Evaluation of Stress Related to Medical Care in Schools for Special Needs Education Using a Salivary Biomarker in Students With Profound and Multiple Learning Disabilities

Mikae Fukasawa1,*, Yurika Inoue2 and Kazunori Takeda3

1 Graduate School of Comprehensive Human Science, University of Tsukuba, Japan
2 Kagoshima Prefectural Kanoya Special School, Japan
3 Institute of Disability Sciences, University of Tsukuba, Japan

This study is the first to use salivary α-amylase activity (sAA) to evaluate stress in students with profound and multiple learning disabilities (PMLD) before and after medical care in schools for special needs education. Oral suction of sputum is one of the medical cares given in schools. And in this study, sAA, heart rate (HR), and degree of oxygen saturation (SpO2) were measured for students before and after such suctioning. Results showed a significant rise in sAA and a rising trend in SpO2 after the care, as well as a negative correlation between SpO2 and sAA before the care. This indicates that while suctioning stabilizes oxygenation, it can also cause the student stress. Furthermore, sAA reflects the child's physiological stress level during a low oxygenation state. In general, suctioning is performed only until a rise in SpO2 and stabilization in HR. However, the findings indicate that sAA can highlight biological changes which cannot be ascertained through other measurements, and also show the significance of measuring sAA before and after medical care to ascertain the physiological and psychological condition of the student.

Key Words: profound and multiple learning disabilities (PMLD), medical care, salivary biomarker, salivary α-amylase activity (sAA)

Introduction

Under Japan's education system, students with profound and multiple learning disabilities (PMLD) have the right to receive elementary and middle school education. This education is often provided through schools for special needs education. Most students with PMLD require constant medical management throughout their lives. Until recently, in Japan, providing of medical care services were limited to doctors, nurses and parents. Therefore, parents had to accompany their children with PMLD to schools in case there were no doctors or nurses available, and families' burden for such care has been frequently indicated. But, in recent years, progress has been made in establishing policies that deal with medical care in the schools for students with PMLD. Improvements have also been made in how medical care is provided by teachers at the schools. Of special importance are the revisions made to laws related to social workers and care workers in Japan. In April 2012, medical care policies made it possible for teachers at schools for special needs education with a certain level of training (Ministry of Education, Culture, Sports, Science and Technology, 2011) to perform certain medical treatment. It is anticipated that teachers will need to provide increasing amount of medical care in schools in the future.

According to Kitazumi (2004), medical care provided in schools for special needs education is undertaken from the following three main perspectives: 1) the medical significance of being able to maintain health and life by providing medical care as necessary; 2) the educational significance of being able to deepen relationships between teachers and students, by reducing absences which are due to family's sched-
ule and maintaining a positive learning environment through the involvement of teachers in care; and 3) the social welfare significance of reducing the burden on families and maintaining quality of life (QOL) for siblings and the entire family. In addition, at a conference on providing medical care in schools for special needs education by the Ministry of Education, Culture, Sports, Science and Technology (2011), the efforts related to medical care were summarized as follows: to ensure the safety of the medical care provided, to improve educational outcomes, and to reduce the mental and physical burden of parents and guardians.

In regard to medical care provided by teachers in Japan, however, a literature review by Tatematsu and Ichie (2009) raised questions about the safety and accountability of this care as well as other concerns about care and the level of burden. These relative concerns are attributable to the following factors. Teachers who are not medical providers will feel concerned about performing medical procedures and lack of feedback from students about the care because of difficulties in communication. Furthermore, it is said that teachers performing medical procedures tend to demand patience to the students, which is not always easy and can thus cause stress.

In schools for special needs education, most children who require daily medical care are students with PMLD that have both severe cognitive and motor disabilities. Because most of these students have difficulties in communication, those who are involved in their medical care and education frequently have little choice, and their judgment on the students' feelings or reactions primarily is based on observation and practical knowledge of the child’s emotional changes (Petry & Maes, 2006). For this reason, in practical environments such as schools, objective evaluation methods which are based on the measurement of physiological indices are required (Chaney, 1996; Lancioni, Singh, O’Reilly, Oliva, and Basili, 2005). In actuality, in practical education settings, many physiological indices have been used to monitor the physical condition of students with PMLD, including heart rate (HR) and electroencephalogram (EEG) (Kawasumi & Nozaki, 2011). Biological substances included in the saliva, known as salivary biomarkers, have attracted interest in recent years for use as physiological indices of mental and physical states, such as stress, given their ease of use and non-invasive method for obtaining samples (Granger, Kivlighan, El-Sheikh, Gordis, & Stroud, 2007). Specifically, there have been many reports on salivary α-amylase activity (sAA), a digestive enzyme in saliva, as a possible indicator reflecting activity of the sympathetic nervous system (SNS) (Chatterton, Vogelsong, Lu, & Hudgens, 1997; Granger et al., 2007; Nater, Rohleder, Gaab, Berger, Jud, Kirschbaum, & Ehlert, 2005; Yamaguchi, Hanawa, & Yoshida, 2007; Yamaguchi, Kanemori, Kanemaru, Takai, Mizuno, & Yoshida, 2004). The efficacy of sAA for use with people with PMLD has already been reported, when evaluating mental and physical stress during relaxation interventions of Snoezelen or invasive medical procedures in medical setting (Takeda, Onishi, Yamaguchi, & Takeya, 2006; Takeda, Watanabe, Onishi, & Yamaguchi, 2008).

The measurement of sAA as a physical and mental indicator in PMLD is growing in popularity. However, there have been no studies on its use in students with PMLD by teachers providing medical care in schools and other places of learning. Therefore, this study measured sAA in children with PMLD to examine whether they experienced acute stress when receiving medical care in a school for special needs education and to determine the usefulness and significance of measuring sAA by comparing it to other physiological indices traditionally used in care.

**Method**

**Participants**

The participants were 12 students (mean age, 11 years 7 months±3 years 1 month; range, 6 years 8 months–17 years 1 month) receiving oral suctioning as medical care at a school for special needs education and for whom consent to participate was received from their guardians. All participants had profound and multiple learning disabilities that met the criteria for a Class 1 Japanese Physical Disability Certificate and were diagnosed as having PMLD. In terms of motor ability, they were unable to turn over by themselves, and in terms of cognitive level, they could not understand language. Detailed profiles of the participants are shown in Table 1.

**Measurement and Protocols**

From among the medical procedures that teachers are able to provide, this study evaluated oral suction-
ing of sputum. sAA and HR of students immediately before and after tube suctioning was measured.

sAA was measured using a salivary amylase monitor (Nipro CM-21, Japan) and HR and oxygen saturation (SpO₂) were measured with a pulse oximeter (Konica Minolta Sensing PULSOX-300i, Japan) on two occasions, within 5 min before and within 5 min after oral suctioning (see Fig. 1).

**Statistical Analysis**

In this study, measurements were conducted during the daily medical care of the participants; it was difficult to unify the number of measurement times across participants. Therefore, with reference to Sievers, Yee, Foley, Blanding, and Berde (1991), the data obtained from a total of 37 measurements in the twelve participants were individually processed as single data and used in the analysis.

Mean values before and after suctioning were compared for each of the physiological variables and differences were examined using a paired *t*-test. *Pearson’s correlation coefficients* were also calculated to determine the relationship between sAA and HR or SpO₂ both before and after suctioning.

Statistical analysis was performed using JMP 8.0 (SAS Institute, USA). The following analyses were carried out, with *p*<.05 taken to indicate statistical significance in all analyses. When .05< *p*<.1, there was considered to be a significant trend.

**Ethical Considerations**

This study was approved by the Ethics Committee of the Graduate School of Comprehensive Human Sciences, University of Tsukuba. The purpose and methods of the study were explained orally and in writing to the participants’ guardians by participants’ teachers, and informed consent was obtained from the guardians. In addition, only students who would cooperate for the saliva collection and measurements of HR were enrolled as subjects.

**Results**

**Change in Physiological Variables after Suctioning**

As shown in Fig. 2, significant differences between before and after suctioning were seen in mean sAA (69.2±52.7 KU/L (kilo units per little) vs. 103.9±101.5 KU/L, respectively; *t*(36)=2.51, *p*<.05). No significance was seen between before and after suctioning in mean HR (100.8±14.9 bpm (beats per minute) vs. 103.1±14.2 bpm, respectively; *p*>.1). Mean SpO₂ was higher after suctioning, but not significantly so (95.7±3.1% vs. 96.8±2.0%; *t*(36)=1.97, .05< *p*<.1).

**Relationship between sAA and HR or SpO₂ before and after Suctioning**

As shown in Fig. 3, before suctioning, a significant negative correlation was observed between sAA and SpO₂ (*r*=-.54, *p*<.01) but not between sAA and HR. After suctioning, no significant correlations were observed between sAA and SpO₂ or HR (see Fig. 4).

**Discussion**

This is the first study to report the use of a salivary biomarker to reveal acute stress in students with
PMLD during medical care at schools for special needs education. The significant increase seen in sAA after oral suctioning suggests that the students were experiencing acute physical and/or mental stress during the medical care. This concurs with the findings of Takeda et al. (2006) that sAA was increased after invasive medical procedure of patients with severe motor and intellectual disabilities. In the present study, the invasive nature of suctioning, by placing a tube in the student's mouth, is thought to cause the student acute stress, which was reflected by the increase in sAA. No significant change was observed in HR, however, a parameter that has been traditionally used to ascertain the physical state of children receiving medical care. For SpO₂, a rising trend was observed, suggesting that the oxygenation state was
improved by suctioning. The significance here is that such medical care is regarded as effective when the sputum has been removed and breathing improves, which is the reason for performing the care. Alongside successfully improving the oxygenation state, however, the sAA values suggest the child also experiences mental and physical stress: sAA may therefore reflect physiological changes and associated psychological changes that cannot be ascertained from measurement of the other indices such as HR or SpO₂.

Furthermore, the negative correlation seen between SpO₂ and sAA before the suctioning procedure suggests that sAA reflects physiological stress due to a low oxygenation state prior to any medical care. Even though sAA is believed to be altered through sympathetic nervous system (SNS) activity, no correlation was observed between sAA and HR, which, like sAA, is an index of SNS activity. Previous studies reported similar results in correlation between sAA and HR (Fukasawa and Takeda, 2012; Takeda et al., 2006; Takeda et al., 2008). It can thus be surmised that sAA is a sufficiently sensitive index of psychological stress which does not cause any major changes in sympathetic nervous activity. Given the above, it is believed that sAA can reflect acute stress in students undergoing medical care, which is difficult to ascertain through physiological indices such as HR or SpO₂ that have traditionally been used when providing medical care in schools for special needs education.

No significant correlation was observed in this study between sAA and either HR or SpO₂ after suctioning. In general terms, the objective of medical care performed for students with PMLD in schools for special needs education is to stabilize the HR. When SpO₂ rises, the medical care is concluded and the child returns to the learning environment. However, the results of this study show that sAA may remain elevated even after HR and SpO₂ have stabilized, suggesting that the child's psychological condition has not stabilized and stress remains high until some time after the ending of care. This suggests the importance of not only maintaining life through medical procedures, but also the need to reconsider the amount of rest needed to restore physical and psychological stability, enabling the student to return smoothly to the learning environment.

**Conclusions**

This study revealed a significant elevation of sAA following the receipt of medical care (oral suctioning of sputum) provided to children with PMLD in schools for special needs education, which suggests that using a tube to perform suction causes them acute stress. Furthermore, the findings highlighted the significance of sAA as an index to reflect physiological and psychological changes, which are difficult to ascertain from indices such as HR and SpO₂ that have been traditionally used when providing medical care at special needs schools.

**References**


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