

Developing a framework for investigating airline pilot debriefing practices

Abstract

There appears to be a wide acceptance that debriefing plays an important role in the learning process of simulation-based programs. Indeed, the last decade has witnessed an increasing number of studies into debriefing across disciplines. The research team has been conducting field research with airlines, over a number of years, to clarify what constitutes effective debriefing for airline pilot training. To assist this clarification, a comprehensive systematic review of existing studies into debriefing across disciplines was designed to direct further analysis of the data the team had collected. A preliminary investigation into this broad debriefing literature exposed that there was little consensus among many papers about effective debriefing practice due to inconsistencies in: (a) methodological approaches, (b) terminology, and (c) professional focus. As a way of overcoming these inconsistencies, this paper initially synthesised research findings from a small number of existing “systematic reviews” scrutinising debriefing across a variety of professional disciplines. The literature search identified ten papers, three meta-analyses and seven qualitative systematic reviews. This paper aims to identify *key elements* influencing learning outcomes from debriefing practices and presents the findings of this study as a single *framework of debriefing elements*.

Key words: systematic literature review, simulation, debriefing, feedback, reflection, after-action-review, professional education

Over a number of years, our research team had conducted field research into debriefing practice across a number of airlines. One study in particular recorded a total of 32 sessions with one airline that included video recordings of briefing, simulator session, debriefing, and post-debriefing interviews of pilots. In this study, specific variables (i.e., simulator time versus debriefing time) were manipulated in order to examine their effect on debriefing outcomes. However, the analysis of the collected data was not as straightforward as anticipated. It highlighted that a number of elements, both known and unknown to the research team, could influence pilot learning during debriefing. To assist the analysis of this

field data, an investigation into existing studies was needed to improve the understanding about what effective debriefing is from a pilot's learning perspective.

A multi-disciplinary systematic review was then undertaken to identify and clarify possible influencing elements within the debriefing literature. Overall, studies of simulation-based learning across different disciplines clearly identified debriefing as critical to learning (Fanning & Gaba, 2007). Many of the studies were designed to focus on feedback from students and instructors about the effectiveness of simulation-based learning. These studies highlighted the importance of, and student preference for, using debriefing in simulation-based learning (e.g., Hyland, Weeks, Ficorelli, & Vanderbeek-Warren, 2012; Kable, Arthur, Levett-Jones, & Reid-Searl, 2013). However, a number of review papers from other professions reported limited evidence about (a) the overall effectiveness of debriefing (e.g., Cant & Cooper, 2011; Dufrene & Young, 2014; Garden, Le Fevre, Waddington, & Weller, 2015; Neill & Wotton, 2011), (b) important elements that influence the effectiveness of debriefing (e.g., Cheng et al., 2014; Fernandez, 2015; Levett-Jones & Lapkin, 2014), and (c) frameworks that direct the development of best practice for debriefing (e.g., Garden et al., 2015; Levett-Jones & Lapkin, 2014; Neill & Wotton, 2011). These reviews also highlighted methodological weaknesses in debriefing research. For example, the heterogeneous nature of debriefing research has resulted in a lack of generalisation (e.g., Fernandez, 2015; Garden et al., 2015; Levett-Jones & Lapkin, 2014; Neill & Wotton, 2011).

On the process of conducting our systematic review into the existing debriefing studies, discrepancies across disciplines were also highlighted and made it difficult to synthesise research findings among a large volume of the debriefing studies. Therefore, as the first step to conceptualise possible influencing factors into debriefing effectiveness, this present study limited its investigation into existing "systematic review" papers. More specifically, this study only examined papers that had conducted systematic reviews into studies of debriefing practices. The primary aim of the study was to synthesise the categories and frameworks from these papers and create a *framework of debriefing elements* that would assist in examining the broader range of debriefing studies and thus underpin our data analysis. For the purpose, first this study will identify what elements have been highlighted to influence debriefing practice and underline the gaps in debriefing research.

Method

Literature search

The search for studies on debriefing practice was conducted in July 2015, using nine major databases including ProQuest, ScienceDirect, Taylor and Francis, PubMed, SAGE, Web of Science, Scopus, Ovid, and ERIC. The primary keywords used were “debrief* OR ‘after action review’” and “simulation.” The result was then narrowed to “feedback”, “reflect*”, “train*”, or “learn*”. The initial search found 2,287 papers after removal of duplicate articles with an addition of 44 papers through a reference checking of review papers. After screening these papers, 493 articles were identified as potentially eligible for debriefing studies that addressed the process and outcomes of debriefing practice. Out of these articles, ten systematic review papers were identified as matching the inclusion criteria of this present study (viz., a review presenting a clear process of literature selection). All of these review papers presented and classified some categories and frameworks regarding effective debriefing, which informed a *framework of debriefing elements*. This framework is now being used to inform the analysis of 493 identified debriefing research articles (e.g., Mavin & Kikkawa, in review). This entire process of study identification and development of the framework is shown in Figure 1.

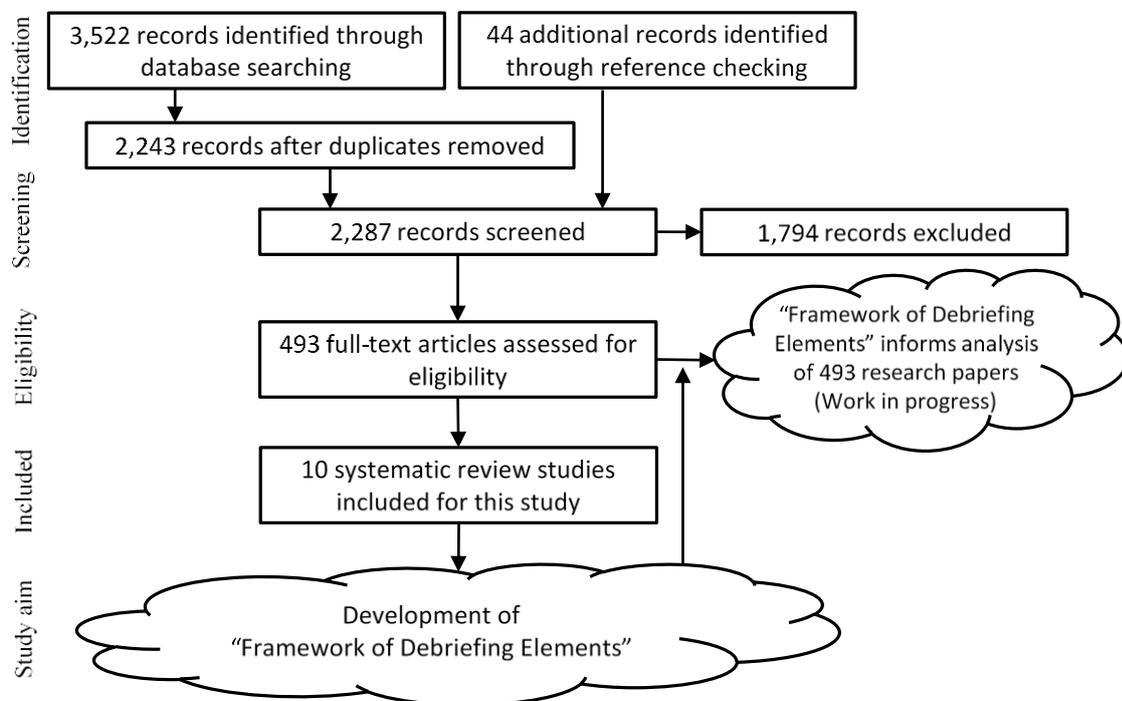


Figure 1. The study identification process and study aim.

Data extraction and thematic analysis

Data from the ten systematic review papers were extracted based on nine topics. These topics included (a) research aims, (b) research fields, (c) methods, (d) databases in use, (e) dates of publications, (f) analysis methods, (g) frameworks or categories for analysis, (h) inclusion and exclusion criteria, and (i) results and findings. The summary of the key results and findings provided an overview of current debriefing practices and research for each paper. Thus, it offered the foundational knowledge required to develop initial codes for thematic analysis. Thematic analysis was then administered using a computer-assisted qualitative analysis software, NVivo (QSR International, 2015), in order to synthesise and categorise the themes identified as influencing the effectiveness of debriefing across the selected papers. A total of 20 themes emerged from this analysis.

A study by Wazonis (2014) identified the inconsistent use of terms describing simulation debriefing through a comprehensive, integrative review of 28 articles. Out of these articles, 22 methods, 7 means of reevaluation, 19 approaches, and 13 elements of debriefing were identified in total. Based on her clarification of these terms, a series of definitions for debriefing terms were summarised and used to synthesise the themes across the selected papers. Her work was used, as forward guidance, to discriminate between and classify the 20 themes identified.

Moreover, in order to organise “identified themes” in our review in a logical way, a framework of debriefing research proposed by Raemer et al. (2011) was applied. Raemer and his colleagues suggested that researchers investigating debriefing practices should consider five questions when designing analytical studies. These five questions (hereafter, the 5Ws) consists of *Who* (who is debriefing and who is being debriefed); *What* (what is the content/method of debriefing); *When* (the timing and duration of the debriefing); *Where* (what is the location of the environment and the situation of the debriefing); and *Why* (what is the theoretical framework supporting the debriefing). This framework was used to group the 20 identified themes.

Evidence quality

Evaluation of evidence quality or research outcome provides an objective indicator of the overall finding of existing studies. The present study attempted to synthesise the findings in order to obtain an overview of the current status of debriefing research and identify “what we don’t know” (Pickering, Grignon, Steven, Guitart, & Byrne, 2014), rather than conducting

random-effects meta-analysis of findings to calculate the overall effect of a particular practice. Therefore, a qualitative method was needed for assessing research outcomes of the 20 identified themes.

Further inspection into the nominated papers highlighted a number of quality indicators to be integrated into the method. For example, some papers presented either positive or negative effects of a particular element with objective data (e.g., pre- and post-measurement) or subjective data of participant perception (e.g., feedback from the participants). These findings were applied in the development of evaluation codes for assessment of how each element impacts on the effectiveness of debriefing. As a result, six codes were created to evaluate the outcome of each theme on the effectiveness of debriefing. They included: (a) the article that highlighted the importance for a specific element (e.g., debriefing structure, use of video) in debriefing, based on the reviewer’s reflection and not supported by evidence; (b) the article that identified a positive outcome for the element, based on objective evidence; (c) the article that identified a positive outcome for the element, only based on participants’ preferences, (d) the article that identified an inconclusive outcome for the element; (e) the article that identified a negative outcome for the element, based on objective evidence; or (f) the article that identified a negative outcome for the element, only based on participants’ perceptions (see Table 1).

Table 1
Evaluation Codes Used for Each Element

Codes	Name	Descriptions
H	Highlighted aspect	Article highlights a specific element in debriefing with no reference to evidence (e.g., only describing findings from some studies rather than evaluating the element through meta-analysis). Note: only positive opinions identified.
E+	Positive evidence	Article presents positive evidence for a specific element in debriefing (i.e., evidence based on meta-analysis)
Part+	Participants’ positive perspective	Article presents positive evidence from participants’ preferences regarding a specific element in debriefing
Neu	Neutral	Article investigates a specific element in a debriefing though is inconclusive about its effects
E-	Negative evidence	Article presents negative evidence for a specific element in debriefing (i.e., no effect, negative effect)
Part-	Participants’ negative perspective	Article presents negative evidence from participants’ preferences regarding a specific element in debriefing

Evaluation of research outcomes

Each paper was classified into a varying number of themes. The text information grouped under these themes within the NVivo were evaluated against the codes, with results

integrated into a Microsoft Excel worksheet. The results were then tabulated with the total number of papers coded for each debriefing theme with each evaluation code. The quality of the coding initially conducted by the first author was then tested by a crosscheck with the second author. He completed the same process of coding for thirty per cent of the whole data entry ($n = 3$) in order to ensure the quality of the categories and the reliability of the coding. The literature recommends confirmation of ten per cent of the whole data (Pickering et al., 2014); however, the researchers in this study performed the process with extra data due to the low number of included papers. Any disagreements were resolved by consensus.

Results

All ten systematic review papers were published between 2011 and 2015 and were in English. As such, these systematic reviews reflect the increasing number of debriefing research in recent years. As a demonstration in Figure 2, the distributions of publication years for the selected review papers were aligned with those of the 493 original studies that were selected for full-text eligibility check for our forthcoming studies. Out of the 10 selected review papers, eight papers came from health related perspectives including nursing, clinical emergency, anaesthesia, and healthcare, while the two remaining papers came from the fields of education and organisational appraisal. Our search confirmed that there was no systematic review from the aviation sector.

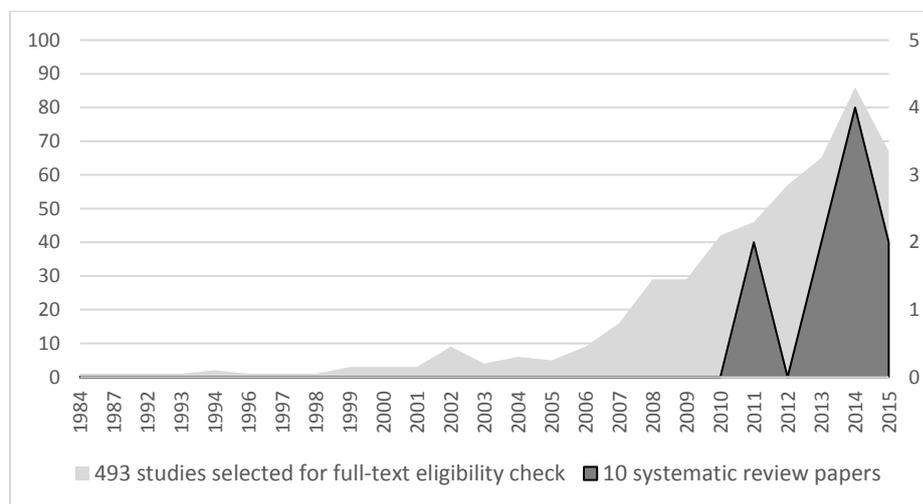


Figure 2. Years of publications.

Out of ten papers, only three used a random-effects model to conduct their meta-analyses, presenting measurable outcomes (Cheng et al., 2014; Couper et al., 2013; Tannenbaum & Cerasoli, 2013). Seven studies used summative and integrative forms of

analysis methods (Cant & Cooper, 2011; Dufrene & Young, 2014; Fernandez, 2015; Garden et al., 2015; Levett-Jones & Lapkin, 2014; Neill & Wotton, 2011; Wazonis, 2014). While some of the studies specified a formal method of qualitative analysis methods (i.e., narrative and thematic analysis), the remainder did not specify their analysis methods. Instead, they presented summaries of their findings using either a tabular form or text. These qualitative papers highlighted the methodological issues and lack of quality evaluation data in debriefing research that would have enabled them to conduct a more quantitative meta-analysis (e.g., Cant & Cooper, 2011; Garden et al., 2015; Levett-Jones & Lapkin, 2014).

Table 2
Themes Emerging from Thematic Analysis and Organised within the 5Ws Category

5Ws	Theme	Theme Descriptions
N/A	Debriefing effectiveness	Levels of impacts of debriefing on participants
Who	Instructor level of involvement	The debriefing is/isn't facilitated by instructor/s
	Instructor characteristics	Instructor's past experience (debriefing, professional practice), training, skills, and attitudes
	Participant characteristics	Participants' age, past experience (simulation, debriefing, professional practice), and/or levels of competence
What	Debriefing structure	Levels of the debriefing structure ^a
	Use of scripted questions	Debriefing is guided by scripted questions (debriefing technique)
	Application of specific debriefing models	The type/s of debriefing structures
	Debriefing topics	The topic/s focused during the debriefing session
	Alignment of learning objectives	The learning objectives are consistent among participants (individuals or group), debriefing focus and intent, and level of measurement
	Practical implication to work	Skills and knowledge directly applicable to practice
	Use of video	Use of video recordings of simulator sessions during the debriefing session
	Use of other multimedia aids	Use of other multimedia aids during the debriefing session
	Type of resource/artefacts	The guiding tools or evaluation instruments used for assessing the debriefing effectiveness
	Use of reflection	Participant reflection is facilitated during the debriefing session (debriefing technique)
	Provision of constructive feedback	Constructive feedback of simulator sessions is given to the participants (debriefing technique)
When	Debriefing timing and sequence	The debriefing is conducted during or after the simulation
	Debriefing thoroughness and depth	Process of debriefing is not interrupted and completed
	Debriefing duration and length	The length of the debriefing session
Where	Safe situation	The psychological condition of the debriefing
Why	Theory or theoretical underpinning	The theoretical framework supporting the debriefing

^aBased on Annenbaum and Carasoli (2013)

The 20 themes were organised under the 5Ws categories (see Table 2). The first theme, debriefing effectiveness, is not applicable to the 5Ws categories as it represents the effects of debriefing practice as a whole. Each of the other themes represents an element that was considered or identified influencing the effectiveness of debriefing.

In this study, we also found that it was important to categorise each theme corresponding to the evidence quality previously discussed. Here each theme identified (e.g. use of video) was assessed using the evaluation codes (e.g. positive evidence or participants' positive evidence) from Table 1. Results from this activity were tabularised in a descending order of identified evidence (Table 3). The outcome of the present study was the development of a *framework of debriefing elements* (Table 2). In the following sections, key aspects of the themes and their evaluations are addressed. Each theme is specifically discussed in the order depicted using the 5Ws categories seen in Table 2.

Table 3
Research Outcomes for the Themes Emerging from Thematic Analysis

Themes	Total	H	E+	Part+	Neu	E-	Part-
Debriefing effectiveness	10	3	5	1	1	0	0
Debriefing structure	9	4	0	2	3	0	0
Instructor level of involvement	7	4	0	1	2	0	0
Use of video	7	2	0	0	4	1	0
Use of other multimedia aid	7	6	0	0	1	0	0
Debriefing timing and sequence	6	3	0	1	2	0	0
Instructor quality	5	3	0	0	2	0	0
Debriefing duration and length	5	2	0	0	2	0	1
Use of reflection	4	3	0	1	0	0	0
Type of resource (tools/evaluation means)	4	3	1	0	0	0	0
Safe situation	4	3	0	0	1	0	0
Theories or theoretical underpinning	4	4	0	0	0	0	0
Provision of constructive feedback	3	3	0	0	0	0	0
Use of scripted questions	3	2	0	0	1	0	0
Debriefing topics	3	2	0	0	1	0	0
Debriefing thoroughness	2	2	0	0	0	0	0
Application of specific debriefing models	2	2	0	0	0	0	0
Alignment of learning objectives	1	0	1	0	0	0	0
Participant characteristics	1	1	0	0	0	0	0
Practical implication to work	1	1	0	0	0	0	0

Note: H = Highlighted Aspect; E+ = Positive Evidence; Part+ = Participant Positive Perspective; Neu = Neutral; E- = Negative Evidence; Part- = Participant Negative Perspective.

Themes organised by the 5Ws categories

Debriefing effectiveness

The theme of *debriefing effectiveness* represents effective levels of debriefing practices on participants. According to Table 3, debriefing effectiveness was addressed in all papers to some degree. Out of the selected studies, five confirmed the positive effects with a variety of evidence (e.g., meta-analysis, percentage of their selected studies presenting the positive evidence), and one highlighted participants' preferences for the use of debriefing. For

example, out of three random-effects meta-analyses, Tannenbaum and Cerasoli (2013) discovered that positive effect sizes of debriefing averaged in the range of twenty per cent to twenty-six per cent regardless of the instructional dimensions (i.e., individual or team), fidelities (i.e., simulation or real settings), and professional fields (i.e., medical or nonmedical participants). Moreover, Couper et al. (2013), using Kirkpatrick's evaluation system (Kirkpatrick & Kirkpatrick, 2006) to assess the effect of clinician debriefing, reported that approximately seventy-five per cent of their selected studies supported the use of debriefing as an educational strategy (e.g., use of self-reflection).

Similarly, the studies based on qualitative summary found debriefing effective, regardless of professional context and practical elements. In these reviews, the theme of debriefing effectiveness highlighted the lack of published evidence regarding (a) the effectiveness of debriefing practices and (b) the elements that contribute to effective debriefing. Many studies showed that the effect of debriefing was confounded by many potential elements because it was not directly focused but evaluated as part of simulated practice; therefore, the efficacy of debriefing alone for learning is uncertain (e.g., Cant & Cooper, 2011). Only one paper provided information regarding the long-term effect of debriefing practices (Levett-Jones & Lapkin, 2014).

Who

The *Who* category includes three themes relating to instructors and participants. The theme of instructor indicated two important aspects in relation to debriefing instructors (i.e., *level of involvement* and *characteristics*). Cheng et al. (2014) found that approximately eighty-five percent of the total studies ($n = 154$ of 177) involved educators (i.e., instructors) in their debriefing practice. However, Table 3 shows that although a total of seven papers addressed the importance of instructor-led debriefing, their evaluation was based on the reviewers' reflections in most cases ($n = 4$). In addition, only one paper reported the participants' preference (Cheng et al., 2014), whilst two addressed inconclusive effects.

The theme of *instructor level of involvement* highlights its associated influence with other themes on debriefing effectiveness. For example, Garden and her colleagues (2015) reviewed debriefing studies for improving nontechnical skills performance and found a lack of additional benefits from expert debriefers (i.e., instructors) in five papers that they reviewed. They highlighted three potential factors preventing their investigation into the effects of instructor involvement: (a) instructors' lack of debriefing expertise; (b) a lack of sensitivity in performance measurement tools; and (c) a larger effect produced by another

confounding element (e.g., level of structures, debriefing timing) in comparison to experimental manipulation of instructor involvement (Garden et al., 2015).

The theme of *instructor characteristics* represents a range of instructor-related features influencing the effect of debriefing. The selected papers frequently used the term “instructor quality”, with instructor experience considered to be a sole attribute to instructor quality. However, further qualitative investigation into what instructor quality means in each nominated study revealed an abstract concept of “quality” in the debriefing context.

The thematic analysis classified two different characteristics regarding the quality of instructors: (a) the instructor’s experience (Cheng et al., 2014) and (b) the instructor’s skill and behaviour (Cant & Cooper, 2011; Fernandez, 2015). Regarding the instructor’s experience, Neill and Wotton (2011) questioned what “knowledge” means in nursing literature. They claimed that the term knowledge did not differentiate “knowledge of debriefing strategies” and “clinical knowledge” when instructor quality was stated in the publications. It stressed the need for clarification of instructor quality (i.e., past experience or knowledge of professional practice and implementing debriefing) in debriefing research. This present study confirmed the significance of both characteristics in delivering effective debriefing.

Importantly, during the process of clarifying the concept of instructor quality, thematic alignments were highlighted between instructor characteristics, particularly skills and behaviours, and other themes under the *What* category. A narrative review by Fernandez (2015), for example, identified a range of instructor’s quality factors (e.g., guidance, feedback, and interaction) and emphasised the significant impact of these factors on debriefing outcomes in comparison to a selection of any other debriefing methods.

Additionally, training for instructors was ascribed to instructor characteristics with regards to both their experience and skills (Fernandez, 2015), and the alignment between effective debriefing practice and instructor training was highlighted in three papers (Cant & Cooper, 2011; Garden et al., 2015; Neill & Wotton, 2011). Instructors who have a supportive, caring attitude was also an important quality attribute, especially in nursing education (Neill & Wotton, 2011). This instructor quality is linked to the *safe situation* theme, where participants feel free to discuss their feelings and thoughts during debriefing.

According to Table 3, only one paper found the theme of *participant characteristics* to be an important element in debriefing effectiveness (Garden et al., 2015). Further analysis

of the selected papers revealed that, in seven of the papers, one empirical study was repeatedly used. This empirical study (Welke et al., 2009) highlighted different effects in the participants' field experience (i.e., novice or experienced participants). More specifically, in the case of experienced anaesthetists, it emphasised that there was similar improvement of participants with or without debriefing (Welke et al., 2009). As such, Welke and his colleagues questioned whether the participants' experience influenced the effectiveness of debriefing. Interestingly, only one of these seven papers highlighted this aspect in their discussions (Garden et al., 2015). The study by Garden et al. (2015), however, reported similar learning improvements in simulation with and without debriefing in the case of experienced anaesthetists (Morgan, Kurrek, Bertram, LeBlanc, & Przybyszewski, 2011). They suggested that participants' field experience may be as important as involvement of instructors in debriefing. This theme indicated that participant characteristics potentially influence the effectiveness of the debriefing and required further investigation.

What

Table 2 shows that the *What* category consists of eight themes regarding the content and methods of debriefing practice. The themes included (a) debriefing structure, (b) use of scripted questions, (c) application of specific debriefing models, (d) debriefing topics, (e) alignment of learning objectives, (f) practical implication to work, (g) use of video, (f) use of other multimedia aid, (g) type of resource and artefact, (h) use of reflection, and (i) provision of constructive feedback.

Out of these themes, the theme of *structure*, representing the use of clear methods to guide the debriefing, was addressed most frequently in the selected papers ($n = 9$) as an influencing element (see Table 3). However, evaluation of its effectiveness was not based on evidence, but rather relied on the reviewers' reflective opinions ($n = 4$) and on subjective data of students' perceptions ($n = 2$). Out of those studies, three papers concluded that the evaluation of this element is vague and inconclusive.

A further investigation into the text segments coded for this theme indicated that a majority of the selected papers only addressed either structured or unstructured debriefing (e.g., Fernandez, 2015; Neill & Wotton, 2011). However, one study applied a framework to synthesise the levels of structure across their nominated publications, and these levels comprised four codes: "high (protocol specified exact questions and procedures), moderate (protocol provided specific goals/objectives, allowing flexibility in deployment), and low (protocol specified only general aims of the debrief), or none (protocol was explicitly non-

existent)” (Tannenbaum & Cerasoli, 2013, p. 235). This description of the levels suggests that features of debriefing processes (e.g., the methods, models, and framework) and approaches (e.g., the techniques and strategies) are attributed to the levels of structure. In fact, a reinvestigation of the text segments coded with a *structure* theme revealed that these text segments also highlighted usefulness of *scripted questions* in the three papers. It confirmed the interrelationship between a structure and a more formalised debriefing technique (i.e., scripted questions).

The theme of *application of specific debriefing models* was found in only two papers (Cheng et al., 2014; Waznonis, 2014). A narrative review (Waznonis, 2014) identified nine design features in debriefing practices in education, including specific models (e.g., Debriefing With Good Judgement; Debriefing for Meaningful Learning©) and more general concepts and multistep debriefing processes (e.g., Lederman’s six validity discussion question; Thiagarajan’s seven debriefing phases). Out of these, the Debriefing With Good Judgement method was highlighted in another paper (Cheng et al., 2014) as one of the characteristics of debriefing. Waznonis (2014, p. 463) suggested that the methods, models, or frameworks reflect specific debriefing processes and concluded that a variety of debriefing processes had similarities:

Most originate from the same theories and frameworks (i.e., constructivism, experiential learning; reflective practice, debriefing expertise, and crew resource management), contain similar phases (i.e., three-phase processes with in-depth discussion and analysis in the middle phase), and use similar approaches (i.e., oral approach with open-ended questions and peer and facilitator feedback).

This notion also draws attention to the interrelation between debriefing processes (i.e., methods, models, or frameworks) and other elements (e.g., theories, phases, or approaches).

The analysis found two papers presenting the reviewers’ reflective evaluation of the theme of *debriefing topics*. In these papers, it was reported that among studies with different topics including technical and nontechnical skills debriefing was effective (Dufrene & Young, 2014; Levett-Jones & Lapkin, 2014). In contrast, Cheng et al. (2014) highlighted a potential influence of different topics on debriefing. For example, they included a study reporting a greater preference for technical rather than cognitive focuses in debriefing content by participants (Bond et al., 2006). However, insufficient evidence of this aspect was observed in this present study for a conclusion to be reached. The limited evidence suggests

that further investigation into what types of learning topics are valuable for debriefing is needed.

The theme, *alignment of learning objectives*, represents the consistency of learning objectives or dimensions (i.e., individual or team work) among participants, debriefing focus, and level of measurements. This theme was only identified in a meta-analysis of the available studies (Tannenbaum & Cerasoli, 2013) through investigation into the association among participants (i.e., individual or team focus), intent (i.e., individual or team performance), and measurement (i.e., assessment of individual or team performance) within a debriefing intervention. Tannenbaum and Cerasoli (2013, p. 240) found that debriefing is most effective when these three aspects are aligned in the research design. Nevertheless, they also found that even “misaligned” debriefing exhibited a reasonable level of efficacy, suggesting a broad range of acceptable applications of debriefing practices.

The theme of *practical implication to work* reflects the applicability of the skills and knowledge gained during the debriefing to the participant’s real-life practice. Although this aspect is considered important for designing a simulation scenario in the health-related literature (e.g., Botma, 2014), it was only highlighted in one integrated, qualitative review by Fernandez (2015). This reviewer included this element as a key component of effective debriefing because she believed it was essential for the participants’ motivational or active learning although only one of her nominated studies noted this aspect. Therefore, further investigation is required for the clarification of this aspect.

Use of video or other multimedia aids was one of the most frequent themes identified in this study (Table 3) and presented the most surprising findings of its effects on debriefing outcomes. The use of video recordings of a participant’s own simulator performance is an ideal element recommended in the debriefing literature (e.g., Cant & Cooper, 2011; Levett-Jones & Lapkin, 2014; Tannenbaum & Cerasoli, 2013). However, four papers concluded its questionable evaluation or nonsignificant effects (Fernandez, 2015; Garden et al., 2015; Levett-Jones & Lapkin, 2014; Tannenbaum & Cerasoli, 2013), and one reported its negligible effects (Cheng et al., 2014). In addition to video recordings, the use of other multimedia was reported, including a variety of feedback techniques (Cant & Cooper, 2011; Cheng et al., 2014), eye-tracking equipment (Garden et al., 2015), and standard computer-based multimedia debriefing (Dufrene & Young, 2014; Fernandez, 2015). However, the absence of clear evaluation was highlighted especially with regards to the use of multimedia aids

including video recording during debriefing. This created a potential barrier to accurate assessment of the methods. Clearly, further investigation is required in this topic.

The theme, *type of resource and artefact*, identified the means or tools used to evaluate debriefing practices. In the papers evaluated, a range of tools were reported (Garden et al., 2015; Levett-Jones & Lapkin, 2014; Tannenbaum & Cerasoli, 2013; Waznonis, 2014). According to Waznonis (2014), whose focus was in nursing education, the majority of debriefing methods did not have an associated instrument for evaluation. She did, however, identify six instruments developed to evaluate simulation–debriefing effectiveness. Out of the evaluation instruments she identified, two did not directly assess a specific method or model of debriefing. These included the Debriefing Experience Scale (DES; Reed, 2012) and Objective Structured Assessment of Debriefing (OSAD; Arora et al., 2012). These two instruments were found to be useful to evaluate any method of debriefing in simulation research and practice. In contrast, the other four instruments Waznonis identified were found to be associated with a specific debriefing method or model. They included the 25-item debriefing assessment instrument (Gururaja, Yang, Paige, & Chauvin, 2008); the Debriefing for Meaningful Learning Supplemental Questions (e.g., DMLSQ; Dreifuerst, 2012); the Outcome Present-State Test (OPT) model rating tool (e.g., Kuiper, Heinrich, Matthias, Graham, & Bell-Kotwall, 2008); and the Debriefing Assessment for Simulation in Healthcare (e.g., DASH; Brett-Fleegler et al., 2012). However, Waznonis (2014) claimed that two of these method-associated instruments (viz., DASH and the 25-item debriefing assessment instrument) could be used for evaluating a broader range of debriefing methods in simulation research and practice.

In addition to identifying means of evaluation, this theme included some supplemental tools which assisted instructors and participants to follow particular debriefing processes. These tools, including scripts, worksheets, and examples of approaches to debriefing, were not necessarily associated with particular methods or models (Waznonis, 2014). However, these tools were regarded as attributes to the structure of debriefing in the review of Tannenbaum and Cerasoli (2013).

Garden et al. (2015) suggested that debriefing researchers should utilise the available evaluation instruments to unpack specific elements of debriefing to measure debriefing effectiveness. However, the elements being evaluated varied significantly among these instruments (Levett-Jones & Lapkin, 2014; Waznonis, 2014). Therefore, it was difficult to produce an overall outcome of debriefing across the studies. In particular, Waznonis (2014)

reported that none of the instruments could be used to evaluate the effectiveness of timing and duration in debriefing. The meta-analysis by Tannenbaum and Cerasoli (2013) found that approximately fifty-four per cent of nominated studies ($n = 31$) used objective rating criteria. They reported that the studies using subjective rating criteria presented a larger effect size of debriefing effectiveness on average, than did those that employed objective criteria. They suggested the design or structure of the debriefing intervention may be more important than the media employed. Again, this suggestion requires further investigation.

The current review also found insufficient evidence of *use of reflection*, despite being one of the elements that have been frequently emphasised in the debriefing literature. According to Table 3, three papers addressed the importance of using reflection for debriefing, based only on their subjective evaluation. One paper by Cheng et al. (2014) highlighted a greater preference of debriefing participants for reflection rather than criticism of performance. In addition, another theme, *provision of constructive feedback*, was mentioned in three papers, which called attention to the importance of providing participants helpful advice during debriefing.

Importantly, thematic alignments of debriefing elements were again confirmed within these themes. For example, both themes (viz., reflection and constructive feedback) were previously underlined as important attributes to instructor quality. Dufrene and Young (2014) claimed that debriefing, or guided reflection, provided an opportunity for participants to reflect on their experiences, thus allowing them to learn from mistakes. As Dufrene and Young (2014) stressed, the debriefing structure and the role of instructors in guiding the students to reflect on their experiences were significant and could be firmly linked to debriefing methods and techniques.

When

The *When* category included three themes relating to timelines in debriefing. These aspects consist of *timing, duration and length*, and *thoroughness and depth*. Although popular guidance for these aspects of debriefing timeline was found in the debriefing literature, we found that research evidence was not available to support such professional guidance across disciplines. For example, debriefing immediately after simulator training has been widely recommended in the literature, but two papers found the results to be inconclusive (Cheng et al., 2014; Neill & Wotton, 2011). In particular, Cheng et al. (2014) found that ideal conditions regarding debriefing timing was dependent on various factors such as learning content, instructional dimensions, and task complexity. This highlighted the interrelationships

between timing and other influencing factors. In addition, Neill and Wotton (2011) found that students favoured debriefing immediately after the simulator experience as the fresh memories enhanced their engagement. However, these authors also concluded that there was insufficient research evidence to prove its actual effects.

Similarly, despite the literature identifying the need for sufficient time to debrief, there is no research evidence suggesting an ideal amount of time or percentage allocation (Levett-Jones & Lapkin, 2014; Neill & Wotton, 2011). For example, Neill and Wotton (2011) found no evidence to support a popular guidance model used in nursing, which advises that “debriefing sessions should be approximately two to three times the length of the scenario itself” as such periods allow sufficient time for students to reflect on and think deeply about their performance (Waxman, 2010, p. 34). In particular, Cheng et al. (2014) found nonsignificant effects in short (shorter than 15 minutes) or long (longer than 15 minutes) debriefing when expert modelling was incorporated. As debriefing is typically much longer in aviation than in the studies examined by Cheng et al. (2014), further research is needed to determine how long debriefing should last for in training pilots.

In addition, the theme, *debriefing thoroughness and depth*, represents a continuous and complete learning engagement without interruption in the debriefing process. The importance of the theme in debriefing was reported in two papers (Dufrene & Young, 2014; Fernandez, 2015) emphasising that it facilitated participant’s reflection during debriefing. However, neither provided sufficient evidence of the impact of debriefing thoroughness on debriefing outcomes. The thematic analysis also revealed that debriefing thoroughness was closely aligned with post-simulation timing as immediate timing assisted deeper or quality of participants’ self-reflection as discussed earlier.

Where

The theme, *safe situation*, was identified related to the environmental factors of debriefing (*Where*). The theme represents a non-threatening, trusting environment for debriefing, which was often highlighted in the nursing education literature. According to Table 3, three papers highlighted the importance of ensuring the safe environment for participants to engage in debriefing. One paper (Neill & Wotton, 2011) presented data on participants’ preference for a safe environment. Yet the paper was coded to “neutral” as there was insufficient evidence to conclude this participant preference.

The earlier analysis reported a close link between this environmental theme and instructor characteristics. More specifically, instructors who had supportive, caring attitudes were highlighted as being influential in participants' satisfaction with the practice of debriefing (Fernandez, 2015; Neill & Wotton, 2011). Similarly, adequate time set aside for debriefing was found an important factor in creating a learning environment within which participants feel safe (Fernandez, 2015).

Why

According to Raemer et al. (2011), the *Why* category represents *theory or theoretical underpinning* leading the debriefing processes. The thematic analysis revealed that four papers stressed the importance of clarifying what theories are used to underpin, design, and guide the debriefing process (Garden et al., 2015; Neill & Wotton, 2011; Tannenbaum & Cerasoli, 2013; Wazonis, 2014). There are several theories that contextualise learning during debriefing in the debriefing literature. Wazonis (2014) stressed the importance of alignments among the theory, design, use, and evaluation of any debriefing method. Similarly, Tannenbaum and Cerasoli (2013) emphasised research needs for clarifying learning explication—why debriefing practice boosts performance and how best to deploy the practice—by understanding how different debriefing elements influence each other and what combinations of them achieve the best outcomes. The findings again pointed to an alignment or interrelatedness between the themes identified in the present study. However, the evidence for this aspect was only reflective in all of the four papers, and no single theoretical approach appeared to be identified as more appropriate than another.

Discussion

A literature search for debriefing studies confirmed a rapid growth of debriefing literature over the last decade. This study is the first attempt to synthesise the information available across professions to inform key considerations for debriefing pilots. Through a thematic analysis, the present study investigated available papers that systematically reviewed debriefing studies, particularly in simulation-based learning across a variety of disciplines (viz., health-related, educational, and organisational fields). Ten published papers were eligible for inclusion in this systematic examination, and application of the 5Ws framework (Raemer et al., 2011) helped organise debriefing themes. The study ascertained key themes that influence the effectiveness of debriefing, while also identifying research gaps on debriefing. The complexity of debriefing practice was exemplified by a repeated report of the interrelatedness of themes although there was no single approach for debriefing. This finding

underlines a need for a broad, all-embracing framework that could be used across different fields of expertise.

The complexity behind “a good debrief”

The current study confirmed the effectiveness of using debriefing in simulation-based learning across professional fields, with five studies reporting positive effects, although actual elements contributing to effective debriefing for simulation-based learning are still inconclusive. Debriefing relies on the reflection of experience, which is in direct alignment with the premises of adult learning theory that emphasises learners’ concrete experiences, reflective observations, abstract conceptualisations, and active experimentation in improving appropriate knowledge and skills (Kolbe et al., 2015). Yet the elements that influence a debriefing are considerable but not yet clearly defined. Hence the arguments of Garden et al. (2015) are supported, who argue that a current trend of debriefing practice appears to be guided more by expert opinion rather than research evidence.

The goal of investigating debriefing effectiveness was further complicated by the interrelationship between debriefing themes. Elements can and do influence each other, potentially producing different learning outcomes for participants. This interrelationship appeared to make research into debriefing effectiveness even harder, as it becomes difficult to set concrete categories. In particular, a confusion of terminology around debriefing practice added to the complexity when trying to identify key themes (Wazonis, 2014). Moreover, the complexity may cause inconsistency in debriefing practice among instructors.

In order to minimise practical barriers to effective debriefing, there is a need for a broad framework, which can inform what it means to be an “effective debriefing.” The framework can be used to achieve effective debriefing practice and contributes to positive learning outcomes. Until that time, this study helps researchers to understand key aspects of debriefing practice, which need to be considered when designing their research programs and which should be included when reporting results of debriefing interventions.

Identification of research gaps

It was clear that all elements identified in the study required further research to ascertain their effects on debriefing outcomes. Particularly, research is needed to verify the effects of what is believed to be best practice. For example, various multimedia aids are commonly used in post-simulation debriefing for pilots. Typically, pilots have specific video segments replayed during debriefing (see Mavin, 2016). However, the questionable finding of its value in

debriefing indicates needs for further clarification of using this type of methods. Indeed, these findings appear to contradict our field research, where pilots value observing and reflecting on team coordination in the flight deck. Research is needed to further clarify how multimedia is used in debriefing to produce positive outcomes and whether or not the value varies between disciplines.

The present study also reported that further research is needed to clarify the estimated time required for debriefing. While health-related literature tends to recommend that debriefing requires two or three times longer than the simulator period, there is no sufficient empirical evidence for this recommendation (Levett-Jones & Lapkin, 2014; Neill & Wotton, 2011). Further, the debriefing duration recommended in the nursing literature is not practical in aviation and some military operations, where they tend to have much longer simulation training sessions. From this consideration, research into the appropriate simulation–debriefing ratio would bridge the outcomes of non-aviation studies to aviation practice.

Regarding the effectiveness of debriefing, many researchers emphasised the utility of using a checklist or a model. Their purposes included, but are not limited to, guiding group discussions during debriefing (Gantt & Webb-Corbett, 2010; Kreps & Lederman, 1985); assessing participants' performance (Flannery & Zahorsky, 2014) and team work (van Schaik, Plant, Diane, Tsang, & O'Sullivan, 2011); promoting learning through both individual and group self-discovery (Greenberg, Tokarczyk, & Small, 2011); and training debriefing facilitators (Fernandez, 2015). Yet, there is little evidence defining such checklists or models and how useful they are in debriefing pilots.

The significance of considering a methodological alignment became apparent through the random-effects meta-analysis, which discovered that when the individual–group dimensions were aligned among participants, learning focus, and measurements (i.e., individual or team) debriefing became more effective (Tannenbaum & Cerasoli, 2013). In other words, when the learning focus is team management, participants should be engaged in the simulator in a team and be assessed with measurement for team management. This finding highlighted a potential impact of learning alignment across simulation-based activities (i.e., prebriefing, simulator, and debriefing) on participants' learning. That is, for the team management training, each of prebriefing, simulator, and debriefing activity should be designed with a consistent focus of team management. The importance of the prebriefing component has become an emerging area that is considered to influence outcomes of

simulation and debriefing (Page-Cuttrara, 2014). Although the present study did not identify the component as an influential element, it could be another element to be included in the framework.

Practical implications for flight examiner training

One practical implication for this study is that the developed framework provides a possible guideline for what skills and knowledge debriefing instructors (i.e., flight examiners) should know, or be aware of, in order to deliver an effective debriefing. In other words, it could be used to outline a training model for flight examiners. In particular, two aspects of instructor training should be considered. First, flight examiners require skills to deliver effective debriefing. These skills are reflected in the *What* category, which includes debriefing structure, constructive feedback, use of reflection, and use of resources. These could be considered as useful techniques and could be taught in flight examiner training. Second, flight examiners need to be aware of appropriate attitudes and behaviours when they facilitate the debriefing sessions. More specifically, they need to be aware that providing a “safe situation” can affect pilot performance, and they should maintain supportive attitudes during the session. This aspect could be linked to the typical training for pilots of two-day biannual examinations and performance assessment. That is, two different aims, training versus assessment, may negatively influence pilot learning and performance especially on assessment day.

Conclusion

This study presented the systematic construction of a framework defining the important elements of effective debriefing across different professions. One of benefits from this study to aviation is to increase awareness of what have been done to improve debriefing across a range of different professions, as many pilots would not reach to the empirical studies being published outside aviation. This, in turn, is the first step to gain better understanding of debriefing practice within aviation as this review provides a mechanism for investigating such practices across a wider domain. Further, it revealed research gaps in practice that need further investigation. Our work continues to gain increasing attention from major airlines and the military, with debriefing now being the major focus of our work. Clearly, the study suggested that aviation and other professions need fewer opinion papers to tell how to conduct debriefing and more empirical research to determine the effectiveness of each element (e.g., formats, models, techniques). The proposed framework would contribute to

development of professional training and programs for flight examiners by providing a possible guideline for effective debriefing.

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