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# Objective Outcomes in Endoscopic Sinus Surgery

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## 1. Introduction

Use of endoscopes in the sinonasal cavity dates as far back as the turn of the 20<sup>th</sup> century with Hirschmann and Reichert performing the first sino-endoscopies and sinus surgeries, respectively. Widespread use was limited until H.H. Hopkins helped address illumination difficulties with the rod optic system in the 1960s and Walter Messerklinger began systematic use of the endoscope to evaluate the lateral nasal wall and mucociliary clearance in the late 1970s (Lee & Kennedy 2006). With the advent of modern endoscopic sinus surgery instruments and techniques in the 1980s, the endoscope has radically altered the surgical approach and management of inflammatory and neoplastic sinonasal disease rendering many of the open approaches nearly obsolete.

Successful outcomes in endoscopic sinus surgery have often been largely based on subjective qualifiers by the patient. Significant improvements in patient perceived nasal congestion, obstruction, facial pressure, rhinorrhea, headache, postnasal drainage have been the impetus for the widespread growth of functional endoscopic sinus surgery, while modest improvements in olfaction, taste, allergic symptoms and tooth pain have also been reported. (Lee & Kennedy 2006). Some objective measures of outcomes previously proposed include acoustic rhinometry, mucociliary measures using saccharine transit times and ciliary beat clearance, and olfactory thresholds using butanol testing and the UPSIT-University of Pennsylvania Smell Identification Test (Min et al 1995; Lund & Scadding 1994). Radiologic evidence of polyp disease on CT scanning has also been studied with validated scoring systems, but with poor correlation with clinical symptoms and as such a poor indicator of outcomes (Newman et al 1994; Friedman 1990; Giklich 1994; Jorgensen 1991; Browne et al 2006; Newton & Ah-See 2008). Increasingly, the rhinologic community looks to standardized objective endoscopic measures in scientific communications to evaluate success in managing sinonasal disease. These various grading schemes have been targeted at eliciting objective reproducible measures of: (1) polyp grade, (2) sinus cavity status, and (3) surgical field visibility. We present the first complete review of all objective published endoscopic scoring schemes for sinonasal disease.

## 2. Objective endoscopic measures of polyp disease

### 2.1 Objective endoscopic measures of polyp disease

Objective, standardized endoscopic scoring systems to communicate disease burden of nasal polyposis dates back at least to the late 1980s with staging systems being proposed by various international clinical groups over the years (Table 1).

YEAR	AUTHOR(S)	COUNTRY	SCALE	TYPE
1990	Levine	United States of America	6 point	Polyp staging
1992	Kennedy	United States of America	5 point	Sinus cavity staging
1992	Gaskins	United States of America	5 point	Sinus cavity staging
1993	Johansen et al.	Denmark	5 point inflammation	Sinus cavity staging
			5 point previous surgery	
			5 point infection	
			4 point polyp staging	
1993	Lund & Mackay	United Kingdom	3 point including polyp, discharge, edema, scars, crusting	Sinus cavity staging
1993	May & Levine	United States of America	5 point	Polyp staging
1995	Lildholdt et al.	Sweden	4 point	Polyp staging
1995	Lund & Kennedy	United Kingdom, United States of America	3 point polyp edema discharge, scarring crusting	Sinus cavity staging
1996	Mackay & Nacleiro	United Kingdom	4 point	Polyp staging
2000	Johansson et al.	Sweden	0-100 VAS	Polyp staging
2000	Rasp	Germany	4 point	Polyp staging
2003	Passali et al	Italy	4 point	Polyp staging
2006	Meltzer et al	United States of America	5 point	Polyp staging
2007	Wright & Agrawal	Canada	20 point	Sinus cavity staging
2009	de Sousa et al	Brazil	4 point horizontal	Polyp staging
			5 point vertical	
			5 point AP	

Table 1. Staging Systems for Endoscopic Polyp Disease and Sinonasal Cavities.

Howard Levine from Cleveland presented his 6 point staging system at the *VIIIth International Symposium on Infection and Allergy of the Nose* in Baltimore, 1989 (Table 2). This system was employed to evaluate outcome in a series of 250 patients undergoing endoscopic

sinus surgery and followed long term up to 42 months post-operatively to advocate for the utility of nasal endoscopy to diagnose and monitor sinonasal disease (Levine, 1990).

0	no polyps
1	polyps totally confined to the middle meatus
2	anterior to the turbinate, extending inferiorly to the inferior turbinate but not covering it
3	medial and posterior to the middle turbinate in addition to being anterior to it
4	extending to the floor of the nose, but with parts of the turbinates visible
5	filling the nasal cavity with no portion of the turbinate visible
Adapted from Levine HL. Functional endoscopic sinus surgery: evaluation, surgery, and follow-up of 250 patients. <i>Laryngoscope</i> 1990; 100:79-84.	

Table 2. Endoscopic grading of polyp systems proposed by Levine, 1990

In 1993, a group from Aarhus, Denmark, under Lars Johansen proposed a 4-point staging system they employed in their study to evaluate the efficacy of intranasal budesonide in treating small and medium sized nasal polyps (See table 3) (Johansen et al, 1993). Simpler than the system proposed by Levine in 1989, the Johansen system outlined parameters to divide eosinophilic sinonasal polyp disease between mild, moderate and severe.

0	<i>no polyps</i>
1	<i>mild polyposis</i> - small polyps not reaching the upper edge of the inferior turbinate, causing only slight obstruction
2	<i>moderate polyposis</i> - medium-sized polyps reaching between the upper and the lower edge of the inferior turbinate and causing troublesome obstruction
3	<i>severe polyposis</i> - large polyps reaching below the lower edge of the inferior turbinate and causing total or almost total obstruction
*total score = sum of scores for each nasal cavity	
Adapted from Johansen VL, Illum P, Kristensen S, Winther L, Petersen S, Synnerstad B. The effect of Budesonide (Rhinocort®) in the treatment of small and medium sized nasal polyps. <i>Clin Otolaryngol</i> 1993; 18: 524-7.	

Table 3. Endoscopic grading of polyp systems proposed by Johansen et al, 1993.

That same year, Howard Levine along with Mark May published staging systems aimed at facilitating quantifying objectively outcomes in sinus surgery (May et al, 1993). Among the various staging systems proposed including staging of the endoscopic sinus surgical intervention, anatomical abnormalities on CT scans, patient subjective measures, etc., a five point scheme was proposed (table 4).

Also in 1993, an overall staging system for sinonasal disease was published by Lund and Mackay from University College of London. In addition to scoring systems for the nasal cavity and of the radiographic appearance on sinus CT, a simple 3 point staging system for endoscopic appearance of nasal polyps was proposed with 0 correlating to no polyps, 1 for polyps confined to the middle meatus and 2 for polyps beyond the middle meatus (Lund & Mackay, 1993). Moreover, the *Danish/Swedish Study Group* carried out a double-blind placebo-controlled study of topical budesonide for nasal polyps and presented a 4 point scoring scheme (table 5) which expanded on the simple classification presented by Lund and Mackay (Lildholdt et al, 1995).

1+	anterior attachment of middle turbinate visible
2+	anterior attachment of middle turbinate obscured
3+	nasal cavity filled to vestibule
4+	nasal cavity filled to nares
5+	nasal cavity filled to lip
Adapted from May M, Levine HL, Schaitkin B, Mester SJ. Results of surgery. In: Levine H, May M, editors. Endoscopic sinus surgery. New York: Thieme Medical Publishers, Inc., 1993:176-92.	

Table 4. Endoscopic grading of polyp systems proposed by May and Levine, 1993

0	no polyposis
1	<i>mild polyposis</i> - (small polyps not reaching the upper edge of the inferior turbinate)
2	<i>moderate polyposis</i> - (medium sized polyps reaching between the upper and lower edge of the inferior turbinate)
3	<i>severe polyposis</i> - (large polyps reaching below the lower edge of the inferior turbinate)
Adapted from Lildholdt T, Rundkrantz H, Lindqvist N. Efficacy of topical corticosteroid powder for nasal polyps: a double-blind, placebo-controlled study of budesonide. <i>Clin Otolaryngol</i> 1995; 20(1): 26-30.	

Table 5. Endoscopic grading of polyp systems proposed by Lildholdt et al., 1995

In March 1996, an international workshop on nasal polyposis in Davos, Switzerland, *the International Conference on Sinus Disease*, proposed a polyp staging scheme somewhat adapted from the polyp staging system based on Lund and MacKay (Lund & MacKay 1993; Lund & Kennedy 1995). This staging system, sometimes referred to as Mackay & Nacleiro, includes an endoscopic polyp grading system with grading from 0 to 3 depending upon the polyp burden (table 6) where a score of 0 indicates to visible polyp disease on endoscopy, 1 polyps confined to the middle meatus, 2 polyps not completely obstructing the nasal cavity and 3 polyps completely obstructing the nasal cavity (Malm, 1997). This system has since been employed several times in the rhinology literature as a validated scale for outcomes measures (Andrews et al, 2005; Browne et al, 2006). Multicentre validation of this system demonstrated a strong correlation between its scores and symptom reduction using the 22-question Sinonasal Outcome Test-SNOT 22, as well as a correlation with complication rates and revision rates (Hopkins et al, 2007).

Johansson et al from the Central Hospital in Skövde, Sweden conducted an evaluation of 5 various endoscopic measures of polyp burden and proposed their own Visual Analog Scale from 0-100 where 0 refers to a total absence of polyps and 100 a nasal cavity completely filled with polyps. They conducted a study to evaluate the reproducibility of this system along with evaluation of the Lildholdt scoring system and the Lund-Mackay scoring systems as well as lateral imaging (where polyps are expressed on a schematic picture of the lateral nasal wall and expressed as a percentage of total area) and their 0-100 visual analog scale for nasal patency. They found that their visual analog scale, along with the Lund-Mackay, and nasal patency score yielded poor inter-rater reproducibility; rather, the Lildholdt score and

0	absence of polyps
1	polyps that do not prolapse beyond the middle turbinate and may require an endoscope for visualization
2	polyps that are extended below the middle turbinate and are visible with a nasal speculum
3	polyps are massive and occlude the entire nasal cavity
Adapted from Malm L. Assessment and staging of nasal polyposis. <i>Acta Otolaryngol (Stockh)</i> 1997; 117:465-467.	

Table 6. Endoscopic grading of polyp systems proposed by Mackay & Nacleiro, 1996

lateral imaging were found to be superior for reliability and reproducibility (Johansson et al, 2000). After finding poor inter-rater agreement using the Lund-Mackay polyp scoring but a high correlation using lateral imaging and the four step scoring system proposed by Lildholdt et al, that same group then conducted a study in 2002 to identify the sensitivity of grading systems for detect early changes in polyp disease with topical budesonide treatments in a prospective, randomized placebo controlled trial. Lateral imaging showed statistically significant changes in polyp size was detectable after 14 days of topical corticosteroid use and found to be more sensitive than the Lildholdt staging (Johansson et al, 2002).

Rasp et al from the Ludwig-Maximilians-Universität in Munich proposed a four grade polyp score to include early polypoid changes and was again validated and employed to evaluate effect of topical and systemic steroid therapy (see table 7) (Rasp et al, 2000, Kramer&Rasp, 1999).

I	polyposal swelling of the mucosa of the middle meatus
II	nasal polyps within the middle or lower meatus
III	polyps extending over the middle turbinate
IV	nasal polyposis with protrusion into the anterior nose
Adapted from Kramer MF, Rasp G. Nasal polyposis: eosinophils and interleukin-5. <i>Allergy</i> 1999; 54:669-680.	

Table 7. Endoscopic grading of polyp systems proposed by Rasp 1999.

Passali et al from the University of Siena conducted a prospective randomized controlled study of 170 patients evaluating the efficacy of intranasal furosemide compared to intranasal mometasone for chronic sinusitis with polyposis. They evaluated subjective patient outcomes and for quantifying objective outcomes proposed a four point staging system very much like the Mackay - Nacleiro system, but taking into account endoscopic appearance as well as nasal volumes on acoustic rhinomanometry (Table 8) (Passali et al 2003).

The multinational *Rhinosinusitis Initiative* with representation from national societies of the USA, Belgium, Netherlands, United Kingdom and Japan, in 2006 developed guidelines for facilitating clinical trials for rhinosinusitis. Among the recommendations put forth by the guidelines was a 5-point polyp grading (table 9) scheme which the group advocated to be used in all subsequent rhinologic literature (Meltzer et al, 2006).

0	no polyps seen
1	polyps confined to the middle meatus with AR values in normal range
2	polyps prolapsing beyond the middle turbinate, with less than 10% reduction in volume by AR
3	subobstructive forms requiring another operation (>50% reduction of nasal volumes)
Adapted from Passali D, Bernstein JM, Passali FM, Damiani V, Passali GC, Bellusi L. Treatment of recurrent chronic hyperplastic sinusitis with nasal polyposis. <i>Arch Otol Head Neck</i> 2003; 129: 656-659.	

Table 8. Grading of polyp system proposed by Passali et al, 2003.

0	no visible polyps seen
1	small amount of polypoid disease confined within the middle meatus
2	multiple polyps occupying the middle meatus
3	polyps extending beyond the middle meatus, within the sphenoethmoid recess but not totally obstructing, or both
4	polyps completely obstructing the nasal cavity
Adapted from Meltzer et al. Rhinosinusitis: developing guidance for clinical trials. <i>J All Clin Immun</i> 2006; 118(suppl): 17-61.	

Table 9. Grading of polyps system proposed by Meltzer et al, 2006.

A group from Brazil proposed a novel endoscopic staging system using three-dimensional nasal polyp assessment and nasal endoscopy with polyp scales in vertical, horizontal and antero-posterior planes (see Table 10) but in the end was found to show less inter-rater agreement than the polyp systems of Johanssen et al and the Lund-Mackay polyp scores (de Sousa et al, 2009).

Overall, a common theme seems to emerge amongst all polyp scores regarding the degree polyp disease obstructs the middle meatus and the overall nasal cavity. Agreeing upon a single polyp system that is reliable, reproducible with high intra and inter-rater reliability and touches on clinically important factors pertaining to extent of polyp disease continues to challenge the rhinologic community.

<i>Horizontal Plane (H)</i>	
H0	no polyps
H1	polyps restricted to the middle meatus
H2	polyps expand beyond the middle meatus
HT	polyps expand beyond the middle meatus and touch the septum
<i>Vertical Plane (V)</i>	
V0	no polyps
V1	polyps in the middle meatus only
VI	polyps extending inferiorly to the middle meatus, going beyond the upper border of the inferior turbinate
VS	polyps extending superiorly to the middle meatus, between the septum and the middle turbinate
VT	polyps occupying the entire vertical aspect of the nasal cavity
<i>Antero-posterior plane (P)</i>	
P0	no polyps
P1	polyps in the middle meatus only
PA	polyps extending anteriorly to the middle meatus, reaching the head of the inferior turbinate
PP	polyps extending posterior to the middle meatus, reaching the tail of the inferior and middle turbinate
PT	polyps occupying the entire antero-posterior aspect of the nasal cavity
Adapted from de Sousa, MCA, Becker HMG, Becker CG, de Castro MM, de Sousa NJA, dos Santos Guimaraes RE. Reproducibility of the three-dimensional endoscopic staging system for nasal polyposis. <i>Braz J Otorhinolaryngol</i> 2009;75(6):814-20.	

Table 10. Grading of polyps system proposed by de Sousa et al, 2009.

## 2.2 Objective endoscopic measures of the sinonasal cavity

Scoring systems for endoscopic findings in the sinonasal cavity beyond simple polyp grading schemes have been used increasingly in the literature to objectively measure outcomes in interventions involving sinonasal disease (Cote & Wright, 2010). As early as the late 1980's, efforts to classify severity of sinus pathology based on endoscopic findings was attempted. A rudimentary staging system was proposed by Jacobs et al relying on CT and endoscopic findings to classify severity of chronic sinusitis (Jacobs et al, 1990). At the first *International Symposium: Contemporary Sinus Surgery* in Pittsburgh, 1990, Ralph Gaskins of Atlanta, GA, presented a staging system for chronic sinusitis that incorporated endoscopic, radiologic findings, and patient immunologic factors, polyp severity, prior surgeries, and infection history into a complex staging system (table 11) to facilitate prediction of surgical response and guide selection of surgical procedure. Gaskins et al recommended Messerklinger technique functional endoscopic middle meatal surgery for stages 1 and early stage 2, with a Wigand total sphenoidectomy for late stage 2 and stage 3 disease and external techniques for stage 4 disease (Gaskins, 1990).

Stage	
0	No surgical sinus disease
I	Score: <1.3
Site	Inflammation limited to the ostiomeatal area
Surgery	No prior sinus/nasal surgery except septoplasty and/or inferior metal antrostomies
Polyps	No polyps or localized to <10% of the sinus space
Infection	Well-controlled infection with no active mucopurulent drainage
Immune status	No underlying immunologic disease except well-controlled allergy
II	Score: 1.3-2.3
Site	Inflammation confined to the maxillary/ethmoid/ostiomeatal areas
Surgery	Prior Caldwell-Luc or polypectomy
Polyps	Polyp disease, with involvement of 10%-50% of the nasal/sinus cavities
Infection	Persistent, localized infection with some active purulent drainage
Immune status	Low-grade immune disorder or fair allergy control
III	Score: >2.3
Site	Pansinus involvement, unilateral or bilateral; isolated sphenoid disease
Surgery	Prior anterior ethmoidectomy/middle turbinate surgery
Polyps	Nasal/sinus polyposis filling more than 50% of the nasal and sinus cavities
Infection	Poorly controlled multisinus infection with active mucopurulent drainage; active fungal disease
Immune status	Poorly controlled allergic rhinitis or significant immune disorder; history of long term steroid treatment
IV	Any score: 4
Site	Sinus disease with extranasal/sinus extension; orbital or intracranial; frontal disease above the nasofrontal duct
Surgery	Prior complete ethmoidectomy or sphenoidectomy
Polyps	Inverting papilloma or other potentially malignant nasal/sinus neoplasm
Infection	Osteomyelitis or infection eroding into the orbit or cranium; mucormycosis
Immune status	Endstage immunologic disease/profoundly immunocompromised patient.
Adapted from Gaskins RE. A surgical staging system for chronic sinusitis. Am J Rhinol 1992; 6:5-12.	

Table 11. Stages of Surgical Sinus Disease by Gaskins, 1990

The University of Pennsylvania's David Kennedy, in his 1992 thesis to the American Laryngological, Rhinological and Otological Society, attempted to classify extent of sinonasal inflammatory disease into 8 groups based on disease found at time of endoscopic surgery (see Table 12). In his study, he reviewed over 240 data fields for each of the 120 patient subjects to establish correlation with outcomes. Extent of preoperative disease and

1	Unilateral or bilateral anatomic abnormality
2	Unilateral ethmoid disease
3	Unilateral ethmoid disease and involvement of 1 dependent sinus
4	Bilateral ethmoid disease
5	Unilateral ethmoid disease and involvement of 2 or 3 dependent sinuses
6	Bilateral ethmoid disease and involvement of 1 dependent sinus
7	Bilateral ethmoid disease and involvement of 2 or more dependent sinuses
8	Diffuse sinonasal polyposis
Adapted from Kennedy DW. Prognostic factors, outcomes and staging in ethmoid sinus surgery. <i>Laryngoscope</i> 1992;102(Suppl 57):1-18.	

Table 12. Classification of the extent of disease by Kennedy, 1992.

surgical outcomes was found to be strongly correlated and as such, a staging system for chronic sinusitis was presented to help facilitate prognosis and comparison in inflammatory sinus disease (Table 13).

I	Anatomic abnormalities
	All unilateral sinus disease
	Bilateral disease limited to ethmoid sinuses
II	Bilateral ethmoid disease with involvement of one dependent sinus
III	Bilateral ethmoid disease with involvement of two or more dependent sinuses on each side
IV	Diffuse sinonasal polyposis
Adapted from Kennedy DW. Prognostic factors, outcomes and staging in ethmoid sinus surgery. <i>Laryngoscope</i> 1992;102(Suppl 57):1-18.	

Table 13. Chronic sinusitis staging system proposed by Kennedy, 1992.

Other endoscopic fields including mucosal hypertrophy, inflammation, discharge, crusting adhesions and polyp recurrence were examined but not incorporated into the staging scheme (Kennedy, 1992). Valerie Lund and Ian Mackay of University College London, in 1993, proposed a preoperative and postoperative inventory of the endoscopic appearance of the nasal cavities with a score of 0-2 for polyps (0: none; 1: confined to middle meatus; 2: polyps beyond the middle meatus), as well as 0-2 for discharge (0: none; 1: clear and thin; 2: thick and purulent) as well as observations for edema, scarring and crusting (Lund-Mackay, 1993). In 1995, the *Staging and Therapy Group*, headed by Valerie Lund and David Kennedy, proposed an endoscopic staging system for non-neoplastic sinonasal to evaluate therapeutic outcomes that was complex enough to incorporate the most important measures of the sinonasal cavity but simple enough to facilitate regular clinical use. Characteristics are assessed endoscopically of each sinonasal cavity to provide a score – polyp disease, mucosal edema/crusting/scarring and nasal secretion each receiving a score from 0 to 2 (Table 14)(Lund & Kennedy, 1997).

This scoring system has since been the instrument of choice to endoscopically evaluate outcomes of interventions in non-neoplastic sinonasal disease prospectively over time in research and clinical practice.

Polyp	0=absence of polyp, 1=polyps in middle meatus only, 2=beyond middle meatus
Edema	0=absent, 1=mild, 2=severe
Discharge	0=no discharge, 1=clear, thin discharge, 2=thick, purulent discharge
Scarring	0=absent, 1=mild, 2=severe
Crusting	0=absent, 1=mild, 2=severe
Adapted from Lund VJ, Kennedy DW. Quantification for staging sinusitis. In: Kennedy DW, editor. International Conference on Sinus Disease: Terminology, Staging, Therapy. Ann Otol Rhinol Laryngol 1995; 104(Suppl 167):17-21.	

Table 14. Sinus endoscopy scoring system proposed by Lund and Kennedy, 1995.

A newer sinonasal scoring system, the Perioperative Sinus Endoscopy (POSE) scoring system was employed by Wright & Agrawal to evaluate the outcomes in a randomized trial of perioperative systemic steroids on surgical patients with chronic rhinosinusitis with polyposis (Wright & Agrawal, 2007). POSE scoring was introduced to enhance face validity and responsiveness to change by providing richer measures of the inflammation in the ethmoid cavity, scarring and obstruction in outflow, as well as evaluation of secondary sinuses and included instructions for baseline assessments (table 15).

<b>Middle Turbinate</b>		Right	Left
Normal	0		
Synechia/Lateralized	1-2		
<b>Middle Meatus/MMA</b>		Right	Left
Healthy	0		
Narrowing/Closure	1-2		
Maxillary Sinus Contents	1-2		
<b>Ethmoid Cavity</b>		Right	Left
Healthy	0		
Crusting	1-2		
Mucosal Edema	1-2		
Polypoid Change	1-2		
Polyposis	1-2		
Secretions	1-2		
<b>Total (16)</b>			
<b>Secondary Sinuses</b>			
Frontal Recess/Sinus	0-2		
Sphenoid Sinus	0-2		
<b>Overall Total</b>	<b>16 18F 18S 20</b>		
18F = middle meatal antrostomy + ethmoidectomy + frontal sinusotomy; 18S = middle meatal antrostomy + ethmoidectomy + sphenoidotomy 20 = middle meatal antrostomy + ethmoidectomy + sphenoidotomy + frontal sinusotomy			
Adapted from Wright ED, Agrawal S. Impact of perioperative systemic steroids on surgical outcomes in patients with chronic rhinosinusitis with polyposis: evaluation with the novel perioperative sinus endoscopy (POSE) scoring system. <i>Laryngoscope</i> 2007; 117(suppl):1-28.			

Table 15. Peri-Operative Sinus Endoscopy (Pose) Score by Wright and Agrawal, 2007.

In that study, both the Lund – Kennedy Endoscopic score and POSE score were shown to be sensitive to changes over time but the POSE seemed to be more sensitive to subtle changes over time (fig 1) and correlated better with symptom scores. (Wright & Agrawal, 2007). We found employing both measures simultaneously has merit in exploiting the established reliability of the Lund-Kennedy score while benefiting from the added information gleaned from the POSE score (Cote & Wright, 2010). With further use and validation of the POSE score, it may perhaps become the staging system of choice to prospectively stage sinonasal cavities over time.

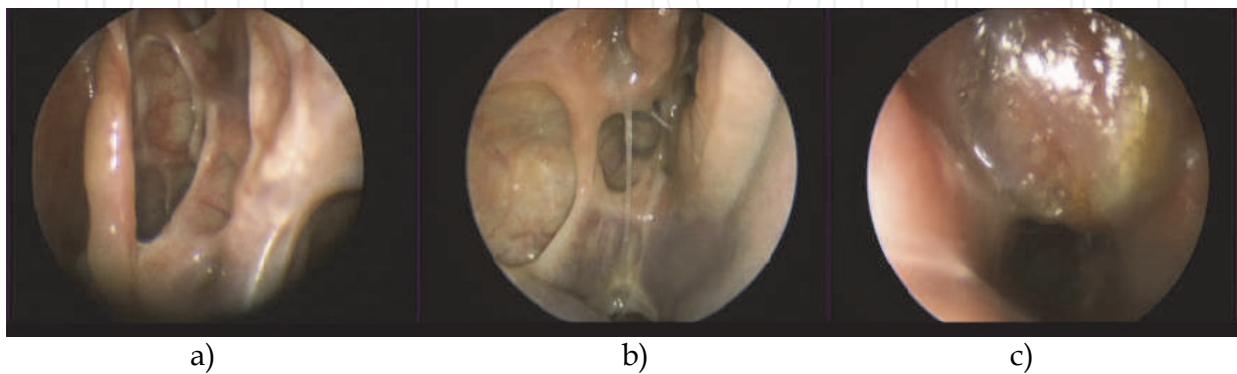


Fig. 1. Three cavities: a) Left cavity, POSE = 0 (normal middle turbinate, healthy middle meatal antrostomy, healthy ethmoid cavity); b) Right cavity, POSE = 3 (2 points for edema, 1 point for mild secretions); c) Right cavity, POSE = 10 (2 points for closure of middle meatus, 2 for edema, 2 for polypoid changes, 2 for polyposis, 2 for secretions)

### 2.3 Objective endoscopic measures of surgical field visibility

With novel technologies and procedures being developed with the aim of facilitating visibility during endoscopic surgery, objective measures to evaluate such techniques are being proposed. The first proposed endoscopic surgical field grading scale (table 16) was published by Boerzaart et al in 1995 to objectively evaluate controlled hypotension with sodium nitroprusside in esmolol to facilitate sinus surgery and found that controlled esmolol-induced hypotension yielded superior surgical conditions.

0	No bleeding.
1	Slight bleeding - no suctioning of blood required.
2	Slight bleeding- occasional suctioning required. Surgical field not threatened.
3	Slight bleeding- frequent suctioning required. Bleeding threatens surgical field a few seconds after suction is removed.
4	Moderate bleeding- frequent suctioning required. Bleeding threatens surgical field directly after suction is removed.
5	Severe bleeding- constant suctioning required. Bleeding appears faster than can be removed by suction. Surgical field severely threatened and surgery not possible.

Adapted from Boerzaart AP, van der Merwe J. Comparison of sodium nitroprusside- and esmolol-induced controlled hypotension for functional endoscopic sinus surgery. *Can J Anaesth* 1995;42:373-376.

Table 16. Assessment of intra-operative surgical field by Boerzaart et al, 1995

This six point scale was aimed at quantifying the amount of bleeding in the surgical field that hindered progression of the surgical intervention – 0 no bleeding, 1 slight bleeding no suctioning, 2 slight bleeding occasional suctioning, 3 slight bleeding frequent suctioning, 4 moderate bleeding frequent suctioning with bleeding threatening the surgical field, 5 severe bleeding constant suctioning (Boezaart 1995).

An eleven point grading scale was then proposed by PJ Wormald's group from Adelaide which sought to address some of the limitations with the Boezaart scale with grades 1-6 varying by number of points of ooze and 7-10 by severity of hemorrhage .

0	No bleeding.
1	1-2 points of ooze
2	3-4 points of ooze
3	5-6 points of ooze
4	7-8 points of ooze
5	9-10 points of ooze (sphenoid fills in 60 seconds)
6	>10 points of ooze, obscuring surface (sphenoid fills in 50 seconds)
7	Mild bleeding/oozing from entire surgical surface with slow accumulation of blood in the post nasal space (sphenoid fills by 40 seconds)
8	Moderate bleeding from entire surgical surface with moderate accumulation of blood in the post nasal space (sphenoid fills by 30 seconds)
9	Moderately severe bleeding with rapid accumulation of blood in the post nasal space (sphenoid fills by 20 seconds)
10	Severe bleeding with nasal cavity filling rapidly (sphenoid fills in <10 seconds)
Adapted from Athanasiadis T, Beule A, Embate J, Steinmeier E, Field J, Wormald PJ. Standardized video-endoscopy and surgical field grading scale for endoscopic sinus surgery: a multi-centre study. <i>Laryngoscope</i> 2008; 118:314-319.	

Table 17. Intra-operative surgical field grading by Wormald, 2008

By employing a standardized video-endoscopy technique both the Boerzaart and Wormald scores were found to have improved intra and inter-rater reliability; the Wormald scale, however, was found to be more sensitive to bleeding changes in endoscopic sinus surgery and demonstrated slightly better inter-rater reliability (Athanasiadis 2008). Further application and evaluation of these two systems must be undertaken before the rhinologic community decides a gold standard and establishes their strengths and limitations.

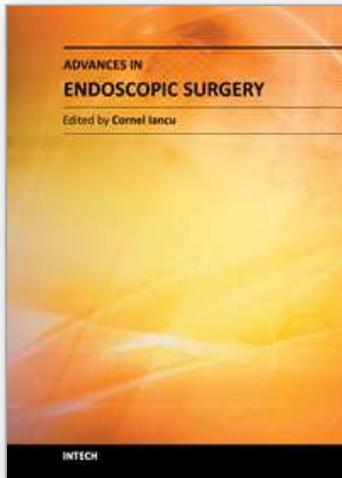
### 3. Conclusion

With increased refinement of endoscopic interventions for sino-nasal disease, there is simultaneous refinement in objective measures to audit the outcomes of these interventions. While each grading system has inherent limitations, they represent efforts to create a means to objectively communicate a richness in observations and outcomes that is both reliable and reproducible by practitioners treating sinonasal disease. In addition, many centres around the world are using these objective measures to monitor inflammatory sinus disease that, based simply on subjective measures, would be occult. This provides the opportunity to intervene with topical or less invasive therapies at a point where the disease may be more easily managed.

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Surgeons from various domains have become fascinated by endoscopy with its very low complications rates, high diagnostic yields and the possibility to perform a large variety of therapeutic procedures. Therefore during the last 30 years, the number and diversity of surgical endoscopic procedures has advanced with many new methods for both diagnoses and treatment, and these achievements are presented in this book. Contributing to the development of endoscopic surgery from all over the world, this is a modern, educational, and engrossing publication precisely presenting the most recent development in the field. New technologies are described in detail and all aspects of both standard and advanced endoscopic maneuvers applied in gastroenterology, urogynecology, otorhinolaryngology, pediatrics and neurology are presented. The intended audience for this book includes surgeons from various specialities, radiologists, internists, and subspecialists.

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