Classification of Hernias

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Introduction

Ventral hernia repair is often culmination of a complex decision-making process by the surgeon. Defect size, location, patient comorbidities, the presence of contamination, acuity of the patient's presentation, necessity for an ostomy, and history of prior repairs with or without a prosthetic all weigh into the ultimate repair approach. The repertoire of operations available does nothing to simplify the matter. Laparoscopic and open approaches are complicated by innumerable prosthetic choices, and the choice of mesh is next met with a judgment regarding the location of its placement relative to the abdominal wall. Underlay, onlay, inlay, and sublay reinforcement are all viable options that typically compliment the approach. Finally, measurements of success can be equally ambiguous. Definitions for wound morbidity have only recently been defined and begun to penetrate the literature. Recurrence, which many would classify as a failure, can be convoluted by bulging or "pseudo recurrence" in the absence of a true fascial defect, while a true recurrence in an asymptomatic patient with significant improvement in quality-of-life can be a clinical achievement in the eyes of the surgeon.

Needless to say, the number of moving parts makes controlled clinical study challenging. Touted superiority of a particular technique can be met with skepticism regarding patient selection and hernia characteristics. The advantages of a prosthetic may only be applicable in the context of a particular technique, and expense cannot be ignored in an era of cost-awareness. The need for evidence-based guidance has never been more apparent. Conversely, evidence-based study necessitates a basic requirement that is noticeably absent in the field of ventral hernia repair: standardization. The absence of a uniform hernia classification scheme to describe a patient's preoperative state (Fig. 2.1a) has severely limited meaningful discussions regarding repair technique and prosthetic choice (Fig 2.1b). Fortunately, progress has been made in standardizing outcome measures (Fig 2.1c), creating a foundation on which to build. In order to adequately assess technique in a controlled fashion, the hernia, patient, and wound characteristics must be summarized in an organized way to allow standard inclusion and exclusion criterion. Here, we review and summarize previous attempts to address this disparity. We also present our approach to hernia classification generated from our data and experience.

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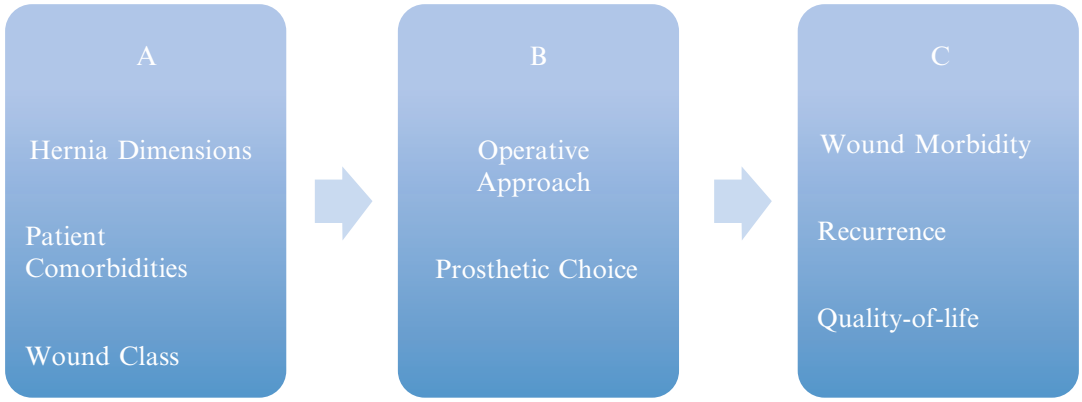

Fig. 2.1 Hernia, technique, and outcomes clinical investigation of any pillar theoretically requires standardized control of the remaining pillars (i.e., operative approach (**b**) cannot be properly studied (**c**) without controlling for the patient's preoperative state (**a**))

Wound Morbidity and Outcomes

The most effective efforts to standardize clinical study have come in the classification of wound morbidity. The designation surgical site occurrence (SSO)—originally coined by the Ventral Hernia Working Group (VHWG)—has been used as an umbrella term to encompass all perioperative wound events [1] (Fig 2.2). SSOs consist of infection, sterile fluid collections, wound dehiscence, and enterocutaneous fistulae. Infections are further subclassified by the CDC's definitions for surgical site infection (SSI) as superficial (skin/soft tissue), deep (adjacent to muscle, fascia, or a prosthetic), or organ space (intraperitoneal) [2]. Wound cellulitis—described as wound erythema treated with antibiotics but not requiring manipulation or opening of the incision—is not classified as an SSI by the CDC, and therefore would be itemized as an SSO. Sterile fluid collections are subclassified as seromas or hematomas based on the character of the fluid. Our practice is to further define collections or infections whether they require procedural interventions, such as bed-side drainage, interventional radiology drainage, or reoperation. Finally, the presence of an enterocutaneous fistula can be characterized by the nature of the fistula output or may be found to be an enteroprosthetic fistula as the underlying cause of a chronic mesh infection. Although the term SSO being increasingly mentioned, the clinical significance of the "occurrences" is unclear and is likely less relevant than SSIs. As a result, we have been using and advocating a term SSE - surgical site events - the notion that includes all SSIs and clinically relevant SSOs. This term, we believe, is a more accurate reflector of true postoperative wound morbidity.

Efforts to identify predictors of SSO and SSI have naturally followed. In 2010, the VHWG generated an expert-based consensus statement that assigned risk of developing an SSO based on patient and wound characteristics [1]. This grading system is summarized in Table 2.1.

In 2012, our group attempted to validate the VHWG system using data from 299 hernia repairs, leading to several important findings. One was that immunosuppression was not statistically associated with development of an SSO and should therefore not be included in comorbid conditions under Grade 2. Next, while no statistical difference was demonstrated in our data between Grades 2–3 and 3–4, a statistical difference between Grades 2 and 4 was present when those patients with a history of wound infection were grouped with Grade 2, and those patients with stomas or GI tract violations included with other contaminated fields in Grade 4. As such, we proposed modifying the grading scheme into a 3-tiered system (Table 2.2). This simplification puts patients without comorbidities or wound

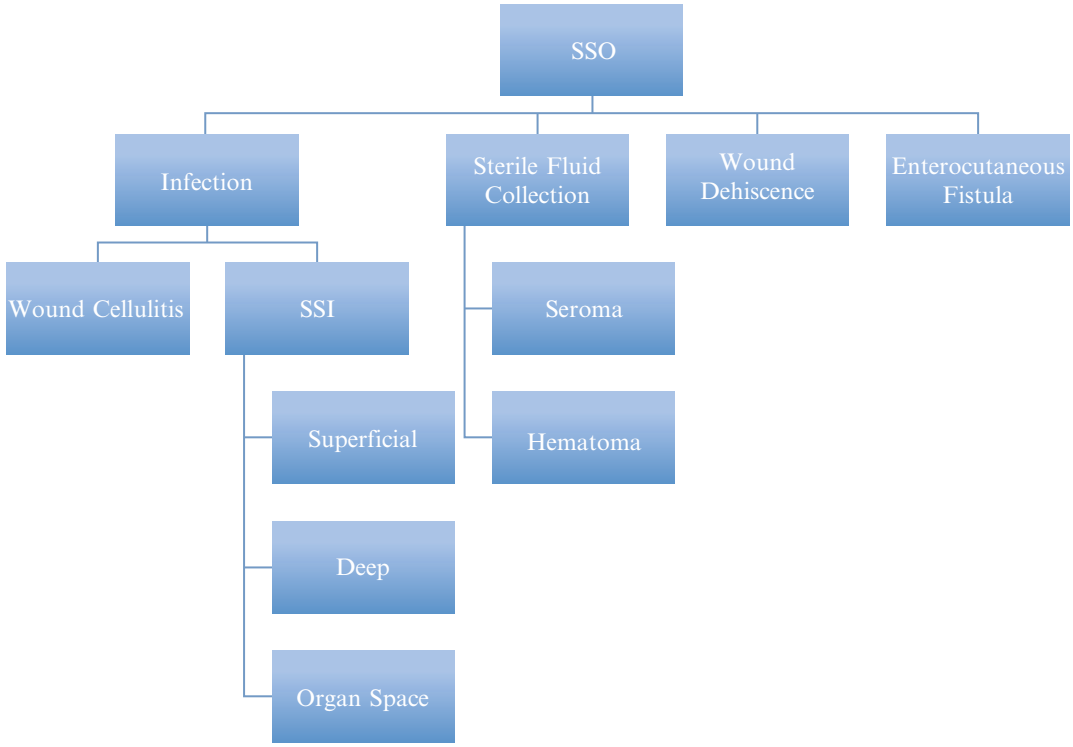

Fig. 2.2 Classification of surgical site occurrences

Table 2.1 VHWG grading system

Grade 1	Grade 2	Grade 3	Grade 4
Low risk	*Comorbid*	*Potentially contaminated*	*Infected*
• Low risk of complications	• Smoking	• Previous wound infection	• Grossly Infected mesh
• No history of wound infection	• Obesity	• Presence of ostomy	
	• Diabetes	• Violation of the GI tract	• Septic dehiscence
	• Immunosuppression		

Table 2.2 Modified ventral hernia working group grading system

Grade 1	Grade 2	Grade 3
Low risk	*Comorbid*	*Contaminated*
• Low risk of complications	• Smoking	• A. Clean-contaminated
• No history of wound infection	• Obesity	• B. Contaminated
	• Diabetes	• C. Active infection
	• Immunosuppression	
	• Previous wound infection	

contamination at low risk, comorbid patients in clean surgical fields at moderate risk, and contaminated cases at the highest risk. Grade 3 could be further stratified based on CDC wound class [3]. The important distinction is that Grade 3C includes chronic and/or active sinuses as well as frankly dirty wounds (CDC Wound Class IV) which makes that group quite heterogeneous.

In fact, one of the limitations of the Modified Grading System is that the studied cohort did not include sufficient number of Wound Class IV patients, limiting its accuracy.

While the aim was to validate the model proposed by the VHWG, some have appropriately pointed out that both systems exclude important hernia and operative characteristics. The presence of incarceration, concomitant surgery, acute presentation, and surgery-related factors, such as operative time, use of drains, and extent of tissue dissection, is not included in the aforementioned models. In an attempt to propose a more complete risk stratification system, Berger and colleagues proposed the Ventral Hernia Risk Score (VHRS) specifically for open ventral hernia repair using data from 888 patients. Odds ratios for those variables most closely associated with SSO and SSI were converted to a point system to stratify patient risk (Fig. 2.3) [4].

The use of operative characteristics in the VHRS system such as mesh implantation, concomitant procedure, or raising of skin flaps as variables for risk stratification becomes problematic, and underscores the difficulty in the creation of such systems. Ideally, if operative technique, mesh choice, and other surgical characteristics are to become dependent variables of study, then they should not be included in a *preoperative* risk-stratification system. While it is important to identify certain technique-dependent risk factors for wound morbidity, such as the association of skin flaps with SSE/SSI, this variable is not inherent to the presenting patient's preoperative state. Certainly, an area of study might be the need to raise skin flaps or not. However, inclusion criterion that would generate patient cohorts with similar preoperative states would need to be defined first using standardized preoperative criteria. Paradoxically, if the preoperative criteria are identified using *no* control for technique—such as in the modified VHWG grading system—then one may incorrectly assume that identified risk factors for wound morbidity are independent of technique. Finally, while the VHWG Grading scheme, our proposed modification, and the VHRS effectively incorporate patient comorbidities and wound characteristics, any portrayal of the hernia itself is noticeably absent.

Hernia Characteristics

Classification of the hernia based on its dimensions and location has most effectively been done by European Hernia Society (EHS). In 2009, a group of international experts met to generate a consensus on hernia classification for future study [5]. For primary hernias, a cross-table was generated based on size and location (Fig. 2.4). As primary ventral hernias—not affiliated with a previous incision/operation—are typically concentric and in a limited number of locations, classification was able to be limited to two variables: diameter and location.

Incisional hernia classification is inherently more complex as defects can essentially take any theoretical configuration. While standard definitions for length and width were determined (Figs. 2.5 and 2.6), no single dimension could be agreed upon to generate a cross-table akin to pri-

	VHRS for SSO			VHRS for SSI		
Variable	**OR**	**95% CI**	**Points**	**OR**	**95% CI**	**Points**
Mesh implant	1.9	1.4–2.7	2	–	–	–
Concomitant hemia repair	2.2	1.5–3.4	2	2.1	1.4–3.3	2
Skin flaps created	2.2	1.6–3.1	2	2.3	1.6–3.4	2
ASA score ≥3	–	–	–	2.1	1.4–3.2	2
BMI ≥40	–	–	–	3.2	1.7–5.9	3
Wound class 4	8.7	3.7–24.1	9	6.8	3.2–15.4	7

ASA, American Society of Anesthesiologists; BMI, body mass index; OR, odds ratio; SSO, surgical site occurrence; SSI, surgical site infection; VHRS, Ventral Hernia Risk Score.

Fig. 2.3 Ventral hernia risk score for SSO and SSI

EHS Primary Abdominal Wall Hernia Classification		Diameter cm	Small <2cm	Medium ≥2-4cm	Large ≥4cm
Midline	Epigastric				
	Umbilical				
Lateral	Spigelian				
	Lumbar				

Fig. 2.4 EHS classification of primary ventral hernias

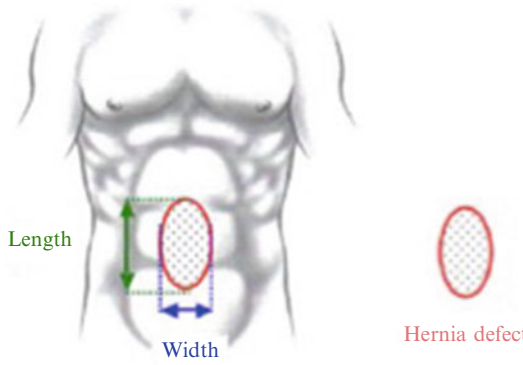

Fig. 2.5 Standardized measure of hernia length/width

mary ventral hernia system. As such, the final system incorporates both length and width, with arbitrary cutoffs (<4, 4–10, >10 cm). The supposition was that data would ultimately be used to make more meaningful designations and potentially validate and/or simplify this system.

Reciprocally, while these EHS classification schemes were an important step in the development of standardized descriptions of hernia dimensions, this does nothing to incorporate patient comorbidities and wound class. Certainly, one could conceive a comprehensive model that would incorporate any and every mentioned variable to accurately incorporate hernia, patient, and wound characteristics. Unfortunately, the result would likely generate a system so complex that it would not be easy to remember, and thus would not be embraced by the surgical community. Other proposed systems have unfortunately met this fate [6, 7]. A classification scheme capable of accurately describing the patient's preoperative state, while not becoming hindered by its own completeness, is an ideal we sought to achieve.

Hernia, Patient, Wound: A TNM-Like Classification

We recently developed a hernia classification system akin to that of the TNM system for cancer staging. The TNM-model is enviable in its ability to amass large amounts of data with multiple variables and group permutations by prognosis. The outcomes of local recurrence and survival could be likened to wound morbidity and hernia recurrence. We therefore sought to generate such a system. The modified VHWG grading scale already stratifies patients' risk of developing wound morbidity using preoperative patient comorbidities and wound class. We next sought to identify hernia dimensions within the EHS classification system most closely associated with outcomes. The EHS classification system for incisional hernias includes nine potential locations on the abdominal wall, as well as length, width, and recurrent nature. In an attempt to validate these classification variables, we initially characterized patients by preoperative CT scan using this system. Crucially, with regards to both hernia recurrence and wound morbidity, we found no association

E H S Incisional Hernia Classification			
Midline	subxiphoidal	M1	
	epigastric	M2	
	umbilical	M3	
	infraumbilical	M4	
	suprapubic	M5	
Lateral	subcostal	L1	
	flank	L2	
	iliac	L3	
	lumbar	L4	
Recurrent incisional hernia ?		Yes O	No O
length: cm		width: cm	
width cm	W1 <4cm O	W2 ≥4-10cm O	W3 ≥10cm O

Fig. 2.6 EHS incisional hernia classification

with hernia length, location, or recurrent nature. These findings are corroborated by data from Chevrel et al. [7]. Width cutoffs of 4 and 10 cm—as proposed by the EHS system—generate an intermediary group of 4–10 cm that is clinically indistinguishable from the smaller and larger counterparts. Interestingly, with width cutoffs of <10, 10–20, and ≥20 cm, we identified stepwise associations with hernia wound morbidity *and* recurrence. Therefore, width appears to be the incisional hernia dimension with the most meaningful ties to short- and long-term morbidity. Not only are these 10 and 20 cm cutoffs easy to remember, but they are clinically meaningful to us, as 10 cm represents the upper limit of what most would consider for laparoscopic repair. The second cutoff of 20 cm also triggers the potential need for myofascial release. As such, we characterize hernias (H) by width alone (H1 < 10 cm, H2 = 10–20 cm, H3 ≥ 20 cm), and patient (P) comorbidities (P0 = no comorbidities; P1 = presence of at least one of the following: morbid obesity, diabetes, smoking, and/or immunosuppression) and wound (W) status (W0 = clean, W1 = contaminated). This allows three important variables (Hernia, Patient, Wound) to be incorporated into a cross-table (Fig. 2.7). Permutations

Fig. 2.7 HPW—A "TNM-like" classification system

a

	HERNIA	PATIENT	WOUND	HPW STAGE
STAGE 1	1	0	0	H1, P0, W0
STAGE 2	1 or 2	any	0	H1, P1, W0 H2, any P, W0
STAGE 3	any	any	0 or 1	H1, any P, W1 H2, any P, W1 H3, P0, W0
STAGE 4	3	any	0 or 1	H3, P1, W0 H3, any P, W1

b

	H1	H2	H3
P0	STAGE 1	STAGE 2	STAGE 3
P1	STAGE 2	STAGE 3	STAGE 4
W1	STAGE 3	STAGE 3	STAGE 4

with similar complication profiles are grouped accordingly. The result is a Hernia, Patient, Wound (HPW) Staging system that ordinally ranks stages (I–IV) by risk of developing an SSE and hernia recurrence. This system is comprehensive, generated from evidence, easy to remember, and predicts both short-term wound morbidity (SSE) and long-term efficacy (recurrence). Two principles we hoped to convey in this effort were:

1. The INCLUSION of variables from all three important preoperative states—the hernia, the patient, and the wound class.
2. The EXCLUSION of intraoperative characteristics.

Our hernia–patient–wound model appears to accurately stratify outcomes using these three "TNM"-like variables (Table 2.3). Ultimately, we hope that all clinical trials involving hernia repair will include a hernia stage. In the future, the proposed system would be amendable to modification as more data are amassed, just as the TNM Classification is currently in its 7th edition. For instance, Grade 3 hernias might be further stratified into "a," "b," and "c" subgroups based on degree of contamination to make the system more precise (i.e., perhaps clean-contaminated hernias act more like clean cases than contaminated). While the first proposal may not be perfect, this model uniquely places key prognostic indicators on a platform that can be easily adjusted and, in our view is a necessary foundation to build upon. We anticipate as this classification is applied to other cohorts of patients, sub-staging like IIA and IIB and IIIA and IIIB will emerge. As a historical analogy, variations of the TNM cancer classification that arose in the 1940s were not unified on an international level until 1987. Seven years later, prognostic indicators were finally identified and published. The scope of this effort is daunting, and emphasizes that our proposal is merely a first step. As more investigators utilize this system on their practice/investigations, a more robust system may emerge using the current HPW system as a foundation.

Table 2.3 Outcomes of our cohort of patients based on HPW characteristics

	SSE rate (%)	Recurrence rate (%)
Stage I	5.8	4.7
Stage II	12.6	9.2
Stage III	20.2	13.2
Stage IV	38.9	31.1

In summary, a uniform classification system will provide the platform for inclusion/exclusion criteria in future investigations regarding technique, prosthetic choice, and perioperative optimization. The importance of defining our patients in a thoughtful and consistent manner will provide meaningful outcome research that is both widely accepted and widely applicable.

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