Les modes de débriefing post-simulation : des sondes organisationnelles de la gestion de la sécurité

Debriefing modes of simulation sessions as organizational probes of safety management

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Résumé **—**.Dans les industries à risques, la sécurité s'effectue grâce à la combinaison d'une sécurité basée sur des règles et d'une sécurité gérée. Le développement de la sécurité qui intègre ces deux facettes mène à une sécurité constructive. Une compétence majeure à développer dans le cadre de la sécurité constructive est la capacité à effectuer les bons arbitrages en situation. Cependant, il est toujours perçu comme difficile de mettre en œuvre des discussions ouvertes sur la gestion de la sécurité dans les organisations à risques qui sont très réglementées. Dans cette contribution, nous suggérons que les séances de débriefing constituent un espace-temps adéquat pour superviser et développer une sécurité constructive. Cette contribution s'appuie sur l'analyse de débriefings post-simulation dans le domaine nucléaire (N=8) et de l'anesthésie-réanimation (N=10). L'analyse thématique orientée par la sécurité constructive fait apparaître les sujets abordés lors du débriefing tels que le partage de bonnes pratiques, l'application des règles, le travail en équipe et le retour d'expériences. Nos résultats montrent qu'il est possible d'avoir une connaissance de la sécurité gérée mise en œuvre lors des débriefings. Notamment, il est possible d'accéder à la mise en œuvre de la sécurité gérée dans l'action et si la situation le permet de corriger les actions non acceptables. L'attitude du formateur lors du débriefing est essentielle pour permettre ou non une discussion ouverte sur les pratiques réelles de travail. De plus, l'attitude du formateur illustre la perception que l'organisation a de la sécurité. C'est pourquoi nous affirmons que les débriefings post-simulation sont des sondes organisationnelles pour la gestion de la sécurité.

Mots-clefs — débriefing, simulation, sécurité constructive, sonde organisationnelle.

Abstract **—**In high reliability organizations, safety is performed through the combination of rule-based safety and managed safety. Orienting the development of safety embedding both results in constructive safety. A major skill to be developed within constructive safety is the ability to perform correct arbitrages in the situation. However, it is still perceived as challenging to implement open discussions on managed safety in such regulated organizations. In this contribution, we suggest that the debriefing sessions are an adequate time and space to oversee and develop constructive safety. This contribution is based on the analysis of post-simulation debriefings in the nuclear field (N=8) and anaesthesia and intensive care field (N=10). The thematic analysis oriented toward constructive safety shows the topics raised in debriefing such as sharing of good practices, rules enforcement, teamwork, and feedback from real experiences. Our findings show that it is possible to get a sense of managed safety during debriefings. It shows how safety is performed in action and provides an opportunity, if discussion is open, to adjust not acceptable actions. The attitude of the trainer during debriefing is key in allowing or not open discussion on real work practices. Furthermore, the trainer's attitude is illustrative of the organization's perception of safety. This is why we claim post-simulation debriefings to be organizational probes of safety management.

Keywords — debriefing, simulation, constructive safety, organizational probe.

I. INTRODUCTION

Organizations are major players in developing safety in high risks fields such as nuclear systems or anaesthesia and intensive care. In HRO (High Risks Organizations), safety is performed through the combination of rule-based safety and managed safety (COFSOH, 2019; Falzon et al., 2019). Rule-based safety relies on normative resources (i.e. procedures, training, team composition) to control risks and leads to standardization of operators' and teams' activity. Managed safety relies on adaptive resources (i.e.: operator's experience, quality of initiatives) enabling operators to cope with unexpected situations (Nascimento et al., 2014; Boulard Masson et al., 2016). From an organizational perspective, the ability to better understand and characterize managed safety to support it would have positive impacts on global safety (Hamer et al. 2021; Borys et al. 2009). The management of unexpected events such as the Fukushima nuclear accident enhances the need for managed safety and for developing it (IAEA, 2015). However, it is still perceived as challenging to implement in such regulated organizations.

Today, the main purpose for using simulators in the High Reliability Organization (HRO) such as nuclear or aircraft industries is staff training. It is seen as a way to enable practitioners to train in specific situations from standard ones to accidental situations that agents will hopefully never face, without any risk involved. We suggest that the debriefing sessions are an adequate time and space to oversee and develop managed safety along with rule-based safety (Rall, et al. 2000; Rocha et al., 2015).

II. LITTERATUR REVIEW

A. From managed safety to constructive safety

Managed safety is the part of safe actions that are not explicitly and directly present in the formal part of organizations such as interaction systems, training, procedures, and hierarchy. Managed safety is present in the way to adapt or bypass procedures in specific situations, in collective work, in experience, informal practices, companioning, or organizational safety culture. We can find other terminology that relates to managed safety such as adaptive safety (Harvey et al., 2019; Nascimento et al., 2014), safety II (Hollnagel 2018), work as done (Blandford et al., 2014), Resilience Engineering (Hollnagel et al., 2006).

High Reliability Organizations (HRO) such as nuclear systems, or anaesthesia care faced an increase in proceduralization and formalization of the operator's activity, notably to avoid human error. As a consequence, the activities of front-end operators have become more and more standardized through procedures, training, and teamwork organization (Hamer et al., 2021). This standardization is seen as a way to ensure safety. In this rule-based, normative approach, safety is supposed to be achieved when operators strictly stick to the rules (Nascimento et al., 2014, Amalberti et al., 2005). In this perspective, the dominant objective of training is conformation (Olry, 2013), i.e. making sure that agents know the rules and comply with them. The assumption is that process supervision supported by the procedures will always be safer than supervision deviating from procedures. This supposes that procedures exist for all kinds of situations that may occur. Thus, the goal of the organization is to try and foresee adverse events to provide guidelines for action in any potential situation. "Out of the scope" situations – and actions – are considered risky.

Today it is this rule-based, normative approach to safety that predominates in high-risk industries (Masson, 2013, Teperi et al., 2022). However, this domination has been challenged by several authors, who pinpoint the importance of better support to adaptation abilities and therefore a level of flexibility in those systems (Dien, 1998; Grote et al., 2009, Amalberti, 2007, Borys et al., 2009, Hamer et al., 2021). This need is justified on different grounds:

- Believing that situations can be constrained to a point where variability is eliminated is a myth. All studies in human factors/ergonomics show that operators always have to cope with some level of variability (Savioja et al., 2014). As a consequence, there is always a gap between "work-as-prescribed" and "work-as-done" (Daniellou, 2005), not because operators are sloppy, but because they need to adapt to situations. Denying this difference and its actual origin is taking a risk.
- In high-risk systems, operators as of now are the only elements of the system that have the capability of adaptation. Therefore they are the only ones that can handle the infinite and unpredictable variability of situations. Standardizing their behaviour would imply loss or impede this capability of adaptation, and therefore constitutes a risk.
- The level of safety reached today by ultra-safe systems has been stable for some decades (Amalberti, 2007; Hamer et al., 2021). To improve the safety level, one option is to grant more flexibility, taking advantage of the adaptive capability of the operators (Falzon, 2011).

Nevertheless, it is a limited approach to focus only on managed safety as it has to develop along with rule-based safety. The question then becomes how to combine those two sorts of safety. Stated differently, the issue is in articulating the objectives of conformation and emancipation (Olry, 2013). For the operators, working safely requires combining all the available resources and constraints toward a defined goal (Falzon 2011).

Hence, we assume that:

- safety results from a relevant arbitrage, in context, between different – formal or informal – resources that need to be assessed and mixed, and from an efficient implementation of this arbitrage;
- arbitraging is a competency that needs to be encouraged and for which specific training methods should be developed. Note that this is not the case today: training systems focus on knowledge acquisition and compliant application of rules and procedures, in a conformation approach;
- safety is not a state, but a permanent process of construction. Safety develops continuously through the confrontation with situations, the use of procedures, their reasoned adaptation in context and the collective assessment of these adaptations.

We will refer to this dynamic, processual, view of safety as constructive safety. In real actions of actors, both rule-based and managed safety contribute to safety. An organization that promotes safety development will aim for constructive safety which supports the skills of arbitraging that is grounded on rule-based safety and managed safety.

B. Constructive safety through reflexive space

As seen above, constructive safety requires operators to be equipped with arbitraging competencies. Appropriate spaces should be devoted to the discussion of past arbitrages. These collective spaces should allow the array of acceptable/unacceptable arbitrages to be identified.

Researchers have explored the resources to support adaptive organizations or resilience in high-risks organizations. The PUMA method has been introduced in simulation training where attention is put on the problem-solving process and coordination/communication during team discussion (Brüngger et al., 2014; Ritz et al. 2015). Other research reports on the value of collective working context with group discussions to develop performance on novel and/or ambiguous tasks (Okhuysen and Eisenhardt, 2002). Self-evaluation methods following simulation sessions fostered discussions on topics such as collaboration, understanding of plant dynamics, and the use of procedures that might support system resilience (Wahlstrom et al., 2017). Other research points to participative development as a way to focus on work, work practices, processes and procedures, and workplace learning and improve safety in nuclear plants (Teperi et al., 2022). In healthcare research, reflexive spaces are identified in leveraging resilience (Wiig et al., 2019). In nuclear power plant maintenance, a video-based method for collaborative learning has been introduced to support resilience (Kuula and Wahlstrom, 2023).

The ability to face unknown situations, to adapt or develop resilience seems to be strongly related to the creation of reflexive spaces (Wiig et al. 2019; Rocha et al., 2015). For organizations it is a place where a lot can be understood regarding how safety is performed in real contexts.

III. METHODS

The research developed here aims at considering the use of post-simulation debriefings, at an organizational level, for the improvement of safety.

We were able to observe and collect recordings of post-simulation debriefings in two industrial contexts: nuclear reactor supervision and anaesthesia and intensive care. Simulation sessions start with a briefing where the goal of the simulation session is shared with the trainees. Then trainees play the scenario on the simulator. It is followed by a post-simulation debriefing where operators and trainers discuss the operators' activity. In this contribution, we describe in detail the analysis of the post-simulation debriefings involving the team and trainers. Observation and data collection took place during the three parts of all the simulation sessions. All the operators and trainers considered in this study were experienced. It means that all operators had completed their initial training and already worked in their role in the field at the time of the experiment.

The context of simulation sessions in anaesthesia and intensive care fit into the continuous training program proposed by the hospital. The experts involved are critical care residents, surgeon, AIC nurses (care nurses specialized in anaesthesia and intensive care), nurses, AIC doctors (specialized in anaesthesia and intensive care) and medical technicians. Scenarios of the simulations include cardiac arrests, anaphylactic shocks, surgery or the arrival of a critical care patient at the hospital.

In the nuclear field, we considered operators from two nuclear systems that are similar in their function (providing nuclear energy) but different in the role ascribed to the human operator regarding safety management. They were designed for the first one in the 60's (before the Three Miles Island accident) and for the second one in the 80's (after the TMI accident). We cannot disclose fully the context of the use of those nuclear installations due to confidential restrictions. Therefore, we will identify those two installations as A (designed in the 60's) and B (designed in the 80's). Technically, systems A and B, albeit different, are quite similar in the way they function. Workers on both systems belong to the same organization. However, the year of design has a strong impact on the safety "philosophy" and the procedures: the guidance level of procedures is much lower in system A as compared to system B (Masson, 2013). This evolution is not surprising considering the changes in prescription and safety in high-risk systems between the 60's and 80's, due to the Three Miles Island accident (1979).The study is an analysis of the training sessions on a simulator with 8 teams of 4 operators. The experiment involved 4 teams on system A and 4 teams on system B. The scenarios were jointly designed by and validated with trainers from systems A and B. They were specifically designed for an experiment. They scenarized the same type of accident on both systems A and B: an accidental situation requires the operators to shut down the system. However, a variation is introduced. In one case, the scenario is unambiguous (clear symptoms) and it is obvious how to handle it. In a second case, the scenario is ambiguous as one key indicator of the type of accident does not show, which is realistic even if unlikely.

TABLE I. TEAMS INVOLVED IN THE STUDY WITH TEAM ID, FIELD, SCENARIO AND THE COMPOSITION OF THE TEAM

Team	Field	Scenario	Number of trainees and roles
N1	Nuclear	Clear accident on A	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N2	Nuclear	Clear accident on A	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N3	Nuclear	Ambiguous accident on A	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N4	Nuclear	Ambiguous accident on A	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N5	Nuclear	Clear accident on B	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N6	Nuclear	Clear accident on B	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N7	Nuclear	Ambiguous accident on B	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
N8	Nuclear	Ambiguous accident on B	4 operators: 1 Shift supervisor, 1 electrical technician, 1 engine technician and 1 reactor technician
AIC1	AIC	Respiratory Cardiac Arrest	2 AIC nurses
AIC2	AIC	Respiratory Cardiac Arrest	2 AIC nurses
AIC3	AIC	Respiratory Cardiac Arrest	2 AIC nurses
AIC4	AIC	Respiratory Cardiac Arrest	2 AIC nurses
AIC5	AIC	Anaphylactic shock	1 AIC nurse
AIC6	AIC	Anaphylactic shock	1 AIC nurse
AIC7	AIC	Anaphylactic shock	1 AIC nurse
AIC8	AIC	Anaphylactic shock	1 AIC nurse
AIC9	AIC	Anaphylactic shock	1 AIC nurse
AIC10	AIC	Emergency related to a traffic accident	Intensive care team of 5: 2 AIC doctors, 1 AIC nurse, 1 surgery nurse and 1 medical technician

The teams in each system for each scenario are presented in TABLE I. in total, we were able to involve 50 participants in this study. The debriefings were audio-recorded and fully transcribed. A content analysis following the grounded theory methodology allowed the authors to identify the recurring themes in the transcript. The results presented below account for debates on how to work safely and illustrates the development of constructive safety during the debriefings.

IV. FINDINGS

The topics addressed during debriefing relate to the actions undertaken by the trainees during the simulation session. Those actions are discussed in terms of what they have done, should or could have done and what is written in procedures. Beyond actions other topics are addressed such as: teamwork, technical system operation, specifics of the context, use of procedures. In this contribution, we focus on situations that contribute to the ability to perform safe arbitrages. In this way it develops constructive safety. We observed instances of sharing or good practices, debating rules, feedback items, work organization and skills enhancement.

A. Sharing of good practices

During debriefings, we were able to observe the sharing of good practices where practitioners, in reference to the situation they just played in the simulator, describe also what their resources in real situations are. Here, the trainer tries to understand how the trainee identify the worsening of the situation.

Trainer: *“It seems that the first signal that alerted you was the desaturation.”*

Anesthesia nurse: “*I really pay attention to this sound since my internship where I had a supervisor that came to see me and made me aware of this little sound to which I was not attentive and that brings so so much information*”. [AIC5]

This beep is therefore identified as a core element for the anesthesia nurse in order to perform safely. This comment also shows that this sound is not necessarily widely used “*to which I was not attentive*”. As a follow up, the anesthesia nurse adds “*I often find myself in rooms where the beep has been cut off, but you’re on the job, […] so after a while you give up, after you’ve been asked to turn it off once, twice, three times*”. This comment is a feedback targeting some specifics of team work that prevent the anesthesia nurse from using the beep, despite having expressed how useful it is to him in order to perform the task. This issue with the beep can be raised at two levels regarding the organization. The first one is that the anesthesia nurses could benefit from this type of informal practices that are more related to managed safety. The second issue is more at the level of the team work. The trainee mentioned that sometimes surgery practitioners said they were disturbed by the beep. This type of

feedback could lead to discussions between anesthesia practitioners and surgery practitioners on the ways they can achieve together safer surgical operations.
In nuclear field, it is a trainer who shares good practices due to his knowledge as simulator trainer.
"Trainer : *If you put [your parameters] on a pressurization diagram [...], you've got all your levers for your situation points ... I'm seeing it more and more now as I'm watching everyone [as a trainer in simulation sessions], if you manage to slide your parameters in there, it'll work [perfectly fine], and then you'll immediately see what's bothering you, where you'll have a stop*." [N2].
The two examples illustrate good practices that support the activity of operators, they allow to make it clear what helps. The example in the AIC field show how organizational issues may make it sometimes difficult to benefit from the "beep". Having the possibility to highlight the good practices during the debriefing provides resources to operators to improve their practices toward safer actions. In the AIC field again, the beep indicating oxygen saturation provides crucial information allowing one to react quickly to a desaturation situation. The quick reaction will improve the management of such situation. In the nuclear field, the example recalls how the use of a pressurization diagram helps in anticipating the supervision of the nuclear reactor. An organization promoting constructive safety could in the AIC field initiate a discussion on the reasons why the oxygen saturation beep is cut off and find solutions to allow AIC practitioners to have the information. In the nuclear field, an organization promoting constructive safety could provide templates of pressurization diagrams that are convenient to promote its use. The discussion of actual practices could result in the development of new tools, hence in the improvement of rule-based safety.

B. Debating rules

Discussion on rules is frequent in debriefings. Actions are assessed according to what rules say. We observed in some debriefings, situations where trainees and trainers had the opportunity to either question the validity of a rule, define informal rules or recall the importance of following a rule. In the examples below, we were able to witness three situations of rules reworking (two in the nuclear field and one in AIC field) and one situation of rules enforcement in AIC field.
In nuclear field, we observed in two different debriefings an instance of rules reworking. What we mean by rules reworking is the possibility to discuss and refine rules that serve as a reference for actions.
In the first instance, the formal rules (here the procedures) were discussed and the way to use them was made more specific.
"Be careful, for that action it's P2 you should take into account and not P1 [...] I know that in the procedures only P1 is mentioned in that paragraph, but don't forget that you should consider P2" (P1 and P2 stand for pressure) [N4].
The trainer took the opportunity to supplement the procedure, warning the operators that the procedure was partly misleading in mentioning only P1.
In the other instance, trainers and operators discussed a threshold that belongs to informal rules. There is an automatic safety action that starts if a specific parameter decreases to the value 30. During the training session on the simulator, the operator stops the decrease at the value 45. The trainer and the operator discuss that choice:
"Trainer: *you take a quite big margin and then it's harder for you to reach your goal*
Operator: *Before I used to go down to 33 but another trainer during a training session said that it was too close to the threshold*
Trainer: *Yes 33 is a bit too short, maybe between 35 and 40 could be a good target, but there is no fixed threshold"* [N3]
Again, in this debriefing, the operator and trainer discuss what the good practice could be to reach the same time safety (not too close to 30) and efficiency (a bit lower than 45). In this case, it is an informal rule that takes into account the automatic actions.
In AIC field, the discussion purpose is the dilution of norepinephrine that should be given to a patient recovering from an anaphylactic shock. The anesthesia nurse chose to put 0.05 mg/h norepinephrine in order to increase the blood pressure that was estimated as too low. During the debriefing the trainer came back on that decision.
Trainer: "*Maybe in another context you would have chosen 0.2 or 0.1?"*
Anesthesia nurse: *"No, not necessarily, a patient without any medical history, on a minor surgery, I feel comfortable to start with 0.05… It's been some months I'm doing that. Then if I have to hand off to a colleague I will carefully explain the situation [as it differs from the prescribed rules] and show him/her how it is easy to manage. Furthermore with that dilution you can put it on a catheter hub."* [AIC7]
A following discussion with the trainer allowed us to understand that this anesthesia nurse was working in the cardiac surgical service and that, in that specific service, they were used to have patients who strongly react to norepinephrine. In that case, it is interesting to see that some anesthesia nurses choose different dilutions from the prescribed ones, and for good reasons. To go further, the trainer, if supported by the organization to do so, could during further debriefings with other practitioners raise this practice to inform them that, in some specific context, they can use another dilution or to recall the importance of communication on dilutions as sometimes practitioners do not strictly follow the prescriptions.
The last example provided in this example relate to rules enforcement. The scenario is again an anaphylactic shock and it relates to the dilution of norepinephrine to use. During the simulation, the anesthesia nurse administrated 10 times the prescribed quantity of epinephrine to the patient.
Anesthesia nurse: *"I said to myself he is displaying an adverse reaction to a muscle relaxant. The latest anaphylactic shock to a muscle relaxant I faced, the patient died. That's why I didn't dilute the epinephrine, I don't care if the patient got a bit more."*
Trainer: *"What does the anaphylactic shock raises for you as medication prescriptions?"*
Anesthesia nurse: *"it's 0.1 then we wait, then 0.1, then we wait. But I did not dilute the adrenaline here because the latest victim of anaphylactic shock we had is dead. Epinephrine 0.1 by 0.1 was not enough for him."*

Trainer: *"so your experience oriented your analysis."*
Anesthesia nurse: *"Yes, it [in the real situation] was not just an erythema. Maybe I should have [during the simulation] diluted the epinephrine as prescribed and not think that everyone always dies from anaphylaxis."* [AIC8]
In this case, the opportunity to replay on the simulator a similar incident, together with the following debriefing, is critical to come back on a situation that brought a strong emotional charge and that led the anesthesia nurse to modify her standards in terms of medication, even though she perfectly knew the prescribed procedure. In this case, epinephrine overdose could be associated with severe reaction such as high blood pressure or ventricular arrhythmia. Here we can see that the debriefing is an adequate environment to frame the constructive safety when it is required by recalling elements of rule-based safety. In order to go further, we could question to which extent organizations such as hospitals can use simulators to support medical teams dealing with emotional charges associated to dramatic situations, by replaying similar incidents on simulator and by debriefing these sessions.
The few examples of debating rules are illustrative of how constructive safety, which embeds rule-based and managed safety, could be developed. We observe here open discussions where trainees are comfortable explaining the good reasons they have for applying the rules the way they did. Similarly, trainers provide feedback and follow-up discussions to develop trainee's skills. It is not a matter of following or not the rules it is rather a matter of understanding the contexts calling for various applications of the rules. If an organization believes safety is limited to rule-based safety, i.e. a normative approach to safety, there is little chance such discussions arise. This leads to little chance that wrong decisions (or arbitrages) will be corrected.

C. Feedback items

At some points during the debriefing, the trainer can take the opportunity to gather some feedback from the field. In the debriefings we analyzed, we found an example of a feedback in AID field on a cardiac arrest.
Trainer: *"what about the cardiac arrests you faced in your unit?"*
Nurse: *"The latest I had to handle was completely unanticipated, not intubated… It was not my patient so I let my colleague take the lead. But at that point I realized that it takes a very long time to assemble the BAVU [manual insufflator]. It can easily take 2 minutes to assemble it"*. [AIC1]
The feedback provided by the nurse here describes a specific situation she experienced in real life, and that has not occurred during the simulation session, indeed the manual insufflator was already assembled for the simulation. With this feedback, it appears that during debriefings it is also possible to gather feedback on real situations. Here, the feedback raises a hardware issue that can be relevant for the unit of the nurse, but also at a broader level for the organization. This hardware issue could lead to some improvements regarding safety and performance.
Similarly, in nuclear field, operators justified their actions in simulation based on what they already experienced in the field. This is a way to address what happened beyond the scope of the simulation. During the debriefing, the reported practices from the field develops REX (Return on Experience). It can be debated and assessed to collectively define a safe set of practices which illustrates an instance of constructive safety.

D. Work organization

Debriefing is also a time when it is possible to raise collective discussions on the real work for instance, the team organization. A nurse stated: "*it's difficult sometimes to ask you* [physician and anesthesia nurses] *some questions when you're already focused on stuff. […] It's difficult to find the right moment*". [AIC10]
In this case, the debriefing allowed a comment to be addressed by the nurse to the anesthetist doctor and a senior nurse who performed in the same simulation. Thus, debriefings convey opportunities to discuss what is found difficult with the organization. This gives an opportunity to refine and progress regarding work practices.
The last example we want to raise is a situation where a critical care resident, who is at the end of her studies to become an anesthesia and intensive care doctor, is discussing her position in the simulation compared to the position she usually holds in real situations.
Intensive care resident: *"I had the feeling to be in the position of the leader doctor that is new to me. During my three months residency at the 'déchoc' [where trauma patients are admitted when arriving in the hospital], I only held the position of the follower [main role is to perform technical tasks such as catheter insertion]. I never really made any decision on critical patients."*
Trainer (Intensive care doctor): "*Actually, we should reposition ourselves, when we can be several intensive care doctors, and let you [the residents] hold the position of leader. We can't really be the follower*."
Intensive care resident: "*Otherwise it could imply to bring in two intensive care residents, one with the senior doctor saying "you manage the situation, I stay behind", and the other to equip the patient"*
Trainer (Intensive care doctor): *"Yes indeed when it's possible, we should possibly do it that way"*. [AIC10]
In this dialogue, we can see that the debriefing gives rise to organizational issues leading to possible new organizations that are debated and adjusted during the debriefing. The new organization of having two AIC residents with one AIC doctor is an opportunity to let residents practice the position of the leader in the management of a trauma patient. If the suggestion is hard to assess, a revised organization could be performed and assessed in simulation.

E. Skills enhancement

Several situations in nuclear field show that debriefings support skills enhancement. In one example, a trainer provided supplementary explanations regarding the operation of the technical system that can have impacts on the way the operators may supervise the system in the future.

” Trainer: *In the initial training you are told that decreasing the pressure would help to decrease the leakage rate, it's true, but not always. Take the time to discuss it together*” [N3]

In this example, the trainer stimulated operators to dig deeper into the physics of leakage. This is not a necessity from the standpoint of procedures or the initial training, nevertheless, it is something perceived as meaningful to question from the trainer's perspective. This background knowledge serves as additional resources the trainees will have when managing a leakage.

For another team, the trainer makes feedback on a set of actions pushing the trainees to go deeper in their understanding of procedures.

“Trainer: *for that situation, you didn't try to answer the question, the reason why the procedures ask us to do that*” [N2].

Again, here the trainer stimulated the operators to get to a higher level of abstraction to gain a better understanding of the procedures.

V. DISCUSSION

Beyond their importance as a core part of simulations to perform training and provide knowledge to trainees, debriefings can be seen as an appropriate time for work debate spaces, as defined by Rocha et al. (2015). Indeed, the results of this study show it is possible, during the debriefings, to discuss the real work practices through the enforcement and adaptation of rules, the good practices, skills enhancement, and feedback items. The results also demonstrated that debriefings enable the discussion of organizational issues, with the possibility to improve some practices.

We were able to observe such discussions in two completely different environments: nuclear and AIC fields. What is shared between those fields is the importance of safety. It suggests that debriefings are relevant as a setup to discuss work practices in HRO and that they give access to the reality of practices given that the trainer allows such debates to arise. If organizations get to know what is discussed in debriefing, they can have access to real practices that are discussed and a part of managed safety that is difficult to know.

Nevertheless, we were not able to witness such debates in every debriefing session. As illustrated in previous studies (Masson 2013), the attitude of the trainer during debriefing strongly influences the possibility of debate on the work practices beyond procedure compliance. The trainers through the evaluation of the trainee's actions and the feedback shared can orient the debriefing toward rule-based safety, managed safety, or a balanced, reasoned mix leading to constructive safety. If organizations specifically train simulation trainers to lead debriefing toward open discussions on real practices, it will support the development of constructive safety. Conversely, an organization with a normative approach of safety (i.e. it is rule-based safety only that will bring safe actions) will limit the trainers to focus on procedure compliance (Masson, 2013).

To go further, analyzing the attitude of trainers during debriefing becomes relevant to understanding how safety is perceived and implemented in an organization. The attitude of the trainers during debriefing with experienced operators is a safety indicator illustrative of the safety culture of the organization. For instance, a safety analyzer index showing that managed safety is neglected, or worse despised, would signal a poor safety management policy.

Additionally, simulators are also a tool to support safety development in organizations and experiment with new solutions without taking risks. The solutions here cover the introduction of a new tool (new template pressurization diagram, or new manual insufflator), a new organization (2 AIC residents and 1 AIC doctor), or a new way to give feedback in debriefing (specifically introduce REX collection, spread the good informal practices among teams).

For all the reasons above, we claim that simulation sessions are a key intervention place for organizations where one can assess safety management in the organization and that transforming the management of debriefing will have consequences on safety culture.

Finally, we are aware that not all HRO activities, can be supported by simulation sessions. For instance, in the maintenance or design activities it is difficult to have a practice of training on simulators. For those situations, we suggest to identify when and where such discussions take place (e.g. REX context) or to develop dedicated reflexive spaces to support constructive safety progress.

VI. CONCLUSION

From the study of eighteen post-simulation debriefings, we have provided new concrete evidence that they provide a highly relevant space where information can emerge, related to developing constructive safety: the sharing of good practices, the enforcement of rules, the skills enhancement, the discussion on feedback items, and the opportunities for improvement of work organization. These post-simulation debriefings should thus be seen as major assets for organizations to grasp the reality of the many dimensions of real work, to initiate change through debates, and to develop a balanced rule-based/managed safety. By watching closely debriefings, organizations can:

- “sound out” the real practices and have access to manage safety
- get indications on safety culture by analysing the attitude of trainers.

If organizations aims to support the development of constructive safety:

- They have to provide training to simulation trainers to ensure that they interact with trainees in the best way to stimulate a strong emergence of information on real practices within the space of debriefing.
- They can develop constructive safety by introducing improvements in the simulation space.

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