

Surgical care at sea: A retrospective review of the maritime surgical and quality improvement database

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BACKGROUND:	Surgical care aboard US Navy warships is delivered in a uniquely austere and operationally complex environment characterized by limited diagnostic resources, constrained evacuation options, and independent surgical practice within an active weapons platform. Despite its importance to military medical readiness, objective outcomes-based evaluations of surgical care performed at sea remain limited.
METHODS:	We performed a retrospective review of a prospectively maintained Maritime Surgery and Quality Improvement database from February 2021 through December 2024, supplemented by longitudinal outcome data from the electronic medical record. Operative cases performed at sea were analyzed to characterize case mix, complication rates, and short and long-term outcomes. Complications were assessed intraoperatively, within 30 days, and up to one year following surgery when electronic follow-up was available.
RESULTS:	A total of 839 entries were recorded, including 322 operative cases and 22 nonoperative patients requiring MEDEVAC. Operative procedures encompassed a broad range of general surgical, orthopedic, gynecologic, urologic, and endoscopic pathology. Maritime surgeons managed both routine and high-acuity conditions, frequently outside traditional general surgery scope, in the absence of subspecialty support. Among operative cases, one intraoperative complication (0.3%) and 24 early postoperative complications (7.1%) were observed. Delayed complications occurred in 11 patients (5.3%) with available long-term follow-up. No deaths were attributed to surgical complications. Selected higher-acuity procedures, including laparoscopic cholecystectomy and diagnostic laparoscopy, were successfully performed at sea in carefully selected patients.
CONCLUSIONS:	In this multiyear, multiplatform cohort, carefully selected surgical interventions were performed safely at sea across a wide range of operative pathologies, with complication rates comparable to civilian benchmarks despite significant resource constraints. These findings provide objective data to inform operative decision-making, support surgeon–command risk assessment, and guide the development of evidence-informed clinical practice guidelines for surgical care in the deployed maritime environment. (<i>J Trauma Acute Care Surg.</i> 2026;00:00–00. Copyright © 2026 Wolters Kluwer Health, Inc. All rights reserved.)
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Performing surgery aboard a US Naval warship is fundamentally different than other forward-deployed settings. Maritime surgeons typically deploy on a single-surgeon team responsible for the elective and emergency surgical care of 5,000 to 7,000 Sailors and Marines em-

barked with an amphibious ready group or carrier strike group.¹ This surgical care is provided along the frontlines on the naval warship—where diagnostic resources are limited, and evacuation options may be constrained or unavailable.

Clinical decision-making in this environment is shaped by dynamic mission requirements, time and distance to higher echelons of care, weather conditions, and aircraft availability for evacuation. Furthermore, the final authority to operate does not rest with the surgeon but with the ship's commanding officer. Therefore, operative decisions must balance patient needs and surgical risk against mission demands and operational considerations.² Compounding these challenges, most maritime surgeons are new graduates of either Navy or civilian residency programs and deploy early in their careers. Therefore, they are heavily reliant on informal mentorship, experiential learning, and knowledge transfer from predecessors.

Although prior retrospective studies and case reports suggest that elective and emergency surgical care can be performed safely at sea, existing evidence is limited

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by small sample sizes, fragmented surgeon logs, and a lack of generalizability.³⁻⁹ Long-term outcomes have not been systematically evaluated, and objective outcomes-based evaluations of shipboard surgical care remain limited.¹⁰

To address these gaps, the Maritime Surgery and Quality Improvement (MSQI) Program was established in 2021 to formalize the capture and review of surgical care delivered at sea. Before MSQI, no comprehensive mechanism existed to systematically document operative decision-making, complications, or outcomes in the deployed maritime environment. The present study provides the initial analysis of this data set, with the objective of defining the scope of surgical care delivered at sea, evaluating associated complications, and generating evidence to support informed operative decision-making in the maritime environment. We hypothesized that carefully selected surgical care could be performed safely at sea with acceptable complication rates.

METHODS

We performed a retrospective review of the prospectively maintained MSQI database from its inception in February 2021 to December 2024, supplemented by longitudinal outcome data from the Defense Health Agency (DHA) electronic medical record (EMR). The study was reviewed and approved by the hospital's Institutional Review Board. This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (Supplemental Digital Content 1, <http://links.lww.com/TA/F423>).

DATA SOURCES

Maritime Surgery and Quality Improvement Surgical Log

US Navy surgeons assigned to naval warships, including aircraft carriers (CVN) and amphibious warships, prospectively recorded operative cases, minor procedures, and surgical evacuations occurring while at sea in a standardized surgical log. Medical evacuations (MEDEVACs) were logged regardless of whether the surgery was performed onboard or deferred to a shore-based facility. Data entry was completed by the operating surgeon and included patient demographics, procedural details, urgency of intervention, intraoperative findings, immediate postoperative outcomes, and surgeon-reported 30-day outcomes. A complete list of variables captured in the MSQI surgical log is provided in Supplemental Digital Content 2 (<http://links.lww.com/TA/F424>). Participation in the MSQI program was voluntary during the study period.

Defense Health Agency Electronic Medical Record Review

To capture longer-term postoperative outcomes, a DHA EMR review was performed for patients with suf-

ficient identifying information documented in the MSQI log. EMR review captured postoperative complications, readmissions, reoperations, and subsequent medical or surgical interventions for up to one year following the index operation.

Not all MSQI entries contained sufficient identifiers to permit EMR linkage, and not all patients had complete medical records available. Accordingly, EMR-based outcomes were analyzed as a predefined subset and reported separately.

Outcomes and Definitions

Operative cases were defined as surgical interventions requiring formal surgical decision-making and involving meaningful clinical risk. Author consensus (S. S., K.C., K.W.M., and M.D.T.) was used to determine case classification and included all operative cases performed under general or regional anesthesia, as well as emergent or urgent endoscopy performed under monitored anesthesia care. Minor procedures not meeting these criteria were excluded from outcome analyses. Operative case type was defined by the procedure recorded in the MSQI surgical log. Cases logged as laparoscopic appendectomy or other definitive therapeutic procedures were classified as therapeutic operations regardless of preoperative diagnostic uncertainty or final pathology. Only cases recorded by the surgeon as diagnostic laparoscopy (DL) or DL converted to laparotomy were classified as DL.

Complications were defined as any deviation from the expected postoperative course attributable to the surgical intervention or underlying surgical pathology. Complications were categorized as intraoperative, early (≤ 30 d), or delayed (> 30 d) and were reported descriptively.

Outcomes were evaluated only for operative cases. EMR-derived outcomes were obtained through DHA chart review and included objectively documented postoperative events recorded within the medical record for up to one year following surgery, depending on the timing of the operation relative to the study end date.

Statistical Analysis

Descriptive statistics were used to summarize patient demographics, procedural characteristics, and outcomes. Continuous variables are reported as median with interquartile range or mean with SD, as appropriate. Categorical variables are reported as counts and percentages. No inferential statistical comparisons were performed, given the descriptive nature of this analysis.

Missing Data

Missing data was anticipated due to the operational environment, limitations in connectivity, and incomplete patient identifiers within the MSQI surgical log. EMR-derived outcomes could only be assessed for cases with sufficient identifying information and accessible DHA records. Analyses were conducted using available data

without imputation, and denominators are reported where relevant.

RESULTS

Case Volume and Study Cohort

From February 2021 through December 2024, 839 entries were recorded in the MSQI database (Fig. 1). Twenty-two cases represented nonoperative MEDEVACs without onboard surgical intervention. These cases included patients with suspected surgical pathology as well as patients with severe medical illness managed by the shipboard surgeon in a consultative role, reflecting the breadth of clinical responsibility in the deployed maritime environment. Clinical details for these cases are summarized in Supplemental Digital Content 4 (<http://links.lww.com/TA/F426>).

After exclusion of nonoperative MEDEVACs, 817 procedures remained for analysis, including 322 operative cases and 495 minor procedures. Outcome analyses were restricted to operative cases, of which 206 (64.0%) had sufficient identifying information to permit linkage to the DHA EMR for longitudinal follow-up. Operative cases without EMR linkage were retained for analysis of intraoperative and 30-day surgeon-reported outcomes but excluded from longer-term outcome analyses.

Demographics

Patient and operational characteristics of operative cases are summarized in Table 1. Operative procedures were performed in a predominantly young, active-duty population that was disproportionately male and enlisted. Procedures were performed across 34 deployments by 32 surgeons on aircraft carriers and amphibious warships. Most surgeons were undertaking their first postresidency deployment (72%). Two surgeons were within two years of residency completion, while seven had five or more years of experience and at least one prior deployment. Eighteen surgeons (56%) completed Navy residency training, and 14 completed civilian residency training. During the study period, 100% of at-sea surgeons assigned to a CVN or amphibious platform participated despite the voluntary nature of participation.

Operative Case Mix

The 322 operative cases reflected the diversity of surgical pathology encountered in the maritime environment (Table 2). General surgery procedures accounted for the largest proportion of cases and included appendectomy, DL, hernia repair, and management of complex soft tissue and perianal infections. Less frequent but higher-acuity procedures included laparoscopic cholecystectomies, an orchiopexy for testicular torsion, and DL. DL was performed in 10 operative cases, seven of which were females. Of these, eight resulted in a therapeutic intervention, two were negative explorations (all female), and five required conversions to laparotomy.

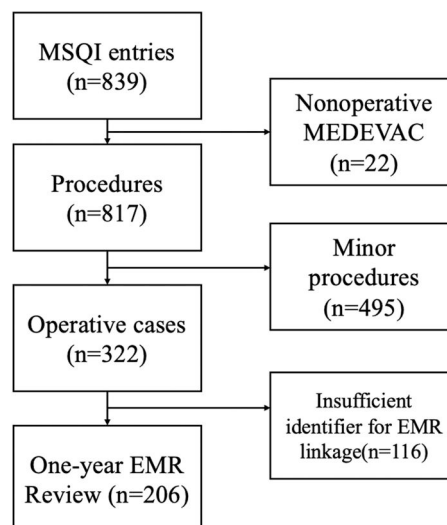


Figure 1. Flow diagram of MSQI case identification and cohort selection.

Pathology included ovarian torsion or ruptured cyst (n = 3), small bowel obstruction due to volvulus, foreign body, intussusception, and newly diagnosed Crohn's disease (n = 4; all males), and ruptured ectopic pregnancy.

A substantial proportion of operative cases involved non-general surgery pathology, including orthopedic and hand trauma, gynecological procedures, urologic procedures, and advanced endoscopy (Table 3). The most common orthopedic procedures were operative washout and debridement for extremity infections, repair of traumatic lacerations, and treatment of open fractures. Indications for esophagogastroduodenoscopy were primarily acute food impaction and evaluation of upper

TABLE 1. Demographics

Demographics	n (%)
Deployments	34
Surgeons,	32
Platform type	
Aircraft carrier (CVN)	251 (78.0)
FST	71 (22.0)
Age, years	
Median (IQR)	22 (21–31)
Sex*	
Male	250 (77.6)
Female	71 (22.0)
Rank	
Enlisted	300 (93)
Officer	22 (7)
Body mass index, kg/m ²	
Mean	27

*Note, sex demographic not available for 1 patient.
FST, fleet surgical team; IQR, interquartile range.

TABLE 2. Procedure Types

Case Type	Case Details	Count
Appendectomy	Laparoscopic	66
	Open	5
Pilonidal disease	Trephination	23
	Cystectomy	20
	Abscess drainage	12
Incision and drainage	Perianal	21
	Other	14
	Bartholin	6
Endoscopy	EGD	19
	Colonoscopy	7
Hernia repair	Inguinal	13
	Umbilical	9
Hand	Trauma	10
	Laceration repair	5
Lumps and bumps	Washout	3
	Lipoma and cyst removal	16
	Laceration repair	6
Non-hand orthopedics	Washouts	15
	Operative reduction	1
Debridement	Burn	9
	NSTI	9
Anorectal	EUA	5
	Hemorrhoid	3
DL	Remained laparoscopic	5
	Converted to open	5
Cholecystectomy	Laparoscopic	6
Other procedures		9

NSTI, Necrotizing Soft Tissue Infection; EUA, Exam Under Anesthesia.

gastrointestinal symptoms refractory to medical management. All non-general surgery operative cases were managed by maritime general surgeons.

Short-term Complications

Among the 322 operative cases, one intraoperative complication occurred. Within 30 days postoperatively, 23 patients (7.1%) experienced a complication (Table 4). Most events were wound-related or infectious in nature, including surgical site infections, hematomas, and recurrent abscesses. Complications occurred most frequently following procedures performed for infectious or soft tissue pathology. A detailed listing of events is provided in Supplemental Digital Content 3 (<http://links.lww.com/TA/F425>).

TABLE 3. Procedure Category by Subspecialist

Procedure Category	n (%)
General surgery	242 (75)
Orthopedic/hand trauma	34 (11)
Gynecologic emergencies	16 (5)
Urologic pathology	4 (1)
Gastroenterology	26 (8)

TABLE 4. Short-term Complications

Complication	n (%)
Intraoperative complication	1 (0.3)
Any 30-day complication	24 (7.1)
Recurrent abscess	4 (1.2)
Hematoma	4 (1.2)
Requiring drainage	3 (0.9)
Surgical site infection (total)	6 (1.8)
Deep infection	1 (0.3)
Return to operating room	1 (0.3)
Delayed wound healing	5 (1.5)
Acute kidney injury	1 (0.3)
Postoperative urinary retention	1 (0.3)

NSTI, Necrotizing Soft Tissue Infection; EUA, Exam Under Anesthesia.

Delayed Complications (30 Days to 1 Year)

Among the 206 operative cases with available one-year EMR follow-up, 11 patients (5.3%) experienced a complication occurring between 30 days and one year following the index operation (Table 5). Most delayed complications reflected recurrence of disease or chronic wound-related issues, particularly following the treatment of subcutaneous abscesses or pilonidal disease. Chronic pain or functional symptoms were documented in three patients. Flexor tenosynovitis with contracture occurred in two patients, and one incisional hernia was identified following exploratory laparotomy. A detailed listing of events is provided in Supplemental Digital Content 3 (<http://links.lww.com/TA/F425>).

Appendectomy

Of 39 appendectomies with available pathology, 72% (n = 30) were appendicitis, 13% (n = 5) normal appendix, and 10.5% (n = 4) had fibrous obliteration. Malignancy was identified in 5% of appendectomies (n = 2), including appendiceal adenocarcinoma and lymphoma of the appendix.

Mortality

Three deaths occurred during the study period. All deaths were attributed to medical causes rather than surgical complications. Accordingly, these deaths were not classified as surgical complications. In each case, the maritime surgeon performed lifesaving interventions before patient death as part of the resuscitation (chest tube insertion, emergent intubation, central line placement).

DISCUSSION

This study provides the first comprehensive description of surgical decision-making and outcomes across US Navy operational maritime platforms, offering insight into real-world practice in an environment defined by diagnostic and therapeutic constraint. Using a prospectively collected cohort, we demonstrate that common

TABLE 5. Delayed Complications

Complication	n (%)
Any delayed complication	11 (5.3)
Recurrence (abscess or pilonidal disease)	5 (2.4)
Chronic pain/functional symptoms	3 (1.4)
Contracture (flexor tenosynovitis)	2 (1.0)
Incisional hernia	1 (0.5)

general surgical conditions can be managed safely at sea, with outcomes comparable to contemporary civilian benchmarks despite limited imaging availability and the absence of subspecialty support. Importantly, these findings emphasize the central role of clinical judgment and adaptable decision-making frameworks.

A defining feature of maritime surgery is the need to balance patient safety with operational constraints, including ship location, mission requirements, weather conditions, and the feasibility of MEDEVAC. Unlike shore-based practice, operative decision-making may be influenced by mission-critical roles of the patient, prior experience of the ship's commanding officer, and risks associated with evacuation or transfer to foreign medical facilities. Collectively, these data provide commanders and medical planners with objective evidence to inform risk–benefit decisions regarding operative intervention at sea versus MEDEVAC. Importantly, this shifts decision-making from anecdote-driven practice toward evidence-informed operational medicine.

The maritime cohort in this study consists predominantly of young, active-duty service members and therefore differs demographically from many civilian surgical populations captured in national databases, which include older patients with greater comorbidity burden. In some respects, this younger and generally healthier population might be expected to have lower baseline surgical risk. However, operative care at sea is delivered under substantial diagnostic and logistical constraints, including limited imaging availability, restricted subspecialty support, and operational factors that may influence the timing of intervention. These competing influences complicate direct comparison. Accordingly, civilian benchmarks are presented to provide context rather than to imply equivalence or formal risk-adjusted comparison.

Appendectomy Outcomes

Outcomes following appendectomy performed in the maritime environment were comparable to those reported in large civilian series. In the present cohort, postoperative complications were infrequent and generally of low severity. Among 66 laparoscopic appendectomy cases, four complications were observed (6.1%), including three hematomas and one postoperative intra-abdominal abscess (perforated appendicitis) requiring drainage by interventional radiology following evacuation. Among five open appendectomy cases, one superficial surgical site infection occurred.

In comparison, large civilian studies using the American College of Surgeons National Surgical Quality Improvement Program report overall 30-day morbidity rates of approximately 4.55 to 5.5%, with surgical site infection rates of 3.3% to 4.1%, and organ-space infection rates of 1.7% to 1.8% following appendectomy, with consistently lower complication rates observed after laparoscopic compared with open approaches.^{11,12}

Reported negative appendectomy rates in contemporary civilian series typically range from 55% to 15%, reflecting improved diagnostic accuracy with routine access to cross-sectional imaging.^{13,14} However, historically accepted negative appendectomy rates of 15% to 20% were considered appropriate to minimize the risk of perforation and its associated morbidity, particularly in settings where diagnostic certainty is limited. Prior work has demonstrated that even in environments where axial imaging is routinely available, diagnostic accuracy depends on selective imaging strategies and clinical judgment rather than imaging availability alone.¹⁵ In the present cohort, the negative appendectomy rate of 13% falls within historically accepted ranges and is notable given the complete absence of computed tomography and reliance on clinical assessment and surgeon-performed ultrasound in the operational maritime environment.

Diagnostic Laparoscopy

DL functioned as both a therapeutic and decision-support tool in the maritime operational environment. In the absence of advanced imaging, DL functioned as a definitive means of clarifying pathology, guiding operative intervention, and informing evacuation decisions. This mirrors experience in other resource-limited and austere settings, where DL has been shown to reduce unnecessary laparotomy rates, improve diagnostic accuracy, and safely guide management of acute abdominal pathology. Prior studies from low-resource environments report diagnostic accuracies exceeding 80% and reductions in unnecessary laparotomy of up to 50% following implementation of DL. This is particularly true in cases of suspected appendicitis, gynecologic pathology, and acute abdomens.^{16,17} The favorable safety profile observed in this cohort supports the role of DL as a force-multiplying capability in the maritime setting, allowing surgeons to make definitive intraoperative decisions while minimizing unnecessary morbidity and evacuation.

Biliary Disease

Management of biliary disease in the maritime environment requires careful patient selection. In this cohort, 13 patients with suspected biliary disease were managed while deployed, of whom six (46%) underwent laparoscopic cholecystectomy at sea (Table 2 and Supplemental Digital Content 4, <http://links.lww.com/TA/F426>). Seven patients (54%) required MEDEVAC, including three who ultimately required intensive care unit-level support or endoscopic retrograde cholangiopancreatography. No postoperative complications

were observed among the patients who underwent surgery at sea, although the small sample size limits definitive conclusions. Prior deployment experience and published series similarly suggest that laparoscopic cholecystectomy can be performed safely in selected maritime patients.^{4,6,18,19}

Together, these findings underscore the importance of careful patient selection, as some presentations of biliary disease exceed onboard capabilities, while others may be reasonably managed onboard. Development of deployment-specific clinical practice guidelines may help standardize risk stratification and operative decision-making in this setting.

Hernia Repair

Twenty-two abdominal wall hernia repairs (9 umbilical, 13 inguinal) were performed during the study period, with mesh used in 59% of cases. Four patients with hernias were MEDEVACed for repair on shore. No mesh infections were observed.

Provider perspectives regarding mesh implantation varied, reflecting differing risk tolerance and operative experience in the maritime environment. At one end of the spectrum were concerns regarding potential mesh-related infection; at the other were considerations related to mission impact, MEDEVAC risk, and timely return of service members to duty. The absence of mesh-related infections in this cohort is reassuring and suggests that abdominal wall hernia repair with mesh may be performed safely in the deployed maritime setting.

Pilonidal Disease Outcomes

Outcomes following operative management of pilonidal disease were characterized by a high rate of wound-related complications and recurrence, consistent with civilian series.

Among 40 pilonidal procedures with follow-up available, postoperative complications occurred in 25% of cases, consisting primarily of wound breakdown and recurrence. This rate falls within contemporary civilian reports describing overall complication rates ranging from ~10% to over 40%, with recurrence commonly reported between 10% and 30%.^{20,21} Complications were largely related to wound healing rather than systemic morbidity. All pilonidal disease cases were performed for ongoing symptomatic disease, and no definitive flaps were performed.

Wound-related complications occurred disproportionately following attempts at primary closure, whereas temporizing approaches such as trephination were associated with fewer acute complications during deployment. Given limited wound care resources, prolonged underway periods, and constrained postoperative follow-up, temporizing management may be preferable during deployment, with definitive surgical management deferred to shore-based settings when feasible. Together, these findings highlight the need for deployment-specific guidance to inform operative decision-making for pilo-

nidal disease, balancing symptom control and infection management against the elevated risk of wound morbidity associated with definitive closure in the maritime environment.

Subspecialist Operations

The breadth of operative pathology captured in this cohort highlights the expansive scope of practice required of maritime surgeons. In addition to core general surgery procedures, surgeons managed orthopedic and hand trauma, hand infections, gynecologic emergencies, urologic pathology, trauma, and complex infections—often without immediate access to subspecialty consultation or advanced diagnostics. Hand and extremity injuries represented a substantial proportion of non-general surgery operative pathology, consistent with prior analyses demonstrating a high burden of occupational and mechanical injuries aboard US Navy vessels during routine operations.⁸ These findings reinforce the importance of broad-based surgical training and targeted preparation for low-frequency, high-acuity scenarios encountered during deployment. One of the long-term goals of the MSQI program is to leverage real-world cases to inform simulation-based, cadaveric, and multimedia training focused on conditions commonly encountered in the deployed maritime environment.

Future Implications

This analysis has important implications for operational planning, training, and decision-making in the deployed maritime environment. For the majority of surgeons in this cohort, deployment represented their first postresidency assignment, and nearly half completed civilian training without regular exposure to senior Naval surgeons throughout training. Furthermore, in the maritime setting, surgeons frequently operate with limited access to senior guidance and must make high-stakes decisions independently. Objective outcomes data, therefore, serve a critical role in supporting both individual surgeon decision-making and command-level risk assessments when determining whether to proceed with operative intervention at sea or pursue MEDEVAC.

Identification of commonly performed procedures and higher-acuity cases provides a data-driven foundation for refining predeployment training curricula, simulation priorities, and equipment allocation. Access to such data allows surgeons, senior medical department officers, and commanding officers to engage in informed discussions grounded in outcomes rather than anecdotes.

Importantly, standardized clinical practice guidelines may also support surgeon advocacy and shared decision-making with command leadership in time-sensitive scenarios. In one case identified through review of the MEDEVACs, a patient presenting with left lower quadrant abdominal pain was evaluated aboard ship, and DL was recommended by the surgeon to exclude ovarian torsion in the setting of limited imaging capability. Operative intervention was deferred based on anticipated

arrival in port and command discretion, and subsequent laparoscopy performed ashore demonstrated endometriosis. While the outcome in this case was ultimately benign, delayed intervention in the setting of true ovarian torsion could have resulted in irreversible ovarian loss. The availability of evidence-informed clinical practice guidelines could strengthen surgeon–command communication and support timely operative decision-making when diagnostic uncertainty carries potentially high morbidity.

Maintaining surgical proficiency in this environment remains a persistent challenge. Although surgeons do operate while deployed, overall case volume and case mix are insufficient to independently sustain a general surgical skillset. Across this cohort, 322 cases were performed by 32 surgeons over 30 deployments, translating to an average of ~10 operative cases per surgeon during a six-month deployment. Predeployment work-up cycles further limit operative exposure at home institutions. Structural mitigation strategies—including shorter shipboard tours, integration with high-volume civilian centers, and team rotation during deployments—represent important avenues for preserving surgical readiness.

Limitations

This study has several limitations. Although the MSQI database is prospectively maintained, this analysis was retrospective in nature and subject to incomplete documentation and reporting bias. Data collection occurred in an operational environment with variable connectivity, and some cases may have been entered after the fact, potentially limiting the completeness or precision of recorded variables. In addition, outcome classification relied in part on surgeon-reported data, which may overestimate or underestimate minor or self-limited complications that did not prompt further evaluation or documentation.

Not all cases contained sufficient identifying information to permit linkage with the DHA EMR. Age and sex were similar between EMR-linked and non-linked cases; however, detailed clinical characteristics were unavailable for direct comparison. Because EMR linkage depended on the completeness of recorded identifiers and varied by deployment and implementation phase, selection bias cannot be fully excluded. In addition, some operations occurred near the end of the study period, limiting the available duration of follow-up. As a result, EMR-derived outcomes reflect events captured up to one year following surgery, and delayed complications may be underrepresented for more recent cases.

Operative cases reflect those selected for onboard intervention following surgeon and command-level decision-making. Patients with more complex or higher-risk pathology were at times medically evacuated rather than treated surgically at sea. As such, complication rates may underestimate the risk profile of all patients evaluated in the maritime environment. Furthermore, surgical cases originating on vessels without organic surgical capability

that were transferred directly to shore facilities, without evaluation by a maritime surgical platform participating in MSQI, would not be captured in this database. Accordingly, the cohort represents surgical care delivered aboard participating maritime platforms rather than all surgical pathology arising within a deployed naval strike group. Although the MSQI database relies on surgeon-reported case logging, and incomplete capture cannot be excluded, all maritime surgeons performing surgery at sea voluntarily participated in MSQI during the study period, strengthening the representativeness of this cohort.

Finally, this analysis was descriptive and reflects care delivered by a selected group of Navy surgeons on specific naval platforms, which may limit generalizability to other operational environments or practice settings. Despite these limitations, this study represents an important first step toward systematically evaluating surgical care at sea and provides a foundation for future prospective data collection and quality improvement initiatives.

CONCLUSIONS

Taken together, these findings provide objective evidence that carefully selected surgical care can be performed safely at sea across a broad range of operative pathologies. Beyond demonstrating safety, this work serves an important cultural and operational function: it gives maritime surgeons data-driven confidence to perform surgery in an environment where decisions have historically been shaped by anecdote, personal comfort, and prior experiences—both positive and negative. By showing what types of operations are being performed safely, and under what circumstances, these data support appropriate onboard intervention when evacuation is not clearly superior. This has downstream benefits for patients, surgeons, and commanders alike, including avoidance of medically unnecessary evacuations that carry financial cost, operational risk, and potential mission impact. At the same time, these data reinforce that operative decision-making at sea must remain a balance, integrating patient factors, surgeon capability, platform resources, and command risk tolerance. In this context, the MSQI program provides a critical foundation for the development of evidence-informed clinical practice guidelines (CPGs), grounded in both outcomes data and expert consensus, to guide future maritime surgeons. These findings underscore the need for such guidance to standardize decision-making, support surgeon–command communication, and ultimately improve the safety, consistency, and credibility of surgical care delivered at sea.

AUTHORSHIP

M.D.T. participated in study conception. S.S., K.C., K.W.M., and M.D.T. participated in study design, literature review, and critical revision. S.S., C.A., L.S., E.H., and B.C.: participated in data collection. S.S., C.A., L.S., E.H., B.C., K.C., K.W.M., and M.D.T.: participated in data analysis and interpretation. S.S., C.A., L.S., E.H., B.C., K.C., K.W.M., and M.D.T.: participated in drafting the manuscript.

DISCLOSURE

The authors declare no conflicts of interest. All authors have supplied signed *Journal of Trauma and Acute Care Surgery* Disclosure Forms, which are provided as Supplemental Digital Content (<http://links.lww.com/TA/F427>).

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