Strategy for decentralised prevention of angle closure glaucoma in Greenland

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ABSTRACT
In 1962 a blindness survey showed glaucomas to be responsible for 64% of all blindness in Greenland. In 1968 primary angle closure glaucoma was found to be the major glaucoma problem. Population studies using gonioscopy, optical anterior chamber depth, corneal thickness, diameter- and curvature measurements as well as ultrasound biometry were gradually performed. Prevalence was estimated at 5.1% in women and 1.6% in men aged 40+. Main findings were eye traits associated with increased risk of angle closure glaucoma: shallow anterior chamber depth and small corneal diameters. A high heritability (70%) was found.

Surgical iridectomies and later YAG-laser iridotomies were introduced as routine procedures by travelling consultants and at the referral centre Rigshospitalet in Copenhagen. Eventually, in 1993-96 a surgical eye clinic was established in the capital Nuuk, also introducing phakoemulsification cataract surgery.

Blindness due to glaucomas had fallen to about 9% of the registrations in Greenland per 1999.

In 1999 an outreach model had to be established again, including consultants covering the 16 districts in 45 weeks and surgical teams of 2 surgeons 3 x 3 weeks per year. In 2002 the coverage was reduced to 31 weeks and only two surgical tours. – The possible consequences for glaucoma blindness will be discussed.

Keywords: Glaucoma, primary angle-closure, laser-iridotomy, blindness

INTRODUCTION
Only a few eye disorders may - eventually - show the fatal outcome of total blindness, with no sense of light in either eye. One of these, angle closure glaucoma, has a remarkable frequency in Greenland. Untreated it may lead to total blindness in a few weeks or months.

The health service in Greenland has to arrange for resources and activities that are capable of dealing with this challenge. A brief survey of old and new trends in this demanding eye health issue will be given.

Blindness. Angle closure glaucoma oriented research
Severe blinding episodes in Greenlanders had been observed throughout the 20th century. The early ophthalmologists found a blindness prevalence of about 3/1,000 and estimated this to be 6 times higher than in Denmark in spite of the great difference in age distribution. In the first comprehensive blindness survey in 1962, Skydsgaard and Clemmesen showed that the great majority - 64% (44/69) - were blind due to glaucoma (1). Most of the blind were women, with no or minimal vision left. The type of glaucoma was not clearly understood. One theory was tuberculosis-associated secondary glaucoma.

On this background a series of population studies was then performed in a stepwise manner (2-4). Viggo Clemmesen (1910-2001) was the mentor, consultant and pioneer in this process. By using a Koeppen lens gonioscope with a portable illuminated hand-held microscope he made the early and original contribution in the late 1960s, showing that 88% of all known glau-
coma cases in the country were due to angle closure (2).

Other main methods were:

• tonometry, primarily a.m. Schiøtz
• anterior chamber depth (ACD) measurements by optical Haag Streit pachymetry and ultrasound
• corneal diameter, curvature and thickness measurements
• pedigrees and refraction
• A 10-year and a 20-year follow-up was added: now also with limbal chamber depth estimation in the slitlamp, a.m. van Herick et al. (4,5)

As to material, the studies focused on total elderly population groups in well-delineated minor town and village communities, mainly in the NW-Greenlandic district of Uummannaq, but with supplementing surveys in 6 other districts. Generally, high participation rates were achieved.

Table I shows population-based survey data which slowly turned up from all Inuit subgroups: Angle closure was found in about 3-6% above age 40, i.e. at a much higher prevalence than in Caucasians; thus e.g. about 50 times higher than in the early Ferndale study in Wales (12) or compared to a newer study, 7 times higher than in Italy (13). A major survey on angle closure glaucoma in East Asia, Inuit and others was presented by Congdon et al. (16).

**Eye health infrastructure in Greenland**

A comprehensive historical survey was given by Norn 1992 (17), also based on long personal experience with Greenland since 1975. The first ophthalmologist was CM Norman-Hansen (1861-1959) in 1908-9. Participation of Danish Ophthalmologic Society members in Greenland eye service was recently described in a 100-year anniversary perspective (18).

In most eye health issues demography of the population is highly important. The total population in 2003 seems fairly stable at 56,700. About 88% are born in Greenland; the others are mostly Danes. Age distribution among Greenlanders shows a mean life expectancy of only 62.5 years for men and 68.9 for women, i.e. about ten years less than in Danes. Thus only 8.9% (4,459 persons in 2002) born in Greenland were above age 60, compared to 20.3% of the population in Denmark.

As to eye health resources: From the 1960s the 16 health districts have gradually been supplied with basic equipment for refraction and eye examination, including slitlamp biomicroscopes of varying quality and minor surgical sets. Medical officers have learnt to use Schiøtz tonometry fairly reliably. Yet, obviously, glaucoma detection with ophthalmoscope and slitlamp is more difficult.

Eventually, in 1993 a fully equipped eye clinic was established in Nuuk (19). For 3 years the post as eye surgeon was filled, even with a second eye specialist most of the time. The obligation was to "take home" the great majority of patients who had earlier been referred to Copenhagen.

Important new steps relevant to glaucoma interventions were

• YAG laser treatments
• introduction of phakoemulsification cataract surgery
• Humphrey analyzer for visual field screening

As in earlier periods, the districts still had to rely

| Table I. Inuit population surveys on primary angle closure (PAC). Caucasian and East Asian surveys for comparison. |
|---------------------------------------------------------------|
| Region (reference)                     | PAC(G) prevalence above age 40 |
| NW Alaska (6)                           | 2.7%                          |
| Alaska (Norton Sound) (7)              | 3.8%                          |
| N Canada (8)                           | 2.9%                          |
| Labrador (9)                            | 3.0%                          |
| Greenland, 6 districts (2,3)           | 3.4%                          |
| Greenland, Uummannaq (10)              | 5.9%                          |
| Greenland, Ittoqortoormiit (11)        | 2.5%                          |
| Ferndale, Wales (12)                   | 0.07%                         |
| Italy (13)                              | 0.6%                          |
| Mongolia* (14)                         | 1.4%                          |
| Singapore* (15)                        | 1.0%                          |

*Prevalence of patients with manifest primary angle closure glaucoma (PACG). Earlier surveys may include PAC cases without manifest glaucoma.
on annual visits by external travelling consultants. From 1996 the post in Nuuk became vacant and visiting consultants took over.

A new phase began in 1999, through a contract between health authorities in Greenland and Rigshospitalet, University of Copenhagen. The contract consisted of:

- 45 weeks of consultant work all over the country
- 3 surgical tours, dealing with cataracts, squint, lacrimal problems, performed in regional centres
- current advise in patient referral issues

From 2002 - due to economic constraints - the Greenland Home Rule had to reduce this contract to 31 weeks consultant work and only 2 surgical tours, with 160 cataract operations.

A limited number of eye patients are seen annually in Rigshospitalet, but poor economy has lead to a reduction of this number as well for the last years. The following glaucoma associated activities were undertaken in 2002 for a total of 85 patients, less than half of them as inpatients:

- iridotomies 16
- cataracts, 29
  of which 6 had angle closure
- filtering operations 4
- cyclodiodelaser. 6

Since 1993 a portable YAG laser slit lamp has become an important part of the outreach travel equipment, highly needed due to the number of angle closure suspects who must have careful gonioscopy and possibly iridotomy. The total number of YAG iridotomies was 104 in 2002, while 30 were treated for sec. cataracts. - The load of the total equipment amounts to about 150 kg in 5 boxes (19).

The blindness register for Greenland has been updated annually through 40 years. The glaucoma blind are now relatively few: 16/185 persons or 9 % of the blind, compared to 64% in 1962, cf. details in report of 1999 in (19). Most are blind due to angle closure glaucoma. So relatively, the reduction of this form of blindness has been pronounced. But total blindness events do still occur, due to delay and the complicated geography of some districts.

**Comments and conclusions**

Important new classification principles have recently been established in angle closure glaucoma. An improved understanding of its pathoanatomy and -physiology and its high importance as a source of blindness, not least in East Asia, has inspired this modified classification. The term primary angle closure (PAC) has been established as "a distinct anterior segment disease that imbues the sufferer with an increased risk of glaucomatous optic neuropathy but does not in itself constitute glaucoma" (20). It may occur in symptomatic forms as intermittent or acute attacks, or more often, in insidious, chronic "creeping" forms. When detected early, many of these clinical forms are open to curative intervention by YAG iridotomy. Angle closure glaucoma is the end stage with glaucomatous optic neuropathy, cupped disk and visual loss. Also a recent Danish publication has accepted this terminology. (21).

![Figure 1. Anterior chamber depth (ACD) in various groups.](image-url)
To sum up: the findings in Greenland have shown:

- A top prevalence of angle closure (PAC and PACG) compared to other ethnic groups, with the typical women surplus and age effect
- The anatomical risk factors: a shallow anterior chamber with narrow angles and a small corneal diameter have been demonstrated in the general population, as an inherited trait from East Asia

As one of the most important quantitative risk factors: anterior chamber depth (ACD) has now been studied in various ethnic groups, (Figure 1). The upper curve shows Belgians, then Japanese, Singaporeans and Mongolians, where a major survey has now been performed, in accordance with the earlier surveys in Greenland (22). Greenlanders are still represented by the lower line from the initial survey in Uummannaq in 1969 (3). The curves seem to reflect the variations in prevalence fairly well. Greenlanders and other Inuit still share the highest prevalence known worldwide. Yet a recent study in East Greenland (Ittoqqortoormiit) points to a somewhat higher ACD level and suggests a reduced risk. A decreasing risk is also to be expected along with an increasing myopia trend in Greenland (11).

Finally about prophylaxis and blindness prevention:

Cure of angle closure is possible by early detection. This was convincingly shown at a follow-up study in Mongolia (23). In Greenland we have found that surgical iridectomy, later YAG iridotomy or phakoemulsification with intraocular lens implantation in the lens capsular bag have as a rule been successful in relieving the angle closure phenomenon. These interventions can be performed as decentralised activities. In angle closure patients, detected early, these strategies do well, and much more complicated filtering surgery is rarely needed.

In conclusion: The basic strategy for dealing with the angle closure high-risk population in Greenland may thus be summarised as follows:

Tonometers, slitlamps and relevant pharmacy supplies are at hand in all districts. With difficult or doubtful cases, subacute referral to Rigshospitalet, or rarely, to an ophthalmologist working somewhere in Greenland, is an established routine.

At the annual visit by the eye specialist routine use of slitlamp biomicroscopy, especially for quick evaluation of limbal chamber depth, is strongly recommended, in order to detect occludable angles in the elderly. A modified grading scheme with high emphasis on shallow chamber depths at limbus has been introduced as a useful screening tool (24). Eye specialists are equipped with gonioscopes and YAG laser iridotomy lenses to do immediate treatment when indicated.

Besides: risky narrow angled anatomy strengthens the indication for early cataract surgery whenever reduced vision due to lens opacities is found.

As is written in one of the classical textbooks: "The very narrow angle is ready for closure in the same way that the loaded, cocked gun is ready to fire. Many different circumstances can trigger the explosion. It is only a matter of time before one of these transient attacks becomes a permanent angle closure" (25). In addition, it has to be mentioned that most angle closure cases also in Greenland are asymptomatic without attacks, a fact that complicates early detection.

On this background it has given rise to concern that eye health service resources have now been reduced to the same level as in the late 1980s, or to only 2/3 of the earlier contract period 1999-2001.

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