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TITLE: Assessing the team's perception on human factors in the operating environment

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“My Thoughts” Review

1 Human factor failures have been identified as major underlying causes for surgical adverse
2 events. However, the impact of such adverse events might not always be evident nor apparent.¹
3 The operating room (OR) is a unique and high-stress environment. Professionals from various
4 specialties, disciplines and level of seniority are required to work closely together as a team. For
5 effective teamwork, it is hence important to ensure that a shared mental model is perceived by all
6 members of the team. This requires the creation of a supportive and safe environment in which the
7 entire team is able to speak up, and team members know what is expected.² A high level of individual
8 'human factor skills' is required as well. Prior research has demonstrated that OR staff may have
9 discrepant attitudes about the level of human factor skills exhibited from one another, which may be
10 caused by differences in status or authority, responsibilities, and culture.³

11 The Human Factors Analysis and Classification System (HFACS) was developed in response to
12 a trend showing that human error was a primary causal factor in 80% of all flight accidents in the
13 Navy and Marine Corps.⁴ HFACS is based on the "Swiss Cheese" model of human error which looks at
14 Reason's four levels of human failure, including organizational influences, unsafe supervision,
15 preconditions for unsafe acts, and unsafe acts.⁵ The HFACS model, as shown in Figure 1, may offer
16 tools for human factor analysis to plan solutions to prevent human factor failures.⁴

17 In order to get more insights in relevant human factors in the OR, we carried out an
18 international multi-center survey study in St. Michael's Hospital (Toronto, Canada) and the
19 Amsterdam UMC, location AMC (The Netherlands). In both locations, a medical data recorder, the OR
20 Black Box® (ORBB) is in use. Between September 2016 and July 2018, 117 elective laparoscopic
21 procedures were recorded using ORBB. The Surgical Team Assessment Record (STAR) questionnaire
22 was administered in both centers. This questionnaire investigates the HFACS's organizational,
23 environmental and personal factors.⁶ The questionnaire, previously used and validated across
24 different surgical settings, was adjusted to better reflect and fit these HFACS factors possibly leading
25 to unsafe acts in laparoscopic surgery.

26 All 507 questionnaires were completed by the asked team members after each surgical case,
27 of which 230 (91 cases) at St. Michael's Hospital (SMH) and 277 (35 cases) at the Amsterdam UMC.
28 The laparoscopic cases included 40 Roux-Y gastric bypasses, 24 Toupet funduplications, 14
29 diaphragmatic hernia repairs, 4 colorectal resections and 4 uni- or bilateral adrenalectomies. In total
30 for both sites, 119 questionnaires were completed by staff surgeons, 96 by surgical residents, 76 by
31 surgical fellows, 78 by the anesthesiology team members (including anesthesia nurses), 41 by scrub
32 nurses, 44 by circulating nurses, and 53 by medical students.

33 According to the HFACS model, there are several important factors that may lead to peri-
34 operative *unsafe acts* and consequently 'human factor failures' by the OR team. *Personal readiness*,
35 was rated significantly lower by the surgical fellows compared to the rest of the team (median 3/5,
36 IQR 0.0, versus 4/5, F-test p -value <0.0001). The same applied to the fellow's assessment of the
37 team's ability to deal with unexpected events (median of 3/5, IQR 0.0, versus 4/5, F-test P -value
38 <0.0001), and the communication between their team members (median of 3/5, IQR 0.0 versus of
39 4/5 IQR 0.0, F-test P -value <0.0001). These are both important aspect of the team's *crew resource*
40 *management skills*.

41 Why did the surgical fellows rate their own *well-being* significantly lower than their resident
42 counterparts? This may be in part caused by stress surrounding career choices and stability. Other
43 factors known to influence staff well-being include workload, climate, or perceptions of teamwork.
44 These human factor elements have been found to have significant associations with burnout
45 symptoms, job satisfaction and organizational commitment. Burnout symptoms, such as emotional
46 exhaustion, fatigue and an inability to concentrate, may hinder one's capacity to ensure surgical
47 safety.⁷ Teamwork and well-being have been linked in a similar manner to mental stress and surgical
48 performance.⁸ Hence, promoting staff well-being may serve to improve crew resource management
49 skills, organizational outcomes and consequently surgical safety.

50 Concerning the *environmental factors*, the staff surgeons more often identified distractions
51 (51.3%, n=61) and aberrations (60.5%, n=72) during surgery, compared to all the other team

52 members. These were usually related to technological issues, such as inadequate anastomosis
53 closure (n=20), bleeding (n=16), small bowel injury (n=10), malfunction equipment (n=9), or poor
54 trocar placement (n=6).

55 Although distractions or aberrations during surgery are inevitable and almost ‘come with the
56 job’, they can be detrimental to overall team performance. Each team member may have a different
57 sense of what is a distraction or aberration, and thus act differently in identifying threats to surgical
58 safety. Indeed, individuals vary in feeling the urge or responsibility to alert the team on a perceived
59 distraction or aberration. They may act differently taking responsibility attempting to resolve the
60 possible safety threat. Yet, the delivery of safe, high-quality care depends on the sound judgement
61 and decision-making capacity of all members of the operating team. Highly cohesive teams with
62 strongly connected members may support the expression of individual opinions, which may promote
63 identification of an active or latent unsafe acts.⁹ If unsafe acts are identified pro-actively, this may
64 mitigate peri-operative errors, as these are usually the result of a cumulation of minor active or
65 latent aberrations resulting from different factors in the OR.⁵

66 Participants in this survey study were under video and audio monitoring, which may have
67 biased their answers and influenced their work *condition*. The non-obstructive set-up for observation
68 with ORBB may however not attribute much to this possible Hawthorne effect, as one usually forgets
69 a camera not disturbing one’s acts, when focusing at their tasks. The team hence reverted back to
70 normal behaviour very quickly.

71 A deeper understanding of the etiology and effect of environment and personal factors on
72 performance may lead to more targeted and sustainable quality improvement initiatives. A
73 supportive team-based approach is recommended, to limit the amount of unnecessary safety threats
74 during a surgical procedure.² Further work is needed to elucidate the impact of human factors on
75 team performance and surgical safety. Further studies should focus on using objective data, such as
76 derived by ORBB, to evaluate human factor behavior in the OR, and to define what type of human
77 factors are most relevant and valuable to surgical safety, and to incorporate in team-based training.

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