Veterinary
Anaesthesia and Analgesia

Formerly the Journal of Veterinary Anaesthesia

Veterinary Anaesthesia and Analgesia, 2015 doi:10.1111/vaa.12269

RESEARCH PAPER

Agreement between veterinary students and anesthesiologists regarding postoperative pain assessment in dogs

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Abstract

Objective To determine the levels of agreement among first- and second-year veterinary students and experienced anesthesiologists in assessing post-operative pain in dogs from video-recordings.

Study design Cross-sectional study.

Subjects Twenty-seven veterinary students, five anesthesiologists and 13 canine clinical patients.

Methods Prior to their enrolment in a core anesthesia course, veterinary students volunteered to watch 13 90 second videos of dogs. Dogs were hospitalized in an intensive care unit after a variety of surgical procedures. Students were asked to score the level of the dogs' pain using the Dynamic Interactive Visual Analog Scale and the Short Form of the Glasgow Composite-Measure Pain Scale. The same videotapes were scored by five board-certified anesthesiologists. The differences and agreement between the ratings of anesthesiologists and students, and first- and second-year students were determined with Mann–Whitney *U*-tests and Fleiss' or Cohen's kappa, respectively.

Results Pain scores assigned by students and anesthesiologists differed significantly ($p < 0.01$). Students assigned higher pain scores to dogs that were given low pain scores by anesthesiologists, and lower pain scores to dogs deemed to be in more pain by anesthesiologists. On average, students assigned higher scores on both scales.

Conclusions and clinical relevance Veterinary students early in their training assigned pain scores to dogs that differed from scores assigned by experienced anesthesiologists.

Keywords dog, pain assessment, pain scale, veterinary student, video.

Introduction

The intensity of pain experienced by a patient is determined by a number of factors, some of which include the type of pain (acute or chronic), the cause of the pain, the body's current physical condition and the imposition of factors such as stress (Anil et al. 2002). This variability presents a challenge in the development of a pain scoring system and may represent an obstacle to novice pain evaluators.

The ability to reliably evaluate pain in animals is important to veterinarians in terms of their capacity to successfully treat painful conditions, which may either temporarily or permanently affect an animal's welfare. However, no standard method to accurately and consistently measure pain has been developed. Various parameters, such as animal behavior or physiologic parameters, are used to judge an animal's level of discomfort and anxiety (Rialland et al.

2012) and tools and questionnaires have been designed to assess the intensity and source of pain. Several scales have been developed to assess pain in veterinary medicine, such as the Visual Analog Scale (VAS) (Mbugua et al. 1988; Reid & Nolan 1991) or Dynamic Interactive Visual Analog Scale (DIVAS) (Lascelles et al. 1998) and the Short Form of the Glasgow Composite-Measure Pain Scale (GCMPS) (Reid et al. 2007).

The VAS is used in people in self-reported levels of pain and has been adapted for pain assessment in veterinary patients (Holton et al. 1998). Some authors have used the term 'VAS' in place of 'DIVAS', even if the assessment involved interaction with the animal (Lascelles et al. 1994; O & Smith 2013). The difference between the two scales lies in how the score is assigned. In the VAS, the score is based only on observation of the animal, whereas in the DIVAS the animal is first observed from a distance and then approached and encouraged to walk. Before a final assessment is made with the DIVAS, the surgical incision and the surrounding area are palpated (Lascelles et al. 1998; Hellyer et al. 2007). Although the DIVAS, like other pain scales, is subjective and has been deemed unreliable by some authors (Holton et al. 1998; Morton et al. 2005), it has been and still is widely used in veterinary medicine to assess pain (Lascelles et al. 1994; O & Smith 2013; Rhouma et al. 2013; Teixeira et al. 2013). Various factors influence the validity and reliability of the DIVAS, including the age and experience of the observer, his or her visual acuity, the use of gradation marks on the line, line orientation (vertical *versus* horizontal), and the level of the patient's sedation (Dixon & Bird 1981; Sriwatanakul et al. 1983; Stephenson & Herman 2000; Plant 2007; Rialland et al. 2012). In a recent study, the authors showed moderate agreement between the DIVAS and GCMPS in dogs hospitalized for a variety of procedures (Moran & Hofmeister 2013). The main advantages of the DIVAS include a high degree of sensitivity arising from the continuous nature of the scale, a direct linear relationship between mild and moderate pain, and its simplicity (Myles et al. 1999; Morton et al. 2005).

The GCMPS is a questionnaire-based scaling system, modeled after the McGill Pain Questionnaire developed by Melzack & Torgerson (1971). Compared with the DIVAS, the GCMPS is a multidimensional scale. The DIVAS measures only one dimension of the pain experience, namely, its intensity, whereas the GCMPS and other multidimensional or composite rating scales also take into account the sensory and affective qualities of pain (Murrell et al. 2008). The GCMPS has shown good inter-observer correlation in post-procedural pain assessment (Guillot et al. 2011), but may be biased by sedation (Murrell et al. 2008; Guillot et al. 2011). Although the GCMPS has proven to be useful for measuring acute pain in dogs (Morton et al. 2005; Murrell et al. 2008), it may be less intuitive than the DIVAS for inexperienced evaluators.

The need for training in pain assessment is well documented in human medicine (Yanni et al. 2009; Murinson et al. 2011; Keefe & Wharrad 2012). Only a few studies have investigated this topic in veterinary medicine (Turnwald et al. 2008; Kerr et al. 2013). Computer-aided learning tools may improve the ability of veterinary students to assess animal welfare (Kerr et al. 2013).

The purpose of this study was to determine whether first- and second-year students would evaluate pain in dogs similarly to experienced anesthesiologists. The hypothesis was that students without any training in pain assessment would score postoperative pain in dogs similarly to experienced anesthesiologists.

Materials and methods

This study was approved by the University of Georgia Institutional Review Board for Human Subjects. After their owners' written consent had been obtained, 13 dogs were videotaped once each in the intensive care unit (ICU) at the University of Georgia Veterinary Teaching Hospital over a 2-week period. The dogs had undergone a variety of surgical procedures including exploratory laparotomy ($n = 6$), hemilaminectomy ($n = 3$), tibial-plateau-leveling osteotomy ($n = 2$), bilateral fragmented coronoid process removal ($n = 1$), and ventral stabilization of atlanto-axial subluxation ($n = 1$). After full recovery from general anesthesia, each dog was videotaped for approximately 90 seconds (Nikon Coolpix S203; Nikon, Inc., NY, USA), while an evaluator interacted with the dog. The person interacting with the dog was always the same person and the animal was required to be awake and to have recovered from anesthesia before the interaction. Analgesic drugs were not withheld for the purpose of this study and were administered based on the standard of care at the University of Georgia Veterinary Teaching Hospital. During the interaction, the dog was first approached and spoken to, and then gently palpated once on the neck, thorax, abdomen, extremities and incision site. A dog that was able to ambulate (10 of the 13 dogs) was also gently stimulated to walk and move around by verbal encouragement and by placing a leash around its neck.

An e-mail describing the study was sent to all first- and second-year veterinary students at the University of Georgia. All participants were asked to complete a questionnaire before watching and scoring the 13 videos. The questionnaire requested information relating to the participant's age, gender, grade point average (GPA), current grade level, and number of dogs owned prior to the study. Student participants were asked to view each video-recording twice and then to rate the behavior of each dog using the DIVAS and GCMPS. Students were given an introductory explanation on how to use the pain scales before watching the videos, but were not given any general content knowledge about scoring pain in dogs. All students scored the videos at the same time in the same room and thus in the same order.

The DIVAS is a scale based on a simple, straight, 10 cm line. A score at the extreme left end, at 0 cm, represents no pain and a score at the extreme right end, at 10 cm, represents unbearable pain. The user is asked to mark the line at the point he or she considers to best represent the intensity of the subject's pain (de Jong et al. 2005; Moran & Hofmeister 2013).

The GCMPS consists of six behavioral categories with different descriptive expressions (descriptors) for each category: vocalization (four descriptors); attention to wound (five descriptors); mobility (five descriptors); response to touch (six descriptors); demeanor (five descriptors), and posture/activity (five descriptors). Descriptors are placed in increasing order of pain intensity and numbered accordingly (Reid et al. 2007). The user assigns the score that best describes the animal's behavior. For example, there are four descriptors in the category labeled 'Vocalization' ('Quiet', 'Crying or whimpering', 'Groaning' and 'Screaming'), marked 0, 1, 2 and 3, respectively. The user scores the animal by marking the descriptor that best describes the animal's behavior. The scores for each category are summed together and pain intensity is determined based on the total score. The maximum scores obtainable were 24 for ambulatory dogs and 20 for non-ambulatory dogs.

Five American College of Veterinary Anesthesia and Analgesia diplomates also watched the videos and recorded scores using both pain scales. The anesthesiologists were asked to watch all 13 videos in a personalized and randomized order in their own time and thus the order in which they watched the videos differed among anesthesiologists.

The intervention point, defined as the pain score at which further analgesia was warranted, was assessed if the median DIVAS score of all students or all anesthesiologists was $\geq$4 cm or the median GCMPS score was $\geq$6 for ambulatory dogs or $\geq$5 for non-ambulatory dogs. Agreement on the intervention point among all students and all anesthesiologists, and agreement between the median scores assigned by students and anesthesiologists for each dog were then assessed.

Statistical analysis

Normality was determined using the D'Agostino–Pearson method. Data were not normally distributed. Differences between DIVAS and GCMPS scores assigned by students and anesthesiologists, and between DIVAS and GCMPS scores assigned by first- and second-year students were determined with a Mann–Whitney *U*-test for each dog. Mean average DIVAS and GCMPS scores were plotted against the mean difference using a Bland–Altman plot. The median intervention points for each dog as assessed by all students and all anesthesiologists, respectively, were calculated. Agreement between students and anesthesiologists on the median intervention point was assessed using Cohen's kappa. Agreement among all students and, separately, among all anesthesiologists on the intervention point for each dog was assessed using Fleiss' kappa. The average difference in scores between anesthesiologists and students was plotted against the order in which the videos were viewed by the students in order to determine whether a learning curve was evident and evaluated using linear regression. All analyses were carried out using Graphpad Prism Version 6.0 (GraphPad Software, Inc., CA, USA). Significance was set at $\alpha < 0.01$.

Results

There were 27 student participants, including 25 female and two male students. Their median age was 23 years [interquartile range (IQR): 22–24 years]. Twelve volunteers were first-year students and 15 were second-year students. Only 10 of the 27 volunteers provided a GPA; consequently this variable was not considered further. Four students had never owned a dog, 12 had owned one dog, and 11 had owned at least two dogs prior to the study. Because of the small number of students who had never owned a dog, this variable was not considered further.

There were significant differences between scores assigned by students and anesthesiologists, respectively, on both scales for the majority of videos (DIVAS scores for videos 1, 3, 5, 6, 7, 8, 9 and 11; GCMPS scores for videos 1, 3, 4, 5, 6, 7, 8 and 11) (Table 1). The comparison of the mean ± standard deviation (SD) differences (bias) in scores for each dog showed that the students, on average, assigned higher pain scores than the anesthesiologists. This was evident when the mean ± SD difference (bias) in scores on both scales was considered [DIVAS: −1.2 ± 3.0 cm, 95% confidence interval (CI) −3.0 to 0.6 cm; GCMPS: −1.8 ± 5.7, 95% CI −5.2 to 1.6]. The Bland–Altman plot showed a scattered pattern above and below zero for both scales; the 95% limits of agreement between anesthesiologists and students were −7.0 to 4.6 cm for the DIVAS and −13.0 to 9.0 for the GCMPS (Fig. 1).

When the scores given by first- and second-year veterinary students were compared, no difference was found for any of the videos or between the scales, with the exception of DIVAS scores for dogs in videos 7 and 8. In both cases, first-year student scores were significantly lower than second-year student scores. Using the DIVAS, first-year students gave a median score of 4.2 cm (IQR: 3.3–5.1 cm) on video 7 and a median score of 5.4 cm (IQR: 3.5–6.5 cm) on video 8, whereas second-year students gave a median score of 6.3 cm (IQR: 5.4–7.2 cm) on video 7 and a median score of 7.4 cm (IQR: 7.1–9.2 cm) on video 8. The agreement between students and anesthesiologists on intervention point, evaluated as the median of all scores assigned to each dog, was less than that expected by chance alone (κ = −0.21, 95% CI −0.73 to 0.31). The level of agreement on intervention point among all students considered together was fair (κ = 0.38, 95% CI 0.36–0.41) and the level of agreement among anesthesiologists was moderate (κ = 0.60, 95% CI −0.40 to 0.73). There was no significant association between video order and average score difference between students and anesthesiologists for either the DIVAS ($p = 0.55$, $R^2 = 0.03$) or the GCMPS ($p = 0.87$, $R^2 < 0.01$).

Discussion

The objectives of this study were to evaluate whether first- and second-year veterinary students without specific training in the evaluation of pain-related

Table 1 Dynamic Interactive Visual Analog Scale (DIVAS) and the Short Form of the Glasgow Composite-Measure Pain Scale (GCMPS) scores assigned by veterinary students ($n = 27$) and anesthesiologists ($n = 5$) after the observation of 13 dogs hospitalized in the intensive care unit and recorded on videotape postoperatively

	Pain scale scores, median (IQR)			
	DIVAS		GCMPS	
Dog/ video no.	Students	Anesthesiologists	Students	Anesthesiologists
1	0.7 (0.3–1.3)	5.3 (3.5–7.8)*	1.0 (1.0–1.2)	11.0 (9.0–12.5)*
2	1.1 (0.5–1.9)	2.9 (1.8–5.7)	3.0 (2.0–5.5)	5.0 (3.5–7.5)
3	1.9 (1.2–3.1)	0.0 (0.0–1.4)*	4.0 (2.8–6.0)	0.0 (0.0–1.0)*
4	2.0 (1.1–3.3)	1.1 (0.1–1.2)	4.0 (3.0–6.0)	2.0 (1.0–3.0)*
5	4.9 (3.6–5.9)	1.4 (0.8–2.1)*	12.0 (11.0–13.0)	3.0 (2.0–7.0)*
6	3.5 (2.1–4.8)	0.7 (0.3–1.7)*	9.0 (6.0–10.0)	3.0 (1.5–4.0)*
7	5.4 (3.7–6.4)	0.7 (0.2–1.6)*	11.0 (9.0–12.0)	1.0 (1.0–4.0)*
8	6.8 (4.6–8.1)	0.1 (0.0–1.7)*	13.0 (10.0–15.0)	1.0 (1.0–2.5)*
9	3.4 (2.4–6.0)	1.0 (0.1–1.9)*	7.0 (4.0–8.3)	6.0 (2.5–8.0)
10	2.1 (0.9–3.2)	0.6 (0.2–1.0)	3.0 (3.0–5.0)	3.0 (1.0–3.5)
11	1.6 (0.8–2.8)	3.7 (2.8–6.3)*	3.0 (1.0–5.0)	11.0 (4.5–13.5)*
12	3.2 (1.9–5.4)	2.2 (1.0–3.4)	6.5 (5.0–8.0)	4.0 (2.5–5.0)
13	3.9 (2.4–4.8)	5.7 (3.1–6.0)	7.0 (5.0–11.0)	10.0 (7.5–11.5)

*Anesthesiologist scores differ significantly from student scores within the specified scoring scale for that dog. IQR, interquartile range.

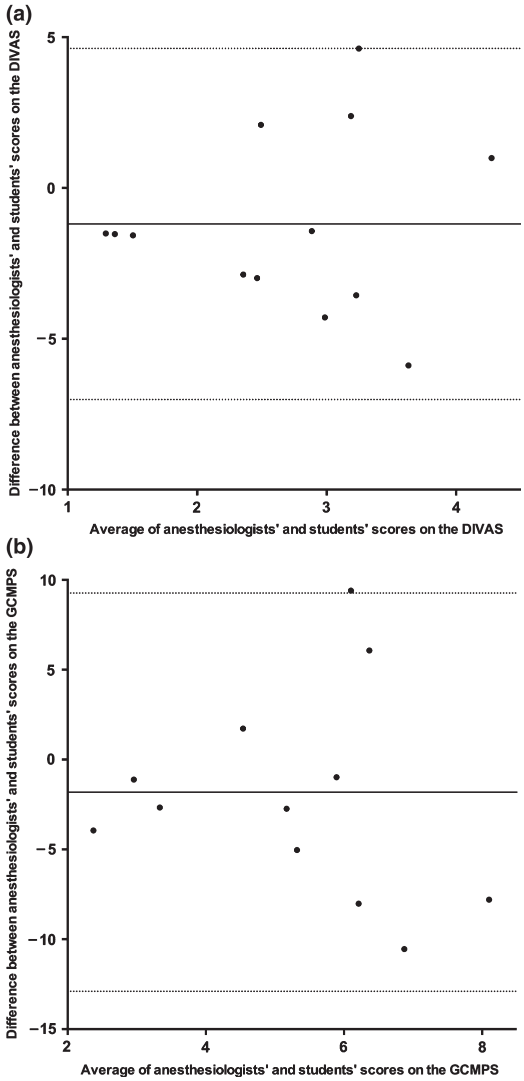

Figure 1 Bland–Altman plots of difference between average scores assigned by anesthesiologists and students using (a) the Dynamic Interactive Visual Analog Scale (DIVAS) and (b) the Short Form of the Glasgow Composite-Measure Pain Scale (GCMPS), against the average of the two (dogs evaluated are represented by the points in the plot). Solid lines represent the mean difference or bias and dashed lines represent the lower and upper 95% limits of agreement.

behavior were able to score pain in dogs similarly to experienced anesthesiologists, and if experience with pets or time spent in veterinary school had any influence on this clinical skill. The students were enrolled in the study before the autumn semester. At this stage, these students had not received any specific training in anesthesia or pain assessment and had not participated in any clinical activities in the Teaching Hospital. The results indicated that students assigned higher pain scores to dogs that were allotted low pain scores by anesthesiologists, and lower pain scores to dogs that were deemed to be in greater pain by anesthesiologists. When the bias of each scale was considered, it was evident that the students assigned higher average scores to the dogs than did the anesthesiologists. This difference reflected the high number of dogs considered to be in mild or no pain by the anesthesiologists.

A lack of consistent bias for both the DIVAS and GCMPS was indicated in the Bland–Altman plots (Fig. 1). Poor to no agreement between anesthesiologists and students was suggested by the wide 95% limits of agreement and Cohen's kappa analysis. The average scores assigned by all students and all anesthesiologists were used, rather than individual scores, because this approach was considered more suitable for the graphic representation of Bland–Altman plots. If individual score comparisons had been carried out, the variation among scores would probably have been even greater than the limits of agreement reported.

A comparison of first- and second-year student scores found no significant difference between them, except for DIVAS scores for dogs in videos 7 and 8. This exception was not clinically relevant as students assigned both dogs scores of >4 cm, which had been determined as the cut-off score indicating whether or not the dog needed further analgesia. Neither of these two dogs was assigned a DIVAS score of ≥4 cm by any of the five anesthesiologists.

The level of agreement on the intervention point among anesthesiologists was considered moderate and showed some degree of inter-observer variability. This may reflect differences in the interpretation of some signs exhibited by the animals, lack of personal interaction, and the short duration of the videos. Inter-observer variability was even higher among students, whose agreement was deemed only fair. When the level of agreement on the median intervention point among all students and all anesthesiologists was assessed, the results showed a negative Cohen's kappa coefficient. Kappa is a measurement of agreement which considers differences between observed and expected agreement. Although the κ-value is usually a positive number, which lies between 0 and 1, negative values are possible. Kappa is indeed standardized to lie on a scale of −1 to 1, where 1 represents perfect agreement, 0 represents exactly what might be expected by chance, and negative values indicate agreement of less than chance (Viera & Garrett

2005). It is not surprising that the agreement between students and anesthesiologists on the intervention point was less than that expected based on chance alone, given that agreement among the anesthesiologists was only moderate. These results suggest that scoring pain in dogs may be challenging and that further work is required to improve proper pain assessment.

Because of the number of videos used and the application of two pain scales, a large number of statistical comparisons were made. This increases the likelihood of a Type I error. However, there were so many differences between anesthesiologists and students that the odds of a Type I error explaining all of them are exceedingly small. Furthermore, a low α-value of 0.01, instead of the more common 0.05, was chosen to decrease the risk for Type I error.

Two pain scales were used in this study in order to determine if the level of agreement related to the type of scale. The DIVAS is a simple scale and lacks the multidimensional depth necessary to encompass all behaviors attributed to the experience of pain, making it less comprehensive than the GCMPS (Hellyer et al. 2007). By contrast, although the GCMPS covers more domains, this scoring method may be more complicated for use in clinical practice. Furthermore, some aspects of the validity and reliability of these scales may not be accepted by certain evaluators; for instance, although the VAS can be both valid and reliable when used by a trained evaluator, it may not be so when used by a novice evaluator (Hielm-Bjorkman et al. 2011). There is also evidence to suggest that physicians are generally better at assessing and managing pain in their patients if they have more years of practice experience (Kim et al. 2011).

The results of this study showed that veterinary students scored pain in dogs differently from experienced anesthesiologists. Different reasons may explain this. Lack of training and experience in recognizing signs of pain may have played a major role. Some dogs may have shown signs of dysphoria, caused by postoperative analgesic drugs, which did not worsen with palpation of the surgical site. Students may have interpreted these signs as indicative of pain and discomfort. On the contrary, dogs that were reluctant to move because of pain may have been considered shy or fearful by the students. Some dogs showed signs of aggression that students may have interpreted as representing normal behavior in the context of the ICU environment rather than signs of pain.

The lack of exposure to pain scales, such as the DIVAS and GCMPS, may have been another important factor contributing to the results of this study. One study showed that VAS validity improved after dog owners had gained some practice and experience in using this scale in comparison with the Helsinki Chronic Pain Index (Hielm-Bjorkman et al. 2011). Another study showed a slight learning effect over time when the VAS was used (Moran & Hofmeister 2013). It is reasonable to assume that the same might happen with the GCMPS.

Some limitations were encountered in this study. Only first- and second-year students were included. The enrollment of third- and fourth-year students, who would have had basic and advanced anesthesia training, might have revealed closer agreement between students and anesthesiologists. The videos used in this study were relatively short (about 90 seconds each). To avoid the misinterpretation of pain-caused behavior, each video was played twice for the students. Longer videos that allowed more time for interaction between the person and the dog might have allowed the students to make more informed and therefore more accurate decisions.

The absence of personal interaction with the dogs is likely to have limited the students' and anesthesiologists' judgments. Physical examination of the patient is essential to determine the level of pain, and lack of contact with the dog can be considered a limitation when videos are used instead. It is also important to evaluate the responses of the dog before the surgical procedure in order to be able to assess the dog's demeanor. However, the use of videos becomes important when multiple evaluators are required to score the same animal, and is critical when evaluations must occur at different times.

In this study, clinically normal dogs were not included. Based on the anesthesiologists' assessment, when both scales were considered, four dogs (in videos 3, 4, 8 and 10) were deemed to be comfortable or experiencing mild pain. When these scores were compared with the students' scores, differences emerged for all of these videos, except in DIVAS scores on videos 4 and 10, and GCMPS scores on video 10 (Table 1). The inclusion of clinically normal dogs might have better identified differences and similarities in pain scores assigned by students and anesthesiologists, respectively.

The intervention point used for the DIVAS was $\geq$4 cm, but a set score at which the students themselves would have administered further analgesic drugs was not established before they watched the videos. The addition to the scoring systems of a question (e.g. 'Does this dog need further analgesia?') might have clarified the intervention point to the students and potentially led to different results.

The median intervention point, rather than individual scores, was used to assess the agreement between students and anesthesiologists. This approach was selected to highlight the level of agreement between the two groups rather than the level of agreement among single individuals in each group. The intervention point was used to assess agreement because it was considered more clinically relevant than the total score assigned by each evaluator. The authors wanted to determine whether or not students and anesthesiologists agreed on which behavior in dogs indicated a requirement for further analgesia. The use of individual scores to assess agreement might have led to different results.

Conclusions

First- and second-year veterinary students, on average, assigned pain scores that differed from those assigned by experienced anesthesiologists. The difference may reflect the enrollment of students without any training in pain assessment, differences in the interpretation of dogs' behavior, lack of personal interaction with the animals, and/or the quality and duration of the videotapes. Future research could investigate whether the training currently offered to students is sufficient to develop the skills necessary to recognize pain in animals by enrolling students who have attended anesthesia and pain management courses in similar studies.

Acknowledgement

The authors acknowledge Deborah Keys, College of Veterinary Medicine, University of Georgia, Athens, GA, USA, for advice on the statistical analysis of the study data.

Conflicts of interest

The authors have no conflicts of interest to report

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Received 20 July 2014; accepted 10 January 2015.

