of the objective indicators from other variables. For instance, measuring

patient safety via subjective ratings or incident reports may not shed light on a unit's safety, but rather measure clinicians' willingness to report errors which will be higher for clinicians working in a positive team climate.[80, 119] Yet, there seems to be a gap between the need for safety indicators that are feasible and a lack of theoretical discussion of what these indicators actually entail.

We identified several conceptual and methodological issues overarching all three constructs, which could be addressed by more focused study designs. These issues included missing or unclear theoretical foundations, definitions of key constructs, research goals and hypotheses, use of instruments with low validity (despite availability of valid instruments), incomplete description of analyses and reporting of results, mismatch of analyses and research question, and overgeneralization of results.

However, none of the studies suffered from all these drawbacks and many studies investigated the larger work environment so that the comprehensive measurement of teamwork, clinician well-being and patient safety was not within the scope of these studies. Despite these gaps, a large proportion of the reviewed studies were of high methodological quality, using triangulated data, validated instruments and statistical analyses of adequate complexity. Still, validity of results could be greatly improved by supporting pragmatic reasoning with sound theory to define key constructs and formulate clear, measurable research goals and hypotheses. In addition, it will be easier to perform analyses accounting for complexity of both the setting and data (i.e., structural equation or multilevel modeling, longitudinal studies, non-dichotomization of continuous variables).

DISCUSSION

This review provides an overview of the current state of research by scrutinizing relationships between teamwork, clinician psychological well-being and patient safety. Overall, ample evidence on associations between combinations of either two of these constructs exists. The volume and diversity of studies highlights the relevance of these

constructs in hospital settings and provides a rich source of information for the design of future studies and interventions. Furthermore, the findings of the review in combination with psychological theories served as the foundation for the framework to explain interrelations between the constructs. The framework is intended to aid interpretation of findings, inconsistencies, and gaps in current research, to serve as a blueprint to designing future studies, and to provide guidance for practitioners aiming to improve teamwork, clinician psychological well-being and patient safety.

Need to explore mechanisms behind relationships

In our opinion, the fact that some studies found no or only partial support for their hypotheses and reported small effect sizes is mainly due to the aforementioned conceptual and methodological issues, rather than non-existent relationships between constructs. These issues could be addressed by more stringent study designs. For instance, one may not find a relationship between general perceptions of teamwork and objective patient safety indicators. However, a targeted approach that draws from theory on aspects of teamwork and error types and uses validated measures may show that distorted shared mental models are related to inadequate nursing care.

Four of the 80 studies investigated relationships between all three constructs. These four, very diverse studies did not provide a sufficient basis for drawing conclusive conclusions regarding the causal mechanisms between the constructs (e.g. because the entire team was not sampled, contradictory results were found across the studies), but show that a recognition of an integrative approach exists.

The next step would be to design coherent studies based on strong theoretical foundations to uncover the *mechanisms* underlying the well-established relationships between teamwork, clinician well-being and patient safety. Knowledge of these mechanisms may serve as a basis for designing interventions that integrate all three constructs.

Adopting an integrative approach

Teamwork is the predominant form of work organization in healthcare. Clinician well-being and patient safety develop in a teamwork context and are dependent on each other. Consequently, clinician well-being and patient safety should not be viewed as outcomes to be managed separately. They may even seem contradictory - additional policies to ensure patient safety may increase clinician workload and decrease well-being. Our findings suggest that they can be integrated into a comprehensive approach: Teamwork may serve as a means to improve both these central organizational outcomes. Also, team-based interventions may be utilized to benefit from the synergies between teamwork, clinician well-being and patient safety. To achieve this, it is essential to focus on multi-professional teamwork and include nurses, physicians and other healthcare professionals. For example, differences in perceptions of teamwork quality by different professions[120, 121] and different approaches to team tasks may result in interpersonal friction[122] and decreased team effectiveness.[5, 12] Aside from proposing general mechanisms between teamwork, clinician well-being and patient safety, the review and framework provide an overview of the specific aspects (i.e., chronic and acute strain, interpersonal and transactional team processes) that may help target particular problems.

Outlook

The findings of this review have implications for both researchers and practitioners, and the proposed framework can help to address them in an integrative manner (figure 2).

1. Comprehensive approach to teamwork, well-being and patient safety

There is a clear need to investigate teamwork, clinician well-being and patient safety simultaneously in order to evaluate the complex interrelations between these constructs. Interdisciplinary exchange (e.g., medical, nursing, psychological) during study design would help harvest the full potential of studying these associations.

2. Exploration of causal relationships

Little is known about the causal associations between teamwork, well-being and patient safety, and their changes over time. Theoretically informed longitudinal studies and practical interventions will shed more light on this issue. Designing and implementing team-based interventions may result in a simultaneous increase of clinician well-being and patient safety.

3. Considering the entire healthcare team

Inter-professional tasks are inherent in healthcare. Thus, only considering nurses *and* physicians (and other healthcare professionals as appropriate) will provide a comprehensive picture of the complex associations between teamwork, clinician well-being and patient safety. In practice, consideration of the entire healthcare team is likely to increase the impact of team-based interventions on clinician and patient outcomes.[123]

Limitations

Although we employed a rigorous search strategy, we may have missed relevant studies. For instance, the lack of consensus between different research approaches concerning terminology for key constructs may have resulted in ambiguous database indexing. However, we compensated for this limitation by including a thorough search of reviews and reference lists. Second, qualitative and interventional studies might have provided additional insights, but – with one exception[75] – were excluded because they did not examine statistical relationships between the constructs that were the focus of this review. Third, study selection, data extraction and rating of study quality were naturally influenced by authors' reporting style. Nevertheless, the detailed review procedure including structured quality rating proved useful in exploring strengths and weaknesses of the selected studies and thus provided a solid foundation for framework development. Lastly, as with all reviews, there is always a possibility of publication bias, because non-significant results are often not published.

Conclusion

Substantial relationships between combinations of two of the three constructs teamwork, well-being and patient safety were identified, indicating that all three might influence each other. The proposed framework provides a basis for overcoming current research gaps and inconsistencies by hypothesizing causal mechanisms between the constructs and investigating relationships between all three constructs simultaneously. Such an integrative perspective of the synergies between teamwork, well-being and patient safety will inform team-based practice improvements aiming to benefit clinicians and patients alike.

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Appendix: Quality rating questions

(Adapted from Buckley[30] and Downs and Black[31])

1. Is the theoretical foundation/study background/past research/research gap clearly described?
2. Is the research question(s) or hypothesis clearly stated?
3. Are the main outcomes & predictors to be measured clearly described in the Introduction or Methods section?
4. Are the methods of data collection reliable and valid for the research question and context?
5. Were all relevant ethical issues addressed?
6. Is the subject group appropriate for the study being carried out?
7. Have subjects dropped out? Is the attrition rate less than 50%? For questionnaire based studies, is the response rate acceptable (60% or above)?
8. Was missing data handled appropriately?
9. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?
10. Are statistical methods/analyses/procedures clearly described?
11. Are the statistical or other methods of results analysis used appropriate (matching research questions, hypotheses, data)?
12. Are the results reported clearly and correctly?
13. Were results supported by data from more than one source?
14. Is it clear that the data justify the conclusions drawn?
15. Could the study be repeated by other researchers?
16. Does the study look forwards in time (prospective) rather than backwards (retrospective)?
17. Are the interventions of interest clearly described? (intervention studies only)
18. Is there a comparison between treatment and control group? (intervention studies only)
19. Was there an additional follow up control measure after the intervention (to investigate long-term effects)? (intervention studies only)

3. STUDY B

Emotional Exhaustion and Workload Predict Clinician-Rated and Objective Patient Safety

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Abstract

Aims: To investigate the role of clinician burnout, demographic and organizational characteristics in predicting subjective and objective indicators of patient safety.

Background: Maintaining clinician health and ensuring safe patient care are important goals for hospitals. While these goals are not independent from each other, the interplay between clinician psychological health, demographic and organizational variables and objective patient safety indicators is poorly understood. The present study addresses this gap.

Method: Participants were 1425 physicians and nurses working in intensive care. Regression analysis (multilevel) was used to investigate the effect of burnout as an indicator of psychological health, demographic (e.g., professional role and experience) and organizational (e.g., workload, predictability) characteristics on standardized mortality ratios, length of stay and clinician-rated patient safety.

Results: Clinician-rated patient safety was associated with burnout, trainee status, and professional role. Mortality was predicted by emotional exhaustion. Length of stay was predicted by workload. Contrary to our expectations, burnout did not predict length of stay, and workload and predictability did not predict standardized mortality ratios.

Conclusion: At least in the short-term, clinicians seem to be able to maintain safety despite high workload and low predictability. Nevertheless, burnout poses a safety risk. Subjectively, burnt-out clinicians rated safety lower, and objectively, units with high emotional exhaustion had higher standardized mortality ratios. In summary, our results indicate that clinician psychological health and patient safety could be managed simultaneously. Further research needs to establish causal relationships between these variables and support to the development of managerial guidelines to ensure clinicians' psychological health and patients' safety.

Keywords: Clinician burnout, patient safety, standardized mortality ratios, length of stay, intensive care unit.

Conflicts of interest: none.

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INTRODUCTION

Safe patient care and care providers' psychological health are central concerns of healthcare organizations. While past research shows that these two organizational outcomes are both at unsatisfactory levels (Aiken et al., 2012; de Vries, Ramrattan, Smorenburg, Gouma, & Boermeester, 2008; Estryn-Behar et al., 2011), the potential connections between them have been largely neglected when designing interventions to improve either outcome. A scientific understanding of linkages between clinicians' psychological health and patient safety might provide healthcare leaders with an opportunity to manage these two important organizational goals synergistically – clinician health and patient safety.

The main aim of this paper is to broaden our understanding of the relationship between clinician burnout as an indicator of reduced psychological health, and patient safety. Burnt-out clinicians might be a patient safety threat because they lack the necessary resources to perform their jobs (Schaufeli, Keijsers, & Miranda, 1995). Thus, reducing clinician burnout might not only alleviate well-known individual and organizational effects (e.g., turnover intentions or sick leave; Heinen et al., 2013; Toppinen-Tanner, Ojajärvi, Väänaänen, Kalimo, & Jäppinen, 2005) but might offer a means to influence patient safety. Existing studies examining relationships between clinician psychological health and patient safety rely largely on safety indicators such as clinicians' overall safety ratings (Ramanujam, Abrahamson, & Anderson, 2008). These safety ratings are influenced by clinicians' subjective perceptions and may differ from more objective data sources collected in the course of patient care, such as standardized mortality ratios. In order to monitor and improve patient outcomes, however, we also need to understand the factors impacting on objectively measurable safety indicators. Therefore, this study includes both objective and subjective patient safety indicators.

A further aim of this study is to explore the role of clinician demographic (e.g., professional role) and organizational characteristics (e.g., workload) that might be related

to patient safety. By identifying modifiable constellations of clinician demographic and organizational characteristics in combination with clinician burnout this paper addresses a current gap in work design interventions, which are aimed at increasing patient safety.

To address this gap, our goal is to answer three questions: Does clinician burnout predict patient safety? What is the role of demographic and organizational characteristics in predicting patient safety? Is burnout a predictor of patient safety over and above demographic and organizational characteristics? We will first provide the relevant theoretical background and describe the current state of research on clinician burnout and patient safety. Based on these foundations, we developed hypotheses concerning the relationships between burnout and demographic and organizational characteristics, and patient safety.

Patient safety

Patient safety is an important indicator of hospital performance. While there is some debate concerning the exact number and degree of severity of safety-related events, the general problem of compromised patient safety is widely accepted. For instance, de Vries et al., (2008) concluded from their systematic review of eight studies covering 74 485 patient records that around 10% of hospitalized patients experience an adverse event, about half of which could have been prevented. They estimated that 7% of patients who are affected by adverse events suffer lasting damage and another 7% die.

Patient safety is decreased if so-called preventable adverse events occur – i.e., adverse events not inherent to the patient's condition but resulting from the provision of care (de Vries et al., 2008). Preventable adverse events comprise not only events that cause temporary or permanent damage or even death, but also those that have the potential to do so. In a safe healthcare system, preventable adverse events are minimized, and, if they occur, recovery from them is maximized (Emanuel et al., 2008). Patient safety can thus be broadly defined as "the avoidance, prevention, and amelioration of adverse outcomes or injuries stemming from the process of healthcare" (Vincent, 2012, p. 4).

Due to the complexity of studying patient safety, many studies use subjective safety indicators. Using subjective patient safety indicators has advantages: Clinicians are

experts in their work domain and may therefore be best suited to detect and evaluate events endangering patient safety during care that might be difficult for outsiders to observe. However, there are often barriers to accurately recalling or reporting adverse events (Pfeiffer, Manser, & Wehner, 2010). Thus, subjective patient safety indicators may be biased. Clinicians may base safety ratings on their own performance, which may not be representative for the entire unit. Subjective safety ratings and error reporting may also be influenced by clinicians' current mental or emotional states (Jones & Johnston, 2012). Clinicians may have trouble remembering the frequency of safety-related events, especially when the period they are asked about is protracted (West, Tan, Habermann, Sloan, & Shanafelt, 2009), or be unaware of them altogether. Finally, many studies use only self-report data to investigate the impact of subjectively perceived work characteristics on subjectively perceived patient safety, which can result in common method bias (Podsakoff, MacKenzie, & Podsakoff, 2012). An alternative to subjective safety indicators is objective patient safety data.

Research investigating burnout and objective patient safety is scarce. One reason for the lack of studies might be that reliable objective patient safety data are often difficult to obtain. Observations require a lot of resources and preventable adverse events can be difficult to identify (does the observed incident constitute an adverse event?) or define (could the event have been avoided?). Adverse events can further be identified from patient record reviews or critical incident reporting systems, neither of which capture the true occurrence rate. Finally, relevant data may not be accessible for ethical reasons, or simply not be available.

However, healthcare organizations increasingly collect relevant patient safety indicators such as length of stay and standardized mortality ratios (e.g., Aiken et al., 2014; Brewer, 2006; Davenport, Henderson, Mosca, Khuri, & Mentzer, 2007; Hoffer Gittell et al., 2000; Merlani et al., 2011; Wheelan, Burchill, & Tilin, 2003). Instead of focusing on preventable adverse events and therefore on process indicators, these data actually represent unfavorable patient outcomes – i.e., they can serve as primary indicators for patient safety issues so severe that preventable adverse events actually did result in a prolonged hospital stay or even death.

The present study investigates patient safety in intensive care units. Patients in intensive care units (ICUs) are particularly prone to preventable adverse events due to

their critical condition requiring a higher number of complex care interventions (Kane-Gill, Jacobi, & Rothschild, 2010; Moyen, Camire, & Stelfox, 2008; Rothschild et al., 2005; Seynaeve et al., 2011) and relevant outcome data such as length of stay and standardized mortality ratios, are routinely collected. Combining them with subjective safety ratings of clinicians, this approach compensates for the advantages and disadvantages of subjective and objective patient safety indicators and allows for comparative analyses. In line with the above definitions, length of stay, standardized mortality ratios, and clinician-rated patient safety are global indicators of reduced patient safety in the sense that the occurrence was not followed by optimal recovery, and clinicians are aware of such incidents.

Burnout

Within the context of clinician health, this study focuses on clinician burnout. Burnout is a core aspect of reduced work-related psychological health and represents a severe, chronic strain response of the individual to enduring stress at work (Maslach & Jackson, 1981; Maslach, Schaufeli, & Leiter, 2001). Burnout as defined by Maslach and Jackson (1981) consists of three dimensions: emotional exhaustion, depersonalization and decreased personal accomplishment. Emotional exhaustion is considered the core dimension of burnout (Maslach et al., 2001). Emotionally exhausted employees feel fatigued and unable to face the demands of their job or engage with people. Depersonalization refers to emotional and cognitive disengagement from one's job and a distant, cynical attitude towards it. The third burnout dimension, reduced personal accomplishment, describes the feeling of not being able to make a meaningful contribution and overall reduced efficacy at work (Maslach & Jackson, 1981).

The conservation of resources theory (COR; Hobfoll, 1989, 2002) is often drawn upon to explain burnout development. According to COR, strain develops if an individual is threatened with loss of material or psychological resources, actually loses them, or an imbalance develops due to resource investment without the appropriate resource gain. Hobfoll (2002) argues that burnout develops particularly in this third case. As a consequence, individuals are hesitant to invest in their jobs, they develop negative

affective states and negative attitudes towards their clients and are less vigilant. In turn, performance may suffer (Halbesleben & Rathert, 2008; Halbesleben et al., 2008).

While originally theorized to be limited to the human services professions, which require employees to invest a lot of emotional resources into their clients (Maslach & Jackson, 1981), it has been established that burnout can develop based on a multitude of stressors inherent to the work itself (e.g., time pressure, low control), social interactions (e.g., role conflict, poor working relationships with colleagues or supervisors) or individual characteristics (e.g., high neuroticism, external locus of control; Maslach et al., 2001).

Burnout is highly prevalent in healthcare workers. A European study found that, depending on the country, between 10% and 78% of registered nurses suffer from burnout (Aiken et al., 2012) and there is evidence that numbers are rising (Arigoni, Bovier, & Sappino, 2010). This rise being attributed to nursing shortages caused by cost-cutting and demographic changes (Duvall & Andrews, 2010).

Healthcare staff in acute care settings such as ICUs seem to be highly susceptible to experiencing burnout, since many of the factors that have been associated with burnout are present in their work environment. A study on burnout in physicians found that 52% of emergency physicians, compared to 42% of physicians working on wards, were burnt out (Estryn-Behar et al., 2011). A variety of work characteristics may contribute to the increased levels of burnout in these settings. For example, the number of patients in critical conditions requiring extensive care is higher than in other care settings (Brinkman et al., 2013; Moyen et al., 2008). This may exhaust clinicians' resources. In addition, patients in ICUs are often unable to communicate effectively, yet may be more agitated than less acute patients, thus requiring clinicians to invest even more time and emotional resources.

Patient safety and clinician burnout

Evidence of a relationship between burnout and objective performance is scarce across organizational settings (Taris, 2006), and healthcare is no exception. Studies investigating relationships between clinicians' psychological health and patient safety are mainly based

on clinician-rated patient safety rather than objectively measured patient safety indicators. For example, West et al. (2009) found that burnout in medical trainees was associated with higher recall of medication errors six months later. Similarly, burnt-out nurses report more adverse events (Teng, Shyu, Chiou, Fan, & Lam, 2010). Other studies investigated recollection of adverse events (Squires, Tourangeau, Laschinger, & Doran, 2010) or errors (Prins et al., 2009).

Since this previous research was focused on subjective patient safety, little is known about the effect of clinician burnout on objective patient outcomes, with two exceptions (Cimiotti, Aiken, Sloane, and Wu, 2012; Schaufeli et al., 1995). Schaufeli et al. (1995) found no effect on standardized mortality ratios, but did find an unexpected negative effect on length of stay. So, the findings on the limited previous research are mixed. We expand on prior studies by utilizing a larger sample including both nurses and physicians, analyzing all three burnout dimensions separately, and in addition, investigating the effect of demographic and organizational characteristics.

We assume that due to an imbalance between resource investment and resource gain, burnt-out clinicians may lack the energy or motivation to effectively perform their duties and are thus less able to provide safe patient care. Unsafe care processes might translate into increased patient mortality and length of stay, and reduced overall patient safety as perceived by the clinicians.

Nahrgang, Morgeson, & Hofmann (2011) generally argue that mental and physical energy levels in burnt-out employees are such that safe work behaviors are lessened and so the likelihood of errors and work-related injuries is increased. An explanation of this relationship for the healthcare setting is offered by Halbesleben & Rathert (2008) and Halbesleben et al. (2008). The authors propose two mechanisms by which burnout may lead to reduced patient safety: First, because of resource depletion, clinicians may be less vigilant so their cognitive functioning suffers meaning preventable adverse events are more likely to happen. Second, as clinicians develop negative attitudes towards their patients, they can be reluctant to invest energy into observing or communicating with them, which may lead to loss of important information and reduce the quality of patient care, as perceived by clinicians and patients (Halbesleben & Rathert, 2008; Halbesleben et al., 2008).

We follow this line of reasoning and discuss these mechanisms separately for each burnout dimension. By definition, emotionally exhausted clinicians feel fatigued and unable to cope with the demands of their job. Emotional exhaustion could thus exert its negative effect on patient safety via a lack of physical and cognitive ability to perform one's duties. To prevent further depletion of resources, emotionally exhausted clinicians may only execute tasks that are absolutely necessary (Demerouti, Bakker, & Leiter, 2014; Halbesleben et al., 2008), neglecting safety behavior. Furthermore, cognitive processes such as executive functions, attention and memory are impaired in burnt-out individuals (Deligkaris, Panagopoulou, Montgomery, & Masoura, 2014). As a result, exhausted clinicians may be less able to process the cognitive demands of highly technical and often rapidly changing ICU environment, pay less attention to details, such as small changes in patient status and are more likely to commit errors.

Depersonalization may function as a (dysfunctional) coping mechanism (Sonnentag, 2005) by which clinicians mentally detach from their work environment in response to a demanding work situation when other coping options, such as physically distancing oneself from or changing the demands, are unavailable. Some authors stress the motivational aspect of depersonalization, arguing that as a mechanism to maintain personal resources, the unwillingness to exert any more effort is the foundation of disengagement from the job (Demerouti et al., 2014; Taris, 2006). This disengagement comprises a depersonalized, dehumanizing attitude towards patients and a cynical attitude towards one's job. Overall, reduced willingness to perform and lower commitment to the job may lead to negligence of duties, paying less attention to important details and thus higher rates of adverse events. For instance, being negligent about hand hygiene could lead to hospital-acquired infections, or committing a medication error could lead to serious drug side effects.

If clinicians are depleted of the resources necessary to perform their jobs, their sense of personal accomplishment –the belief that they can complete their tasks and make a meaningful contribution in their job – might decrease. Personal accomplishment is conceptually close to self-efficacy – i.e., the conviction that one has the capabilities to successfully accomplish a challenging task (Bandura, 1977). Self-efficacious individuals show higher performance because they are more persistent, exert more effort and view tasks as challenging rather than a threat (Stajkovic & Luthans, 1998). We assume that

clinicians' performance might suffer due to the belief that they are not capable of accomplishing work-related tasks. Clinicians might not invest the energy required to provide safe patient care, for instance, by neglecting hand hygiene or double-checks during medication preparation. They might also be less persistent when dealing with unexpected problems, for instance, irregularities in a patients' condition, which might lead to decreased safety.

In summary, patients may be at a higher risk of suffering a preventable adverse event due to clinician burnout. A higher number of preventable adverse events is associated with more complications, which can lead to a prolonged hospital stay or, in very severe cases, death. The effect of burnout affecting patient safety via adverse events leading to increased mortality and length of stay would thus indicate a serious threat to patients.

Hypothesis 1: Burnout is associated with patient safety. Specifically,

a) emotional exhaustion and depersonalization are negatively correlated with clinician-rated patient safety, and personal accomplishment is positively correlated with clinician-rated patient safety.
b) emotional exhaustion and depersonalization are positively correlated with standardized mortality ratios, and personal accomplishment is negatively correlated with standardized mortality ratios.
c) emotional exhaustion and depersonalization are positively correlated with length of stay, and personal accomplishment is negatively correlated with length of stay.

Demographic and organizational characteristics

In addition to burnout, we included clinician demographic and organizational characteristics as predictors of patient safety. Demographic characteristics are individual attributes defining the role of a clinician within the ICU, such as his / her profession. Organizational characteristics are attributes of the work context, such as workload. Both demographic and organizational characteristics vary considerably across ICUs (Kirwan, Matthews, & Scott, 2013; Merlani et al., 2011). The effect of burnout on patient safety

might be masked by them, or they may be independent predictors of patient safety. Including demographic and organizational characteristics can increase the practical applicability of research findings by pointing to additional opportunities for interventions (e.g., optimal team composition with regard to experience levels; Gibbs, McCaughan, & Griffiths, 1991). Therefore, we will investigate the relationship of the demographic characteristics professional role (nurse vs. physician), professional experience, and professional status (trainee vs. non-trainee and clinical leader vs. non-leader), and the organizational characteristics workload, predictability, and team professional experience with patient safety.

Previous studies showed that safety perceptions differ depending on professional role, status, and professional experience (e.g. Chang & Mark, 2009; Cimiotti et al., 2012; Vogus & Sutcliffe, 2007). Findings regarding the direction of these associations are, however, mixed (Wilson, Redman, Talsma, & Aebersold, 2012). On the one hand, it has been reported that nurse leaders who spend less time at the bedside but have more experience in detecting safety threats report lower safety levels (Singer et al., 2009; Wilson et al., 2012). On the other hand, there is evidence that clinicians who spend more time on actual patient care tasks and are more exposed to safety-relevant situations tend to have lower safety perceptions than those who work in non-clinical areas (Singer et al., 2009). Since these studies only used subjective safety ratings, we do not know if these perceptions of patient safety correspond to objective safety indicators.

Based on prior findings, we expect clinician-rated patient safety to be lower in clinicians that spend more time at the bedside, specifically nurses (as opposed to physicians), trainees, and clinicians without leadership status. Nurses tend to spend more time on the unit, with the patient or involved in patient care, than physicians and might therefore be more sensitive to safety risks. Trainees might be overwhelmed and insecure about their abilities, which could lead to lower safety perceptions. Clinical leaders spend less time at the bedside and are thus less exposed to safety-threatening situations, which could be associated with more positive perceptions of safety.

We also expect standardized mortality ratios and length of stay to be higher on units with a higher percentage of trainees and lower percentages of clinical leaders. Trainees tend to commit more errors (West et al., 2006) and, if not supervised accordingly, might pose a safety threat. We do not have any assumptions regarding the

impact of the ratio of nurses to physicians on standardized mortality ratios and length of stay so will only perform exploratory analyses of this effect.

Lastly, professional experience might relate positively to patient safety (Blegen, Vaughn, & Goode, 2001) as it enables the individual to process and integrate novel information more quickly and to lead colleagues (Chang & Mark, 2009; Yun, Faraj, & Sims, 2005). The impact of high team professional experience might be even more pronounced, because the pooled competence of the entire team might be able to compensate for errors or lapses of less experienced team members.

In addition to the above characteristics, we will explore the effect of the organizational characteristics workload and predictability on standardized mortality ratios and length of stay. We define workload and predictability as work demands - i.e., physical, psychological, social, or organizational facets associated with clinician's jobs which require effort (Demerouti, 2001; Karasek, 1979). In contrast to team professional experience, high workload and low predictability make acute care settings such as ICUs particularly demanding (Brinkman et al., 2013; Estryn-Behar et al., 2011; Moyen et al., 2008) and vulnerable to safety problems. High workload is thought to be detrimental to safety performance due to increased cognitive, emotional or physical load. For example, Baethge & Rigotti (2013) showed that perceived time pressure in clinicians predicted decreased subjective performance. Schubert et al. (2013) found that nurses who rationed the amount of nursing care due to overload, also perceived safety to be lower. Common indicators of workload in healthcare studies are nurse-patient-ratios or staffing adequacy (Coetzee, Klopper, Ellis, & Aiken, 2013). In the present study, we employed a quantitative approach to workload by calculating the number of patient care interventions executed by nurses such as medication or monitoring, relative to the number of patients, as an indicator of workload.

Low predictability is an additional risk factor for poor performance and low patient safety. For instance, self-reported interruptions predicted failure to remember intended actions and lower subjective performance (Baethge & Rigotti, 2013). Observational studies in operating theatres linked unforeseen complications (so-called non-routine events) with clinical performance (Burtscher et al., 2011). Low predictability requires clinicians to process a large amount of additional information in a short time and may force them to deviate from the routine path and change their behavior (Manser,

Harrison, Gaba, & Howard, 2009; Schraagen, 2011), thus increasing cognitive load which in turn can lead to both decreased performance and patient safety. We include the proportion of unplanned admissions as an objective indicator of low predictability.

Hypothesis 2: Demographic and organizational characteristics are associated with patient safety. Specifically,

a) trainee status, non-leadership status, being a nurse, low professional experience, high workload, and low predictability are negatively correlated with clinician-rated patient safety.
b) trainee status, non-leadership status, low professional experience, high workload, and low predictability are positively correlated with standardized mortality ratios.
c) trainee status, non-leadership status, low professional experience, high workload, and low predictability are positively correlated with length of stay.

MATERIAL AND METHODS

Participants and Procedures

Ethics approval for this study was granted from both the departmental and cantonal ethics committees (75, 2013-06-03; 024/13-CER-FR, 2013-24-06). We recruited medical and nursing staff working in ICUs in Switzerland. Participants were 1425 nurses and physicians in 54 ICU teams distributed across 48 hospitals. Of these participants, 1130 were nurses, 243 physicians, and 52 did not provide information on their professional background. The sample was predominantly female (N = 1027), 364 were men, and 34 did not provide this information. Age ranged from 19 to 63 years (N = 1401, M = 39.13, SD = 10.14), and professional experience from 0 to 43 years (N = 1386, M = 12.56, SD = 8.93).

Data on clinician burnout and clinician-rated patient safety were collected via an online self-report questionnaire over the period of one month. Data on workload,

predictability, and objective patient safety were obtained during the same time period from a standardized dataset routinely collected by each ICU and then submitted to a central database at the Swiss Society for Intensive Care Medicine (SGI). Written consent to participate as a unit was obtained from ICU leaders, who also functioned as local study coordinators who forwarded the online questionnaire to their colleagues and were responsible for transmission of the patient care and unit data to the SGI. Individual clinicians were asked for their consent to participate, assured complete anonymity and confidential handling of their data upon opening the online questionnaire.

Measures

Patient safety

Patient safety was assessed via clinician-rated patient safety, length of stay and standardized mortality ratios. Clinicians were asked to rate their perception of the unit's safety level with one item ("Please give your unit in this hospital an overall grade on patient safety") from the Hospital Survey Of Patient Safety Culture (HSOPSC, Sorra & Nieva, 2004) translated to German, French, and Italian (Pfeiffer & Manser, 2010; Occelli et al., 2013, Bagnasco et al., 2011). Answers were provided on a five-point Likert Scale (1 = *failing,* 5 = *excellent*). While increased length of stay does not represent patient harm per se, it is widely used as an indicator of adverse events or complications that necessitate a longer ICU or hospital stay (Brewer, 2006; Hoffer Gittell et al., 2000; Merlani et al., 2011). Both crude and standardized mortality ratios are frequently used as indicators for quality of care processes and patient safety (Tourangeau, Cranley, & Jeffs, 2006). Crude mortality ratios indicate the percentage of deceased patients compared to all patients. Standardized mortality ratios are adjusted for patients' risk of death by including several characteristics reflecting the severity of their condition (Le Gall, Lemeshow, & Saulnier, 1993; Wheelan et al., 2003). Thus, standardized mortality ratios are considered to be more reliable than crude mortality ratios (Tourangeau & Tu, 2003).

Burnout

Clinician burnout was assessed with the Maslach Burnout Inventory Human Services (MBI-HSS, Maslach, Jackson, & Leiter, 1996) in its appropriate translations to German, French, and Italian (Büssing & Glaser, 1998; Dion & Tessier, 1994; Pisanti, Lombardo, Lucidi, Violani, & Lazzari, 2013). The MBI-HSS consists of the three dimensions *emotional exhaustion* (nine items, sample item "I feel mentally exhausted because of my work"), *depersonalization* (five items, sample item "I doubt the significance of my work"), and a positively formulated subscale called *personal accomplishment* (seven items, sample item "I deal very effectively with the problems at my work"). Responses were given on a seven-point Likert scale (1 = *never*, 7 = *always*). Cronbach's alphas were .87, .63, and .71 for emotional exhaustion, depersonalization, and professional efficacy, respectively.

Demographic and organizational characteristics

Demographic characteristics professional role (nurse vs. physician), professional status (trainee vs. non-trainee and leader vs. non-leader), and professional experience were taken from the online survey data. Trainees comprised nurses and physicians undergoing advanced training to specialize in intensive care, and leadership status was defined as senior nurses and physicians leading the ICU. Team professional experience (in years), workload, and level of predictability served as organizational characteristics. We aggregated participant's professional experience from the online survey to the unit level as an indicator of team professional experience, divided by the number of participants per unit. Nursing care interventions per patient relative to the number of patients, served as an indicator of workload. Nursing care interventions – also called nine equivalents of nursing manpower (NEMS) are patient care tasks executed by nurses such as monitoring, intravenous medication, ventilation or dialysis. They are frequently used as an objective workload indicator both for practical and research purposes (Carmona-Monge, Rollan Rodriguez, Quiros Herranz, Garcia Gomez, & Marin-Morales, 2013; Reis Miranda, Moreno, & Iapichino, 1997; Rothen, Kung, Ryser, Zurcher, & Regli, 1999). Furthermore, we used the proportion of unplanned admissions (i.e., ratio of patients whose admission to ICU was not planned divided by all admissions during the data collection period) as an indicator of low predictability at the workplace. Data on workload and predictability were extracted from the central database of the SGI.

Control variables

Previous studies showed that clinicians' ratings of burnout and safety differ between males and females: males tend to report lower burnout (Merlani et al., 2011; Myhren, Ekeberg, & Stokland) and errors (Klein, Frie, Blum, & von dem Knesebeck, 2010; Myhren et al.; Prins et al., 2009). Thus, we controlled for the effects of gender. In addition, age was included as a control variable to explore the effect of professional experience independent from age.

Analyses

Clinician-rated patient safety was measured at the individual level. To account for the nested data structure (i.e., individuals nested in teams), effects on clinician-rated patient safety were investigated using multilevel analyses with HLM 6 (Raudenbush et al., 2004). Age and gender were entered as control variables. Continuous predictors; emotional exhaustion, depersonalization, personal accomplishment, workload, predictability, and age were grand mean centered. Demographic characteristics; professional role, trainee status, and leadership status and control variable gender were dichotomous and thus dummy coded (0 = *nurses, non-trainees, non-leaders, females*; 1 = *physicians, trainees, leaders, males*). We used the restricted maximum-likelihood procedure in HLM for estimating the fixed and random parameters and robust standard errors for the significance tests (Hox, 2010).

In contrast to clinician-rated patient safety, mortality ratios and length of stay were measured on the unit-level, hence, no nested data structure exists and OLS regression analyses using SPSS were conducted. To predict the unit level outcomes of mortality and length of stay, individual-level predictors emotional exhaustion, depersonalization, personal accomplishment, professional experience, and age were aggregated at the unit level by calculating the unit mean. Gender, professional role, trainee status, and leadership status were aggregated by calculating the percentage of male participants, trainees, leaders, and physicians. Stepwise regressions were performed. In the first step, control variables age and gender were entered into the regression equation. In the second step, demographic characteristics professional role, trainee and leadership status, and organizational characteristics team professional experience, workload, predictability were

added. Finally, emotional exhaustion, depersonalization, and personal accomplishment were entered into the equation.

Three units were deleted from the sample based on an outlier analysis following recommendations by Aguinis, Gottfredson, & Joo (2013). The final sample for analyses at the unit level consisted of 54 ICUs.

RESULTS

Descriptive statistics and correlations

Means, standard deviations, and zero-order Pearson correlations among all variables at both individual and unit levels are presented in Tables 1 and 2, respectively.

Table 1

Means, Standard Deviations, and Pearson Correlations among Variables at the Individual Level (N = 1391)

		M	*SD*	1	2	3	4	5	6	7	8	9
1	Gender	-	-									
2	Age	39.13	10.14	.10*								
3	Emotional exhaustion	2.73	0.87	.03	.01							
4	Depersonalization	2.27	0.77	.14**	-.08*	.50**						
5	Personal accomplishment	4.78	0.50	-.06*	.11*	-.33**	-.44**					
6	Clinician-rated patient safety	3.71	0.62	.08*	.00	-.25**	-.16**	.18**				
7	Professional experience	12.56	8.93	.00	.76**	-.01	-.13**	.10**	-.03			
8	Professional role (nurse vs. physician)	-	-	.35**	.03	.10	.03	.02	.14**	-.16**		
9	(non-) Trainee status	-	-	.05*	-.26**	.10**	.08**	-.05	.06**	-.31**	.32**	
10	(non-) Leadership status	-	-	.18*	.19**	-.05*	-.08**	.11**	.06*	.15**	.22**	-.06*

Note. * $p < .05$ (one-tailed test); ** $p < .01$ (one-tailed test). Dichotomous variables gender, professional role, trainee status, and managerial status are dummy coded (0 = nurses, non-trainees, non-managers, females; 1 = physicians, trainees, clinical leaders, males).

Table 2

Means, Standard Deviations, and Pearson Correlations among Variables at the Unit Level (N= 54)

		M	*SD*	1	2	3	4	5	6	7	8
1	Gender	-	-								
2	Age	39.35	3.54	.10*							
3	Emotional exhaustion	2.68	1.29	-.24	-.10						
4	Depersonalization	2.26	1.34	-.13	-.27*	.46**					
5	Personal accomplishment	4.76	1.16	-.16	.26*	-.15	-.57**				
6	Clinician-rated patient safety	3.70	1.22	.02	-.07	-.33**	-.02	-.12			
7	Standardized mortality ratios	0.18	1.07	-.02	-.31*	.27*	.01	-.04	-.26*		
8	Length of stay	2.61	1.34	.18	.18	.12	.07	-.07	.15	.11	
9	Team professional experience	12.64	3.58	-.01	.90**	-.05	-.17	.30*	-.13	-.36*	.14
10	Physicians	18.14	15.65	.42**	.01*	-.29*	-.20	-.05	-.17	-.10	.16
11	Trainee status	14.61	10.16	.14	-.31*	.07	.15	-.07	.03	.11	-.05
12	Leadership status	14.67	10.11	.24*	.29*	-.18	-.34*	.07	-.01	-.10	.16
13	Workload	3.33	4.11	.23*	.42**	.06	.05	.07	.10	-.19	.80**
14	Predictability	0.72	0.17	.65	-.08	.01	-.25*	-.03	.08	-.04	.17

Note. * $p < .05$ (one-tailed test); ** $p < .01$ (one-tailed test). Dichotomous variables gender, professional role, trainee status, and managerial status are aggregated to percentages of males, physicians, trainees, and clinical leaders.

(continued on next page)

Table 2 (continued)

Means, Standard Deviations, and Pearson Correlations among Variables at the Unit Level (N = 54)

		9	10	11	12	13
1	Gender					
2	Age					
3	Emotional exhaustion					
4	Depersonalization					
5	Personal accomplishment					
6	Clinician-rated patient safety					
7	Standardized mortality ratios					
8	Length of stay					
9	Team professional experience					
10	Physicians	-.14				
11	Trainee status	-.35*	.55**			
12	Leadership status	.24*	.51**	.06		
13	Workload	.38**	.17	-.09	.21	
14	Predictability	-.07	.07	-.18	-.08	.05

Note. * $p < .05$ (one-tailed test); ** $p < .01$ (one-tailed test). Dichotomous variables gender, professional role, trainee status, and managerial status are aggregated to percentages of males, physicians, trainees, and clinical leaders.

Predictors of clinician-rated patient safety

In order to test whether burnout, demographic and organizational characteristics predicted clinician-rated patient safety, we conducted a multilevel model (see Table 3). With regard to control variables, results showed that males rated patient safety we conducted a multilevel model (see Table 3). With regard to control variables, results showed that males rated patient safety higher than females (B = 0.12, $t = 3.00$, $p = .003$),

Table 3

Multilevel Random Slopes Model Predicting Clinician Safety Ratings on Burnout and Organizational Characteristics

		Clinician-rated patient safety
Predictors		
Level 1	Age	-0.00
	Gender	0.12**
	Professional role	0.15**
	Professional experience	0.002
	Trainee status	0.12*
	Leadership status	0.003
	Emotional exhaustion	-0.13***
	Depersonalization	-0.07*
	Personal accomplishment	0.16**
Level 2	Workload	0.003
	Predictability	0.12

Note. Individual-level data n = 1454, unit-level data n = 54. Unstandardized regression coefficients are reported.
* p < .05 (two-tailed test); ** p <.01 (two-tailed test); *** p <.001 (two-tailed test).

but age did not have an influence (B = -0.001, t = -0.69, p= .590). All burnout components predicted clinician-rated patient safety (B_{EE} = -0.13, t = -4.52, p < .001, B_{DP} = -0.07, t = -2.11, p = .04, B_{PA} = 0.16, t = 3.38, p = .002). With regard to clinician-rated patient safety, hypothesis 1a was confirmed. In line with our assumption, physicians rated patient safety higher than nurses; B = 0.15, t = 2.95, p =.004). Contrary to our expectations, trainees (B= 0.12, t = 2.41, p = .016) rated patient safety higher than non-trainees. Professional experience (B = 0.002, t = 0.72, p = .47), leadership status (B = 0.03, t = 0.64, p = .52), workload (B = 0.003, t = 0.52, p = .61) and predictability (B = -0.12, t = - 0.92, p = .36) did not have an effect on clinician safety ratings (see table 3).

Except for professional role, hypothesis 2a was not confirmed.

Predictors of standardized mortality ratios

Contrary to hypothesis 2b, none of the demographic (nurse vs. physician, leadership or trainee status) or unit characteristics (workload, predictability, and team professional experience) predicted standardized mortality ratios ($\beta_{\text{percentage physicians}}$ = -.19., t = -.80, p = .43; $\beta_{\text{percentage trainees}}$ = .06, t = -.28, p = .78; $\beta_{\text{percentage leaders}}$ = .03, t = -.19, p = .85; β_{workload} = .12, t = -.82, p = .42; $\beta_{\text{predicatiblity}}$ = -.10, t = -.61, p = .55; $\beta_{\text{team professional experience}}$ = -.77, t = -1.99, p = .54; see table 4). However, we suspect that team professional experience was not a significant predictor because of its high correlation with age (r = .90, p < .001). We

repeated the regressions excluding age as a control variable, resulting in the expected association of team professional experience with standardized mortality ratios (β = -.39, t = -2.30, p = .03). Of the three burnout dimensions, only emotional exhaustion predicted standardized mortality ratios (β_{EE} = .39, t = -2.23, p = .03; β_{DP} = -.24, t = -1.24, p = .22; β_{PA} = -.10, t = -0.06, p = .96; see Table 4). Hypothesis 1b was thus partially confirmed.

Table 4

Results of Regression Analyses of Standardized Mortality Ratios & Length of Stay on Burnout and Organizational Characteristics (N = 54)

	Standardized mortality ratios			Length of stay		
Step and Variables	step 1	step 2	step 3	step 1	step 2	step 3
1 Age	-.32*	.39	.43	.21	.18	.24
Gender	-.17	.08	.10	.17	-.03	-.04
2 Professional role		-.35	-.19		-.03	.01
Trainee status		.14	.06		.01	.01
Leadership status		.10	.03		-.003	-.04
Team professional experience		-.75	-.77		-.34	-.15
Workload		-.03	-.10		.86***	.84***
Predictability		-.05	-.12		.12	.15
3 Emotional exhaustion			.39*			.01
Depersonalization			-.24			.14
Personal accomplishment			.01			-.02
ΔR^2	.10	.10	.10	.08	.61	.02
Adjusted R^2	.07	.05	.10	.04	.63	.63

Note. Standardized regression coefficients are reported for the respective regression steps. Step 1 including control variables age and gender, step 2 including organizational characteristics, and step 3 including respective burnout dimensions.

* p < .05 (two-tailed test); ** p <.01 (two-tailed test); *** p <.001 (two-tailed test).

Predictors of length of stay

In line with hypothesis 2c, workload ($\beta = .86$, $t = 9.96$, $p = .00$; see table 4) was related to longer patient stays, however, none of the other demographic and organizational characteristics predicted length of stay ($\beta_{\text{percentage physicians}} = .01.$, $t = .06$, $p = .96$; $\beta_{\text{percentage trainees}} = -.004$, $t = -.29$, $p = .77$; $\beta_{\text{percentage leaders}} = .01$, $t = -.09$, $p = .93$; $\beta_{\text{workload}} = .84$, $t = 8.54$, $p < .001$; $\beta_{\text{predictability}} = -.15$, $t = -1.61$, $p = .11$; $\beta_{\text{team professional experience}} = -.38$, $t = -1.59$, $p = .12$). The relationship between workload and length of stay remained significant when the three burnout dimensions were entered into the regression equation ($\beta = .85$, $t = 9.79$, $p = .00$). Again, due to the large correlation between team professional experience and age ($r = .90$, $p < .001$), we repeated the regressions excluding age from the analyses, but team professional experience did not predict length of stay ($\beta = -.17$, $t = 1.58$, $p = .12$). Overall, hypothesis 2c was partially confirmed. None of the burnout dimensions predicted length of stay ($\beta_{EE} = .01$, $t = 1.32$, $p = .90$; $\beta_{DP} = .10$, $t = 0.86$, $p = .39$; $\beta_{PA} = -.04$, $t = -0.46$, $p = .65$). Hypothesis 1c was not supported.

DISCUSSION

Our study investigated relationships between clinician burnout and patient safety while incorporating the effects of demographic and organizational characteristics. It expands on results of previous investigations by contributing several new findings: We included burnout, demographic, and organizational characteristics to investigate their combined impact on patient safety and established that overall, burnout was a stronger predictor of patient safety than demographic or organizational characteristics. More specifically, we established a positive relationship between emotional exhaustion and standardized mortality ratios as an objective patient safety indicator. In addition, workload and trainee status predicted patient safety. Lastly, in contrast to most studies in this field, we included

the two main professional groups in intensive care, nurses and physicians, to gain a more comprehensive insight into the relationships between clinician burnout on patient safety.

The role of burnout in predicting patient safety

Overall, we found evidence that burnout is associated with patient safety. Emotional exhaustion was the main predictor of standardized mortality ratios as well as of clinicians' patient safety ratings. Emotional exhaustion is the core dimension of the burnout construct and relates to the feeling of being exhausted, depleted of energy, and not being able to complete one's tasks. Therefore, it might impact on patient safety in two ways: Firstly, continually feeling exhausted may lead to a decreased self-assessment of one's performance and hence to lower subjective ratings of patient safety. Secondly, it might shape clinical performance via reduced vigilance or increased response times, which in turn, could lead to higher mortality ratios and thus to objectively decreased patient safety.

High levels of burnout might not just pose a problem for individual clinicians, but for the entire team. Previous research has established that burnout levels between individuals working in the same ICU are very similar and that burnout might carry over from one team member to another (Bakker, Le Blanc, & Schaufeli, 2005). A single burnt-out individual on an ICU may not necessarily pose a safety risk as co-workers may be able to support burnt-out individuals. But if the majority of a team is burnt out, errors may be more likely to go unnoticed or not be intercepted by colleagues, which might increase the likelihood for patient harm prolonging ICU stay or even contributing to death.

An alternative explanation for this relationship is that if high mortality ratios exist in a unit despite the high effort invested into caring for these critically ill patients, it may pose an increased risk for developing burnout. Future studies with a longitudinal design are required to test for causal effects.

Depersonalization did not predict objective patient safety indicators. There are several possible explanations for this finding. From a conceptual point of view, emotionally distancing oneself from one's work to some degree might be an appropriate coping mechanism in this emotionally demanding work environment that does not necessarily decrease patient safety. From a methodological perspective, some items of the

depersonalization scale refer to distanced interactions with conscious patients – yet many patients in ICUs have altered levels of consciousness or have difficulties communicating. Therefore, the depersonalization scale might not be entirely applicable to the ICU context.

Personal accomplishment was associated with clinicians' patient safety ratings, but not with the objective safety indicators (i.e. length of stay and standardized mortality ratios). Personal accomplishment is the feeling of doing something worthwhile at work and having reached goals important to oneself. It is less about actual clinical competence and skills, which might explain why we did not find an association with objective outcomes such as length of stay and standardized mortality ratios. Moreover, clinicians providing the best possible care in critical care might feel that they have accomplished something worthwhile in their career despite high mortality ratios. Also, the fact that personal accomplishment was correlated with professional experience and occupying a leadership position could imply that clinicians might gain a feeling of personal accomplishment from other, more status-related sources rather than from actual patient care.

In contrast to standardized mortality ratios, clinician-rated safety was associated with all burnout dimensions. There are several potential explanations for this finding: Firstly, burnout scores and patient safety as perceived by clinicians are both self-report data. Even though we asked clinicians to rate patient safety in their unit they might have focused on their own performance as the more salient information. Therefore, a (perceived) decrease in personal performance due to burnout might have had an immediate effect on their safety ratings. In addition, subjective safety ratings may have been negatively biased due to burnt-out employees' generally decreased psychological health (Hakanen & Schaufeli, 2012).

Secondly, the link between burnout and patient safety *outcomes* such as mortality might not be as immediate. For example, errors caused by decreased performance in the *process* of patient care might be compensated for by colleagues; thus never resulting in negative *outcomes*. Even though not all burnout dimensions predicted all patient safety indicators, our core finding remains that a relationship exists between emotional exhaustion and standardized mortality ratios. Thus, their interplay should be taken into consideration when aiming to improve either outcome.

Comparing relationships of burnout and unit characteristics with patient safety

Emotional exhaustion was a predictor of standardized mortality ratios, even when controlling for objective unit characteristics (i.e., workload, predictability). This finding has both positive and negative implications. Higher workload was associated with longer patient stays, but units with high workload and an unpredictable environment did not have more negative subjective safety perceptions or increased mortality ratios. Thus, with regard to these objective patient safety outcomes, clinicians seem to be able to cope with unfavorable working conditions. This does not exclude the possibility that workload or low predictability may have a negative impact in the healthcare environment – high workload or an unpredictable environment might still pose stressors for clinicians that contribute to or at least increase the likelihood of medical errors. It should be seen as alarming that the relationship between emotional exhaustion and standardized mortality – a very severe safety outcome – does play such a strong role and was not masked by other factors. This suggests that clinicians who feel overwhelmed and cannot cope with their work cannot care for their patients effectively and therefore, patients may have a higher risk of dying.

Contrary to our expectations, professional experience predicted neither of the safety outcomes. However, the relationship between team professional experience and standardized mortality ratios was close to significance. We believe that multicollinearity issues between team professional experience and age prevented this relationship from reaching full significance. When age was excluded from the analyses, team professional experience predicted standardized mortality ratios, and we believe that professional experience contributes to patient safety and should thus be considered in staffing decisions. Although experienced teams were associated with lower mortality, experienced clinicians did not rate safety on their units higher. On the contrary, trainees judged safety to be higher than clinicians who had completed their education. Trainees may not be able to judge safety as accurately as their experienced colleagues; this in itself might pose a threat to patient safety.

Limitations

This study was cross-sectional, therefore, no inferences about causal relationships can be drawn. Also, selection bias may have influenced the results: Units or individuals with high burnout levels may have declined to participate due to stressful working conditions. Compared to other European countries (Aiken et al., 2012), burnout in our sample was rather low. However, our results seem representative since Aiken et al., 2012 also showed that (clinician) burnout rates in Switzerland are amongst the lowest in Europe. Finally, working conditions in ICUs are very different from other healthcare settings. Thus, we do not know if our results are transferable. Currently, the kind of detailed, objective outcome data necessary for this research is mainly only collect within high-risk specializations in hospitals. Improved availability of reliable and valid outcome data for other care settings would allow similar analyses in other healthcare contexts to be conducted.

Practical implications

Our results provide input for managerial decisions concerning team composition and burnout prevention in intensive care. Emotional exhaustion was associated with mortality and clinician safety ratings. In addition, depersonalization and personal accomplishment were related to clinician safety ratings. These findings illustrate the importance of burnout prevention to ensure patient safety and prevent negative effects for the organization. Burnt-out clinicians may not only be unable to maintain appropriate safety levels, but also further deplete their personal resources in an attempt to do so. This may have significant consequences in the long term, such as long sick leave absences (Toppinen-Tanner et al., 2005), turnover (Heinen et al., 2013) or early retirement (Hasselhorn et al.; Sutinen, Kivimaki, Elovainio, & Forma, 2005).

Trainee status was predictive of clinician rated safety, and there was a tendency of an association between team professional experience with standardized mortality ratios. To ensure appropriate levels of safety it seems important to have an appropriately high level of experience available on the unit at all times, or to encourage less experienced team members to seek the support they need to provide safe patient care, and help them to judge their safety performance accurately. It seems important to control workload in

order to decrease complications that might result in longer hospital stays and incur higher costs.

Outlook

The Institute of Medicine defined six dimensions of quality healthcare (safe, effective, equitable, patient-centered, timely, and efficient; Kohn, Corrigan, & Donaldson, 1999). The last two dimensions explicitly include clinician health as an essential aspect of healthcare quality. They state that high quality healthcare is timely, i.e., avoiding delays that are harmful to either patient or clinician, and that it is efficient, i.e., avoiding wasting material resources and ideas or energy of care providers. Our results lend support to the assumption that there is no trade-off between maintaining either patient safety or clinician psychological health, but that it is necessary and feasible to keep both at satisfactory levels in order to provide safe patient care. This finding carries great potential: The interdependence between clinician psychological health and patient safety might open up opportunities for managing both outcomes synergistically – i.e., by the same interventions.

In order to do so, we need an improved understanding of the factors impacting on objective safety indicators. Therefore, to clarify the causal relationships between burnout, demographic and organizational characteristics and patient safety, future research will require longitudinal and interventional studies. These studies should include subjective and objective process and outcome indicators of patient safety, short- and long-term stress and psychological health measures, and change of parameters possibly influencing both psychological health and safety.

So far, there seem to be two major scientific approaches to the clinician psychological health – patient safety relationship. Many studies assume that burnt-out employees perform poorly and thus might endanger patients (e.g., Halbesleben & Rathert, 2008; West et al., 2006). Others focus on safety-related events and argue that committing an error in the process of healthcare might affect clinician psychological health in the form of short-term emotional or physiological distress (Jones & Johnston, 2012; Keijsers et al., 1995; Merlani et al., 2011). For instance, Merlani et al. (2011) assumed that high

crude mortality ratios were associated with higher burnout. If these events are severe or occur repeatedly, chronic strain or even symptoms similar to those of post-traumatic stress disorder might develop (Rassin, Kanti, & Silner, 2005). We believe that clinician psychological health and patient safety influence each other and evolve together. To our knowledge, there are no quantitative studies addressing this vicious cycle, and very few explore causal relationships (West et al., 2009). It is essential to not only include safety outcomes, but also process safety indicators, such as medication errors or infections, because these process errors committed by burnt-out individuals may have been compensated for by a colleague during the care process. So even if they did not result in drastic outcomes such as mortality, they might still have harmed the patient. Also, subjective ratings, for instance in the form of diary entries, can be valuable, as they can help identify safety risk moments. Other factors, such as teamwork might influence both clinician psychological health and safety, or compensate for the effects of burnout.

Conclusion

To our knowledge, this is the first study that links clinician burnout with increased standardized mortality ratios and subjective patient safety indicators while incorporating demographic and objective organizational characteristics. We have shown that patient safety and clinician burnout are dependent on one another. Furthermore, we identified different predictors for the safety outcomes; standardized mortality ratios, length of stay, and clinician-rated safety. Evidence was found that mortality adjusted for severity of disease is higher on units with high emotional exhaustion. Our results led us to the conclusion that clinician psychological health and patient safety could and should be managed harmoniously.

Our study furthermore highlights the importance of combining the two major lines of research exploring the clinician psychological health - patient safety relationship. While one view assumes that decreased psychological health hinders safety, the other argues that safety-related events lead to short- or long-term reduced psychological health in clinicians. Integrating both views is necessary to explore the causal relationships between clinician psychological health and patient safety. This will lead to more specific

insights into how to simultaneously improve and manage these two central hospital outcomes.

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4. STUDY C

The interplay between teamwork, burnout, and patient safety - a longitudinal study

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Abstract

Objective: Good teamwork is generally associated with lower clinician burnout and better patient safety. However, longitudinal simultaneous interrelations between the three concepts have not been investigated. The current longitudinal study addresses this gap.

Design: Three-wave longitudinal study

Setting: 55 intensive care units.

Subjects: 2100 intensive care nurses and physicians.

Measurement and Main Results: Participants answered an online questionnaire on interpersonal and cognitive-behavioral aspects of teamwork, burnout, and patient safety at three time points with a three month lag. Data were analyzed with cross-lagged structural equation modeling. Analyses revealed that emotional exhaustion reduced the quality of interpersonal teamwork. Interpersonal and cognitive-behavioral teamwork aspects mutually influenced each other. Furthermore, cognitive-behavioral teamwork was associated with an increase in later patient safety. Physicians reported better teamwork and higher safety than nurses but also experienced more burnout.

Conclusion: This is the first study to investigate causal relationships between teamwork, clinician burnout and patient safety. Preventing clinician burnout can positively affect interpersonal teamwork. Interpersonal and cognitive-behavioral teamwork mutually reinforce each other. Investing in teamwork may thus result in a virtuous cycle leading to improved patient safety.

Keywords: Healthcare team, interdisciplinary health team, professional burnout, patient safety, intensive care, critical care.

Conflicts of interest: none.

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INTRODUCTION

Healthcare is to a large degree delivered by interprofessional teams. In recent years, the significance of effective teamwork for the provision of safe, high quality care in fast-paced, unpredictable environments like intensive care has been increasingly recognized.(1, 2) Effective teams need to function on the cognitive, behavioral and interpersonal level.(3-5) One important aspect of interpersonal teamwork is clinician's perception of the quality of collaboration between nurses and physicians. Clinicians consider interprofessional teamwork to be highly important,(6) yet nurses and physicians differ in their ratings of teamwork quality.(7, 8) Investigation of the role of interprofessional teamwork in intensive care is only beginning to emerge,(9, 10) however, studies conducted in other settings illustrate its importance for patient outcomes.(11, 12)

Interpersonal team processes are considered the foundation upon which team cognitions and behaviors unfold.(3) Accurate team cognitions and effective team behaviors are associated with higher performance.(13, 14) Examples of cognitive and behavioral teamwork include the extent to which team members have a shared representation of distribution of expertise amongst their members; a shared understanding of work processes; the ability to communicate about and jointly execute tasks; and anticipating and learning from failure. These cognitions and behaviors are associated with safer care and can be summarized as 'safety organizing'.(15) (16) This aspect of teamwork is especially important in acute care settings, where patients are more prone to adverse events, and where healthcare teams often have to respond quickly to a dynamically evolving situation.(17, 18)

Teamwork is not only a means to achieve higher safety, but also a resource that prevents clinician burnout. Burnout among clinicians, especially those working in demanding environments such as intensive care, is a considerable problem.(19, 20) Studies estimate that 30 to 45% of clinicians in acute care settings are affected.(21, 22) Burnout develops in individuals whose resources are insufficient to meet the cognitive,

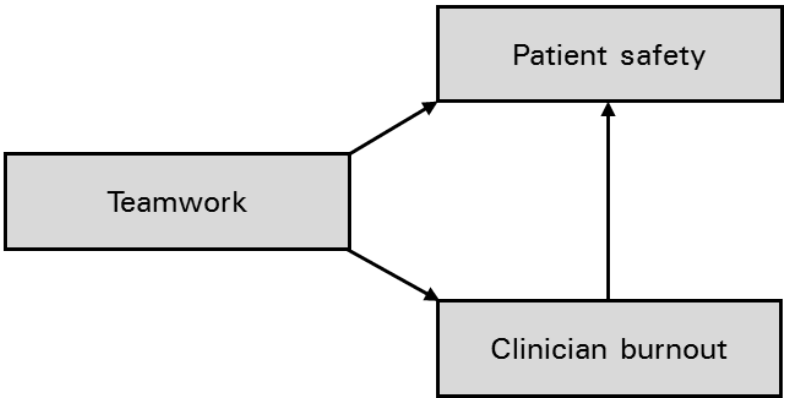
emotional or physical demands of their job.(23, 24) However, clinicians who are satisfied with the quality of teamwork in their unit, particularly with interprofessional teamwork, experience less emotional exhaustion.(25, 26) In effective teams, job demands are distributed more evenly between team members thus reducing the demands on the individual. Effective communication and coordination may help reduce physical and cognitive demands, and positive interprofessional relationships may reduce emotional demands by providing social support.(27, 28)

Furthermore, reduction of clinician burnout is important because of its association with patient safety: burnt-out clinicians report more errors and adverse events.(29, 30) They may have fewer cognitive, emotional or physical resources to cope with their job demands; they are less vigilant;(31) their motivation to exhibit safe work practices may decrease; and thus errors are more likely to occur.(32, 33) This is especially true in intensive care, where patients are more vulnerable to the effects of errors due to their critical condition.(18)

While previous research has repeatedly shown that teamwork, patient safety and burnout are correlated, it is less clear how they actually *influence* each other. Causal relationships have rarely been investigated (34, 35) and theoretical assumptions regarding their interrelations are mainly based on cross-sectional studies, which are mute about the causal directions. Furthermore, although teamwork, patient safety, and burnout are strongly intertwined, very few studies have so far integrated all three constructs. (36, 37)

To provide a more holistic picture of the interplay between teamwork, patient safety, and clinician burnout, and to test the causal directions, the current study examines longitudinal effects between teamwork, clinician burnout, and patient safety in multidisciplinary intensive care teams. We hypothesize that teamwork has a positive effect on patient safety, and that it reduces clinician burnout. In addition, we hypothesize that clinician burnout decreases

Figure 1
Conceptual model



patient safety (see figure 1). By testing this conceptual model the study will provide knowledge about causal relationships that is needed to identify strategies for improving clinician and patient outcomes via teamwork.

MATERIALS AND METHODS

Participants and Procedures

The study was conducted in ICUs across all language regions in Switzerland. Ethics permission was granted from the university and the cantonal ethics committees (75, 2013-06-03; 024/13-CER-FR, 2013-24-06). We collected data from medical and nursing staff using an online survey that included three assessments at three-month intervals. We contacted nursing and medical leaders of each unit, informing them about the purpose of the study and asking them to decide about participation with their colleagues. We then obtained written consent to participate per unit from the unit leaders, who forwarded the online questionnaire to their colleagues. Upon accessing the online questionnaire, participants were asked for their consent to participate, and assured complete anonymity and confidential handling of their data. Participants were altogether 2100 nurses and physicians distributed across 55 intensive care units in 48 hospitals (see table 1 for detailed descriptive statistics).

Measures

Teamwork

Teamwork was assessed with two scales covering cognitive-behavioral and interpersonal aspects of teamwork. Items of all teamwork measure are listed in the appendix (p.175).

Safety organizing. We used the validated German, Italian, and French versions of the nine-item safety organizing scale.(15, 38) It covers team cognitions and behaviors such as knowledge about and utilization of collective expertise (sample item: "We have a

good map of each other's talents and skills"). Responses were given on a seven-point Likert scale (1 = *not at all*, 7 = *to a very great extent*).

Interprofessional teamwork. The interpersonal aspect of teamwork was assessed with the three item nurse-physician-relations scale from the nursing work index revised (PES-NWI-R)(39) in its appropriate validated translations.(40, 41) It assesses clinicians' perception of teamwork quality between nurses and physicians (sample item: "Physicians and nurses have good working relationships"). Answers are given on a 4-point Likert scale (1 = *disagree* to 4 = *agree*). A sample item is "Physicians and nurses have good working relationships".

Burnout. We measured clinician burnout with the appropriate validated German, French, and Italian translations(42-44) of the emotional exhaustion subscale of the Maslach Burnout Inventory Human Services Survey (MBI-HSS)(45). Emotional exhaustion is the core dimension of burnout.(46) It is characterized by constant fatigue and lack of energy to face work related tasks. The scale assesses individuals' perceptions of feeling fatigued, drained, and not having enough energy to complete one's work (sample item: "I feel mentally exhausted because of my work").[4]

Patient safety. Clinicians rated the overall safety in their unit with one item ("Please give your unit in this hospital an overall grade on patient safety") from the validated German, French, and Italian translations of the Hospital Survey of Patient Safety Culture (HSOPSC).(49-52) Responses were given on a five-point Likert Scale (1 = *unsatisfactory,* 5 = *excellent*). To examine the agreement on patient safety per unit, illustrating how representative individual safety ratings are of general perception of safety in each unit, we calculated the R_{WG}s(53) for clinician-rated patient safety. This index compares the standard deviation of raters on each unit to the standard deviation that was to be expected if ratings were completely at random. R_{WG}s ranged from .50 to .94, with a mean of .81 (*SD* = .17), indicating that there was a high level of agreement regarding overall

[4] The survey also included the depersonalization and personal accomplishment scales of the Maslach Burnout Inventory(45) as well as the psychological safety scale, which measures whether the team feels safe for interpersonal risk taking.(47) The number of parameters (i.e. relationships between variables) defined in a clustered SEM is limited by the sample size at the unit level. Based on our core research aim of testing simultaneous interrelations and the results of a previous cross-sectional study which showed that emotional exhaustion was the main predictor of patient safety,(48) we opted to exclude the other burnout components in the main analyses to develop a meaningful and reliable statistical model.

safety between clinicians in each unit. Reliability statistics for all measures are reported in table 2.

Covariates. Potential differences between professions in perceptions of emotional exhaustion, teamwork and patient safety were taken into account by controlling for professional role (nurse / physician).

Analyses

Hypothesis testing. We tested our hypotheses by conducting structural equation modeling (SEM) analyses using Mplus version 7.(54) To test the causal relationships between all variables, we used a cross-lagged design. In this approach, the dependent variable at a later time point (e.g., burnout at time 2) is predicted by the hypothesized independent variables at an earlier time point (e.g., teamwork at time 1; lagged effect) whilst controlling for its baseline level (e.g., burnout at time 1; autoregression). Further, to examine potential reversed causal relationships, we reversed dependent and independent variables (e.g., burnout at time 1 predicts teamwork at time 2). In addition, we correlated variables within each measurement point to account for their shared variance. Paths between time 1 and time 2, and time 2 and time 3 were constrained to be equal in order to increase precision and generalizability of the estimated coefficients and to reduce the complexity of the model.

Model estimation and fit. Maximum likelihood estimation for complex survey data was applied to deal with missing values and to account for the nested data structure (i.e. individuals nested in teams) by adjusting the standard error for data clustering.(55)

Results

Based on an outlier analysis following best-practice recommendations we deleted three ICUs from the sample.(56) Descriptive statistics and correlations are reported in tables 1 and 2, respectively.

Table 1

Descriptive statistics

	Time1*	Time 2*	Time 3*
	Frequency (per cent)		
N	1460	978	790
Men/Women	1028 (73.8) / 365 (26.2)	755 (75) / 250 (24.8)	583 (72.2) / 218 (27.0)
Nurses/Physicians	1131 (83.1) / 243 (17.5)	506 (84.1) / 90 (15.0)	357 (81.3) / 72 (16.4)
Leadership status	193 (13.7)	13 (6.9)	-
Trainee status	237 (16.2)	35 (18.4)	-
	Mean (standard deviation)		
Age	39.56 (9.33)	40.44 (9.33)	40.64 (9.07)
Tenure	10.89 (41.35)	8.29 (7.59)	7.22 (6.71)
Professional experience	12.57 (8.94)	11.57 (8.71)	10.30 (8.50)
Safety organizing	5.24 (0.81)	5.25 (0.76)	5.21 (0.78)
Interprofessional teamwork	3.13 (0.61)	3.14 (0.63)	3.11 (0.62)
Emotional exhaustion	2.73 (0.84)	2.67 (0.83)	2.65 (0.85)
Clinician-rated patient safety	3.71 (0.62)	3.71 (0.59)	3.70 (0.59)

Note. Not all participants provided their demographic information. *N = 493 clinicians participated across all three measurement occasions.

Table 2

Correlations

			1	2	3	4	5	6	7	8	9	10	11	12
Time 1	1	Professional role												
	2	Safety organizing	.18***	(.89)										
	3	Interprofessional teamwork	.24***	.49***	(.86)									
	4	Emotional exhaustion	.01	-.26***	-.23***	(.87)								
	5	Clinician-rated patient safety	.14***	.49***	.38***	-.25***								
Time 2	6	Safety organizing	.14***	.69***	.45***	-.19***	.40***	(.89)						
	7	Interprofessional teamwork	.21***	.48***	.66***	-.23***	.31***	.51***	(.87)					
	8	Emotional exhaustion	.05	-.19***	-.20***	.81***	-.16***	-.22***	-.23***	(.88)				
	9	Clinician-rated patient safety	.12***	.44***	.33***	-.18***	.56***	.46***	.35***	-.25***				
Time 3	10	Safety organizing	.17***	.71***	.43***	-.16***	.37***	.74***	.48***	-.13***	.41***	(.90)		
	11	Interprofessional teamwork	.26***	.42***	.63***	-.16***	.21***	.45***	.68***	-.15***	.31***	.48***	(.89)	
	12	Emotional exhaustion	.05	-.16***	-.23***	.75***	-.11*	-.13**	-.13***	.83***	-.19***	-.22***	-.24***	(.88)
	13	Clinician-rated patient safety	.12*	.35***	.23***	-.18***	.48***	.42***	.33***	-.17***	.57***	.48***	.32***	-.18***

Note. * $p < .05$ (two-tailed test); ** $p < .01$ (two-tailed test); *** $p < .001$ (two-tailed test). Cronbach's alphas for each scale in brackets.

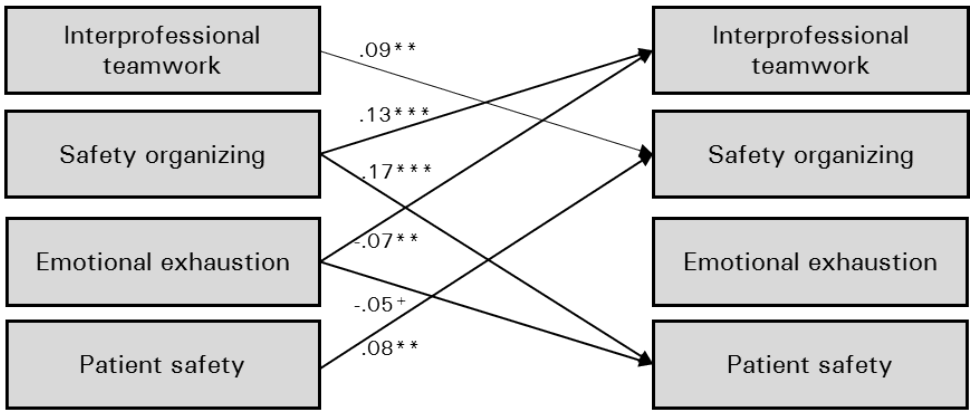
Longitudinal relationships between teamwork, emotional exhaustion, and patient safety

Our analyses revealed that safety organizing, interprofessional teamwork, emotional exhaustion, and clinicians' perceptions of patient safety were interrelated. Safety organizing (β = .17, *p* =.03), but not interprofessional teamwork (β = .03, *p* = .30) predicted an increase in clinicians' safety perceptions (see figure 2 and table 3). In turn, clinicians' safety perceptions predicted an increase in safety organizing (β = .08, *p* = .03).

Moreover, there was a reciprocal lagged relationship between safety organizing on interprofessional teamwork (β = .13, *p* = .03) and vice versa (β = .09, *p* = .03). Thus, safety organizing predicts an improvement in interprofessional teamwork and teamwork predicts an improvement in safety organizing. With regard to the role of burnout, safety organizing (β = -.01, *p* = .02) and interprofessional teamwork (β = -.03, *p* = .02) had no effect on later emotional exhaustion. However, emotional exhaustion predicted a deterioration of the quality of the interprofessional teamwork (β = -.07, *p* = .02).

In addition, there was a tendency for emotional exhaustion to predict a decrease in safety perceptions (β = -.05, *p* = .09). In general, physicians reported better safety organizing (β = .08, *p* = .02), interprofessional teamwork (β = .15, *p* = .02), patient safety (β = 06, *p* = .02) and higher emotional exhaustion (β = .04, *p* = .01).

Figure 2
Model coefficients of cross-lagged effects



Note. Coefficients are standardized. $^{**}p < .01$; $^{***}p < .001$; $^{+}p <. 10$ (two-tailed test).

Table 3

Standardized estimates of the structural coefficients in the model

Outcome / Predictor	Safety organizing	Interprofessional teamwork	Emotional exhaustion	Patient safety
Professional role	.08*** (.02)	.15*** (.02)	.04* (.01)	.06** (.02)
Safety organizing	.63*** (.03)	.13*** (.03)	-.01 (.02)	.17*** (.03)
Interprofessional teamwork	.09** (.03)	.56*** (.32)	-.03 (.02)	.03 (.30)
Emotional exhaustion	-.01 (.02)	-.07** (.02)	.82*** (.01)	-.05 (.09)
Patient safety	.08** (.03)	-.01 (.02)	.02 (.02)	.50*** (.03)

Note. * $p < .05$ (two-tailed test); ** $p < .01$ (two-tailed test); *** $p < .001$ (two-tailed test). Standard errors are in brackets. Model fit indices: RMSEA (root mean square error of approximation) = 0.05, CFI (comparative fit index) = 0.96, TLI (Tucker-Lewis-Index) = 0.93, indicating a good fit.(63, 64)

Testing an alternative model

In addition to the measures described above, our survey also included the psychological safety scale, which measures whether the team feels safe for interpersonal risk taking.(47)

Testing the alternative model, in which interprofessional teamwork was replaced by psychological safety yielded very similar results (RMSEA = 0.05; CFI = 0.97; TLI = 0.94). Psychological safety predicted later safety organizing ($\beta = .15$, $p < .01$) and vice versa ($\beta = .06$, $p < .01$), and psychological safety was increased by earlier emotional exhaustion ($\beta = -.03$, $p = .02$). Furthermore, the tendency for emotional exhaustion to predict later patient safety was confirmed ($\beta = -0.04$, $p = .09$). Overall, these results confirm the role of interpersonal teamwork, which connects emotional exhaustion, cognitive-behavioral teamwork and patient safety.

DISCUSSION

This study highlights the importance of longitudinal, integrative research approaches to examine the complex interrelations between teamwork, clinician well-being and patient safety. Overall, our results suggest that burnt-out clinicians are unable to contribute to effective teamwork, which in turn is necessary to maintain patient safety. Specifically, analyses showed that low burnout increased the quality of interpersonal teamwork. Interpersonal teamwork had a positive effect on cognitive-behavioral teamwork and vice versa. Finally, cognitive-behavioral teamwork improved patient safety.

Our study goes beyond prior studies that tended to focus on a single aspect of the multi-dimensional construct of teamwork.(57) Our findings demonstrate that the interpersonal and cognitive-behavioral dimensions of teamwork are dependent on one another: better teamwork between professions facilitates cognitive-behavioral teamwork, such as coordination, communication and cognitive functioning. This is in line with previous work suggesting that interpersonal teamwork forms the foundation on which cognitive-behavioral teamwork components are executed.(3) Trust and mutual respect foster a positive team climate that encourages individuals to contribute their expertise to the common goal, to speak up and voice their concerns in situations where they might deviate from the majority, or to report errors.(16, 58)

Our results furthermore suggest that the relationship between interpersonal and cognitive-behavioral teamwork is reversed: it increases the quality of teamwork between professions and interpersonal trust if teams exhibit effective cognitive-behavioral aspects of teamwork, such as maintaining shared situation awareness or integrating individual clinicians' expertise to complete their task.

Generally, previous studies established that *interpersonal* teamwork aspects are associated with clinician psychological well-being whereas team *cognitions and behaviors* are related to patient safety.(57, 59) Our analyses provide insights into causal relationships between teamwork and clinician and patient variables: burnout is not the outcome of low-quality teamwork, as hypothesized in cross-sectional studies,(60) but an antecedent. Interprofessional teamwork is a global evaluation of the quality of collaboration between

nurses and physicians, and does not include behaviors directly related to patient care. As such, it does not have an immediate impact on patient safety.

Safety organizing, on the other hand, consists of tangible cognitive and behavioral team processes required to accomplish actual patient care tasks, such as pooling collective expertise to solve problems, and these processes result in higher patient safety.

Yet clinician burnout and patient safety do not evolve independently. Our results imply that teamwork, clinician burnout, and patient safety are connected via the reciprocal relationships between interprofessional teamwork and safety organizing: clinicians with low burnout invest more resources in interprofessional relationships. These, in turn, facilitate the practice of safety organizing and vice versa. Finally, safety organizing contributes to higher patient safety.

The alternative model we tested – with psychological safety as an aspect of interpersonal teamwork – supports the assumption of interpersonal teamwork being the connection between burnout on the one hand, and cognitive-behavioral teamwork and patient safety on the other hand. Burnt-out clinicians seem to invest fewer resources to generate a team climate in which team members feel respected and safe to voice their concerns, which results in lower safety organizing, eventually reducing patient safety.

Furthermore, we identified a trend of burnout decreasing patient safety in both models. A previous cross-sectional study conducted in the intensive care setting showed that emotional exhaustion was not only related to clinician-rated patient safety, but also to standardized mortality ratios.(48) The current examined cross-lagged effects. Cross-lagged relationships constitute quite strong effects, as they occur over and above cross-sectional and auto-regressive effects. Moreover, by constraining parallel effects between measurement occasions, only effects that occur consistently at all measurement occasions would become apparent. Thus, our results strongly suggest that a direct effect of burnout on patient safety exists, but it may unfold in a time lag shorter than three months.

Finally, our results highlight the importance of interprofessional teamwork. We confirmed that nurses' and physicians' ratings of teamwork, burnout and patient safety differ. After controlling for profession, interprofessional teamwork remained an important component of the study: it can be reduced by burnout, but may also improve safety organizing. Interprofessionalism is a defining feature of teams. However, few survey studies that investigate relationships between teamwork and clinician burnout or

patient safety include multiple professions or explicitly address interprofessional teamwork.(7, 8)

Limitations

The results of this study should be interpreted with some limitations in mind. The sample size on the unit level prevented us from testing a more complex model including more survey and unit data. Nevertheless, we believe our results are representative and reliable, because 55 out of 82 Swiss ICUs and a total of 2100 clinicians constitute a high participation rate and large sample size at the individual level.

Patient safety was measured with a single-item indicator that assessed clinicians' perceptions of overall unit safety and may therefore be less reliable than detailed surveys or objective indicators. However, previous research has shown that subjective safety ratings are indicative of objective patient safety, as subjective and objective safety measures partly overlap.(48) In addition, our data showed a high level of agreement regarding patient safety between team members, which illustrates that safety perceptions are a unit attribute, and not an individual rating of safety or performance caused by emotional exhaustion and associated negative cognitions.

Practical implications

Interpersonal and cognitive-behavioral aspects of teamwork build upon one another and are thus both important for effective team functioning. Even in high-technology environments such as the ICU setting, good interpersonal relationships can facilitate cognitive-behavioral teamwork. Thus, interventions targeting teamwork should be designed with both teamwork aspects in mind, as such interventions carry the potential to reinforce each other: inclusion of the entire, multi-professional team; focusing on similarities and shared goals; building of shared mental models; and improving communication and coordination. Observational studies in critical care settings have highlighted the significance of cognitive-behavioral teamwork for immediate team performance outcomes.(2, 61) Our study complements these findings by highlighting long-term effects. Long-term investment in teamwork is likely to build routine on which team members can rely in stressful situations. Previous research has shown that burnout can spread from one critical care clinician to another.(62) It is important to prevent the

development of clinician burnout before it becomes a problem for the entire team, as burnt-out clinicians are less likely to have the resources to engage in or benefit from team trainings.

Conclusion

To our knowledge, this is the first study to investigate simultaneous relationships between teamwork, clinician burnout and patient safety using an interprofessional sample. Our results highlight the importance of longitudinal studies, which are necessary to detect long-term, causal effects. Targeting clinician burnout is essential in order to ensure effective teamwork and a high level of patient safety. Interventions intended to reduce clinician burnout may set a cycle in motion that increases patient safety via mutual reinforcement of interpersonal and cognitive-behavioral teamwork.

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5. ADDITIONAL ANALYSES

The analyses described in this section address issues relevant to this dissertation that could not be included in studies A, B, and C. The systematic literature review conducted (study A) included articles up to December 2012 – section D updates the literature search to June 2015 and highlight new insights. Section E complements study B by investigating the relationship between *teamwork* and *objective* patient safety. Finally, section F addresses the issue of a potential construct overlap of the safety organizing and the patient safety measure utilized in study C.

D: Updating the systematic review

The systematic review conducted in study A pointed out research gaps of studies investigating relationships between teamwork, clinician well-being and patient safety. Repeating the search to identify studies that have been published since January 2013 (see table 1; including two additional studies from 2010 and 2012) revealed that some of these gaps have been addressed by recent studies. In addition, it seems that the 18 studies published from 2013 to June 2015 were of overall higher methodological quality. They used validated measures, accounted for nested data structures, collected objective patient safety indicators and/or provided a solid theoretical foundation and discussion. Garrouste-Orgeas et al. (2015) and Profit et al. (2014) provide empirical evidence on the relationship between physician well-being and patient safety. The study by Wetzel et al. (2010) was the first to address the relationship between acute stress and teamwork in a simulated setting – they found that stressed clinicians were less likely to exhibit non-technical skills.

Studies investigating multidisciplinary teams or effects of interprofessional teamwork on patient safety or clinician well-being are still scarce. Only five publications (including study B in this dissertation) sampled nurses and physicians (see table 1).

Investigations of teamwork and well-being are common, but the majority of these studies focused on the quality of interprofessional teamwork from the nurses' point of view. Thus, multiple professions working together in the operating or emergency room seem to be considered a team, whereas multiple professions contributing their expertise to care for patients on a ward are not necessarily one, despite the importance nurses and physicians place on collaboration with the other profession (Thomas, Sexton, & Helmreich, 2003). The reasons for this issue may be related to the characteristics of the healthcare setting (West & Lyubovnikova, 2013). Healthcare teams do not constantly work together for a stable amount of time, and physicians, as opposed to nurses, do not continually work in one ward. Moreover, strong hierarchies may prevent symmetrical interactions. Clinicians may also belong to several teams (healthcare team on a ward, team of surgeons, management team) and identify to varying degrees with these teams. Thus, clinicians may answer the question of who belongs to a team via profession, not contribution to a shared goal. Thus, overall, the quality of research on teamwork, clinician well-being and patient safety seems to improve, but the topic of interprofessional teams remains on the agenda.

Table 1

Overview of additional studies examining relationships between teamwork, clinician well-being and patient safety

Study	Sample	Observation/ Survey	Teamwork – Well-being	Teamwork – Patient safety	Well-being – Patient safety
Brunetto et al., 2001	Nurses	Survey	x		
Chen et al., 2001	Physicians	Survey			x
Cheng et al., 2001	Nurses	Survey	x		
Cimiotti et al., 2001	Nurses	Survey & unit records			x
Endacott et al., 2001	Nurses	Observation		x	
Garrouste-Orgeas et al., 2015	Nurses & physicians	Survey & unit records			x
Hwang & Ahn, 2015	Nurses	Survey	x		
Kirwan et al., 2013	Nurses	Survey			x
Li, 2013	Nurses & physicians	Survey		x	
Li et al., 2013	Nurses	Survey	x		
Ogbolu et al., 2015	Nurses	Survey		x	
Ortega et al., 2014	Nurses & physicians	Survey	x		
Park & Kim, 2013	Nurses	Survey			x
Pisarski & Barbour, 2014	Nurses	Survey	x		
Profit et al., 2014	Nurses & physicians	Survey			x
Van Bogaert et al., 2013	Nurses	Survey	x		
Van Bogaert et al., 2014	Nurses	Survey	x		
Van Bogaert et al., 2014	Nurses	Survey	x		
Welp et al., 2015	Nurses & physicians	Survey & unit records			x
Wetzel et al., 2010	Physicians	Observation			x

E: Investigating teamwork and objective patient safety

Study B investigated the relationship between clinician burnout and objective patient safety, but did not address associations between teamwork and objective patient safety. To close this gap, I conducted additional analyses to explore these associations cross-sectionally at time 1. Median standardized mortality ratios were correlated with safety organizing (r = .34, p = .02), but not with interprofessional teamwork (r = .13, p = .36) or psychological safety (r = -.17, p = .25). Subsequent hierarchical regressions conducted at the unit level revealed that safety organizing was a stable predictor of median standardized mortality ratios, whereas the demographic and organizational characteristics that were analyzed in study B (age, professional experience, workload, and predictability) were not (table 2). These results lend support to the hypothesis developed in study C that cognitive-behavioral teamwork is an important predictor of objective patient safety, whereas interpersonal teamwork may facilitate cognitive-behavioral teamwork, but does not have a direct impact.

Table 2

Results of Regression Analyses of Median Standardized Mortality Ratios on Burnout and Organizational Characteristics (N = 54)

	Median standardized mortality ratios		
Step and Variables	step 1	step 2	step 3
1 Age	-.22	-.15	-.02
2 Team professional experience		-.11	-.26
Workload		.21	.19
Predictability		.02	.01
3 Safety organizing			-.34*
ΔR^2	.05	.05	.15
Adjusted R^2	.03	.02	.12

Note. Standardized regression coefficients are reported for the respective regression steps. Step 1 including control variables age, step 2 including organizational characteristics, and step 3 including safety organizing. *p < .05 (two-tailed test); **p < .01 (two-tailed test); ***p < .001 (two-tailed test).

F: Taking "safety" out of the Safety Organizing Scale

Study C found that cognitive-behavioral teamwork, as measured with the Safety Organizing Scale (Vogus & Sutcliffe, 2007) predicted later clinician-rated patient safety. Some of the items of the Safety Organizing Scale refer to team cognitions and behaviors with regard to safety issues (marked with an asterisk in the appendix, p. 175). To exclude the possibility that clinician-rated safety and safety organizing measure the same construct, which might lead to inflated relationships, these items were excluded from the Safety Organizing Scale (Cronbach's alpha = .81) and the analyses investigating cross-lagged relationships between teamwork, clinician burnout and patient safety as described in study C were repeated. Model 1 included the Safety Organizing Scale and interprofessional teamwork, and model 2 included the Safety Organizing Scale and psychological safety. This approach did not significantly change the relationships between cognitive-behavioral teamwork and patient safety. Safety organizing predicted later clinician-rated patient safety (model 1: $\beta = 0.11$, $p < .001$; model 2: $\beta = 0.1$, $p < .001$) and clinician-rated patient safety predicted later safety organizing (model 1: $\beta = 0.14$, $p = .001$; model 2: $\beta = 0.13$, $p = .003$). It also did not significantly change the overall model fit (model 1: RMSEA = 0.05; CFI = 0.96; TLI = 0.93; TLI = 0.94; model 2: RMSEA = 0.05; CFI = 0.97; TLI = 0.94). These results confirm that cognitive-behavioral teamwork is an important contributor to patient safety. In any case, cognitive-behavioral teamwork and safety-specific teamwork are closely related: Fruhen and Keith (2014) found that the relationship between general teamwork and safety outcomes is mediated by safety-specific team processes.

6. SYNTHESIS & DISCUSSION

The purpose of this dissertation was the integration of teamwork, clinician well-being, and patient safety in the hospital setting. Previous research has established that these constructs are closely related, but they have not been investigated in conjunction or longitudinally. This dissertation expands and builds upon the existing body of knowledge in several ways.

Study A evaluated existing studies on quantitative relationships between teamwork, clinician well-being and patient safety. Many studies suffered from conceptual and methodological limitations. A theory-based framework was developed that links all three constructs, and provides suggestions to overcome current research gaps. Updating the systematic review to 2015 revealed that some of these gaps have since been addressed.

Study B explored the link between clinician well-being and patient safety. Analyses showed that burnt-out clinicians report lower patient safety. In addition, standardized mortality was higher on intensive care units with high emotional exhaustion. Additional analyses revealed that cognitive-behavioral teamwork was associated with standardized mortality ratios.

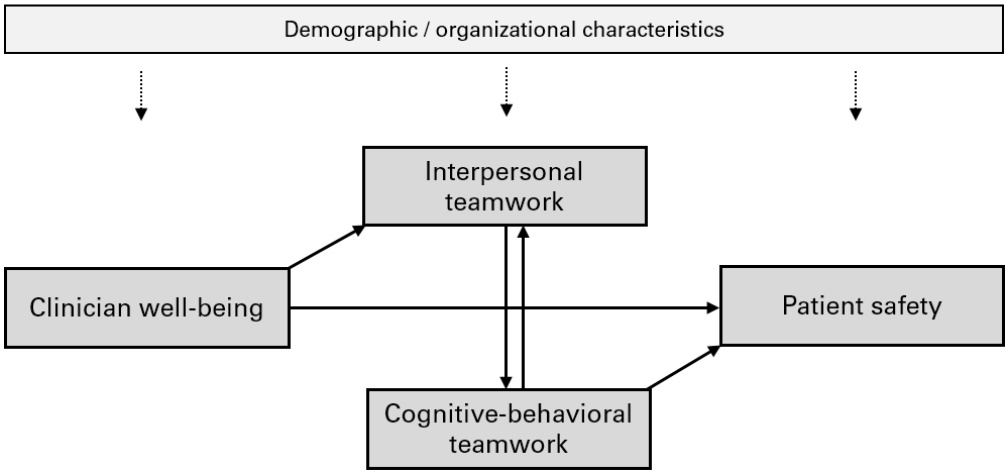
Study C explored longitudinal relationships between teamwork, clinician well-being and patient safety. Emotional exhaustion influenced later interpersonal teamwork, which in turn had a positive impact on cognitive-behavioral teamwork and vice versa. In addition, cognitive-behavioral teamwork predicted later patient safety.

In the following section, the results of the insights gained from studies A to C and the additional analyses will be set in relation to the conceptual framework presented in the introduction (figure 2) and compared to previous research findings. Contributions of this dissertation to theory and practice will be discussed, and finally an outlook for future research will be presented.

Updating the conceptual framework

Study A added more depth to the hypotheses developed in the introduction concerning the relationships between teamwork, clinician well-being and patient safety and thus enhanced the conceptual framework presented in the introduction (figure 2) that served as the backbone of this dissertation. Studies B, C, and the additional analyses tested the hypothesized relationships empirically. The framework was updated based on the key findings of studies B, C and the additional analyses (see figure 3). The updated framework distinguishes between interpersonal and cognitive-behavioral teamwork and includes the effect of clinician well-being on teamwork. Figure 4 provides more detail on the studies and analyses that tested specific linkages of this model, and the measures that were utilized to represent the superordinate constructs shown in figure 3.

Figure 3
Adapted conceptual framework



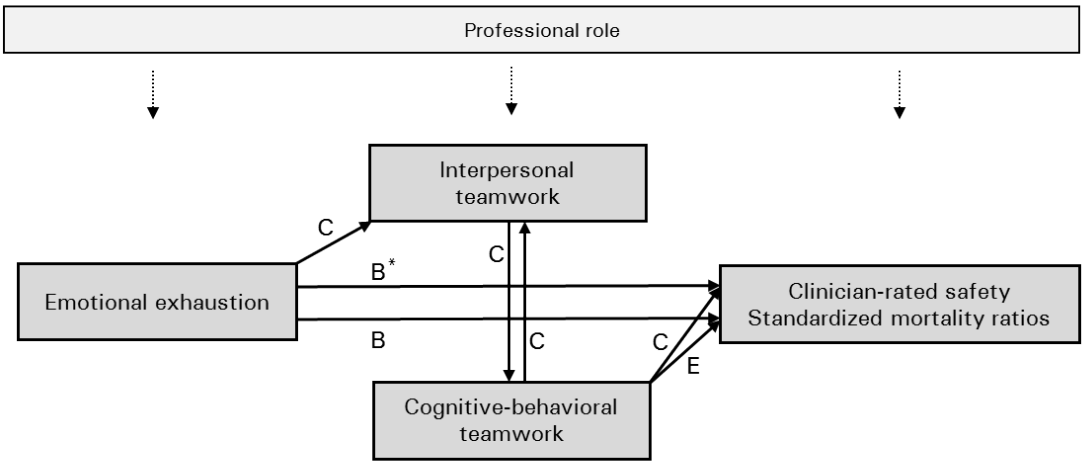
Distinguishing between the effects of interpersonal and cognitive-behavioral teamwork

Based on the results of study C, it seems warranted to disentangle the interpersonal and cognitive-behavioral aspects of teamwork, as their respective relationships with clinician well-being and patient safety differ significantly. Cognitive-behavioral teamwork – i.e., knowledge about and execution of communicative and coordinative behaviors – increased patient safety. Interpersonal teamwork, represented by psychological safety and interprofessional teamwork, was influenced by emotional exhaustion. The systematic

review (study A) revealed a tendency for research examining relationships between teamwork and clinician well-being to focus on interpersonal aspects – whether the lack of knowledge on well-being and cognitive-behavioral teamwork is due to lack of research on or non-publication of insignificant results is not clear. Study C, by examining both aspects, shows that cognitive-behavioral teamwork may indeed be unrelated to clinician well-being.

The systematic review (study A) furthermore established that research findings on the association between teamwork and patient safety are somewhat ambiguous. Study A states that one reason for this ambiguity may have been the vague conceptualization of teamwork and the use of unvalidated teamwork measures. Based on the results of study C and analyses E, distinguishing between interpersonal and cognitive-behavioral teamwork may be the explanation as to why some of the studies included in the systematic review did not confirm the hypothesized global association between teamwork and patient safety: Study C suggests that it is the *cognitions and behaviors related to tangible patient care tasks* that directly improve patient safety as perceived by clinicians. Analyses E confirmed this assumption for standardized mortality ratios, an objective indicator of patient safety. Interpersonal teamwork, in contrast, focuses on the *quality of interactions between team members*, instead of tangible behaviors, and these quality or climate-like attributes of teams seem to have no direct effect on patient safety. Study C showed that interpersonal

Figure 4
Empirical evidence for link confirmed in study B (cross-sectional), study C (longitudinal), and additional analyses E (cross-sectional)



*Note.** Relationship also confirmed for depersonalization and personal accomplishment.

teamwork is instead influenced by team members' attributes – namely, emotional exhaustion. This differentiation between interpersonal and cognitive-behavioral teamwork is in line with Marks et al. (2001), who argue that interpersonal teamwork facilitates team behaviors, but is not directly related to team performance. A meta-analysis by LePine, Piccolo, Jackson, Mathieu, and Saul (2008) confirmed the differentiation between interpersonal and action/transition processes as suggested by Marks et al. (2001). Burke et al. (2006), extending the IPO model, specifically suggest the inclusion of psychological safety as a precursor of team behaviors. DeChurch and Mesmer-Magnus (2010) meta-analyzed studies across various organizational and experimental settings, and found that team cognitions were the most important predictors of team performance.

Interpersonal and cognitive-behavioral teamwork: a virtuous cycle

The specific associations between cognitive-behavioral teamwork and patient safety, and that emotional exhaustion and interpersonal teamwork, respectively do not imply that these processes occur independently. Study C showed that interpersonal and cognitive-behavioral teamwork are interconnected: interpersonal teamwork improves cognitive-behavioral teamwork and vice versa. In addition to the direct link between emotional exhaustion and patient safety (study B), the mutual reinforcement between the two teamwork dimensions may act like a mediating mechanism that connects well-being with safety, as suggested in figures 3 and 4. Marks et al. (2001) and Burke et al. (2006) did not include this virtuous cycle in their adaptations of the IPO model. A review on team adaptation showed that interpersonal teamwork, let alone its interplay with other dimensions of teamwork, is rarely investigated (Maynard, Kennedy, & Sommer, 2015). From the perspective of self-categorization theory (Turner & Oakes, 1986) it makes sense that cognitive-behavioral teamwork may influence interpersonal teamwork. Individuals are motivated to identify with a group they belong to, and to create a sense of 'we' (Kozlowski & Chao, 2012). If communication and coordination run smoothly, and team members contribute their knowledge and skills, the team completes a task that individual members would not have achieved on their own. Clinicians focus on the shared goal and less on interpersonal differences. Achieving this goal may increase clinicians' identification and create a sense of cohesion within the team. Clinicians are informed of the value of

their contribution to the shared goal, thus increasing their sense of psychological safety and good interprofessional teamwork.

Teamwork suffers when clinicians are burnt out

Drawing from the job demands-resources model (JD-R; Demerouti et al., 2001) and the conversation of resources theory (COR; Hobfoll, 1989, 2002), the original framework (figure 2) hypothesized that clinician well-being depends on the quality of teamwork – whether it is perceived as a demand or a resource. The majority of studies included in the systematic review adopted this assumption, with the exception of Gevers, van Erven, de Jonge, Maas, and de Jong (2010), who found that clinicians who suffer from acute emotional strain may not have the resources to exhibit effective teamwork behaviors. In Study C, emotional exhaustion had a negative impact interprofessional teamwork and psychological safety. Based on these results, the adapted framework (figure 3) follows the rationale by Gevers et al. (2010) and generalizes it to overall well-being:

Emotionally exhausted individuals are considered to be unable to perform certain tasks and behaviors due to lack of energy and resources (Demerouti, Bakker, & Leiter, 2014; Taris, 2006). Reduced job performance, sick leave, turnover intentions, and decreased organizational performance are often the consequences of emotional exhaustion or burnout in general (Maslach, Schaufeli, & Leiter, 2001; Schaufeli, Leiter, & Maslach, 2009; Shirom, 2003). With the exception of reduced job performance, which may also be immediate, these are rather long-term outcomes. Scholars argue that psychological withdrawal from work is a coping mechanism to prevent further resource depletion (Demerouti et al., 2014; Maslach, Schaufeli, & Leiter, 2001). However, in healthcare, clinicians cannot simply withdraw from their teams. In order to provide care, the appropriate team cognitions and behaviors still need to be executed – hence there was no lagged effect of emotional exhaustion on cognitive-behavioral teamwork in study C. Yet interpersonal teamwork – being supportive and appreciative of colleagues' contributions – may not be seen as essential by burnt-out clinicians. They may invest fewer resources into working relationships with colleagues, and consequently it is the interpersonal aspect of teamwork that suffers first. This finding is in line with Qin, Direnzo, Xu, and Duan (2014), who found that burnt-out employees were less likely to speak up – a consequence of high psychological safety, especially in unfavorable

organizational conditions. As figure 4 suggests, reduced clinician well-being may thus set in motion a chain by which impaired interpersonal teamwork is followed by impaired cognitive-behavioral teamwork and, finally, reduced patient safety.

Can adverse events lead to adverse clinician outcomes?

The framework in figure 3 suggests that clinician well-being leads to increased patient safety. Study B evidenced that emotional exhaustion predicted standardized mortality ratios, and study C showed that it increased later patient safety as rated by clinicians. These findings are in line with the COR-based assumption that clinicians with reduced well-being do not have the cognitive, physical, or mental capacities to fulfil their duties (Halbesleben, Wakefield, Wakefield, & Cooper, 2008; Hobfoll, 1989, 2002), and as a consequence, quality of patient care suffers. Hypotheses of studies included in the systematic review (study A) were equivocal regarding causal relationships of these constructs, with some following the above rationale and others arguing that safety-related events are stressors that cause reduced well-being. Study A revealed that these viewpoints are only contradictory at first sight, because they are based on the conceptualization of strain as short-term versus chronic. It furthermore argued that well-being and patient safety may be tightly coupled. Tangible patient safety incidents are likely to cause short-term emotional distress in clinicians (Rassin et al., 2005). Chronic strain may develop if emotional distress or other work demands occur repeatedly (Oerlemans & Bakker, 2014), thus reducing clinicians' motivation and efficiency, which may lead to reduced patient safety in the long run (e.g., West et al., 2006). The results of study C lent support to this rationale by investigating emotional exhaustion, a *chronic* indicator of work strain, which influenced clinician's perception of safety, but not vice versa.

Contribution to theory and practice

Teamwork, well-being, and safety are well-researched topics in work and organizational psychology, and thus psychological theories and methodology from this discipline were utilized to answer questions specific to the healthcare setting. The IPO framework (McGrath, 1964) and its adaptations (Burke et al., 2006; Marks et al., 2001) provided a

useful template to integrate the constructs of teamwork, well-being, and patient safety. The assumptions concerning the interplay between these constructs that are expressed in this dissertation were based on the job demands-resources model (Demerouti et al., 2001) and the conservation of resources theory (Hobfoll, 1989, 2002). The findings of this dissertation advance both theory and practice in several ways.

First, scientific studies from the different disciplines contributing to the topics that were addressed in this dissertation were gathered. Study A is thus intended to provide orientation to researchers and practitioners by arranging those contributions within the larger context. It provides information about the magnitude of relationships and the implications of different conceptualizations of the three constructs; it summarizes measurement tools; and it points out avenues for future research.

Second, the systematic review illustrated the necessity of transferring the construct of interprofessional teamwork to healthcare research and practice. Interprofessionalism, or specific roles and specialized knowledge of team members, is a defining aspect of teams (Kozlowski & Ilgen, 2006), including teams in healthcare organizations. Nurses and physicians (and other professions) work closely together. It is therefore plausible that clinician well-being, patient safety, or teamwork develop based on the contributions of both professional groups. Nurses and physicians are educated in different systems and are thus socialized and equipped with different skills, values, and principles (Hall, 2005). Yet after the completion of their (basic) training, they work alongside each other in the same system, contributing to a common goal. In this dissertation, interprofessionalism was accounted for by including it as a demographic characteristic in studies B and C, and explicitly addressing it in study C as a subdimension of interpersonal teamwork. Study C illustrates that exhibiting the appropriate team behaviors is not sufficient. Members of interprofessional teams do not just need to work alongside one another, but must also collaborate well to facilitate team cognitions and behaviors, and eventually patient safety. Interprofessional teamwork is also the first to suffer if burnout increases.

Third, this dissertation advances the knowledge of predictors of patient safety: study B showed a clear association between emotional exhaustion and both clinician-rated patient safety and standardized mortality ratios. Additional analyses E showed that cognitive-behavioral teamwork predicted standardized mortality ratios. Previously, it was not been clear whether the relationships between clinician well-being or teamwork and

patient safety would extend from clinician's perceptions of safety to objective safety indicators collected by hospital wards. Clinician-rated patient safety might thus have been an indicator of reduced self-efficacy caused by reduced well-being (Hakanen & Schaufeli, 2012). Cimiotti et al. (2012) found that burnout predicted hospital-acquired infections, which constitute a more proximal outcome. Study B showed that this association extends to more severe safety outcomes, and that clinician-rated patient safety and standardized mortality ratios go hand in hand. Thus, this dissertation's results concerning patient safety advocate for the adoption of a systemic approach in healthcare (Vincent, Burnett, & Carthey, 2014; Vincent, Taylor-Adams, & Stanhope, 1998). For instance, cause of error should not be attributed (solely) to individual failure, but instead be analyzed within the context of the healthcare system to prevent it in the future. A systemic approach to patient safety includes the impact of contextual factors on all organizational levels on patient safety. These factors include, amongst others, the level of management (e.g., accessibility of personnel), the immediate work environment (e.g., noise, material resources, functionality of technical equipment) and task, *individual or team characteristics* (e.g., quality of teamwork, individual well-being, workload; Garrouste-Orgeas et al., 2012; Kristensen et al., 2007). Studies B and C illustrate that patient safety depends on the integration of such contextual factors, as they highlight the importance of taking burnout seriously and implementing appropriate measures to increase clinician well-being or promote teamwork when managing patient safety.

Fourth, studies B and C advance the state of research methodologically, thus addressing a limitation identified in study A. Study B reduced the probability of common method bias (Podsakoff, MacKenzie, & Podsakoff, 2012) by using data from multiple sources. Reliable and standardized indicators were used. The nine equivalent of nursing manpower (NEMS) indicator is frequently used as an objective workload measure (Carmona-Monge, Rollan Rodriguez, Quiros Herranz, Garcia Gomez, & Marin-Morales, 2013; Reis Miranda, Moreno, & Iapichino, 1997; Rothen, Kung, Ryser, Zurcher, & Regli, 1999). Predictability of the work environment was measured by the ratio of planned to unplanned admissions; standardized mortality ratios are adjusted for the severity of the patient's condition. Results of study B also show that these data, which are routinely collected by intensive care units in Switzerland, can be integrated into research projects in a meaningful way in order to advance theory and practice. This approach requires a high

level of coordination between researchers and practitioners; however, study B showed that it is well worth the effort. On a related note, the systematic review revealed that many studies suffered from inadequate data analysis techniques. In studies B and C, more stringent methods to obtain reliable results were applied by accounting for the nested data structure. In addition, study C analyzed teamwork, clinician well-being, and patient safety simultaneously and longitudinally, thus providing an answer to hypotheses regarding causal relationships expressed in the studies included in the systematic review.

Fifth, an implication of the conceptual framework in figure 2 was that team-based interventions may simultaneously improve clinician well-being and patient safety. Study C shows that it is not teamwork but clinician well-being that is at the beginning of the causal chain and that may have the capacity to improve the other two. Thus, the first incentive might be to increase clinician well-being (Kuoppala, Lamminpaa, & Husman, 2008). That is not to say that interventions addressing teamwork to increase patient safety may not be effective. In fact, numerous effective interventions to improve teamwork in healthcare settings exist (Sacks et al., 2015). However, study C suggests that such interventions might be more effective if clinician well-being is on a high level.

Lastly, the results illustrate that the IPO framework (McGrath, 1964) should not be viewed as a rigid model depicting one-directional processes, but as a template to organize ideas. The adapted conceptual framework developed in this dissertation (figures 3 & 4) departs from the original framework insofar as clinician well-being was not an output of, but an input for teamwork (see figure 3). Furthermore, a multi-dimensional team concept was employed, and was shown that the relationships between interpersonal and cognitive-behavioral teamwork are reciprocal rather than linear. They also relate differently to clinician well-being and patient safety. In addition, individual and organizational characteristics are not just an input for teamwork, but also for clinician well-being and patient safety. These issues have partially been accounted for in the advanced models developed by Burke et al. (2006) and Marks et al. (2001) – they pay particular attention to concurrent and reciprocal processes and feedback loops.

Limitations

Despite its strengths, some limitations need to be taken into account when interpreting the results of this dissertation.

First, teamwork was measured with self-report methods. Thus, some uncertainty remains as to whether individual perceptions of teamwork accurately represent teamwork at the unit level. However, carefully selected teamwork scales that were worded at the unit level (i.e., *we*, *in this team*) and instructed participants to answer from their team's point of view, not their individual perspective. The clustered structure of the data – individuals nested within teams – was taken into account in the analyses. Moreover, alternative methods of assessment of teamwork are not feasible for longitudinal studies of teamwork. Observations are a popular method to analyze micro-level snapshots of teamwork and immediate outcomes, but would not provide information on the general development of teamwork quality the way survey studies do. Cullen, Edwards, Casper, and Gue (2014) argued that self-report measures may be the most appropriate method to gather data on individual well-being. Teams are made up of employees who contribute their individual attitudes and knowledge and shape team processes. Thus, collecting data from several team members may be an accurate representation of the team.

Second, it is difficult to determine the optimal time lag between measurement occasions. In recent years, there has been a shift from time lags of one or several years to a few weeks or months. However, Dormann and van de Ven (2014) showed that causal effects of psychosocial factors at work may unfold within an even shorter time frame. Therefore, it may well be possible that we did not capture all lagged relationships because the time lag of three months was too long. This time lag was, however, chosen for methodological and practical reasons. A study of this scale required commitment from the unit leaders, who helped coordinate data collection in their units, and from the participants, who volunteered their time to answer the questionnaire despite their heavy workload. Being confronted with a questionnaire in very short intervals might have decreased commitment to participate and consequently, data quality. Lastly, one objective of this project was to connect survey to unit data, and standardized mortality ratios are less reliable when they are collected over a very short time frame (Pouw, Peelen, Moons, Kalkman, & Lingsma, 2013).

Third, the sample size at the unit level did not allow for longitudinal analyses of unit-level variables, such as standardized mortality ratios. The reasons behind this limitation are structural. One aim of this dissertation was to analyze objective patient safety, and ICUs in Switzerland – as opposed to other wards - collect standardized and reliable patient safety indicators, and possess the resources to centrally collect and transmit the data. Switzerland has 82 accredited ICUs, of which the majority - about 70% - participated. Thus, the response rate at the unit level was very satisfactory, but not sufficient for longitudinal analyses. Despite this limitation, we confirmed the hypothesized relationships between teamwork / well-being and patient safety at the cross-sectional level.

Outlook

This dissertation project addressed many of the research gaps identified in the systematic review; however, we could not tap into all of them.

The adapted conceptual framework depicted in figures 3 and 4 integrates the results of studies B and C, but these studies did not test the actual path model that is implied. Future studies could verify the paths or test the effects of an intervention targeting clinician well-being on teamwork and patient safety in order to demonstrate the practical applicability of the model.

Extending the framework presented in figure 3 and including alternative aspects of teamwork, well-being, and patient safety may provide additional insights into their relationships. Standardized mortality ratios are the last in a chain of safety-related events. However, one indicator cannot cover the entire concept of patient safety, or detect all opportunities for error (Vincent et al., 2014). Analysis of indicators such as medication errors or hospital-acquired infections may help determine how teamwork or clinician well-being might prevent adverse events earlier on in the chain to prevent extreme harm.

It has been discussed earlier in this chapter that the relationship between clinician well-being and patient safety may be circular and not linear. Studies B and C addressed one link in this circle by showing that chronic strain predicts reduced patient safety. There is a large body of literature dedicated to the 'second victim' phenomenon, stating that

clinicians and not just patients suffer from adverse events (Sirriyeh, Lawton, Gardner, & Armitage, 2010). They feel guilty and distressed, and question their professional skills. Qualitative studies suggest that acute emotional distress may have long-term consequences for clinicians, and eventually a negative impact on their performance and on patient safety (Berland et al., 2008; Rassin et al., 2005). Future studies might address this linkage or the full circle between clinician well-being and patient safety longitudinally by combining acute and chronic strain measures.

Figure 3 shows clinician well-being as the beginning of a chain of events, but it does not explain factors that influence clinician well-being. Generally, high workload and time pressure are considered stressors that impact employee well-being (Maslach et al., 2001; Schaufeli et al., 2009). Identifying stressors specific to the healthcare or ICU setting might help reduce the development of burnout or increase clinician well-being. Many of the participants in studies B and C stated that agitated or aggressive patients constitute a source of stress. In fact, the data that was collected from the intensive care units contains an agitation indicator as well as the number of ventilated patients. These data, along with the nursing workload indicator of study B, might constitute a realistic indicator of workload on intensive care units, the impact of which on burnout could be explored in a future study.

I mentioned earlier that teams in healthcare face specific challenges – teams are short-lived, and team members may belong to multiple teams or frequently change team membership. In fact, some of the ICUs in this study employed very sophisticated rotation schemes that resulted in completely different team compositions that constantly changed wards. A study in an experimental setting (Gorman & Cooke, 2011) showed that such rotation may facilitate development of team knowledge. Whether these team structural aspects hinder or facilitate interpersonal and cognitive-behavioral teamwork in healthcare, and what the effects on clinicians' well-being and patient safety are, might be addressed by future research.

Conclusion

I began the introduction of this dissertation with some quotes pointing out the importance of teamwork, clinician well-being and patient safety from clinicians' point of view. The contribution of this dissertation is to bring these topics together and disentangle the relationships between them to benefit both theory and practice. Clinician's subjective experiences were translated into theory-based research models, which were tested using validated measures and current analytical strategies. Results were then reported back to clinicians. Research on teamwork, clinician well-being and patient safety is an interdisciplinary research field, yet the disciplines – psychology, nursing sciences, medical sciences, and human factors – do not necessarily communicate with each other. The systematic review gathered the contributions of these fields, and arranged them within the larger picture. Hopefully, future research will be truly interdisciplinary and benefit from the unique contributions of each field.

Studies B and C showed that medical skills are not all that matter in healthcare. Training and education, as well as financial and material resources are essential to provide safe healthcare, but they are not sufficient. Clinicians are not able to provide quality healthcare despite being exhausted. If team members are well-trained, but do not know which colleague possesses the skills complementary to theirs, or whose responsibility it is to act, patient care suffers. Moreover, such skills cannot be orchestrated if team members feel disrespected and see that their input is not appreciated. Teamwork, clinician well-being and patient safety are interrelated in a complex manner: if one suffers, it might affect the other, ending in a downward spiral. On the other hand, investing in only one of these constructs might have the opposite effect and thus be a very efficient means to induce improvement of teamwork, clinician well-being and patient safety simultaneously, thus benefiting both clinicians and patients.

I will end with a final quote by one of the study participants, whose thoughts accurately illustrate the incentive of this project and the importance of investing in teamwork, clinician well-being and patient safety for the benefit of all those being a part of the healthcare system:

"Even small conflicts and antipathies diminish the performance of the collective. The better the team functions and the higher the individual well-being, the easier it is for each individual to perform, and the higher is the quality [of their performance]."

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8. APPENDIX

Teamwork Measures

Safety Organizing Scale (Vogus & Sutcliffe, 2007) [5]

1. We have a good "map" of each other's talents and skills.
2. We talk about mistakes and ways to learn from them.*
3. We discuss our unique skills with each other, so that we know who on the unit has relevant specialized skills and knowledge.
4. We discuss alternatives of how to go about our normal work activities.
5. When giving report to an oncoming nurse, we usually discuss what to look out for.
6. When attempting to resolve a problem, we take advantage of the unique skills of our colleagues.
7. We spend time identifying activities we do not want to go wrong.*
8. When errors happen, we discuss how we could have prevented them.*
9. When a patient crisis occurs, we rapidly pool our collective expertise to attempt to resolve it.*

Psychological Safety (Edmondson, 1999)

1. If you make a mistake on this team, it is often held against you.
2. Members of this team are able to bring up problems and tough issues.
3. People on this team sometimes reject others for being different.
4. It is safe to take a risk on this team.
5. It is difficult to ask other members of this team for help
6. No one on this team would deliberately act in a way that undermines my efforts.
7. Working with members of this team, my unique skills and talents are valued and utilized.

[5] Items marked with an asterisk were excluded from the additional analyses described in chapter 5

Interprofessional teamwork (Lake,2002)

Present in Current Job

1. Physicians and nurses have good working relationships.
2. A lot of teamwork between nurses and physicians.
3. Collaboration (joint practice) between nurses and physicians.

9. CURRICULUM VITAE

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Personal Details

Date of birth:	12.03.1982	Place of birth:	Wesseling (Germany)
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1992 – 2001	Abitur, Adolf-Reichwein-Gesamtschule, Lüdenscheid, Germany

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02/2010 – 04/2010	Internship, Macquarie University, Sydney, Australia
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2002 – 2004	Nursing assistant, Cologne, Germany

Publications (published and in preparation)

Welp, A., Meier, L., & Manser, T. (2015). Emotional exhaustion and workload predict clinician-rated and objective patient safety. *Frontiers in Psychology, 5*, 1573.

Schmutz, J., Welp, A. & Kolbe, M. Teamwork in healthcare organizations (in press). In Örtenblad, A. Abrahamson Löfström, C., & Sheaff, R.(Eds.) *Management Strategies for Health Care Organizations: Adopt, Abandon, or Adapt?* London: Routledge.

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Welp, A., Meier, L., & Manser, T. (in preparation). The interplay between teamwork, burnout, and patient safety – a longitudinal study. To be submitted to *Critical Care Medicine*.

Welp, A., Perry, L., Johnson, A., Nguyen, H., Murray, S., & Yu, N. (in preparation). Impact of nurses' practice development activities on teamwork and quality of patient care: the mediating role of reflexivity. To be submitted to *Journal of Advanced Nursing*.

Conference Contributions

Welp, A., Meier, L. & Manser, T (2015, July). Integrating teamwork, clinician well-being, and patient safety. 6th International Conference on Applied Human Factors and Ergonomics. Las Vegas, USA.

Welp, A. & Manser, T. (2015, May). Relationships between teamwork, clinician burnout and patient safety – a longitudinal study. 17th Conference of the European Association of Work and Organizational Psychology, Oslo, Norway.

Welp, A. & Manser, T. (2014, October). Relationships between burnout, individual and unit factors, and patient safety in intensive care. 31st Conference of the International Society for Quality in Health Care, Rio de Janeiro, Brazil.

Welp, A. & Manser, T. (2014, October). Differences in teamwork, clinician well-being and patient safety in Swiss intensive care units. Annual Meeting of the Swiss Society for Intensive Care Medicine, Interlaken, Switzerland.

Welp, A. & Manser, T. (2014, September). Teamwork in healthcare and patient safety: the mediating role of clinician burnout. International Commission of Occupational Health - Work and Psychosocial Factors, Adelaide, Australia.

Welp, A. & Manser, T. (2014, August). Teamwork in healthcare: relationships with work stress and patient safety. 28th Conference of the European Health Psychology Society, Innsbruck, Austria.

Welp, A. & Manser, T. (2014, June). Patientensicherheit & Arbeitsstress: Zusammenhänge mit Teamarbeit auf Schweizer Intensivstationen, 6e Congrès Santé dans le Monde du Travail, Lausanne, Switzerland.

Welp, A. & Manser, T. (2014, May). Relationships between teamwork, clinician well-being and patient safety – what and who is the "team"? Well-med – 1st International meeting on wellbeing and performance in clinical practice, Alexandropoulis, Greece.

Welp, A. & Manser, T. (2014, March). Teamwork, clinician well-being and patient safety – a call for an integrative approach. Human Factors and Ergonomics Society, Symposium on Human Factors and Ergonomics in Health Care, Chicago, USA.

Welp, A. & Poortvliet, P. M. (2011). Mastery Goals and their Relationship with Occupational Stress: Mediation by Job Demands, Job Satisfaction & Job Performance. Dutch Society of Work and Organisational Psychology Researchers, 25th November 2011, Tilburg, the Netherlands

Grants & Awards

12/2014: Mobility Grant awarded by the Swiss National Science Foundation (CHF 6800)

10/2014: Best Presentation (free communications), Annual Meeting of the Swiss Society for Intensive Care Medicine (CHF 2000)

Ehrenwörtliche Erklärung

Ich erkläre ehrenwörtlich, dass ich meine Dissertation selbständig und ohne unzulässige fremde Hilfe verfasst habe und sie noch keiner anderen Fakultät vorgelegt habe.

Annalena Welp Fribourg, 15.07.2015