The Journal of International Advanced Otology

J Int Adv Otol 2018; 14(2): 216–26 • DOI: 10.5152/iao.2018.5553

Review

International Otology Outcome Group and the International Consensus on the Categorization of Tympanomastoid Surgery

Matthew Yung, Adrian James, Paul Merkus, John Philips, Bruce Black, Tetsuya Tono, Thomas Linder, John Dornhoffer, Armagan İncesulu

Department of Otolaryngology, East Suffolk and North Essex NHS Foundation Trust, Ipswich, United Kingdom (MY)
Department of Otolaryngology – Head & Neck Surgery, Hospital for Sick Children, University of Toronto, Toronto, Canada (AJ)
Department of Otolaryngology– Head & Neck Surgery, Section Ear & Hearing, VU University Medical Center, Amsterdam Public Health Research Institute, Amsterdam, Netherlands (PM)
Norfolk & Norwich University Hospitals NHS Foundation Trust, Department of Otolaryngology, Norwich, United Kingdom (JP)
Clinic of Otology, Queensland Otology, Brisbane, Australia (BB)
Department of Otolaryngology-Head and Neck Surgery, University of Miyazaki, Miyazaki, Japan (TT)
Department of Otorhinolaryngology – Head & Neck Surgery, Kantonsspital Luzern, Luzern, Switzerland (TL)
Department of Otolaryngology - Head and Neck Surgery, University of Arkansas for Medical Sciences, Arkansas, USA (JD)
Department of Otolaryngology-Head & Neck Surgery, Eskişehir Osmangazi University Faculty of Medicine, Eskişehir, Turkey (Aİ)

ORCID IDs of the authors: M.Y. 0000-0002-2058-3253; A.J. 0000-0002-4125-4053; P.M. 0000-0002-5859-7386; J.P. 0000-0001-7886-6283; B.B. 0000-0002-3974-1514; T.T. 0000-0001-7853-2179; T.L. 0000-0001-5187-3010; J.D. 0000-0002-3034-378X

Cite this article as: Yung M, James A, Merkus P, Philips J, Black B, Tono T, et al. International Otology Outcome Group and The International Consensus on The Categorization of Tympanomastoid Surgery. J Int Adv Otol 2018; 14(2): 216-26.

The International Otology Outcome Group (IOOG) was founded in 2017 to encourage and facilitate international collaboration with regard to the surgical outcome of ear surgery. This report outlines the methodology and recommendations of the consensus-based categorization of tympanomastoid surgery produced by the IOOG. The IOOG Steering Committee used the acronym SAMEO-ATO to categorize tympanomastoid operations, representing the stage of surgery, approach, mastoid bone extirpation, external bony wall repair, obliteration of the mastoid cavity, access to the middle ear, tympanic membrane reconstruction, and ossicular reconstruction. A modified Delphi technique was used to obtain international consensus. The expert panels included the chairpersons from 21 otology societies. The approval rate of the SAMEO-ATO system from the otology societies was 95%. The SAMEO-ATO scheme was presented at the 31st Politzer Meeting for field testing. There were no objections or serious concerns raised. Some international otologists wished to see more surgical categories included to reflect the varieties of surgical techniques, but they accepted that it would make the whole system cumbersome. In addition to providing an international categorization of tympanomastoid surgery, the IOOG Steering Committee plans to introduce a common otology dataset that the international otology community could use to record their surgical outcome. The high level of international consensus on the IOOG categorization of tympanomastoid surgery supports this tool for surgeons to pool their surgical data into a large database for research and comparative audit.

KEYWORDS: International, consensus, classification, mastoidectomy, middle ear surgery

INTRODUCTION

There is a paucity of high-level evidence regarding the surgical management of cholesteatoma. This is in part due to a lack of randomized controlled studies in the field of tympanomastoid surgery, as more readily achievable study designs are prone to biases that may not be easily overcome: for example, allocation, observer, and selection bias. Surgeons inevitably select what they consider to be the optimum surgical intervention, based on the varying degrees of factors such as their experience, resource availability, and assessment of individual patient circumstances. Consequently, published appraisals of outcomes from different surgical interventions rely to a large extent on comparison between different surgeons and different institutions. Unfortunately, there is no consensus on the nomenclature of surgical procedures, thus making such comparisons unreliable [1].

In 2017, the European Academy of Otology and Neurotology (EAONO) and the Japan Otological Society (JOS) produced a "Joint Consensus on Definitions, Classification and Staging of Middle Ear Cholesteatoma". Via consultation with the international otology

Corresponding Address: Matthew Yung E-mail: matthewyung@btconnect.com
Submitted: 27.04.2018 • **Accepted:** 16.05.2018 • **Available Online Date**: 03.08.2018

community, it has become clear that there is great need for common otology data fields that surgeons can collect systematically for comparative audit and research [2]. In 2017, the International Otology Outcome Group (IOOG) was established to address these issues (www.IOOG.net).

The initial IOOG focus was on the development of a new classification of tympanomastoid surgery, as this is performed commonly by most otologists and comprises a wide range of different techniques. The primary aim was to develop a classification system that would encompass all aspects of a surgical technique that are likely to influence the outcome of tympanomastoid surgery. A pre-requisite was to describe interventions using unambiguous nomenclature, to encourage a uniform manner or reporting, and categorize them in a system that would be acceptable to otologists and neuro-otologists internationally by employing a simple, logical, and user-friendly format. This report outlines the principles used to devise the new classification, including use of the Delphi method to ascertain international acceptance [3].

Formulation of the International Consensus on the "Categorization of Tympanomastoid Surgery"

The IOOG Steering Committee recognized that there is a wide variety of surgical techniques employed by surgeons all over the world. Many of these are "hybrid operations," for example, creating a window in the scutum, front-to-back mastoidectomy, and exclusion of the mastoid cells remnant using cartilage or soft tissue grafts. It was not the intention of the Steering Committee to produce a coding book for surgery. Surgeons are advised to exercise their judgment by placing their surgical procedure into the best-fitting category within the IOOG categorization to aid international comparison, therefore reducing confusion. The IOOG Steering Committee has produced a user guide to aid explanation.

a. Consensus on mastoid operations

To minimize ambiguity, the IOOG Steering Committee used terms that describe what the surgeon does rather than historical terminologies that are open to personal interpretation. For this reason, terms such as "modified radical mastoidectomy," "radical mastoidectomy," and "tympanoplasty" were deliberately abandoned.

The IOOG Steering Committee tried to make the description of the surgical procedure compatible with ICD-10 if possible. The label "Mastoidectomy with removal of the bony canal" was used instead of "Canal wall down mastoidectomy"; "Mastoidectomy with canal wall preserved" was used instead of "Canal wall up mastoidectomy."

The IOOG Steering Committee used the acronym SAMEO to categorize mastoid bone operations, representing the stage of surgery, approach, mastoid bone extirpation, external bony wall repair, and obliteration of the mastoid cavity.

b. Consensus on middle ear operations

The IOOG Steering Committee used the acronym ATO to categorize middle ear operations, with this representing the access to the middle ear, tympanic membrane reconstruction, and ossicular reconstruction. To allow compatibility with ICD-10, the label "repair of tympanic membrane" was used instead of "myringoplasty." The terms "PORP" and "TORP" were deliberately omitted. The IOOG Steering Committee advises that the SAMEO-ATO scheme should be used as a whole rather than in parts, as the terms "stage of surgery" and "approach" are universally applicable to middle ear operations.

In anticipation of the consensus exercise, the IOOG Steering Committee pre-determined 80% or above as the threshold criteria required to fulfill international consensus. This paper describes the SAMEO-ATO scheme and the methodology on how the IOOG Steering Committee arrived at the final version.

The IOOG international consensus on the categorization of tympanomastoid surgery was based on two cycles of consensus surveys and a field test (Figure 1). The categorization consists of the SAMEO-ATO schemes (Figures 2 and 3) and two schematic drawings that depict the different categories of "Mastoidectomy" and "Ossicular Chain" (Figures 4 and 5). The SAMEO-ATO scheme is complimented by a user guide for explanation and illustration (Appendix 1).

International Consensus Survey Round 1 (Draft 1)

Draft 1 of the categorization document (SAMEO-ATO) was the result of many rounds of discussion and refinement amongst the members of the Steering Committee.

International feedback was sought from international otology societies rather than individuals. Initially, an email in English was sent to the chairpersons of 44 otology societies within the IOOG address book to establish a relationship and to validate the email address contact. There is no an official national otology society for Belgium and the Netherlands. Instead, there is a Dutch–Belgian Otology Group with

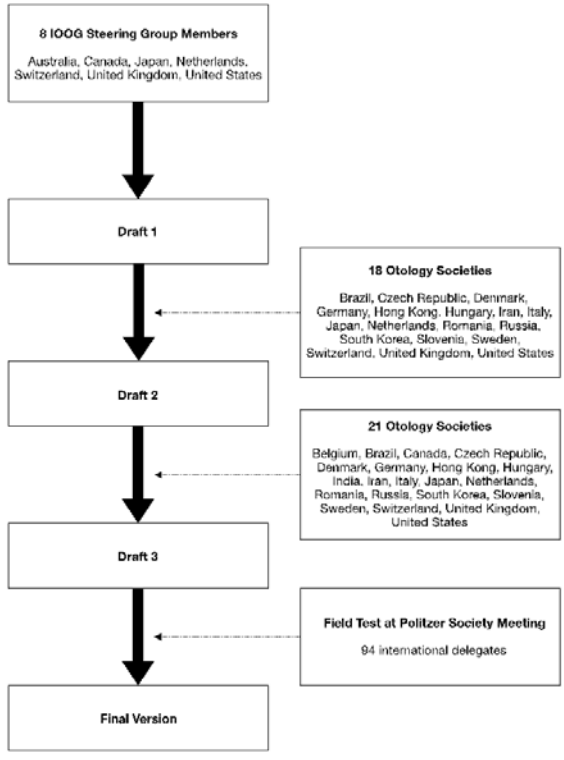


Figure 1. Participants involved in the consensus methodology of the "IOOG categorization of tympanomastoid surgery".

IOOG categorisation of tympanomastoid surgery: the SAMEO-ATO framework

SAMEO for Mastoid surgery

S	Stage of surgery	
	S1	Primary (first surgery)
	S_{2p}	Planned (2nd look or staged procedure)*
	S_{2r}	Revision (unplanned)*
		**2 represents non-primary surgery and not the number of previous surgery*
A	Approach	
	A1	Endoscopic transcanal
	A2	Microscopic transcanal
	A3	Endaural**
	A4	Retroauricular
		***A_1 and A_2 become A_3 when a (external/widening) incision is made*
M	Mastoidectomy	
	Mx	No mastoidectomy
	M1a	Mastoidectomy with canal wall preserved (cortical mastoidectomy)
	M1b	Mastoidectomy with canal wall preserved (cortical mastoidectomy) + posterior tympanotomy
	M2a	Mastoidectomy with superior scutum removed only (atticotomy)
	M2b	Mastoidectomy with superior scutum and postero-superior canal wall removed (attico-antrostomy)
	M2c	Mastoidectomy with whole canal wall removed (modified radical or radical mastoidectomy)
	M1a+2a	Mastoidectomy with canal wall preserved + atticotomy
	M1b+2a	Mastoidectomy with canal wall preserved + posterior tympanotomy + atticotomy
	M3a	Subtotal Petrosectomy with preservation of otic capsula*** - exenteration of all mastoid and middle ear pneumatized cells
	M3b	subtotal Petrosectomy with removal of the otic capsula - includes labyrinthectomy and/or removal of the cochlea
		**** M_{3a} differs from M_{2c} in that the eardrum is removed intentionally prior to obliteration of cavity and blind pit closure as well as blocking up of the tympanic opening of the Eustachian tube*
E	External ear canal reconstruction	
	Ex	No external ear canal reconstruction
	E1	Reconstruction with soft materials†
	E2	Reconstruction with rigid materials†
		† space behind graft not obliterated
O	Obliteration of mastoid cavity	
	Ox	No obliteration
	O1	Partial obliteration††
	O2	Total obliteration††
		†† Total obliteration is obliteration of the whole mastoid and attic cavities. Partial obliteration spares the attic cavity ± part of mastoid cavity (ie just a reduction of the size of cavity)

Figure 2. The IOOG SAMEO scheme of the SAMEO-ATO framework

one Dutch representative and one Belgian representative. For the purpose of this consensus process, the Dutch Otology Group and the Belgian Otology Group were treated as two separate otology societies. Twenty-five out of 44 societies responded. It is possible that the emails sent to others did not reach the intended person due to the use of an outdated email address, or they might have been rejected due to language barriers.

The draft SAMEO-ATO scheme, user guide, and the diagrams were sent to the 25 willing chairpersons accompanied by a survey ques-

IOOG categorisation of tympanomastoid surgery: the SAMEO-ATO framework

ATO for Middle ear surgery

A Access to middle ear

Ax	No bone removal from the external ear canal wall (flattening of suture line alone is still considered as Ax)
A1	Widening of the posterior portion of tympanic sulcus (including canal curettage or drilling to visualise the ossicular chain or hypotympanum)
A2	Partial or circumferential widening of the bony canal (canalplasty)
A3	Total canalplasty with soft tissue grafting of exposed bone†††

††† *The IOOG Categorization does not apply to congenital meatal atresia. A3 differs from A2 in the absence of original canal skin.*

T Tympanic membrane

Tx	No tympanic membrane grafting performed
Tn	Original tympanic membrane preserved
T1	Supplement to intact tympanic membrane (reinforcement)
T2	Partial tympanic membrane grafting
T3	Subtotal / total tympanic membrane grafting††††

†††† *Total perforation is defined as complete absence of the tympanic membrane and annulus. Subtotal perforation is the absence of tympanic membrane but the annulus is still preserved.*

O Ossicular chain

Ox	No reconstruction performed
On	Intact chain preservation
Osi	Reconstruction between incus and stapes head (IS joint repair, bone cement, prosthesis or cartilage)
Osm	Reconstruction between malleus and stapes head
Ost	Reconstruction between tympanic membrane and stapes head
Osd	Tympanic membrane directly repositioned onto stapes head
Ofi	Reconstruction between incus and stapes footplate
Ofm	Reconstruction between malleus and stapes footplate (± stapes preserved)
Oft	Reconstruction between tympanic membrane and stapes footplate (± stapes preserved)
Ofd	Tympanic membrane directly repositioned onto stapes footplate
Ovi	Reconstruction between incus and vestibule (including stapedotomy)
Ovm	Reconstruction between malleus and vestibule (malleo-stapedotomy) (± tissue graft seal over vestibule)
Ovt	Reconstruction between tympanic membrane and vestibule (± tissue graft seal over vestibule)

Figure 3. The IOOG ATO scheme of the SAMEO-ATO framework

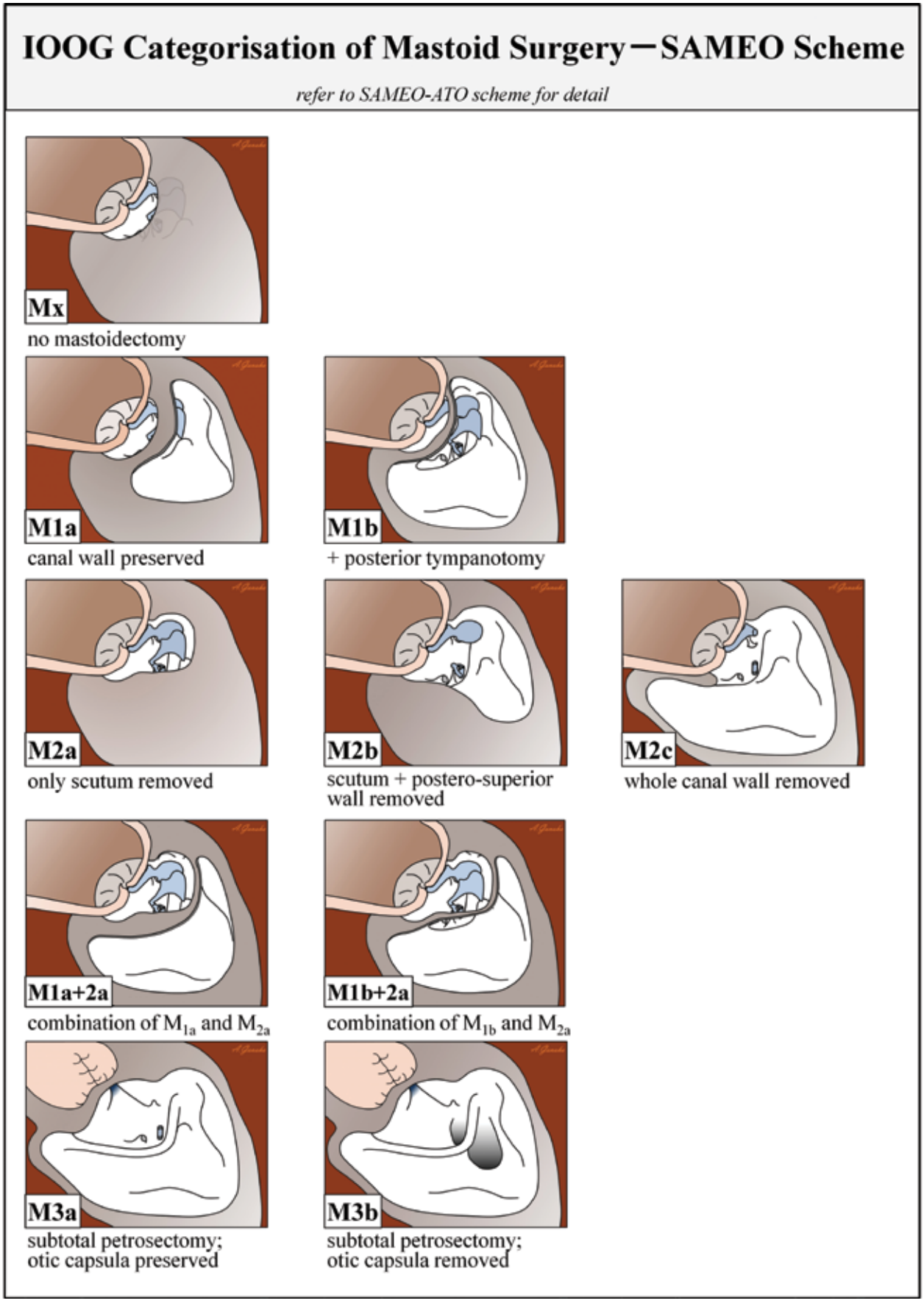


Figure 4. Schematic illustration of the IOOG categorization of "mastoidectomy".

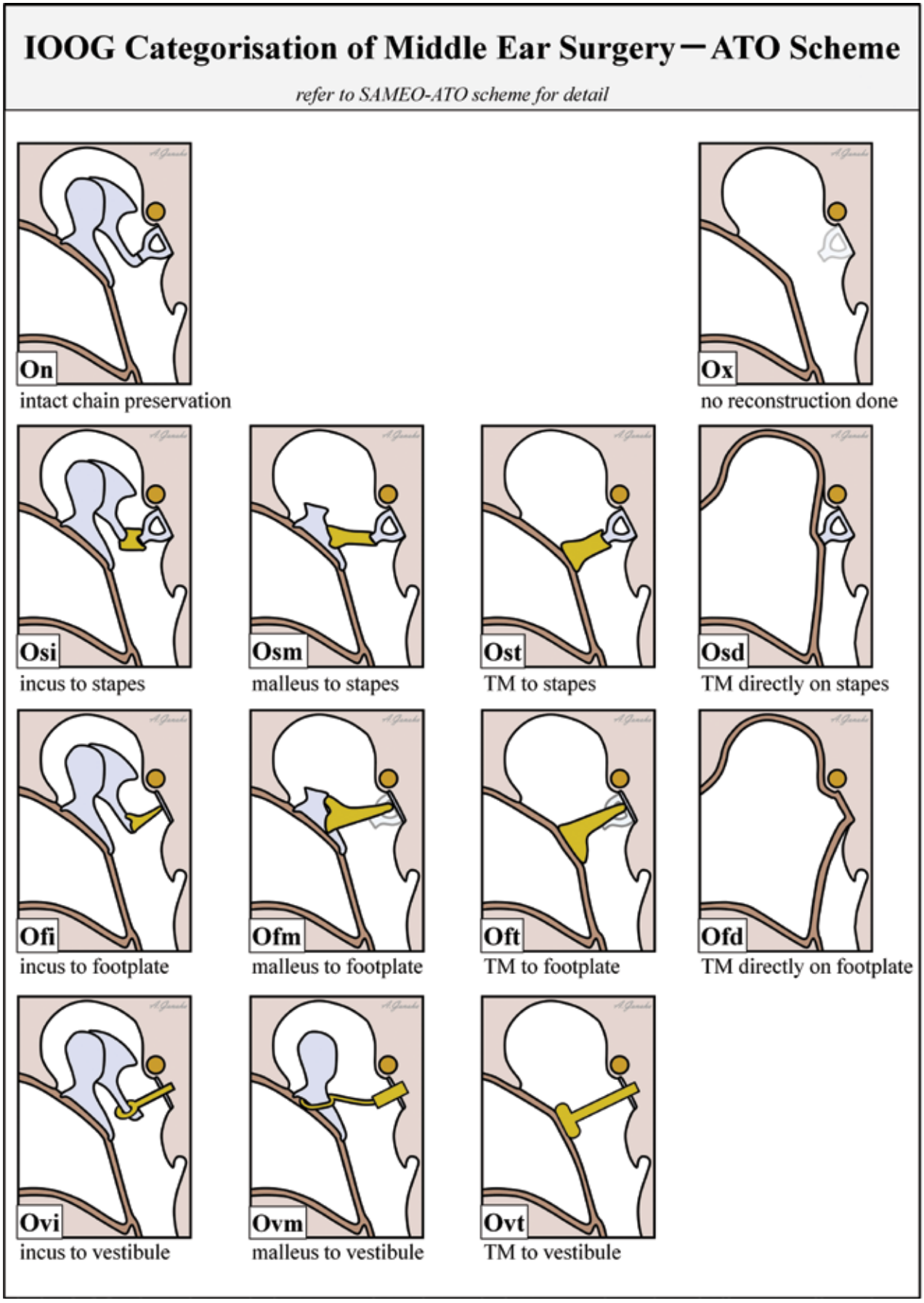


Figure 5. Schematic illustration of the IOOG categorization of "ossicular reconstruction".

Summary of IOOG SAMEO-ATO framework

www.IOOG.net

S Stage of surgery

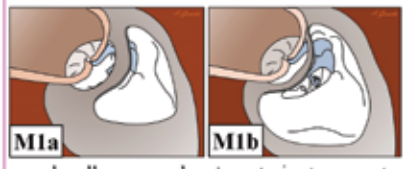
- **S1** Primary (first surgery)
- **S_{2p}** Planned (2nd look or staged procedure)
- **S_{2r}** Revision (unplanned)

A Approach

- **A1** Endoscopic transcanal
- **A2** Microscopic transcanal
- **A3** Endaural
- **A4** Retroauricular

M Mastoidectomy

no mastoidectomy



canal wall preserved | + posterior tympanotomy

only scutum removed | scutum + postero-superior wall removed | whole canal wall removed

combination of M_{1a} and M_{2a} | combination of M_{1b} and M_{2a}

subtotal petrosectomy; otic capsula preserved | subtotal petrosectomy; otic capsula removed

E External ear canal reconstruction

- **Ex** No external ear canal reconstruction
- **E1** Reconstruction with soft materials†
- **E2** Reconstruction with rigid materials†

† *space behind graft not obliterated*

O Obliteration of mastoid cavity

- **Ox** No obliteration
- **O1** Partial obliteration
- **O2** Total obliteration

A Access to middle ear

- **Ax** No bone removal from the external ear canal wall (flattening of suture line alone is still considered as Ax)
- **A1** Widening of the posterior portion of tympanic sulcus (including canal curettage or drilling to visualise the ossicular chain or hypotympanum)
- **A2** Partial or circumferential widening of the bony canal (canalplasty)
- **A3** Total canalplasty with soft tissue grafting of exposed bone

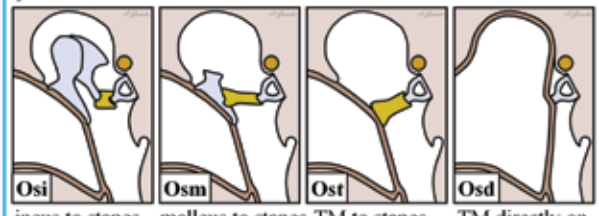
T Tympanic membrane

- **Tx** No tympanic membrane grafting performed
- **Tn** Original tympanic membrane preserved
- **T1** Supplement to intact tympanic membrane (reinforcement)
- **T2** Partial tympanic membrane grafting
- **T3** Subtotal / total tympanic membrane grafting

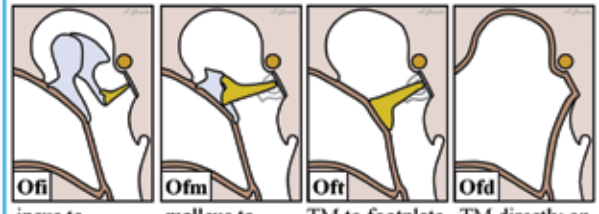
O Ossicular chain

intact chain preservation

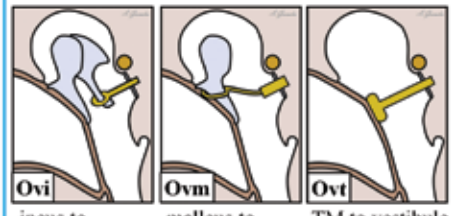
no reconstruction done



incus to stapes | malleus to stapes | TM to stapes | TM directly on stapes



incus to footplate | malleus to footplate | TM to footplate | TM directly on footplate



incus to vestibule | malleus to vestibule | TM to vestibule

Figure 6. Summary poster of the IOOG SAMEO-ATO scheme for categorization of tympanomastoid surgery

tionnaire (Appendix 2). The responders were encouraged to provide approval or disapproval to each recommendation and were further invited to provide comments or suggestions regarding each element of the SAMEO-ATO scheme. All of the societies were given a period of 2 months to allow each chairperson time to consult their councils. A prolonged consultation period would risk interrupting the consensus cycles as the chairpersons and council members might leave office before the second cycle is completed. Therefore, the principal author (MWY) acted as the facilitator in this consensus process to ensure that the procedure was conducted efficiently.

Of the 25 otology societies contacted, 18 gave their responses during Round 1. They were the otology societies from Brazil, Czech Republic, Denmark, Germany, Hong Kong, Hungary, Iran, Italy, Japan, the Netherlands, Romania, Russia, South Korea, Slovenia, Sweden, Switzerland, the United Kingdom, and the United States of America.

During Round 1, all of the chairpersons agreed that there is a need for an international consensus on the categorization of tympanomastoid procedures. Seventeen out of the 18 responders gave approval to the SAMEO-ATO scheme proposed by IOOG, and one disapproved. All 18 responders indicated that they will encourage the use of the SAMEO-ATO scheme for the categorization of tympanomastoid surgery following launch.

The level of approval of each section of the SAMEO-ATO scheme together with selected comments from 18 otology societies in Round 1 are listed in Table 1.

The comments received can be categorized into three main themes:

1. Semantic changes: Based on some of the feedback, the IOOG Steering Committee made changes to the wordings to make them clearer to the users.
2. Mastoidectomy with preservation of the bony canal combined with atticotomy was not represented: The IOOG Steering Committee added a new category within the revised document (Draft 2) to address this.
3. Level of detail within the SAMEO-ATO scheme: Conflicting comments were received. Some societies wished to have more sub-categories, such as materials of reconstruction, nature of revision surgeries (previous surgery performed in same institution versus elsewhere), the use of active middle ear implants, etc. Other societies advised a more minimalist approach to allow the system to be simpler and more user-friendly. The IOOG decided to take a balanced view and to keep the categorization simple without losing the distinction between important categories. In addition to the Categorization of tympanomastoid surgery, the IOOG intends to produce a common otology dataset for the purpose of comparative audit as a follow-up project. The comments and suggestions received during the consensus exercise will help in the design of this dataset.

International Consensus Survey Round 2 (Draft 2)

Despite a high level of approval of SAMEO-ATO during the first round of the consensus survey (17/18 approval; 1/18 disapproval), the IOOG Steering Committee used the feedback to improve the document. The main change was to insert a category that represents "Mastoidectomy with preservation of the external ear canal in combination with atticotomy."

The revised SAMEO-ATO scheme (Draft 2) with supporting documents and diagrams was sent again to the chairperson of the 25 otol-

Table 1. The level of approval and comments on Round 1 of consensus survey on the SAMEO-ATO scheme from 18 otology societies (Brazil, Czech Republic, Denmark, Germany, Hong Kong, Hungary, Iran, Italy, Japan, the Netherlands, Romania, Russia, South Korea, Slovenia, Sweden, Switzerland, the United Kingdom, the United States)

	Stage	Approach	Mastoidectomy	Ext Ear Canal	Obliteration	Access	Tym Memb	Ossiculoplasty
Approval	17 Yes (94%) 1 No	17 Yes (94%) 1 No	17 Yes (94%) 1 No	17 Yes (94%) 1 No	17 Yes (94%) 1 No	16 Yes (94%) 1 abstain 1 No	16 Yes (94%) 1 abstain 1 No	17 Yes (94%) 1 No
Comments Given	Specify if rev alone or with someone else; Identify number of previous op	Considered combination endoscope and incision; Preferred "transcanal to permeatal"; The society that objected insisted that endural or endoscopic approach has no place in mastoidectomy.	Like to specific front-to-back Vs back-to-front; Questions if atticotomy is CWU or CWD; Suggest Mod R Mastoid and R Mastoid in separate categories. The society that objected favored using front-to-back Vs back-to-front mastoidectomy, and include cortical Vs extended cortical mastoidectomy into the system.	Distinguish inflammatory Vs congenital atresia; Question if scutumplasty+ atticotomy should be CWU or CWD; Suggest fascia or other soft tissue graft group together. The society that objected felt there is too much overlap between external canal reconstruction and obliteration.	Like to see more categories on specific technique; Define partial Vs total oblit; Reduce repetition in sub-categories between M and O. The society that objected wished detail of obliteration technique or materials used to be listed.	Wish more clarity of A2 and A3	Wish to see more categories on specific techniques and graft materials; Define partial graft, subtotal, and total perforation; Suggest a sub-category on concomitant VT. The society that objected wished detail of technique and material of eardrum graft to be listed.	Wish a sub-category on active middle ear implant. The society that objected wished detail of technique and material of ossiculoplasty to be listed.

Ext: external; Tym Memb: tympanic membrane; rev: revision; op: operation; Mastoid: mastoidectomy; CWU: canal wall up; CWD: canal wall down; Mod R Mastoid: modified radical mastoidectomy; R: radical; Oblit: obliteration; VT: ventilation tube

ogy societies for Round 2 of the consensus survey. The comments received from all the otology societies at Round 1 were anonymized and categorized into themes. They were sent along with Draft 2 to all the chairpersons in compliance with the Delphi method. Again, a consultation period of 2 months was provided to each society.

Out of 25 otology societies, 21 gave their responses in Round 2. The otology societies in Belgium, Canada, and India gave their full approval in Round 2, even though they missed the deadline in Round 1. For Round 2, the responders were the otology societies from Belgium, Brazil, Canada, Czech Republic, Denmark, Germany, Hong Kong, Hungary, India, Iran, Italy, Japan, the Netherlands, Romania, Russia, South Korea, Slovenia, Sweden, Switzerland, the United Kingdom, and the United States of America. There were fewer comments received from the various otology societies in round 2. The comments from the American Otological Society were mixed. They felt that there is no need for a new classification, as historical terminologies are sufficient for reporting. Nevertheless, they were happy with the description and accuracy of the SAMEO-ATO scheme. They were concerned that the complexity of the system may discourage routine use by busy clinicians. As such, they are reluctant to recommend the SAMEO-ATO scheme to be mandatory for the reporting of surgical outcome in their official journal Otology and Neurotology.

The comments received by the IOOG Steering Committee during Round 2 are listed in full rather than grouping them into themes (Table 2). The single society who expressed disapproval during Round 1 provided approval at Round 2. The only disapproval received in Round 2 was from the Dutch otology group regarding "Ear canal wall reconstruction." They suggested deleting the statement regarding "air behind graft," as it was considered to lead to confusion. After deliberation, the IOOG Steering Committee decided to retain this statement, but to revise the wording from "air behind graft" to "space behind graft." Encouraged by the high degree of consensus, the IOOG Steering Committee did not make any further changes to the SAMEO-ATO scheme but have updated the user guide to clarify some of the expressed confusion. The suggestions received have been helpful for the construction of the common otology dataset that the IOOG Steering Committee is currently working on.

In summary, 20 out of 21 (95%) responding otology societies have provided full approval to the SAMEO-ATO scheme in Round 2. This exceeds the level of 80% set in the beginning of this process. At this stage, the IOOG Steering Committee decided to conclude the consensus stage, and to take the SAMEO-ATO scheme to a "field test."

Field Test (Draft 3)

Field testing of the SAMEO-ATO scheme for the "Categorization of tympanomastoid surgery" was acquired at the 31st Politzer Society Meeting in Gran Canaria on February 23rd, 2018. The aim of the field test was to identify the areas of potential ambiguity and/or dispute. Ninety-four international delegates attended the scientific session on the 'Consensus on the International Categorisation of tympano-mastoid operations'. Each delegate was provided with a printed handout of the SAMEO-ATO scheme together with diagrams. Comments from the delegates were noted and are listed in Table 3. Several comments were from delegates seeking clarification regarding various categories. There was no common concern regarding any particular aspect of the SAMEO-ATO scheme. The Steering Group was mindful that any significant change to the document could invalidate the consensus provided by the otology societies. It was reassuring that the field test did not identify any significant area of dispute or controversy.

Several delegates requested more details regarding the surgical procedures included within the SAMEO-ATO scheme, but they accepted that it would make the system too complicated and less user-friendly. There was a discussion regarding how to categorize reconstruction between the malleus and footplate in the presence of a stapes suprastructure. There was general agreement that this should be rep-

Table 2. The level of approval and comments on Round 2 of consensus survey from 21 otology societies (Belgium, Brazil, Canada, Czech Republic, Denmark, Germany, Hong Kong, Hungary, India, Iran, Italy, Japan, the Netherlands, Romania, Russia, South Korea, Slovenia, Sweden, Switzerland, the United Kingdom, the United States)

	Stage	Approach	Mastoidectomy	Ext Ear Canal	Obliteration	Access	Tym Memb	Ossiculoplasty
Approval	21 Yes (100%)	21 Yes (100%)	21 Yes (100%)	20 Yes (95%) 1 No (5%)	21 Yes (100%)	21 Yes (100%)	21 Yes (100%)	21 Yes (100%)
Comments Given	Specify if rev op on own cases Vs elsewhere.	Query the term "approach" as it has different meaning to "incision"; Should distinguish "front-to-back" Vs "back-to-front" Mastoid+ "endoscopic" Vs "microscopic surgery"	Make distinction between "Mod R Mastoid" Vs "R Mastoid"; Consider category for Intact Bridge Mastoid; Question how to classify "making a window in scutum"; Suggest adding "/Partial" to "Mastoid" in heading; Question how "disease destruction of labyrinth" should be classified.	Some overlap here with O; Suggest adding "/Partial" to "Ext Ear Canal" in heading; Need clarification on terminologies "soft" Vs "rigid." Suggest deleting the statement about "air behind graft."	Acronym of E and O are confusing.		More categories based on graft materials; Add a category on completely absent of annulus.	Term "columellar" should be reserved for TORP only.

Ext: external; Tym Memb: tympanic membrane; rev: revision; op: operation; Mast: mastoidectomy; CWU: canal wall up; CWD: canal wall down; Mod R Mastoid: modified radical mastoidectomy; R: radical; Oblit: obliteration; TORP: total ossicular replacement prosthesis

Table 3. Questions and comments received from international delegates on the IOOG international consensus on the categorization of tympanomastoid surgery and the responses

Country of Work	Question/Comment	Action Taken by the IOOG Steering Group
New Zealand	How to categorize TORP in the presence of stapes	General agreement that is Ofm or Oft. Will make this clearer on a diagram
UK	Can SAMEO-ATO be used retrospectively?	Depends on how detailed the original dataset is. Best is prospectively. The IOOG Steering Group members will try to retrospectively categorize their own surgery and present that in a report
Spain	Clarification on terminologies under "Approaches"	Reinforce A1 and A2 involve no external incision; Will make "Endoscopic" and "Microscopic" more prominent under the transcanal approach
USA	Suggest use term "removal" and "preserved" instead of CWU and CWD to make it more compatible with ICD-10	General agreement on the suggestion and changes will be made to the terminology.
UK	Make a distinction between "subtotal" and "total" TM repair.	Difficulty to define total perforation based on amount of annulus present. Such distinction can be included in the data field set rather be given a separate category
Belgium	Ovt is a dangerous procedure and should not be performed.	The current scheme is not designed to teach surgeons what to do.
Canada	Make a separate category under O for total removal of footplate—by accident or by design at surgery.	Most delegates agreed that there is no need to include Ovd as it is extremely rare. Total stapedectomy with soft tissue graft could be included in the data field set rather than given a separate category
France	Clarify if cartilage plate/sheet over stapes head Ost or Osd.	Osd: If the cartilage strut is inserted between eardrum and stapes, then it is Ost.
Belgium	Why is middle ear pathology not featured?	The categorization is only for surgical procedure. The IOOG is working on minimal data fields that include all risk factors of chronic ear surgery.
UK	What about including procedures for complications?	These are rare, and their inclusion will make the system too complicated.

TM: tympanic membrane; Ofm: ossicular reconstruction between the footplate and malleus; Oft: ossicular reconstruction between the footplate and tympanic membrane; Ovd: tympanic membrane directly placed over an open vestibule directly; Ost: ossicular reconstruction between stapes and tympanic membrane; Osd: tympanic membrane directly placed on the stapes head)

resented as O_{fm}. The IOOG Steering Committee has now introduced labeling on the relevant diagram to clarify this.

The delegates were asked to give a show of hands at the end of the session. Sixty persons indicated approval of the SAMEO-ATO scheme, and none indicated disapproval.

The international consensus on IOOG categorization of tympanomastoid surgery and user guide is presented in Figures 2–5. The IOOG Steering Committee also provides a poster summary of the scheme for users to display in their operating room (Figure 6).

After the launch of the categorization of tympanomastoid surgery, the IOOG Steering Group will organize a multi-center study to measure how well the SAMEO-ATO scheme is holding up.

DISCUSSION

The primary aim of IOOG was to develop an internationally approved categorization of tympanomastoid surgery that would encompass all aspects of surgical technique. This could provide the basis for surgeons to pool their surgical data into a large database for research purpose. There are a number of historical classifications for middle ear and mastoid surgery in the literature.[1] A recent systematic literature review showed that many of these systems are outdated or incomplete; most are not widely accepted and only few correspond with all current surgical techniques. IOOG decided to produce a system based on international consensus.

Much consideration was given to get maximum international representations in the consensus process. The members of the IOOG Steering Committee were from seven countries. The expert group or raters were the representatives or chairpersons of 21 otology societies. The reason for inviting the chairpersons as members of the expert group was because they are the experts and can help in the eventual dissemination of the scheme amongst the members of the societies. In order to facilitate the analysis of the survey responses from each society through its representative, binary response was sought on each question rather than on a Likert scale.

The design of the SAMEO-ATO system is to make it compliant with the ICD-10 coding system and avoid using historical terminologies that are often confusing [1]. The SAMEO-ATO system incorporates modern surgical techniques such as 'endosopic approach' and the techniques of mastoid cavity reconstruction.

The Delphi technique was chosen for the consensus methodology because it allows time for each chairperson to consult the council members of each society. This could not be done with the Nominal

Group Technique. The Delphi technique also has the advantage of anonymity and thus avoids dominance by certain groups. The high international approval rating of over 90% on the IOOG SAMEO-ATO scheme supports its use as the international categorization of tympanomastoid surgery.

Peer-review: Externally peer-reviewed.

Author contributions: Concept – M.Y.; Design – M.Y., A.J., P.M., J.P., B.B., T.T., T.L., J.D.; Supervision – M.Y., A.J., P.M., J.P., B.B., T.T., T.L., J.D.; Resource – T.T.; Materials – N.A.; Data Collection and/or Processing – M.Y., A.J., P.M., J.P., B.B., T.T., T.L., J.D.; Analysis and/or Interpretation – M.Y., A.J., P.M., J.P., B.B., T.T., T.L., J.D.; Literature Search – A.İ.; Writing – M.Y., A.J., J.P.; Critical Reviews – P.M., T.T.

Acknowledgements: The authors would like to thank Dr. Akira Ganaha for the illustrative art work in this paper.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

You can reach the appendix of this article at https://doi.org/10.5152/iao.2018.5553

REFERENCES

1. Merkus P, Kemp P, Ziylan F, Yung M. Classifications of mastoid and middle ear surgery: A scoping review. JInt Adv Otol 2018; 14(2): 227-232.
2. Yung M, Tono T, Olszewska E, Yamamoto Y, Sudhoff H, Sakagami M, et al. EAONO/JOS joint consensus statements on the Definitions, Classification and Staging of Middle Ear Cholesteatoma. J Int Adv Otol 2017; 13: 1-8. [CrossRef]
3. Humphrey-Murto, Susan MD, MEd, FRCPC; Varpio, Lara PhD; Wood, Timothy J. PhD; Gonsalves, Carol MD, MMed; Ufholz, Lee-Anne MLIS; Foth, Thomas RN, PhD. The Use of the Delphi and Other Consensus Group Methods in Medical Education. Acad Med 2016; 91: 11. [CrossRef]

Appendix 1. Explanatory notes on the IOOG categorization of tympanomastoid surgery

1. The aim of the SAMEO-ATO categorization is to aid the comparison of surgical outcome from middle ear and mastoid surgery between institutions.

2. SAMEO-ATO is an acronym that outlines the subgroups of mastoid and middle ear surgery that comprise the classification system:

    Stage of operation
    Approach
    Mastoidectomy procedure
    External auditory canal reconstruction
    Mastoid Surgery
    Obliteration of mastoid cavity
    Access
    Tympanic membrane (TM) repair
    Middle ear surgery
    Ossicular chain repair

3. Where possible, terminology in the SAMEO-ATO system is derived from descriptors used in ICD-10-PCS (see www.icd10data.com/ICD10PCS/Codes/0/9). To minimize ambiguity, terms describe what the surgeon does rather than historical nomenclature that may be open to variable interpretation. For this reason, procedures are not grouped by terms such as "atticotomy" (see also below), "modified radical mastoidectomy," "radical mastoidectomy," and "tympanoplasty." Nevertheless, common names such as these are included in brackets to facilitate understanding.
4. The IOOG Steering Committee recognizes that there is great variation in surgical techniques used by surgeons all over the world. The Committee has aimed for a balance in the SAMEO-ATO system between simplicity and over-complexity to provide a usable classification that includes the parameters that distinguish important differences in surgical intervention. Surgeons that perform a procedure that they consider to be significantly different from any of the categories defined by the SAMEO-ATO are encouraged to allocate their procedures to the closest fit. Details of any such differences should be recorded separately to generate data than can be used to stimulate future revisions of the SAMEO-ATO system.
5. Other important parameters that might influence the outcome, including patient-related variables, complications of disease or surgery, and further surgical details such as the nature of previous surgery, grafting materials, concomitant use of ventilation tube and active middle ear implants, are beyond the scope of this surgical classification. The IOOG Steering Committee is developing a common dataset for middle ear surgery to use alongside the SAMEO-ATO system that will include such topics. Of course, additional parameters may be recorded by individual surgeons, but this should not compromise allocation of procedures into the SAMEO-ATO categories.
6. The SAMEO-ATO system has been developed for implementation in prospective data collection. Although it may be possible to apply the system retrospectively, the accuracy of classification will be impaired significantly by the limits of previously collected data fields. Users should report whether the system has been applied prospectively or retrospectively and emphasize potential discrepancies from retrospective use.
7. The IOOG Steering Committee does not advocate any particular surgical procedure or combination of procedures that may be defined by the SAMEO-ATO classification but has simply attempted to derive a comprehensive classification system. An example raised during consensus discussions was that ossiculoplasty type O_{vt} might be dangerous so arguably should not be performed, but it remains in the classification for completeness.

Guidance on implementation of the SAMEO-ATO categorization in tympanomastoid surgery

These notes provide guidance on use of the SAMEO-ATO system. The IOOG advises that surgeries be categorized using all components of the SAMEO-ATO, not limited just to the parts of surgery that are completed (e.g., the absence of any mastoid surgery is categorized as $M_xE_xO_x$). "Stage of surgery" and "Approach" are applicable to both middle ear and mastoid operations.

- Stage of operation
    i. S_1 signifies the first surgery for the condition being treated.
        - For example, first operation for cholesteatoma after a previous TM perforation repair
    ii. S_2 signifies any subsequent surgery for that condition, not the number of operations completed
        - For example, third surgery for a recurrence of cholesteatoma after two planned stages of surgery is coded as S_{2r}
- Approach
    i. If an incision is used to access the mastoid, the use of an endoscopic surgery is considered to be an adjunct procedure
        - for example, post-auricular incision used for endoscopic access to the mastoid is A_4, even if no microscope is used
    ii. If an external incision is made for harvest of a graft but not used for access to mastoid or middle ear, this is classified as A_1 or A_2.
    iii. The term "permeatal approach" is considered to be synonymous with "transcanal approach."

Mastoid Surgery

- Mastoidectomy procedure
    i. An M1 procedure is a mastoidectomy leaving the canal wall intact (preserved), and an M2 procedure is a mastoidectomy with the removal of the canal wall partly or completely.
    ii. M2a: As part of the canal wall is removed with the removal of the scutum (atticotomy), this procedure is categorized according to the SAMEO-ATO with other "canal wall down" surgeries. However, many surgeons incorporate an atticotomy and scutum reconstruction with a cortical mastoidectomy in what is considered to be "canal wall up" surgery. This hybrid procedure is defined in the SAMEO-ATO by combining the mastoid codes for cortical mastoid-

ectomy and scutum removal (e.g., $M_{1a,2a}$ or $M_{1b,2a}$ if posterior tympanostomy is included).

iii. Partial scutum removal to create only a window at the scutum (for access to the epitympanum)while preserving its inferior border is also to be classified as M_{2a}.

iv. M_{3a} differs from M_{2c} in that the cavity is closed off completely with an ear canal closure (removal of all ear canal skin and TM), as well as blocking up of the tympanic opening of the Eustachian tube.

- External auditory canal reconstruction
  i. Different materials may be used to reconstruct the scutum and/or bony canal wall with the intention of leaving a ventilated attic and mastoid under the graft.
- E_1 Soft tissues include fascia, perichondrium, pericranium, periosteum, and some bio-engineered grafts (e.g., porcine collagen or cadaveric human skin derivatives)
- E_2 Hard reconstruction includes cartilage, bone, or solid prosthetic materials (e.g., titanium, hydroxyapatite).
  ii. If an obliteration is added to the canal wall procedure, the reconstruction of the ear canal prior obliteration can be noted under E.
  iii. Surgeons should still record material for reconstruction in their own database in addition to the SAMEO-ATO system.
- Obliteration of mastoid cavity
  i. O_x means that an empty air space is present behind the ear canal or in the cavity.
  ii. Partial obliteration spares the attic cavity±part of the mastoid cavity (i.e., just a reduction of the cavity size). A total obliteration is a complete obliteration of the whole mastoid *and* the attic cavity.
  iii. Obliteration of the attic without obliteration of the mastoid is considered to be O_1.
  iv. The type of obliteration material can be added to with small letters in own database and should be reported when presenting a series.

Middle Ear Surgery

- Access
  i. The distinction between A_2 and A_3 is that in A_3, there is an absence of the meatal skin to line the ear canal, for example, during surgery for medial canal fibrosis.
  ii. This Access category has not been developed for the congenital meatal atresia surgery.
- TM repair
  i. T_n TM normal, no need for surgery
  ii. T_x TM not normal, but not repaired
- e.g., atelectatic TM elevated but not reconstructed; perforation present, but surgeon chose not to repair; or previous cartilage tympanoplasty
  iii. T_3 Total perforation is defined as complete absence or removal of the TM and annulus. Subtotal perforation is the absence of TM, but the annulus is still preserved.
- Ossicular chain repair
- O_n Normal ossicular chain. Ossicular repair not needed
- O_x Ossicles not normal, but no ossiculoplasty performed
  i. It should be noted that the ossiculoplasty diagrams are conceptual and not a surgical illustration of technique. The stapes superstructure is shown in faded outline (O_{fm} and O_{ft}) to indicate that a reconstruction can be performed whether superstructure is absent or present.
  ii. Categories of ossiculoplasty are defined by the furthest points of contact of the graft or prosthesis between these anatomical structures:
    - m malleus handle
    - t TM
    - i incus
    - s superstructure of stapes
    - f footplate of stapes
    - v vestibule (no distinction is made between footplate perforation, footplate removal, or placement of a soft tissue graft, although these differences may be recorded for presenting/reporting on the dataset)
    - d direct coupling of TM without a graft or prosthesis (e.g., O_{sd} is myringostapediopexy)
  iii. Regarding cartilage tympanoplasty with absent incus but intact stapes:
- O_{sd} Flat cartilage graft used in TM reconstruction in contact with stapes (cartilage myringostapediopexy)
- O_{st} Shaped piece of cartilage placed as a bridge between stapes and TM
  iv. Placement of a silastic band around the stapes superstructure and the shaft of a total ossicular replacement prosthesis between footplate and TM is included within O_{ft} and O_{fm}.

Appendix 2. Survey Questionnaire

The International Otology Outcome Group wishes to get an international consensus on the categorization of tympanomastoid surgery. This is the first step toward starting an international audit of surgical outcomes in chronic otitis media. It will help us if you can give your approval/disapproval of the SAMEO-ATO system designed by members of the Steering Group. Please answer yes or no on the following questions. If you disagree, please give your reasons and suggestions for improvement. Please put yes or no and any comment for each question. **We like to have one response from each otology association.**

1. Do you think there is a need for an international consensus on the definition and categorization of tympanomastoid surgery?
   Yes / No …….
   Comment…….

2. Do you approve the description of the mastoidectomy procedure using the system of SAMEO (stage of surgery, approach, mastoidectomy, external ear canal reconstruction, and obliteration)?
   Yes / No …….
   Comment…….

3. Do you approve the description of the tympanoplasty procedure using the system of ATO (access to middle ear, tympanic membrane reconstruction, ossicular chain reconstruction)?
   Yes / No …….
   Comment…….

4. Do you approve the description under S?
   Yes / No …….
   Comment…….

5. Do you approve the description under A (Approach in Mastoidectomy)?
   Yes / No …….
   Comment…….

6. Do you approve the description under M?
   Yes / No …….
   Comment…….

7. Do you approve the description under E?
   Yes / No …….
   Comment…….

8. Do you approve the description under O (Obliteration)?
   Yes / No …….
   Comment…….

9. Do you approve the description under A (Access to Middle Ear)?
   Yes / No …….
   Comment…….

10. Do you approve the description under T?
    Yes / No …….
    Comment…….

11. Do you approve the description under O (Ossicular Chain Reconstruction)?
    Yes / No …….
    Comment…….

12. Would you recommend the members of your society to use this in recording their operations?
    Yes / No …….
    Comment…….