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Corneal Laser Refractive Surgery Curriculum Development in the Military: Using the Nominal Group Technique

Short title: CRS Curriculum Development in the Military

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38

39 **Abstract**

40 Introduction: Corneal laser refractive surgery (CRS) has emerged over the past three decades as a surgical
41 method for correcting or improving vision. In the military, CRS helps warfighters achieve weapon grade
42 vision, which offers a tactical advantage in the deployed environment. As refractive surgery has become
43 more prevalent both in the military and civilian sector, more ophthalmologists need to learn about
44 treatment options as well as management of complications in order to meet increasing patient
45 demand. Currently, little is known about the most effective curriculum for teaching refractive surgery in
46 training programs and a standardized curriculum does not exist. Since unification of training programs is
47 a Defense Health Agency (DHA) priority, this study aimed to collect expert consensus on a standardized
48 curriculum for CRS training in the military.

49 Materials and Methods: To achieve this goal, the Nominal Group Technique (NGT) was used wherein a
50 panel of experts, currently practicing refractive surgeons involved in military refractive surgery training
51 programs, arrived at consensus on a standardized CRS curriculum. The framework for developing this
52 curriculum is based on Kern's Six Step Approach to Curriculum Development. The International Council
53 of Ophthalmology (ICO) refractive surgery curriculum, National Curriculum for Ophthalmology
54 Residency Training, Accreditation Council for Graduate Medical Education (ACGME) competencies and
55 surgical minimums, and American Academy of Ophthalmology Refractive Surgery Preferred Practice
56 Guidelines were used as the starting materials from which panelists' consensus was drawn. This
57 consensus building method allowed for equal representation of experts' ideas and fostered collaboration
58 to aid in the creation of a robust and standardized curriculum for refractive surgery training programs in
59 the military.

60 Results: The panelist experts from this NGT were able to reach consensus on the components of a
61 standardized military refractive surgery curriculum to include generalized and targeted needs assessment,
62 goals and objectives, educational strategies and curriculum implementation.

63 Conclusion: A standardized CRS curriculum is warranted in military training programs. This NGT
64 achieved expert consensus on the goals, objectives, educational methods, and implementation strategies
65 for a standardized CRS curriculum in military ophthalmology residency.

66

67 **Introduction**

68 Corneal laser refractive surgery (CRS), also known as laser vision correction, is a procedure that reshapes
69 the corneal surface to allow more independence from spectacles (i.e., eyeglasses and contact lenses). It
70 has emerged over the past three decades, yet because the technology is still evolving, little is known about
71 the most effective curriculum for teaching refractive surgery including CRS in training programs. In 2009,
72 it was reported that only about 50% of residency training programs in the United States had provided
73 CRS experience to resident trainees.¹⁻³ In 2010, 75% of young ophthalmologists in practice for less than 6
74 years and ophthalmology residents surveyed by the American Society of Cataract and Refractive Surgery
75 had never performed CRS.⁴

76

77 People are increasingly electing to have CRS to become more independent of eyeglasses and contact
78 lenses. In the civilian sector, this choice is considered an elective cosmetic procedure. However, in the
79 military, it enhances occupational performance of warfighters especially in the deployed environment,
80 which makes it an essential component of combat readiness. Warfighters have increased tactical
81 advantage after CRS as they are less dependent on corrective lenses that often get in their way during
82 combat.⁵ In 2010, Wright et al reported about 40-50% of United States Air Force (USAF) pilots and
83 aircrew require corrective lenses to perform their duties. Their study also reported a prior survey that
84 estimated about 50% of aircrew experience spontaneous loss of a lens and about half of those lost their
85 lens in flight.⁶ The important role of CRS in helping service members decrease performance vulnerability
86 explains the need for a standardized and robust refractive surgery curriculum to consistently ensure the
87 quality of refractive surgery training in the military. In addition, as refractive surgery is becoming more

88 common, more patients will likely present with a history of having had this surgery. Thus, it is essential
89 that ophthalmology residency programs incorporate refractive surgery evaluation, skills transfer and
90 postoperative management training.⁷

91
92 There are a limited number of publications on CRS curriculum. The Accreditation Council for Graduate
93 Medical Education (ACGME) requires that ophthalmology residents be trained in CRS procedures.⁸
94 However, the ACGME only requires each resident trainee to perform or observe a minimum of six of
95 these procedures. On the other hand, the Association of University Professors of Ophthalmology (AUPO)
96 mandates cornea and refractive surgery fellows to perform a minimum of 8 and observe a minimum of 50
97 CRS procedures.⁹ The International Council of Ophthalmology (ICO) has published a residency
98 curriculum that includes a refractive surgery section listing the cognitive and technical skills
99 recommended for refractive surgery training.¹⁰ Similarly, in 2018, Grover et al¹¹ published a national
100 curriculum for ophthalmology residency training. Although these references provide a list of
101 competencies, cognitive goals and surgical skills pertinent to CRS, they also combined all refractive
102 surgery including CRS, phakic intraocular lenses, cataract surgery and clear lens exchange. Intermixing
103 these different surgical approaches in one curriculum makes implementation and tracking competencies
104 of all the different procedures particularly challenging. Furthermore, practical curriculum implementation
105 requires more specific details such as CRS specific objectives and teaching methods than currently
106 published that may be particularly helpful for novice staff and faculty who are considering CRS
107 curriculum implementation.

108
109 The surgical minimum required by ACGME and AUPO does not guarantee clinical and technical
110 competency for all CRS procedures. Furthermore, the lack of standardized curriculum requirements
111 among training programs may lead to unintentional bias towards teaching select procedures that may not
112 necessarily be the best procedure for every patient. Some procedures such as LASIK and SMILE can be
113 technically more challenging, which require higher surgical volume experience. With the growing body

114 of refractive surgery patients, training programs must be able to teach not only the technical aspect, but
115 also the preoperative planning, counseling and postoperative management of the procedures. Developing
116 a robust and unified curriculum may help all training programs produce competent refractive surgeons
117 that would meet current and future demands of the MHS.

118

119 In the military, a unified and highly reliable medical training system that would support readiness is a
120 Defense Health Agency (DHA)¹² priority. A comprehensive ophthalmologist in the military may serve as
121 the sole refractive surgeon in their local duty station, making the need for a standardized CRS curriculum
122 to produce competent military refractive surgeons stark. Thus, the goal of this study is to develop a
123 standardized CRS curriculum for military training programs using a consensus method from experts in
124 the field. This may then be further expanded into a more comprehensive curriculum that can help all
125 training programs produce competent refractive surgeons who would meet current demands of a growing
126 body of refractive surgery patients.

127

128 This study used the ICO curriculum guide and National Curriculum for Ophthalmology Residency
129 Training as baseline content guides, which both described the knowledge and skills ophthalmology
130 residents and advanced trainees need to know in the area of refractive surgery. It also used Kern's Six
131 Step Approach to Curriculum Development¹³ as an overarching framework to develop the curriculum
132 components.

133

134 **Methods**

135

136 Nominal Group Technique

137

138 The Nominal Group Technique (NGT) used in this study was adopted from prior health professional
139 research.¹⁴⁻¹⁶ NGT was originally developed by Andre Delbecq and Andrew Van de Ven in the 1970s^{17, 18}
140 and has been used in curriculum development.^{19, 20} This consensus-building method allows for equal
141 representation of experts' ideas and fosters collaboration.^{14, 21} The protocol has five steps: introduction
142 and presentation of the nominal question to a group of experts, silent generation of ideas, sharing of ideas,
143 group discussion, and voting/ranking of ideas. The goal is to arrive at a consensus defined in this study as
144 >50% agreement among experts (adopted criteria from Bell et al¹⁴). After introducing the NGT process to
145 the group, the first question is presented by the moderator, followed by a period of silence for their
146 independent thoughts. Then, in a round robin fashion, each expert shares their ideas without interruption
147 from other panelists. All ideas are listed and visible to the group. The floor is then opened up for group
148 discussion until all ideas are exhausted. Then anonymous voting or ranking of ideas transpires. In this
149 study, this sequence of steps recurred for each question or topic of interest until the two-hour allotted time
150 was finished. The 59th Medical Wing Joint Base San Antonio Institutional Review Board determined this
151 study to be exempt from further review (Protocol FWH20200128E).

152

153 This NGT session was coordinated and conducted through an online video conference session due to the
154 geographic separation of the participants. The principal investigator, who is a refractive surgeon and
155 teaches refractive surgery to residents and fellows, moderated the session. Two assistant investigators
156 provided technical assistance and logistical feedback. Two hours were allotted for this NGT, which was
157 the ideal maximum time for NGT.^{15, 16} The session was recorded with participant consent.

158

159 Prior to the session, the majority of the participants inquired about preparatory material. An optional
160 questionnaire was sent out to participants that outlined the questions for the NGT. Questions were created
161 based on Kern's Six Step Approach to Curriculum Development,¹³ ACGME competencies²² and surgical
162 minimums,⁸ American Academy of Ophthalmology Refractive Surgery Preferred Practice Pattern,²³ ICO
163 refractive surgery curriculum¹⁰ and National Curriculum for Ophthalmology Residency Training.¹¹ Most

164 participants opted to answer this pre-session questionnaire, but individual answers were only available to
165 the moderator and not to other participants. This allowed the moderator to pre-list the range of possible
166 answers in a polling system, and modify the list as needed during the session, which made the
167 voting/ranking portion more efficient. At the beginning of the session, the moderator reviewed the NGT
168 process and the definition of a curriculum based on Kern's Six Step Approach to Curriculum
169 Development. Upon the conclusion of the NGT, voting results were shared with the group.

170

171 Expert Panelists

172

173 At the time of this study, there were four military ophthalmology residency programs that incorporated
174 refractive surgery training. Upon institutional review board (IRB) approval, experienced military
175 refractive surgery faculty members from these training programs were identified as potential participant
176 experts for the NGT. To be considered eligible experts, participants had to be subject matter experts who
177 were currently practicing and teaching refractive surgery and had the ability to implement changes.¹⁶ A
178 total of twelve potential participant experts were identified and invited through e-mail to participate in
179 this NGT. The e-mail also described the purpose of the study. Agreement through an email response
180 served as participant consent. Participants were able to opt out of the study at any time prior to or during
181 the session if they desired. Eight experts (Table 1) agreed to participate, a higher participation rate than
182 prior reports of 30-50% participation.¹⁵

183

184 The participants were composed of active duty military field grade officers who have also led their
185 respective refractive surgery centers. All of them were at least 5 years out of residency and had been in
186 clinical refractive surgery practice for at least 3 years -- half of them for over 10 years. Six were
187 fellowship-trained in Cornea and Refractive Surgery. Each held leadership and/or teaching positions in
188 refractive surgery at the time of this study.

189

190 Data Analysis

191 Both quantitative and qualitative data were gathered and analyzed in this study. The voting and ranking
192 results captured through an automated polling system were used to quantitatively identify consensus
193 agreement for each key idea. The primary investigator transcribed the video recording and de-identified
194 the data for qualitative analysis. We used inductive content analysis as described by Patton,²⁴ which
195 allows data verification of key information using multiple responses from participants.¹⁶ Specifically,
196 qualitative data from the transcription including individual ideas and group ideas were used to further
197 contextualize the voting results and look for patterns or emerging themes not captured in the voting
198 results. In this study, expert statements were used in order to: 1. obtain quotes to support identification of
199 best practices, 2. clarify the context of the expert consensus obtained from voting, and 3. add depth to
200 some of the expert answers.

201 Results were organized and analyzed using Microsoft Excel (2018) spreadsheet, which was created and
202 audited by two investigators (CE and AS) to enhance trustworthiness and validity. A third investigator
203 (KL) helped with clarification of conflicting analysis when needed.

204

205 **Results**

206 *General Needs Assessment*

207 The NGT participants in this study acknowledged that the development of highly competent CRS
208 surgeons to enhance warfighter vision directly supports military mission. They also recognized that a
209 standardized CRS curriculum was nonexistent at the time of this study. Since individual military service
210 branches have different CRS curricula but share the same mission, the participants agreed unanimously
211 that there is a general need for unification of all military CRS curricula in order to produce competent
212 military refractive surgeons. They also agreed that this is in line with the DHA mission to integrate the
213 Department of Defense (DoD) medical force and enhance warfighter readiness through collaboration and
214 standardization of training and education.

215

216 ***Targeted Needs Assessment***

217 The participants recognized that each military refractive surgery training center follows their own pre-
218 existing curriculum built independently from other centers. The details and components of each
219 curriculum are currently unknown to other training programs. The CRS skill level of each military
220 ophthalmology resident varies depending on their training locations. And oftentimes military
221 ophthalmologists need to go to a remote duty station and serve as an independent refractive surgeon
222 immediately after residency training, which is a different expectation compared to their civilian
223 counterparts. Because of this, the participant experts in this NGT agreed that US military ophthalmology
224 residents should be trained under a standardized curriculum sharing the same goals, objectives and
225 educational methods to become competent refractive surgeons.

226

227 ***Goals and Objectives***

228 A summary of the goals and objectives the participants identified can be found in Table S1.

229

230 ***Broad program goals***

231 The participant experts agreed that the primary goal of the military CRS curriculum is to teach military
232 ophthalmology residents laser-assisted in situ keratomileusis (LASIK) and photorefractive keratectomy
233 (PRK) procedures. Different refractive surgery centers have different laser platforms so training and
234 certification on more than one laser platform would be ideal. However, since case volumes may be
235 limited in training programs, they recommended that trainees should at least prioritize familiarization with
236 the same laser platform they will be using at their duty station. One of the participants mentioned a
237 possible future goal is standardization of laser platforms in order to have a more uniform training.

238

239 The participant experts felt that small-incision lenticule extraction (SMILE), which is a newer FDA-
240 approved CRS procedure, should eventually be incorporated in the CRS curriculum. However, at the time

241 of this study, the industry required at least 50 LASIK cases performed prior to SMILE certification, which
242 significantly adds to the number required from each trainee and is currently not feasible in residency
243 training programs. In addition, the consensus in this NGT was that SMILE needed more advanced
244 surgical skills that may not be consistently attainable during residency. Because of the above constraints,
245 the participants reached consensus that SMILE should not be required during residency training.

246

247 The experts agreed that at least an introduction to implantable collamer lens (ICL) implantation should be
248 incorporated in CRS curriculum because it is another refractive surgery alternative for qualified
249 candidates. However, experts felt that it also requires more specialized surgical skills that may not be
250 acquired during residency due to resource and volume limitations similar to SMILE.

251

252 *Specific program objectives*

253 The consensus in this NGT was that the majority (>70%) of trainees should achieve laser certification on
254 at least one excimer and one femtosecond laser platform during residency. The participants emphasized,
255 however, that the volume of training is more important than the type or brand of laser platform.

256

257 The experts agreed that residents must personally examine and consent all patients prior to participating
258 in surgery. Residents need to review all test results and plan all treatments under the supervision of a staff
259 surgeon. Some of the experts recommended reviewing and planning at least 50 to 100 patient charts with
260 a supervising surgeon during training in order to gain the skills of discerning what patients qualify or do
261 not qualify for CRS. In addition, the experts agreed that trainees need to accomplish a minimum of 5
262 comprehensive preoperative screening from start to finish, which includes personally doing the screening
263 tests that technicians often perform such as manifest and cycloplegic refraction, topography, tomography,
264 pupillometry and wavefront aberrometry. This is to ensure that surgeons know how to do the entire
265 evaluation themselves and be able to verify all test results in their clinical practice.

266

267 In terms of the number of procedures performed, the experts felt that a higher volume than what is
268 required for certification is optimal. This will increase the chances of skill sets being ingrained and
269 retained longer as in-processing to the next duty station takes time. Based on this consensus, the surgical
270 minimum requirement per trainee should be 5 to 10 PRK and 21 to 25 LASIK procedures. They
271 emphasized that the surgeon's technical skill set is different from the surgical planning skill set. The latter
272 is much more difficult and is the skill that gives residents confidence to make the treatment decision and
273 ultimately perform the procedure. Thus, surgical planning requires a higher number of cases compared to
274 the surgical minimum as previously suggested.

275

276 The experts also agreed that trainees should, at a minimum, see postoperative patients at postoperative
277 day 1, week 1 and month 1 for PRK, and postoperative day 1 and week 1 for LASIK. Overall, the
278 consensus was that the earlier postoperative visits provide more valuable teaching for LASIK, while later
279 postoperative visits have more pertinent teaching points in PRK. There was no consensus on the
280 minimum number of post-PRK patients trainees should see. However, they agreed that trainees should see
281 16 to 20 post-LASIK patients in order to see the gamut of conditions and interventions that may transpire
282 after surgery. This may also help trainees inform their patients better during the consent process.

283

284 *Educational Strategies*

285 The top five methods that were unanimously voted to be absolutely needed when teaching CRS include
286 using a tomography and topography teaching guide, demonstration of live surgery by the staff surgeon,
287 direct observation during preoperative evaluation, direct supervision during surgery and direct supervision
288 during postoperative visits. Other educational strategies and lecture topics that reached consensus of being
289 absolutely needed and those that were deemed to be nice to have are all listed in Table 2.

290

291 *Implementation*

292 Due to the intrinsic technical differences between PRK and LASIK, the experts felt that it is appropriate
293 to introduce PRK during the second year of residency (postgraduate year or PGY 3) and LASIK during
294 the third year of residency (or PGY 4). Attending faculty need to be available and willing to
295 accommodate the number of trainees. Ideally, there is a 1:1 faculty to trainee ratio at any given teaching
296 session. Consensus faculty qualifications such as 1 to 2 years of clinical experience as well as over 100
297 total procedures performed were believed to be necessary. Other items that experts felt are key to
298 curriculum implementation, such as command support, staff training and support staff availability, are all
299 listed in Table 3.

300

301 *Evaluation and Feedback*

302 Due to the time constraints allotted for an NGT, this section was not explored in this study. The main
303 evaluation and feedback forms utilized by military training programs at the time of this study included
304 generalized ophthalmology evaluations forms required by ACGME, but were not yet validated
305 specifically for military CRS curriculum. The authors deemed a separate study should be conducted to
306 explore the standardization of the Evaluation and Feedback tools for a CRS curriculum.

307

308 **Discussion**

309 Effective CRS training, including PRK, LASIK and SMILE, is becoming more relevant as the number of
310 general population with CRS increases. In the military, its relevance is more emphasized in terms of
311 deployment readiness; CRS allows for independence from eyeglasses which has a valuable impact
312 downrange when warfighters need to wear specific headgear or goggles where prescription eyeglasses
313 may be on the way. This emphasizes the importance of consistently producing competent CRS surgeons
314 through curriculum improvement and standardization, which is integral to the DHA mission.¹²

315 The unique mission of the military validates the need for curriculum standardization within military
316 training programs. We used Kern's Six Step Approach to Curriculum Development, which defines

317 curriculum as a “planned educational experience” and curriculum development as a process composed of
318 problem identification, general and targeted needs assessment, and development of goals, objectives,
319 educational strategies, implementation plan, and evaluation and feedback tools.¹³

320

321 This study was able to establish consensus that CRS curriculum in the military should at least prioritize
322 teaching PRK and LASIK to military ophthalmology residents because these are the most prevalent
323 treatment platforms in their immediate duty stations at the time of this study. Another CRS procedure,
324 SMILE, was felt by the expert panelists to be more appropriate for advanced CRS surgeons and not
325 necessarily required during ophthalmology residency training.

326

327 Increasing surgical volume to more than what is currently required for certification was found to be
328 optimal. However, the experts agreed that it is even more important to focus on the amount of
329 preoperative evaluations trainees perform including chart reviews and surgical treatment planning in order
330 to solidify their CRS training and ensure consistent delivery of excellent results.

331

332 In support of the goals and objectives, this NGT was also able to establish a consensus list of educational
333 strategies mainly focusing on demonstration of skills and direct supervision of trainees by the attending
334 surgeon during the preoperative evaluation, actual surgery and postoperative visits. The experts were able
335 to reach consensus on items relevant to successful curriculum implementation such as organizational
336 support, staff training, teaching facility and equipment. The experts notably agreed that a qualified
337 teaching faculty does not necessarily require cornea and refractive surgery fellowship as long as they have
338 significant CRS experience defined in Table 3. Finally, it was also realized during this NGT that
339 standardized feedback and assessment tools still needed to be developed.

340

341 We chose NGT to establish a consensus baseline curriculum that allowed collaboration and development
342 of ideas with equal representation from all panelists.^{14-16, 18} It also allowed immediate feedback and

343 availability of results.^{14, 16} Furthermore, in the setting of a pandemic, this NGT allowed for a socially-
344 distanced, yet still organized and efficient consensus-building methodology.

345
346 Reaching consensus in this study was not difficult because the panelists have similar clinical practices and
347 shared the same mission. They found relief knowing that they agreed and shared similar teaching
348 methodologies. When their opinions varied, the discussion helped them understand each other's
349 perspectives.

350
351 Existence of consensus does not mean these findings are hard and fast rules. Curriculum development is
352 an ongoing process that needs constant reassessment and refinement to ensure goals and objectives are
353 met.¹³ The consensus findings established in this NGT are not the only items that should be considered
354 when developing a military CRS curriculum. Instead, these items are meant to serve as a starting point for
355 developing a comprehensive, current and successful curriculum.

356

357 **Conclusions**

358 This is the first study that attempted to obtain a consensus of experts to establish and describe essential
359 elements of a military refractive surgery curriculum. It provides a standardized curriculum that may be
360 used in all military refractive surgery training programs irrespective of the branch of service. A limitation
361 of this study is the time constraint recommended in an NGT preventing the discussion of the sixth step
362 curriculum development. Evaluation and feedback is an important part of a curriculum and needs to be
363 explored. Currently, there are no standardized or validated evaluation and feedback forms for military
364 CRS curriculum. The pre-existing evaluation forms required by ACGME may not necessarily capture the
365 CRS goals and objectives described in this study. Similar consensus-building techniques may be needed
366 to compile any pre-existing evaluation and feedback tools and potentially validate them.

367

368 It is also worth noting that the primary researcher in this study is currently a director of one of the major
369 military residency training programs which may have influenced the discussion topics and interpretation
370 of findings. However, Potter et al argue that the NGT's inherently high structured process minimizes
371 researcher bias.¹⁶ It is important to note that the investigators followed the NGT protocol and did not
372 participate in idea sharing, discussion and voting. None of them discussed the details of the study with
373 any of the panelists prior to the session. The primary investigator works in the same location as two of the
374 panelists, but is not a supervisor for any of the panelists.

375

376 To address validity and acceptability of results, panelist experts were identified based on their current
377 duty assignment, previous experience in both teaching and clinical practice, and capability to enforce
378 changes as suggested in prior NGT studies.¹⁵ To enhance data trustworthiness and replicability, data
379 analysis and interpretation were independently reviewed and verified by two co-investigators who do not
380 have expertise in refractive surgery but are experts in academic research.

381

382 This study provides a starting point for program directors and curriculum developers to further enhance
383 training standards and outcomes. Continued effort is needed to develop a more comprehensive curriculum
384 that would include feedback and evaluation criteria for refractive surgery, not just in the military, but also
385 in civilian refractive surgery training programs.

386

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