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European military surgical teams in combat theater: A survey study on deployment preparation and experience

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A R T I C L E   I N F O

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A B S T R A C T

Introduction: Adequate (predeployment) training of the nowadays highly specialized Western military surgical teams is vital to ensure a broad range of surgical skills to treat combat casualties. This survey study aimed to assess the self-perceived preparedness, training needs, deployment experience, and post-deployment impact of surgical teams deployed with the Danish, Dutch, or Finnish Armed Forces. Study findings may facilitate a customized predeployment training.

Methods: A questionnaire was distributed among Danish, Dutch, and Finnish military surgical teams deployed between January 2013 and December 2020 ($N = 142$). The primary endpoint of self-perceived preparedness ratings, and data on the training needs, deployment experiences, and post-deployment impacts were compared between professions and nations.

Results: The respondents comprised 35 surgeons, 25 anesthesiologists, and 39 supporting staff members, with a response rate of 69.7 % (99/142). Self-perceived deployment preparedness was rated with a median of 4.0 (IQR 4.0–4.0; scale: 1 [very unprepared]–5 [more than sufficient]). No differences were found among professions and nations. Skills that surgeons rated below average (median <6.0; scale: 1 [low]–10 [high]) included tropical disease management and maxillofacial, neurological, gynecological, ophthalmic, and nerve repair surgery. The deployment caseload was most often reported as <1 case per week (41/99, 41.4 %). The need for professional psychological help was rated at a median of 1.0 (IQR 1.0–1.0; scale: 1 [not at all]–5 [very much]).

Conclusions: Military surgical teams report overall adequate preparedness for deployment. Challenges remain for establishing broadly skilled teams because of a low deployment caseload and ongoing primary specializations. Additional training and exposure were indicated for several specialism-specific skill areas. The need for specific training should be addressed through customized predeployment programs.

Introduction

Recently unfolded international conflicts have increased the urgency of establishing greater military readiness among NATO and other Western allies. According to previous conflicts' case logs, military medical services should be prepared to treat combat casualties, which often involve penetrating injuries due to blasts or gunshots [1]. Such injury patterns differ significantly from those of the regular caseload of most Western surgical teams, indicating that relevant trauma exposure is rare in the non-deployed (i.e., civilian) setting in low-violence countries [2,3].

The issue of low relevant peacetime exposure has been broadly addressed in the American literature [2–4], but it is an even greater challenge in European countries, which have a lower incidence of

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penetrating trauma (approximately 3 % of the trauma population) [5–8]. A relevant caseload is not even guaranteed during military deployment [9]. With ongoing surgical sub-specialization occurring in most European countries, the lack of all-round exposure is progressive. Serious challenges arise in establishing a broadly skilled surgical team for military deployment.

Therefore, considering the low threat levels and low relevant exposure, NATO allies require more comprehensive, standardized preparation efforts when striving for high overall standards of care on NATO missions. Currently, there is no international standardized predeployment training, but various training strategies are available and recommended. For example, trauma care courses (e.g., the Definitive Surgical and Anesthetic Trauma Care course, Battlefield Advanced Trauma Life Support course, and the Advanced Course for Deployment Surgery) [10, 11] and simulation-based training [12] have been shown to contribute to deployment readiness. Military–civilian partnerships with high-volume trauma centers are essential to gain relevant clinical experience [13–16]. However, this leaves the question of whether current training strategies suffice in light of ongoing sub-specialization and low caseload exposure. Thus, it should be evaluated which training needs remain to meet the requisite skills for military surgical deployment as presumed in literature [17–19]. Adequate identification of training needs requires assessment from the trainee's perspective and should be placed in the context of (pre)deployment experience.

This identification and understanding of military surgical teams' training needs in light of their previous (deployment) experience is needed to guide the development of future predeployment training. Therefore, this study aimed to assess self-perceived medical preparedness, training needs, deployment experiences, and post-deployment impact (on skills and mental wellbeing) among surgical teams deployed with the Danish, Dutch, and Finnish Armed Forces.

Ethical approval was granted by the Dutch Ministry of Defence (reference No. DGOO41O 18XXX Semistruc). This research was deemed exempt from the Medical Research Involving Human Subjects Act by the Medical Ethics Committee of the Alrijne Health Institution (reference No. 18.412wb.tk). The Danish and Finnish Defence Forces Health Services formally granted approval for participation.

Materials and methods

The research design is a quantitative observational study in which data were longitudinally collected through a digital questionnaire.

Study subjects and recruitment

The study subjects were military surgical team members deployed with the Danish, Dutch, or Finnish Armed Forces between January 2013 and December 2020. Military surgical teams usually comprise surgeons, anesthesiologists, anesthesia technicians, and (scrub) nurses who have completed full medical training and some military training, the latter of which varies across countries in extent. Military medical professionals typically work in civilian settings and can be deployed on demand for several months, but full-time military medical personnel were also included.

Eligible study participants received an invitation email with project information and a unique web link to a questionnaire. Depending on organizational preference, email addresses were sent to the researchers, or invitation emails were forwarded by the Ministry of Defence. Two weeks later, reminder emails were sent to non-responders. For Dutch non-responders, the emails announced that they would also be contacted by phone, with the option to opt out if they did not wish to be contacted. The informed consent form (Additional File 1) was available via a weblink on the displayed questionnaire. Digitally provided informed consent for study participation was required before the commencement of the questionnaire.

Study context

Each country has a different curriculum for medical professionals deployed by their Armed Forces. The characteristics of Danish, Dutch, and Finnish medical and specialist education are shown in Table 1.

Data collection

Data collection began in April 2020, and databases were definitively closed in August 2022. Teams deployed between January 2013 and April 2020 of any mission type received questionnaires in retrospect. Those deployed between April 2020 and December 2020 received questionnaires after they returned from deployment. The initial data collection period (until the end of January 2021) was extended because of the need to increase the response rate among Dutch military teams, which at that time was $N = 40$ (40.8 %), through phone reminders.

The questionnaire content (Additional File 2) was based on previous surveys on similar topics and was reviewed by experts in military and emergency surgical care, including the authors of this study [20,21]. The questionnaire included questions about participants' backgrounds, work experience, predeployment preparation activities, self-perceived preparedness (predeployment and post-deployment), deployment properties, and deployment's influence on professional development and personal well-being. All questionnaires were in English, and although English language use could have led to bias among non-native English speakers, it was selected for uniformity. Castor EDC was used to develop the questionnaires and collect data [22]. After closing the Castor database, the data were exported to IBM SPSS Statistics (version 27, IBM Corporation, Armonk, New York). After participants had submitted their responses, the collected data were deidentified. All data were stored on encrypted servers at the Radboud University Medical Centre (Radboudumc) and were only made accessible to the researchers involved in this study. The Dutch Ministry of Defence owns the data.

Data analysis

Data analyses were performed using IBM SPSS Statistics (version 27, IBM Corporation, Armonk, New York). Descriptive statistics appear as medians with an interquartile range (IQR) or frequencies with percentages. Comparative analyses were performed across professions (surgeons, anesthesiologists, and supporting staff consisting of [scrub] nurses and anesthesia technicians), nations (Danish, Dutch, or Finnish Armed Forces), and deployment locations (Afghanistan, Iraq, and Mali). The variables compared among these groups included years of clinical experience, self-perceived preparedness, skill ratings, caseload, and time on call during deployment, the need for mental support, and the effect of deployment on personal and professional development. Nominal and ordinal (5-point Likert scale) variables were compared using chi-square testing. Continuous variables were compared with Kruskal–Wallis testing, and these results were displayed with corresponding mean ranks. The mean rank is calculated by ranking all absolute values included in the analysis from the smallest (1) to the largest value ($n =$ the total number of values included). Then, for each group included in the comparison, the mean of these ranks is calculated, and it is tested whether these mean ranks differ between groups. An alpha level of <0.05 was determined to be statistically significant. Missing data were considered missing randomly and were handled accordingly by excluding missing data per analysis instead of excluding these cases from all analyses.

Results

The total response rate was 69.7 % (99/142). Response rates per participating nation were 78.9 % (15/19), 73.2 % (71/98), and 52.0 % (13/25) for the Danish, Dutch, and Finnish Armed Forces, respectively. Among the 43 non-responders were 15 medical specialists

Table 1
Medical and specialist curricular structure.

	Denmark	Finland	Netherlands
General surgery curriculum	• Medical Degree • 1 year surgical residency • 5 years of specialization	• Medical Degree • 6 years of specialization (including 2.25 years of surgical residency)	• Medical Degree • 6 years of specialization
Subspecialties within surgical curriculum	• Colo-rectal • Upper GI • Acute care and trauma	• Gastrointestinal • Breast surgery • General Surgery	• (Orthopedic) trauma • Vascular • Gastrointestinal and Oncology • Paediatric
Surgical specialties eligible for deployment	• Orthopedic surgeons • General surgeons	• All • Most often: orthopedic and general surgeons	• All • Most often: trauma surgeons
Anesthesia curriculum	• Medical Degree • 1 year anesthetic residency • 4 years of specialization	• Medical Degree • 5 years of specialization	• Medical Degree • 5 years of specialization
Scrub nurse curriculum	• 3 years nursing school • Registered nurse	• 3.5 years • Registered nurse	• 3 years • Not a registered nurse
Anesthesia nurse curriculum	• 3 years of nursing school • Registered nurse • Specialization	• 3.5 years • Registered nurse	• 3 years • Not a registered nurse
Mandatory medical predeployment training	• Not mandatory	• Not mandatory	• DSATC course

DSATC Definitive Surgical and Anaesthetic Trauma Care course.

(anesthesiologists or surgeons) and 15 nurses. The profession of 13 non-responders was unknown due to organizational privacy reasons. Respondents' background characteristics are shown in Table 2. Descriptive statistics, in addition to the manuscript text, are provided in the Tables of Additional File 3.

Self-perceived preparedness

Table 3 displays respondents' self-perceived preparedness as rated on a 5-point Likert scale of 1 (very unprepared)–5 (more than sufficiently prepared). All but five missing respondents reported feeling sufficiently prepared for deployment, with a rating of 3 or higher. The median predeployment rating of self-perceived preparedness was 4.0 (IQR 4.0–4.0; minimum 3, maximum 5). No significant differences were found among professions for self-perceived preparedness (surgeons' mean rank, 47.84; anesthesiologists' mean rank, 51.95; and support staff's mean rank, 44.81; $p = 0.527$) or nations (Danish mean rank, 42.03; Dutch mean rank, 51.04; and Finnish mean rank, 35.85; $p = 0.063$). Respondents rated the medical training, knowledge, and skills of their colleagues with a median of 4.0 (IQR 3.0–4.0)) on a scale of 1 (very poor)– 5 (excellent). Four respondents (4/91; 4.4 %; 8 missing) rated their colleagues' skills as insufficient, indicated by a rating of below 3. Respondents deployed with the Armed Forces three or more times rated their self-perceived preparedness higher (mean rank 51.08) than those with two deployments or less (mean rank 41.19; $p = 0.049$). Deployment caseload did not correlate with a lower or higher post-deployment rating of self-perceived preparedness (caseload <1 cases per week with mean rank 40.35 versus caseload 1–20 cases per week with mean rank 46.97; $p = 0.152$).

The ratings of deployment-related medical skills per profession are shown in Tables 4a,b,c. Skills rated below average (median <6.0 on a scale of 1 [low]–10 [high]) are indicated in each table. Comparisons among nations revealed that Danish surgeons rated their skills in reconstructive surgery (mean rank 5.80; $p = 0.023$) and tropical diseases (mean rank 5.80; $p = 0.023$) lower than Dutch (mean rank 18.71 for both skills) and Finnish (mean rank 21.62 for both skills) surgeons. Furthermore, Danish surgeons rated their thoracic surgery skills lower (mean rank 7.40) than Dutch surgeons (mean rank 19.79; $p = 0.030$).

The same trend was observed among Danish support staff, who rated their skills in caring for patients with vascular trauma and hemodynamic instability (mean rank 10.67 versus mean rank 22.80; $p = 0.045$) and neurotrauma (mean rank 8.17 versus mean rank 23.17; $p = 0$ 0.009) and providing care for patients in the intensive care unit (mean rank 10.25 versus mean rank 23.15; $p = 0.019$) significantly lower than Dutch support staff.

Preparation activities

The most valued preparation activities for deployment were military courses on trauma care, emergency care, and advanced life support (52/99, 52.5 %); training on crew resource management or team dynamics (50/99, 50.5 %); and clinical placement in a trauma center with high numbers of severe trauma injuries (50/99, 50.5 %). The most frequently attended predeployment courses were Advanced Trauma Life Support (60/99, 60.6 %), Advanced Life Support (59/99, 59.6 %), Battlefield Advanced Trauma Life Support (47/99, 47.5 %), Emergency Management of Severe Burns Course (46/99, 46.5 %), and the Definitive Surgical Trauma Care course (38/99, 38.4 %).

Deployment characteristics

The three most reported countries as the last deployment location were Afghanistan (45/99, 45.5 %), Iraq (28/99, 28.3 %), and Mali (10/99, 10.1 %). Most respondents noted that they were on call 20–24 h per day (54/99, 54.5 %), and seven days a week (42/99, 42.4 %) during deployment. A caseload of less than one case per week (41/99, 41.4 %) or 1–20 cases per week (35/99, 35.4 %) was most frequently reported. Dutch deployed teams reported a significantly higher caseload than Danish and Finnish teams ($p = 0.015$). One respondent has mentioned a caseload of 81–100 cases per week.

About half of the respondents (45/99, 45.5 %) reported having treated injuries outside their field of expertise less than once a month. A greater proportion of support staff (26/39 66.7 %) noted this low frequency than surgeons (12/35, 34.3 %) and anesthesiologists (7/25, 28.0 %; $p = 0.009$). The same trend was seen in the Danish teams (12/15, 80.0 %) compared to the Dutch (26/71, 36.6 %) and Finnish (7/13, 53.8 %; $p = 0.039$) teams. The quality of care during deployment at the resuscitation room and the military Role 2 or 3 Medical Treatment Facilities (MTFs) were both rated with a median of 8.0 (IQR 7.0–9.0) on a scale of 1 (low)– 10 (high). A military Role 2 MTF involves services such as triage, advanced resuscitation, damage control surgery, intensive care, short hospitalization, and evacuation preparation to a higher care level. A Role 3 MTF is usually a field hospital where specialist surgical and medical care is delivered.

Table 2
Respondents' background characteristics.

Characteristics	N (%)
Sex (N,%); $N = 99$	
Male	76 (76.8 %)
Female	23 (23.2 %)
Age in years (median, IQR); $N = 99$	47.0 (41.0–53.0)
Country (N,%); $N = 99$	
Denmark	15 (15.2 %)
Finland	13 (13.1 %)
Netherlands	71 (71.7 %)
Profession (N,%); $N = 99$	
Supporting staff	39 (39.4 %)
Surgeon	35 (35.4 %)
Anesthesiologist	25 (25.3 %)
Surgical specialties (N,%)[a]; $N = 35$	
Breast/endocrine surgeon	1 (2.9 %)
Gastrointestinal surgeon	6 (17.1 %)
General surgeon	17 (48.6 %)
Orthopedic surgeon	8 (22.9 %)
Surgical oncologist	2 (5.7 %)
Trauma surgeon	24 (68.6 %)
Vascular surgeon	5 (14.3 %)
The abovementioned plus ≥2 years of specialization in general trauma surgery	3 (8.6 %)
Other (senior resident in orthopedics & traumatology)	1 (2.9 %)
Supporting staff / Nursing specialties (N,%)[a]; $N = 39$	
Certified Registered Nurse Anesthetist	4 (10.3 %)
Emergency Department nurse	23 (59.0 %)
Intensive Care Unit nurse	31 (79.5 %)
Operation theatre nurse	2 (5.1 %)
Teaching nurse	2 (5.1 %)
Ward nurse	1 (2.6 %)
Other	
Paramedic	1 (2.6 %)
Specialized for medical and surgical nursing	1 (2.6 %)
Ventilation practitioner	2 (5.1 %)
Intense Care Unit (training year 3)	1 (2.6 %)
Years since MD[b] (median, IQR); $N = 54$	21.5 (15.0–28.0)
Years since specialization[b] (median, IQR); $N = 51$	12.0 (7.0–17.0)
Years since registration as nurse (median, IQR); $N = 38$	17.0 (12.8–26.3)
Return from last deployment	
≤2017	17 (17.2 %)
2018	20 (20.2 %)
2019	26 (26.3 %)
2020	19 (19.2 %)
2021	7 (7.1 %)
Missing	10 (10.1 %)
Contract with military; $N = 99$	
Full time military medical personnel	23 (23.2 %)
Mainly working in civilian hospital, but deployment related military contract	74 (74.7 %)
Other ("voluntary")	1 (1.0 %)
Missing	1 (1.0 %)
Number of deployments with Armed Forces[c]; $N = 99$	
0	2 (2.0 %)
1	18 (18.2 %)
2	17 (17.2 %)
3	18 (18.2 %)
4	10 (10.1 %)
≥5	33 (33.3 %)
1 deployment of shorter duration than 28 days (exploratory mission)	1 (1.0 %)
Previous deployment experience with organizations other than the Armed Forces; $N = 96$	11 (11.5 %)

[a] Multiple answers possible.
[b] For surgeons and anesthesiologists.
[c] Deployments with a minimum duration of 28 days.

Table 3
Self-perceived preparedness.

	Median (IQR)	N
Pre-deployment		
Total	4.0 (4.0–4.0)	94[a]
Surgeons	4.0 (4.0–4.0)	34
Anesthesiologists	4.0 (4.0–5.0)	21
Nurses	4.0 (4.0–4.0)	39
Post-deployment		
Total	4.0 (4.0–4.0)	88[b]
Surgeons	4.0 (4.0–4.0)	31
Anesthesiologists	4.0 (4.0–5.0)	20
Nurses	4.0 (4.0–4.5)	37

[a] Missing $N = 5$.
[b] Missing $N = 11$
Scale 1 (very unprepared)–5 (more than sufficiently prepared).

Table 4a
Skill ratings by surgeons.

Skills	Rating ($N = 34$) Median (IQR)
Ophthalmic surgery	3.0 (2.0–4.3) [a]
Maxillofacial surgery	4.0 (3.0–5.0)[a]
Obstetrics/Gynecology	4.0 (2.0–5.3) [a]
Neurosurgery	4.0 (3.0–6.0) [a]
Nerve repair techniques	4.0 (2.0–6.0) [a]
Tropical diseases	5.0 (3.0–6.3) [a]
Pediatrics	5.0 (3.0–6.3) [a]
Plastic (reconstructive) surgery	6.0 (4.0–7.0)
Urology	6.0 (4.0–7.0)
Sonography/Ultrasound skills	7.0 (6.0–8.0)
ICU care	6.0 (5.8–8.0)
Pediatric surgery	7.0 (6.0–8.0)
Thoracic surgery	7.0 (6.0–8.0)
Hand surgery	7.0 (6.0–8.0)
Vascular surgery	7.0 (6.0–8.0)
Burn treatment	7.5 (6.8–8.0)
Antibiotic selection/management	8.0 (7.0–8.3)
Resuscitation	8.0 (7.0–9.0)
Abdominal surgery	8.0 (7.0–9.0)
Amputation techniques	9.0 (9.0–10.0)
Soft tissue surgery	9.0 (8.0–9.0)
Fracture surgery	9.0 (8.0–10.0)
Triage skills	9.0 (8.0–9.3)
(Surgical) decision making	9.0 (9.0–10.0)

[a] rating of <6.0
Scale 1 Low – 10 High.

When asked whether future deployments should be combined with NATO member countries, 55.6 % (55/99) of respondents supported it, 27.3 % (27/99) stated that it would depend on which country, and one respondent (1/99, 1.0 %) opposed it (16 missing responses). Opinions on shortening deployment durations for some professions varied, but most respondents (56/99, 56.6 %) did not consider it an option.

Deployment's influence on professional development and well-being

Military deployment did not seem to significantly impact respondents' trauma management skills and primary specialization skills, as these were respectively rated with a median of 3.0 (IQR 3.0–4.0) and 3.0 (IQR 3.0–3.0) on a scale of 1 (much deteriorated)–5 (much improved). The effects of deployment on personal development, personal lives, and personal finances were respectively rated with medians of 4.0 (IQR 3.0–4.0), 3.0 (IQR 3.0–3.0), and 3.0 (IQR 3.0–4.0) on a scale of 1 (major negative)– 5 (major positive). Surgeons reported a relatively greater negative effect on their personal lives than support staff (mean rank 35.35 versus mean rank 52.29; $p = 0.005$), as did Dutch deployed teams compared to Finnish teams (mean rank 41.46 versus mean rank 64.08; $p = 0.010$). As a reflection of potential long-term effects,

Table 4b
Skill ratings by anesthesiologists.

Skills	Rating (N = 21) Median (IQR)
Tropical diseases	5.0 (3.5–6.5)[a]
Sonography/ultrasound skills (other than used for loco-regional anesthesia or central canulation) like TTE or TEE	6.0 (4.0–7.0)
Antibiotic selection and/or management	6.0 (3.5–8.0)
Anesthetic care for burn patients	7.0 (5.0–9.0)
Involvement/exposure in prehospital trauma treatment (ambulance, HEMS or equivalent)	7.0 (5.5–9.3)[b]
Anesthetic care for pediatric patients	7.0 (7.0–8.5)
Skills for (emergency) tracheostomy, cricothyrotomy or coniotomy	8.0 (5.5–8.0)
Anesthetic care for neurosurgery	8.0 (5.5–10.0)
Anesthetic care for thoracic surgery	8.0 (7.0–9.0)
Anesthetic skills in one-lung ventilation (double lumen tubes, bronchus blockers or equivalent)	8.0 (7.0–9.5)
Intubation skills for maxillo-facial trauma	8.0 (6.5–9.0)
Triage skills	8.0 (7.0–9.0)
Involvement/exposure in trauma treatment in the A&E department	8.0 (7.0–10.0)[b]
Anesthetic care for vascular surgery	8.0 (8.0–10.0)
Involvement/exposure in critical care or ICU	9.0 (7.0–9.0)
Involvement/exposure in cardiopulmonary resuscitation (not traumatic)	9.0 (7.0–10.0)
(Sonography/ultrasound guided) loco-regional anesthetic techniques	9.0 (8.0–10.0)
Involvement/exposure in damage control resuscitation and/or hemostatic resuscitation	9.0 (7.8–10.0)[b]
Anesthetic care for obstetric and/or gynecology surgery	9.0 (8.0–10.0)
Intubation skills for difficult airway (video assisted laryngoscopy, bronchoscopy or equivalent)	9.0 (8.0–10.0)
(Sonography/ultrasound guided) central canulation techniques (jugular, subclavian or femoral)	9.0 (8.0–10.0)
Anesthetic care for gastro-intestinal and/or abdominal surgery	9.0 (8.0–10.0)
(Anesthetic) decision making	10.0 (9.0–10.0)

[a] rating of $\leq$5.5<6.0.
[b] $N = 22$
Scale 1 Low – 10 High.

Table 4c
Skill ratings by nurses.

Skills	Rating (N = 39) Median (IQR)
Newborn NCD management	2.0 (1.0–4.0)[a]
Care of the obstetric patient	3.0 (2.0–5.0)[a]
Tropical disease management	3.0 (2.0–5.0)[a]
Care of the pediatric patient	5.0 (4.0–7.0)[a]
Care of patients with traction devices or external fixators	6.0 (4.0–7.0)
Care of patients with burn injuries	6.0 (5.0–8.0)
Triage and mass casualty management	7.0 (5.0–8.0)
Care of the patient with neurotrauma	7.0 (5.0–9.0)
Wound care	7.0 (6.0–9.0)
Tourniquet application	8.0 (6.0–9.0)
Pain management	8.0 (7.0–9.0)
Care of patients with vascular trauma/hemodynamic instability	8.0 (7.0–10.0)
ICU care	10.0 (8.0–10.0)

[a] rating of <6.0
Scale 1 Low – 10 High
NCD Non-communicable disease.

respondents who had returned from deployment in 2018 or before did not rate the effects of deployment on personal development or their private situation at home differently than respondents who had returned more recently ($p = 0.118$ for personal development and $p = 0.931$ for situation at home).

Respondents rated their need for debriefing during deployment with a median of 3.0 (IQR 2.0–4.0) on a scale of 1 (not at all)–5 (very much). Seventy-nine respondents (79/99, 79.8 %) declared that debriefing occurred during their last deployment. Informal debriefing was valued with a median rating of 4.0 (IQR 3.0–5.0) and formal debriefing with a median of 4.0 (IQR 3.0–4.0) on a scale of 1 (not important at all)–5 (absolutely essential). Respondents who have experienced a deployment caseload of 1–20 cases per week reported a greater need for debriefing (mean rank 51.89) than those who experienced a lower caseload (<1 cases per week with mean rank 37.75; $p = 0.007$).

The need for professional psychological help was scored with a median score of 1.0 (IQR 1.0–1.0). There were no significant differences among professions or nations when comparing this need. The top three activities deemed most helpful for coping with stress were the follow-up of individual team members (50/99, 50.5 %), stress management training before deployment (33/99, 33.3 %), and the availability of a mental health professional during deployment (32/99, 32.3 %).

Discussion

This study showed that all military surgical team members reported sufficient self-perceived preparedness for their tasks during deployment. Nevertheless, several specialty-specific skills were identified as below average. The low caseload during deployment raises concerns about skill maintenance. A low need was found for debriefing and psychological help during deployment.

The military surgical teams of the studied NATO allies have not noticed a recent decline in skills [20]. Although the use of subjective measurements poses a risk of overestimation of skills, the peer-rated preparedness level was only slightly lower than the self-perceived preparedness rating. Additionally, the limited caseload may correspond with higher levels of subjectively measured preparedness, indicating that self-perceived preparedness levels could decrease when the caseload increases.

Adequate self-perceived preparedness for unpredictable deployment circumstances in the absence of significant recent deployment experience could result from a construct called adaptive expertise. Adaptive expertise is the ability to overcome changes in work requirements using expert knowledge in innovative ways [23]. An adaptive expert can innovatively apply their routine expertise in non-conflict-related trauma care to effectively approach conflict-related injuries. This adaptability will be specifically important considering that most military surgical team members gain their trauma experience in a civilian, non-conflict setting.

When comparing medical professions, nurses have been previously concerned about feeling insufficiently prepared for deployment, mainly because they anticipate managing injuries and diseases that they do not often treat in non-deployed settings [24,25]. The current findings did not show significant differences between military nurses and specialists in their self-perceived preparedness, which might be attributable to the nurses' median work experience of nearly 20 years.

Despite an overall sense of deployment readiness, military surgical teams still expressed a need for additional training in specific skills. The skills that Dutch surgeons who were deployed to Afghanistan between 2006 and 2010 rated as below average overlap with our findings (insufficient skill ratings in maxillofacial, ophthalmic, neurological, and gynecological surgery), now with a specification of unsatisfactory skills in nerve repair techniques and tropical diseases [20]. This trend likely reflects the ongoing sub-specialization of surgeons, which is most prominent within the Danish surgical curriculum (Table 1) among the surveyed nations. This could explain why Danish surgeons rate their skills in reconstructive or thoracic surgery lower than Dutch and Finnish military surgeons.

Profound sub-specialization limits the range of surgical care available at deployment facilities. However, most of the skills highlighted as needing further training are listed in guidelines on surgical requirements for military deployment to ensure a broad spectrum of limb-saving and lifesaving procedures [18,19]. On top of intensified training, telemedicine could aid in the extension of the surgical services available in a Role 3 treatment facility. A recent study demonstrated that it was feasible to provide telemedicine support from a senior surgeon for combat medics when performing a lower leg fasciotomy [26].

Still, gaining relevant exposure is vital when preparing for the delivery of acute trauma care in a deployment setting. This is supported by the finding that previous deployment experience correlated with increased confidence in trauma skills, which is in line with previous research [20,29]. For a first-time deployment, deployment preparation is recommended to fundamentally consist of relevant clinical experience, preferably through at least three to six months' work experience in a high-volume trauma center. It is advised to go on an onboarding mission first, operating under the supervision of a more senior colleague. For maintenance training after the first deployment, preferably at least one month per year should be devoted to a clinical placement in a high volume trauma center. International collaboration will be indispensable to reach adequate exposure in penetrating and severe multisystem injuries. An example of the latter is the mutually beneficial collaborative program between a major South African trauma service and the Dutch Ministry of Defence [30]. Note that such programs should comprise regulated fellowships in which the exchanged medical professionals work under local supervision, and preferably fulfill mutual objectives. Additional predeployment exposure can be provided through formal training (i.e., trauma care courses or scenario-based team training before or during deployment), but a course format is unexpected to generate full proficiency in the required technical skills and should be valued accordingly.

On top of mastering the fundamentals of trauma care and damage control surgery, supplementary customized predeployment training is recommended to meet the varying training needs based on educational background and location-specific requirements. Besides interprofessional training in other specialties (i.e., a trauma surgeon rotating through vascular, maxillofacial, and plastic surgery), intra-professional training might be equally important. Surgeons that are primarily trained to perform laparoscopy or endovascular procedures should be prepared to perform open procedures. Selected courses on specific skill areas can be attended to fill individual skill gaps. If known beforehand, analysis of conflict specifications (i.e., expected patient population, type and mechanisms of injury, and time to reach the treatment facility) will allow for deployment-specific training recommendations.

Based on the diversity of specialty-specific skills that were rated as insufficient in this study, together with the trend of sub-specialization, competency-based deployments of expanded teams could be considered. However, it can be challenging to generate such a large number of military medical personnel, especially since peacetime exposure is already limited.

Along with surgical skill preparation for deployment, there should be psychological preparation and support. The reported low psychological deployment impact might be partly explained by a correspondingly low caseload. Nevertheless, an organizational psychological support system should be in place for the psychological stress that is inherent to the working conditions in a conflict zone (i.e., being away from home, having limited contact with family members, and experiencing the local threat of the conflict). Various debriefing strategies are widely used to reduce negative psychological effects after military deployment [27,28]. All three studied nations have psychological support systems in place, which could have contributed to the low need for debriefing and psychological help after deployment. The Dutch Ministry of Defence has implemented a mandatory debriefing and adaptation period immediately following deployment, during which the team stays in a third location (non-deployment and not at home). The Finnish Ministry of Defence holds a mandatory two-day debriefing session following deployment for one of the military units in Finland. In Denmark, all deployed medical personnel undergo mandatory psychological screening and are offered a consultation with a psychologist after deployment.

Strengths and limitations

This is the first international study of three European military allies to evaluate the multiple deployment aspects of their surgical teams, including their sense of preparedness, training needs, and deployment experiences and impact. The response rate approaches 70 % of all surgical team members that have been deployed over almost a decade, which supports the credibility of the results.

One main limitation that impairs the generalizability of the study findings is that military surgical training requirements vary depending on deployment location, previous experience, and training background. Respondents comprised a fairly senior group of medical professionals, and the training needs of less experienced individuals might shift more towards the fundamentals of (damage control) trauma care. On the other hand, the training needs of this experienced group might better reflect the additional needs that are specific for trauma care in a conflict zone. Several subanalyses have been performed to assess the relationship between the varying background characteristics and self-perceived preparedness levels, but definitive causative conclusions could not be drawn and do not lie within the scope of this study. The study results might be applicable to other nations and organizations that deploy teams with similar primary medical curricula and clinical work environments.

Furthermore, the low caseloads that were faced by the deployed study participants could limit the potential to draw conclusions on the actual skill requirements for deployment. However, the respondents have significant (military) experience beyond the studied deployment periods (Table 1), and it is likely that their indicated training needs will overlap with actual training requirements.

Although the questionnaire used was based on previous studies and reviewed by military medical experts, it was not further validated with a pilot study. A pre- and post-deployment questionnaire design could provide additional information on whether predeployment expectations and preparations met the actual deployment requirements. Furthermore, a low deployment rate required a broad data collection period, but the wide range of deployment periods might have led to recall bias in cases where the most recent deployment was more than a year ago.

Conclusions

Besides demonstrating sufficient self-perceived preparedness among the members of deployed Danish, Dutch, and Finnish military surgical teams, this study confirmed that several known challenges are still pressing for European military organizations regarding establishing readiness levels for a broad range of surgical skills. Gaining relevant clinical experience is a significant contributor toward deployment readiness, but it is also a growing challenge. This study identified the specialty-specific skill areas for which military surgical team members requested more training and exposure. However, because of low relevant caseloads, it will require targeted efforts to meet these training needs through clinical placements, exchange programs, and formal military surgical courses. An extended international collaboration between deploying military organizations to ultimately define international standards for military surgical teams should be the focus of future projects.

Availability of data and materials

Descriptive data generated during this study are included in the published article and its supplementary information files. The primary research data are not publicly available. The Netherlands Ministry of Defence owns the data.

Additional files

Additional file 1. Informed consent form (pdf)

Additional file 2. Questionnaire (pdf)

Additional file 3. Descriptive statistics (pdf). This file contains descriptive data which is not otherwise incorporated in the manuscript

CRediT authorship contribution statement

Frederike J.C. Haverkamp: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Thijs T.C.F. Van Dongen:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Validation, Writing – review & editing. **Michael J.R. Edwards:** Conceptualization, Methodology, Resources, Supervision, Validation, Writing – review & editing. **Thomas Boel:** Conceptualization, Data curation, Investigation, Methodology, Resources, Supervision, Validation, Writing – review & editing. **Antti Pöyhönen:** Conceptualization, Data curation, Investigation, Methodology, Resources, Supervision, Validation, Writing – review & editing. **Edward C.T.H. Tan:** Conceptualization, Data curation, Investigation, Methodology, Resources, Supervision, Validation, Writing – review & editing. **Rigo Hoencamp:** Conceptualization, Data curation, Investigation, Methodology, Resources, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.111320.

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