Factors Affecting Reliability and Accuracy of Contact Lens Complications' Clinical Grading Skills: A Thematic Review

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ABSTRACT

Contact lens complication cases were rising among contact lens wearers because of poor hygiene and maintenance. The grading scale is vital to be used to monitor changes in ocular conditions from contact lens wear. This article aimed to discuss factors affecting the reliability and accuracy of clinical grading skills of ocular signs from contact lens complications. Forty-five articles were selected in this literature review based on the PICO strategy (P=Population, I=Intervention, C=Comparator, O=Outcomes). It is essential to have good clinical reasoning for accurate decision making when performing gradings. The Efron and the CCLRU grading scales are the most common grading scales used by eye care practitioners across countries around the world when accessing contact lens patients. Therefore, it is recommended to use the same common grading scale among eye care practitioners to ensure familiarity and proper recording of contact lens complications. Correspondingly, eye care practitioners are suggested to grade using grading scales by increments of 0.5-unit scale, record in pictorial for ocular anterior segment and to sketch complex ocular complications to help better visualization of the real ocular structure complications on record

Keywords: Clinical grading skills, Contact lens complications, Grading scales, Reliability, Accuracy.

ABSTRAK

Kes komplikasi kanta lekap meningkat dalam kalangan pemakai kanta lekap kerana aspek kebersihan dan penjagaan kanta lekap yang diambil mudah. Skala penggredan sangat penting digunakan untuk memantau perubahan keadaan okular akibat pemakaian kanta lekap. Artikel ini bertujuan membincangkan faktor-faktor yang mempengaruhi kebolehpercayaan dan ketepatan kemahiran penilaian klinikal tanda-tanda okular dari komplikasi kanta lekap. 45 artikel terpilih telah dinilai dan telah dihuraikan dalam perbincangan sorotan kajian ini. mengikut strategi 'PICO' (*P=Population; Populasi, I=Intervention; Intervensi, C=Comparator;Perbandingan, O=Outcomes; Hasil*). Pengamal penjagaan mata disyorkan mempunyai penaakulan klinikal yang baik agar dapat membuat keputusan yang tepat semasa menggred komplikasi pemakaian kanta lekap. Skala penggredan Efron dan CCLRU adalah yang paling biasa digunakan oleh pengamal penjagaan mata di seluruh dunia ketika memeriksa pesakit kanta lekap. Oleh itu, disarankan untuk menggunakan skala penggreddan umum yang sama dalam kalangan pengamal penjagaan mata untuk memastikan ketepatan dan rekod komplikasi kanta lekap yang tepat. Sejajar dengan itu, pengamal penjagaan mata disarankan untuk membuat penilaian menggunakan skala penggredan dengan kenaikan sebanyak 0.5-unit skala, merekodkan secara bergambar untuk segmen anterior okular dan membuat lakaran bagi komplikasi okular yang kompleks agar visualisasi komplikasi struktur okular sebenar dapat direkod dengan baik.

Kata kunci: Kemahiran penggredan klinikal, Komplikasi kanta lekap, Skala penggredan, Kebolehpercayaan, Ketepatan.

INTRODUCTION

Based on the International Contact Lens Prescribing 2019, total cumulative contact lens fit cases from 1996 until 2019 have exceeded 400,000 fits from databases of over 71 countries (Morgan et al. 2020). A survey of optometrists' contact lens prescribing in Malaysia showed approximately 90 new pairs of contact lens per year was prescribed among Malaysians (Mohidin et al. 2009). This trend was seen rising to a total of up to 686 cases in 2014 (Morgan et al. 2014). The rising number of contact lens wearers causes an increase in the incidence of contact lens complications due to a lack of hygiene awareness in handling contact lens. Close monitoring of contact lens wearers is needed to prevent any severe cases of contact lens complications that could result in blindness.

The grading scale is a tool of reference to record the severity of eye complications. Optometrists and ophthalmologists use a grading scale to monitor eye health status, especially for

contact lens wearers, to minimize contact lens complications. However, the reliability and accuracy of the grading become uncertain as the result solely depended on assessment and subjective interpretation of the examiners. Many factors can affect the reliability and accuracy of the clinical grading scale. According to Bullimore & Bailey (1993), grading reliability is the ability of practitioners to grade similar results time over time. Accuracy is defined by International standard ISO 5725-1 (1994) as "the closeness of agreement between a test result and the accepted reference value'' (ISO 1994). Accuracy and reliability grading skills are essential in both clinical and research purposes to differentiate the anterior segment of the eyes' normal physiology from pathological changes, to monitor eye diseases and record-keeping of patient's condition, and for communication between experts.

In addition, grading of eye complications depends on the examiner's ability and cognitive interpretation. Condition of eye complications may be under or overestimated, and these can lead to mistreatment. The prognosis of complications of contact lenses depends mainly on the ability of the examiner to determine the actual severity or state of emergency requiring immediate treatment (Cardona & Serés 2009).

METHODS

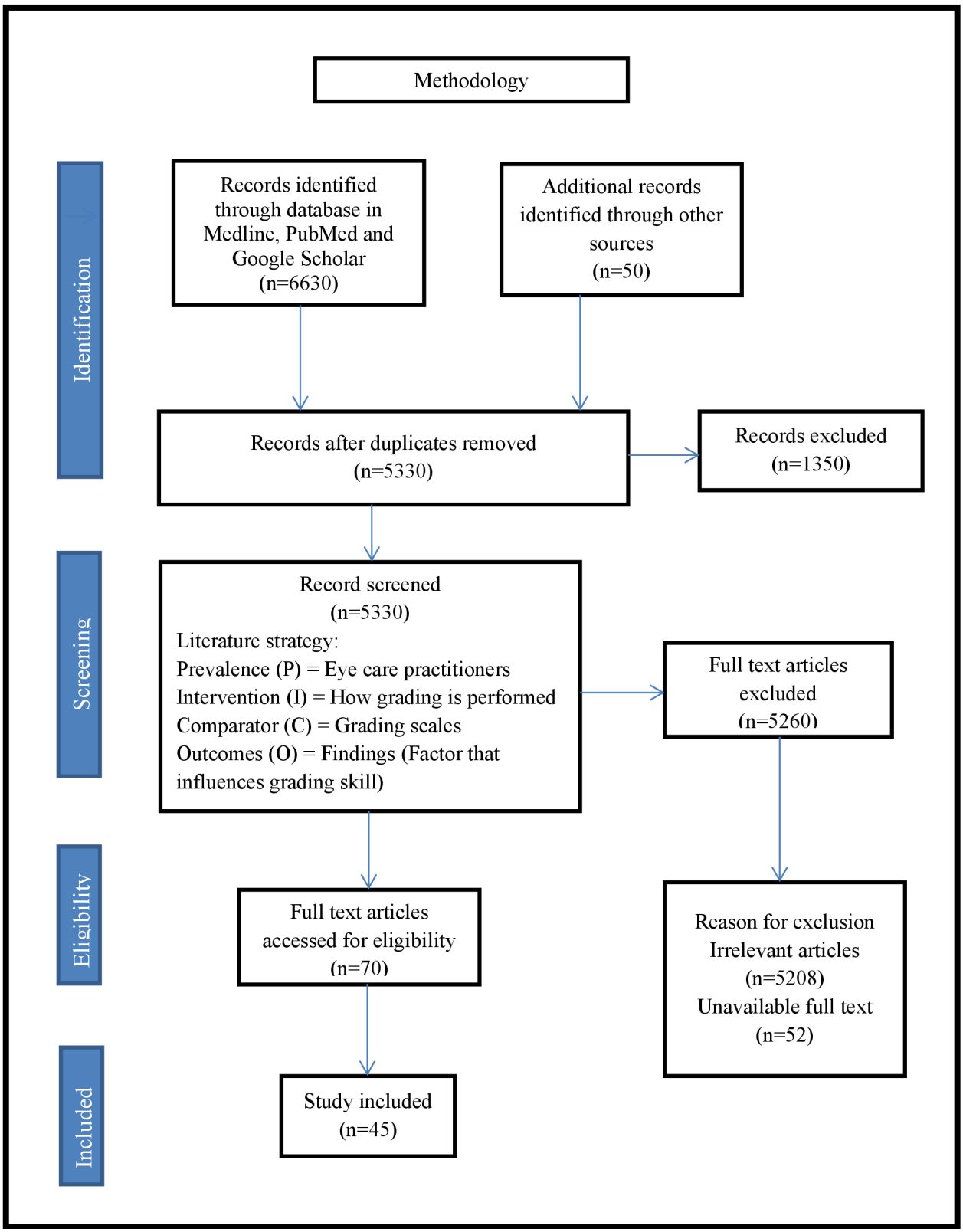
A few keywords such as 'eye care practitioners', 'grading skill', 'factor affecting grading eye complications' 'contact lens complications', 'accuracy grading skill', 'reliability of grading scale of complications', 'clinical reasoning', 'decision making' were searched on multiple databases of Medline, Google Scholar, and PubMed. Seventy-five articles have been reviewed based on keyword searches. Forty-five articles were selected based on the PICO (Population, Intervention, Comparator, and Outcome) strategy with parameters set as per the following; 'Population' as 'eye care practitioners', 'Intervention' was determined as 'focus on how the grading is performed', 'Comparator' as 'variations of grading scale available' and 'Outcomes' as 'any factors affecting clinical grading skills on eye care practitioners'. We reviewed articles published from any countries, based on all age groups and related to themes and literature review strategy established. All articles that are not related to the theme, those on animal studies, abstract-view only, inaccessible articles, and incomplete research, were excluded in this review. The selection process is shown by the flow chart in Figure 1.

Factors affecting Clinical Grading Skills

1. Clinical Reasoning

Grading on contact lens complications of the patient is an essential and complicated process that requires clinical reasoning to ensure proper patient management. Clinical reasoning is the process of integrated thinking and decision making in the healthcare professional (Cerullo & Cruz 2010). There are three categories of skills needed for clinical reasoning, namely, cognitive, behavioral, and mental health (Carvalho et al. 2017). Cognitive is referring to how a person able to analyze, seeking information, making inferences, able to interpret, predict something, and transform knowledge. Based on Schmidt et al. (1990), clinical reasoning will develop a cognitive structure of expertise based on the accumulation of clinically relevant knowledge about disease signs and symptoms. In addition to that, behavioral skill is the ability to do analysis, have self-confidence, open-mindedness, and systematization. At the same time, mental habits refer to understanding, confidence, creativity, curiosity, flexibility, intellectual flexibility, intellectual integrity, and reflection. A combination of these three categories of skills could guide individuals to do exact clinical reasoning. The process of clinical reasoning involved the thinking process of conceives, judge, and reason. It is started with an organized thinking process by recognizing the problem and situation in the clinic setting. From the situation, they need to identify similarities and differences in situation for cues. Then, conclude thinking based on two and more judgment with all the cues (Carvalho et al. 2017). There are a few factors of the clinical reasoning process that affect decision making. The factors involved are theoretical knowledge, experience acquired in practice, judgment and reasoning, and good sense. In conclusion, clinical reasoning will affect correct decision making for the safe and effective care of patients.

FIGURE 1: Flow chart for the article selection process.



2. Clinical Skill Set

According to Efron et al. (2003a), the concept of clinical skill set involved three key attributes that will influence the individual accuracy and reliability of grading, which are knowledge, experience, and training. Without a relevant clinical skill set, the challenge of grading was reduced to a basic matching task. An examiner with the complete clinical set could make an overall decision of severity of the condition with complementary information that has and able to ignore all sorts of potential confounding artifacts (Chun & Park 2014).

2.1 Knowledge

Knowledge is one of the critical aspects that influence grading reliability and accuracy. Grading skills will improve by knowledge intensity and specificity through a different mechanism. There are two fundamental elements that able to maintain the memory of knowledge, which is assimilation and retention while performing gradings in a clinical setting. 'Assimilation' is a process of understanding and using the new idea, while 'retention' is the ability to keep something in memory (Hughes 2013). Assimilative and retention capacity of student knowledge can be improved after a theoretical lesson with audio-visual resources (Ferreira et al. 2016). Arriving to the correct contact lens complications prognosis, assimilative and retention are applied in which the ability to decide upon the actual severity and urgency of the condition and to act accordingly to make sure patients will get the best treatment and referral are vital (Cardona & Serés 2009).

However, Ferreira et al. (2016) has reported that acquired knowledge will remain the same and deteriorate over time, whereas the retention capacity will deteriorate over time. In the meantime, short term memory of an adult will rapidly be lost when the absence of information maintenance that can lead to possible failure to recall. Thus, information maintenance needs to be taken seriously to preserve acquired knowledge (Atkinson & Shiffrin 1971).

In contrast, a study concluded that knowledge is not necessarily influencing the reliability and accuracy of grading. Wallace et al. (2000) has reported that different expert levels do not significantly influence the ability to diagnose a condition does. In conclusion, knowledge is one of the important components in the clinical skill set that needs to develop from time to time to improve grading skills among eye care practitioners.

2.2 Training

Training is an extension of instruction or learning in theoretical development with a specific grading tool (Efron et al. 2003b). Previous studies have reported on trained examiners being more skillful and superior than untrained examiners in performance decision-making tasks (Stainer et al. 2015; Hall & Williams 1970). Conversely, Chun & Park (2014) has shown that untrained examiners were able to grade successfully without any special training. Dundas et al. (2001) also reported that untrained and unexperienced examiners were able to use the corneal staining scale successfully and grade correctly. Similarly, Shahimin & Razali (2020) found an insignificant association between ophthalmologists and optometrists in diagnosing posterior eye health diseases, in which supporting the notion that trained and untrained examiners skills are comparable.

Nevertheless, to achieve reliable and accurate grading skills, training could be beneficial to increase consistency in grading (Efron et al. 2011). Training highlights the importance of carefully and accurately monitoring the rate of progression and recovery from ocular disease as a basis for ocular management. Appropriate training is needed to minimize differences between subjective grading between eye care practitioners, and therefore, the accuracy of grading will be improved from time to time (Efron et al. 2003a; Efron et al. 2003b; Efron et al. 2011).

2.3 Experience

Experience is the improved performance by trial and error over time as a result of repeated use of grading skills (Efron et al. 2003a). The development of advanced clinical reasoning skills is highly related and depends on experience gained by practitioners that involve hypothesis formation and testing to confirm or refute a diagnosis (Noll et al. 2001). Experience is a vital component in the clinical skill set required by eye care practitioners to develop effective grading skills. Efron et al. (2003b) reported that experienced clinicians have better reliability compared to inexperienced clinicians. This statement is also supported by Chun & Park (2014) that reports on ophthalmologists with 4 to 13

years of experience showed better grading reliability. However, Quigley et al. (1993) reported a contradicted result that claimed no differences found in the reliability of grading performance between experienced and novice. Mackinven et al. (2001) also found an insignificant difference between the gradings of two trainee optometrists when grading tarsal conjunctiva. However, the paper also argues that with practice, accurate grading and clinical judgment can be attained. Concisely, the experience is one of the most critical components in clinical set skills that are needed by every eye care practitioner to have good reliability and accuracy of grading.

2.4 Combination of clinical skills

Theoretically, we expect eye care practitioners that have a combination of different clinical skills would be better in grading performance. Efron (2003a) suggested that eye care practitioners who have a combination of experience and training will have better performance in grading compared to the practitioners who have the basic knowledge. Quigley et al. (1993) demonstrated that inexperienced eye care practitioners could reach the same level of grading skills to experienced eye care practitioners with a few hours of training. Comparatively, Efron et al. (2003b) suggested that training via tutorial and supervised training is not effective in improving grading performance. Direct observation could be another strategy for the learning process to enhance practitioners' confidence in handling complex cases. Direct observation is an assessment that occurs in the workplace that involves supervisor and student learning via participation in clinical practice together (Kogan et al. 2017). Kneebone et al. (2006) believed that practitioners who handle real cases could be more efficient and quicker in enhancing their clinical skills. This strategy is a wise approach to encourage learner's motivation to improve in clinical decision making and to urge them to be prepared and self-study. To conclude, clinical grading skills can be improved by a combination of these clinical skills set.

3. The grading system of the grading scale

In clinical decision making, it is vital to use a grading system that has both high discrimination and reliability that are simple to use and quick to ensure consistency in grading among practitioners (Efron 1997). The grading scale is a standard reference tool to record the severity and advancement of ocular conditions for patients and to monitor the changes over time (McMonnies & Davies 1987). Thus, grading scale is essential to be used in contact lens practice and need to be included in eye care practitioners' guidelines and standard for good clinical practice toward patients (Efron et al. 2011).

In the 1990's, four comprehensive sets of full colours, illustrative contact lens-related eye complications charts/grading scales have been developed which are the Annunziato, the Efron, the Cornea and Contact Lens Research Unit (CCLRU), and the Vistakon grading scales. However, other grading scales are available in a research-based setting, such as the Oxford Scheme and the National Eye Institute grading scale (Chun et al. 2014). These grading scales were developed based on either artist-rendered, photographic, or the black and white illustration grading. Each grading scales have their advantages and disadvantages and will be discussed in the following section.

3.1 Artist rendered grading scale system

Artist rendered grading scale system is a grading scale that depicted contact lens complications by professional ophthalmic artists. The Efron grading scale is an example of this grading scale system and was painted by Terry R. Tarrant (Efron et al. 2001). The Efron grading provides detailed information about changes of each tissue for contact lens complications (Efron 1997). It is a series of grading scales in five images that portray the different levels of severity of each complication with zero to four-unit scale (Efron et al. 2001; Efron 1998).

The Efron grading scale has its advantages in grading contact lens complications. First, it could explain the desired level of changes for each complication in the same colour scheme. The angle of view, magnification, and associated colour features were standardized to make comparison easier (Efron et al. 2011). Moreover, this grading scale has ancillary cues that are used for highlighting the increasing severity, such as increasing light scatters of slit lamp illumination reflex or limbal redness in the grading images (Efron et al. 2011). Furthermore, this grading scale could potentially avoid confounding artifacts as seen in real-time still images in which artistic skill

can be adopted to add clarity to each image (Efron et al. 2011).

However, this grading scale has a weakness in which it grades the redness and roughness of tarsal conjunctiva together on one scale. Contact lens wearers may exhibit different ocular signs on tarsal conjunctiva. It has been reported that 60% of contact lens wear showed signs of redness of more than 2.0 scale-unit, but only 12.5% contact lens wearer has a roughness of the same grading (Mohd-Ali et al. 2014). Hence, the grading of roughness and redness must be separated to get accurate recording and diagnosis for the patients.

3.2 Photographic grading system

Photographic grading is a grading scale that constructed in a series of photographic images to show contact lens complications. The grading scale that uses a photographic grading system is the Cornea and Contact Lens Research Unit (CCLRU) grading scales (Murphy et al. 2007). This grading scale provides four images that increase in severity of the condition, which is labelled from Grade 1 as very slight; Grade 2= slight; Grade 3=moderate and Grade 4 as severe. This grading scale is later rebranded as the Institute of Eye Research (IER) grading scale (Christie 2015). The grading system uses real images of contact lens complications to provide a more sensitive and reliable evaluation for clinical research purposes (Sorbara et al. 2015). It also grades tarsal conjunctiva redness and roughness separately (Mohd-Ali et al. 2014).

Nevertheless, a series of increasing clinical severity images by the photographic system has limited consistency as it lacks precise magnification, consistent location of pathology, constant pupil size and colour, and different photographic conditions. There is no homogeneity in the photograph images provided due to the illumination factor and the non-uniform size of the image (Perez-Cabre et al. 2005). Wolffsohn (2004) has also reported that incremental of red colouration of palpebral conjunctiva between grades were less regular with a photographic grading scale.

3.3 Black and white illustration

As mentioned before, the Oxford Scheme grading scales, the National Eye Institute (NEI) grading scales, and the Sjögren's International Collaborative Clinical Alliance (SICCA) grading scales use black and white illustration grading scale. The grading scales have a typical pattern of corneal erosion for recording symptoms and severity of dry eye (Bron et al. 2003, Lemp 1995).

Nevertheless, the Oxford Scheme has been adopted by many researches to determine contact lens complications because of its ease of use and simpleness (Berntsen et al. 2006). Besides, the Oxford Scheme has good repeatability in corneal staining grading (Chun & Park 2014). However, this grading scale shows unclear comparison features from its reference grading panel. This downside may instigate problems in identifying and labeling images. The Sjogren's International Collaborative Clinical (SICCA) grading system is a modified Oxford Scheme to prevent the problems (Chun & Park 2014).

Unfortunately, the illustrative grading system has its own limitation whereby there may be a possibility that increasing clinical-image scale is not evenly distributed (Efron et al. 2001). In this case, it is likely to show variation in grading performance range of scale (Efron et al. 2001). Chun & Park (2014) has stated that limitation in grading system involved subjective judgment, unequal steps, based references description of severity, and restriction to a specific condition such as CCLRU and Oxford Scheme. In conclusion, it was suggested to use a standard grading scale to provide high reliability and accuracy of grading to ensure a correct and accurate decision making for the patient.

3.4 Grading scales used among eye care practitioners

The Efron and the CCLRU grading scales are the common grading scales used as a reference in subjective grading of contact lens complications around the world. However, there are different preferences according to regions (Wolffsohn et al. 2015). In Africa, most eye care practitioners use the Efron grading scale (72.4%) than the CCLRU grading scale (14.9%). However, the reverse result was reported in the United Kingdom and Ireland in which more eye care practitioners use the CCLRU grading scale compared to the Efron grading scale (31.3% and 54.0%, respectively). In Australia, there is a split of 65% to 25% of the optometrist in using the Efron grading scale compared to the IER grading scale (Efron et al. 2011). The same grading scales are also used in Malaysia (Mohd-Ali et al. 2014; Mutalib et al. 2018)

The preferences of grading scales used could be due to familiarity with the scale and complications to be diagnosed. In comparison, the Efron grading scales depicted 16 complications, the CCLRU portrays six complications, and the Vistakon displayed 13 complications (Efron et al. 2001). These grading scales have different approaches to visualising eye complications, and not all ocular signs are presented in every grading scale. For example, corneal ulcers were only presented in the Efron grading scale as compared to the CCLRU grading scale and the Vistakon grading scale. Wolffsohn (2004) has shown that the Efron grading scale is consistent incremental between grade (from normal to severe) in green colouration for corneal staining. Whereby the CCLRU and Vistakon grading scales have shown decreases and inconsistency of green colour colouration between the grades for corneal staining.

In addition, Efron et al. (2001) have concluded that painted grading scales have better reliability compared to photographic grading scales. The reason is the painted grading scale has a superior precise level of severity of ocular complications compared to photographic grading scales. Cardona & Serés (2009) believed that the Efron grading scale is capable of solving the problem of the inconsistency of ocular images from other grading scales by increasing the artistic clarity so that the severity of the problem to be evaluated can be graded correctly. On the other hand, Murphy et al. (2007) reported that the CCLRU grading scale had offered a similar grading range with the Efron grading scale, in which grading less than two units is considered normal.

4. Method of grading

4.1 Increment unit scales

Eye care practitioners around the world adopted either incremental grading or grading with the whole number (Efron et al. 2011). Grading in decimal interval could increase sensitivity and accuracy in interpreting observation (Chong et al. 2000; Murphy et al. 2007). Bailey et al. (1991) have stated that increment by 0.1-unit scale can increase discrimination. Conversely, Christie (2015) has stated that a 0.1-unit scale in grading would limit inter-variability and promote poor concordance among eye care practitioners. Therefore, Bailey et al. (1991) also has suggested that grading scale increment should not exceed 1 unit of the standard deviation to reach moderate sensitivity meanwhile, for fine clinical sensitivity scale, increment should not exceed one-third unit of the standard deviation of incremental. However, there was a study stated when eye condition is halfway between the grade 0-1 scale, the examiner should record as 0.5 (Wolffsohn et al. 2004). This is because recording into half or 0.5-unit scales will reach moderate sensitivity and overcome the problem of low concordance between eye care practitioners. The study also mentioned that there was no significant difference between colour extraction and edge detection for each grading scale (the Annunziato, the Efron, the CCLRU, and the Vistakon grading scales) for image analysis results from a designed computer program (Wolfsohn et al. 2004). Thus, it is acceptable to apply the same incremental scale by 0.5 for any type of scale.

4.2 Grading with and without the use of quadrant and zones.

Corneal staining, papillary conjunctivitis, and conjunctival redness are common ocular features graded by eye care practitioners as they are often related to patient symptoms (Efron et al. 2011). Consistency of recording is needed as it will affect the reliability and accuracy of grading. Many recent studies have suggested the use of quadrant and zones in grading to achieve accuracy (Sorbara et al. 2015; Woods et al. 2018). Quadrants and zones are applied when grading cornea, bulbar, and palpebral conjunctiva as they can help differentiate the intensity of ocular changes in every quadrant easily (Papas et al. 1997). Therefore, the grading will be more accurate (Murphy et al. 2007).

4.3 Dynamic versus static photographic anterior segment of ocular surfaces.

Recent technologies have brought the availability of digital photo slit lamps in clinical practice to enhance the ability of grading anterior segment of ocular surfaces by capturing real-time picture (Sorbara et al. 2015). This method helps in data collection and recording to ensure consistency of grading among clinicians (Sorbara et al. 2015). Several studies argued the efficiency of using dynamic images of the slit lamp and photographic images of the slit lamp. The study from Sorbara et al. (2015) conducted on two selected investigators to perform grading on 105 images of corneal staining performed live and still images in random

order. This study revealed that there was an underestimation of grading on still images where the mean of five zones (nasal, temporal, center, superior and inferior) of whole cornea staining show lower value in still images compared to the live images. Efron et al. (2002) reported that the use of still images have limitation in which it is captured at a single point in time while live slit lamp observation is performed in a dynamic point of time. The limitation of still images could be due to factors, such as variations in light intensity, insufficient depth of focus, low resolution or out of focus images, limitation of magnification, area of focus camera, and size of resolution screen. Lower magnification is needed to capture the entire cornea, and this, in turn, will cause lower resolution, and the image will be harder to discern. Thus, this can affect low reliability and accuracy of still images of the anterior segment ocular surface (Sorbara et al. 2015).

CONCLUSION

In conclusion, many factors can influence clinical grading skills of contact lens complications. It is suggested that eye care practitioners need to have a set of clinical skills (experience, knowledge, and training) to enhance clinical reasoning skills that will help accurate and correct decision making. When accessing contact lens patients, eye care practitioners need to consider all factors that may affect the reliability and accuracy of the grading.

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