Asian Journal of

HUMAN SERVICES

Printed 2017.1030 ISSN2188-059X
Published by Asian Society of Human Services

October 2017
VOL. 13

Asian Society of Human Services

Human Services

DOI:http://dx.doi.org/10.14391/ajhs.13.10
Asian Journal of Human Services, VOL.13 10-22

ORIGINAL ARTICLE

Study on Triage Education for Nursing Students
:Analysis of Their Errors in Triage

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ABSTRACT

START is a system of primary triage performed on casualties at the scene of a mass-casualty incident. START is an acronym for "Simple Triage and Rapid Treatment" by which casualties are sorted into four triage categories. After conducting the triage simulation exercises, the authors realized that some students repeated the same errors despite having completed the triage classes. The purpose of this study is retrospectively to examine some mis-categorized cases to identify causes of triage errors, and thereby inform the future design of courses for triage education.

Subjects were 115 fourth-year nursing students at a university in Kyushu, Japan who completed a two-day disaster nursing course. Nursing students were asked to fill out an answer sheet in the first session (hereafter referred to as "pre-intervention") and again in the second session held a week later (hereafter referred to as "post-intervention"). Many of those were about mis-categorizing "green" casualties as "yellow" and vice versa, which implied that students had difficulty in making triage decisions between the "walking wounded/minor" and "delayed" categories.

The results of the study showed that most students were likely to answer the triage questions largely based on their perception of visual information (such as video images) rather than on triage criteria.

＜Key-words＞
triage education, nursing students, triage error, triage simulation, visual information

Received
June 8, 2017

Revised
September 1, 2017

Accepted
September 15, 2017

Published
October 30, 2017

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Asian J Human Services, 2017, 13:10-22.

DOI: http://dx.doi.org/10.14391/ajhs.13.10
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I. Introduction

START is a system of primary triage performed on casualties at the scene of a mass-casualty incident. START is an acronym for "Simple Triage and Rapid Treatment" by which casualties are sorted into four triage categories. The purpose of using this system is to filter casualties with minor injuries from the remainder, and determine the severity and urgency of a large number of casualties' injuries in a short time (Somes, 2014). A university in Japan has been offering courses in disaster medical response, disaster nursing and triage since 2003 (Umesaki, 2011). From 2004 to 2009 the university invited instructors from Tokyo DMAT (Tokyo Metropolitan Government Disaster Medical Assistance Teams) to provide disaster medical response training for physicians, registered nurses, paramedics, administrators and nursing students. The training consisted of classroom sessions and field training exercises covering such topics as triage, medical care at aid stations and sites littered with rubble, information and communication, and response to extraordinary events including NBC incidents (Akinaga, 2011; Akinaga, 2012). A post-training comparative survey to assess the educational impact of the training on registered nurses and nursing students showed the same degree of effects on both groups (Akinaga, 2011). A follow-up survey of the same groups performed a year later found that the knowledge gained through a field training exercise was far better retained in their memory than that acquired through desktop learning (Akinaga, 2012).

A number of studies have reported on the effectiveness of simulation education, including field training exercise, both in Japan and abroad (Powers, 2007; Howard, 2014; Donatelli , 2012; Nesbitt, 2015). Although the field training exercise at the above-mentioned university was also proven to be effective, it was difficult for the university to continue to organize a field training exercise for nursing students every year. In an effort to complement desktop learning, the university introduced a triage simulation exercise using video content to allow the students to practice triaging casualties. After conducting the triage simulation exercises, the authors realized that some students repeated the same errors despite having completed the triage classes, and in addition, multiple students gave the same wrong answers to certain questions. The authors had predicted that the students would have difficulty in making triage decisions between the "yellow" and "red" categories most probably because they would be unable fully to understand the levels of severity for those categories. Contrary to that prediction, students' test records indicate that they wavered most between the "green" and "yellow" categories, both before and after the triage classes.

A review of literature relevant to triage found a few articles published in international journals. Leibovici et al. (1997) conducted a study to identify possible errors in triage by analyzing medical records of victims (Leibovici, 1997). Brannigan, et al. (2006) noted the difficulty in triaging casualties with seemingly minor injuries as some of

DOI:http://dx.doi.org/10.14391/ajhs.13.10
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them can deteriorate afterwards, and further pointed out the possibility that triage decisions are not made appropriately (Brannigan, 2006). Bhalla, et al. (2015) sought to determine the efficacy of START and SALT (Sort, Assess, Life-saving interventions, Treatment and transport) in predicting clinical outcomes(Bhalla, 2015) and concluded that both systems resulted in many under-triaged patients. The above studies have revealed the difficulty students find in distinguishing patients in the "green" category from those in the "yellow" category. The authors believe that it is important to identify factors behind such difficulty for the future advancement of disaster medical response.

The purpose of this study is retrospectively to examine some mis-categorized cases to identify causes of triage errors.

II. Subjects and Methods

1. Subjects and Procedures

Participants: 115 fourth-year university nursing students at a university in Kyushu, Japan who completed a two-day disaster nursing course

1) From the class of 2012: 66 participants

Valid response rate: 97.0%.

(In 2012, 68 students took the course. Two were eliminated from the study as they missed one of the two days of the course.)

2) From the class of 2013: 49 participants Valid response rate: 96.0%.

(In 2013, 52 students took the course. Three were eliminated from the study as they received triage training in an elective course.)

3) Average age ± standard deviation（SD）

Class of 2012: 21.9 ± 1.28 yrs. Class of 2013: 22.1 ± 1.47 yrs.

In total, 115 students with no prior experience of triage training participated in this study.

2. Data Collection

Nursing students who took the disaster nursing course in 2012 and those who took it in 2013 were asked to fill out an answer sheet in the first session (hereafter referred to as "pre-intervention") and again in the second session held a week later (hereafter referred to as "post-intervention"). The answer sheets were used for data analysis.

1) Instructions in triage classes

In the first session, the instructor briefly explained the concept of START triage, then showed a commercially-available triage simulation video (with case examples) [13] and asked the students to make a triage decision on each case and fill in the answer sheet. The students were then taught in detail about triage. In the second session, held a week later, they spent the first 30 minutes reviewing the previous session, then watched the

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same video, writing their triage decisions on the answer sheet as they had a week before. In both sessions they used the same answer sheet format with a comment box in which they were asked freely to write their impression about their triage exercise or any other comments. The question sheets were collected after each session.

<Course contents>

START triage: "Purpose of triage", "Situations that require triage", "Categories of treatment priority"

How to perform triage: "Color coding for each category - walking wounded/minor (hereafter referred to as 'green'), delayed (hereafter referred to as 'yellow'), immediate (hereafter referred to as 'red') and deceased/expectant (hereafter referred to as 'black')", and "Triage algorithm – ability to walk, spontaneous respiration, respiratory rate, mental state, and radial pulse/capillary refill time (CRT)"

2) Ethical considerations

This study was conducted with ethics committee approval (28-11) from Junshin Gakuen University. The same answer sheet format was used for both pre- and post-intervention tests for ease of comparison. The format included entry fields for age and sex, but no other personal information about the students.

3) Definition of terms

Visual: something that immediately conjures up an image for the viewers

Visual information: images presented through media such as videotape

4) Study components

Age of the participants

Answer data from pre-and post-intervention tests (30-question tests; each correct answer is worth one point; full score is 30)

Free-text comments: challenges they faced in learning triage or any other comments

3. Statistics analysis

1) SPSS Statistics 23 was used as a tool for statistical analysis.

Although age is a basic attribute of the classes of 2012 and 2013, the population of this survey was limited to fourth-year university nursing students and it did not follow a normal distribution. Therefore, the Mann-Whitney U test was used to see if there was any variation due to age difference.

As the common type of data extracted from pre- and post-intervention tests are four-choice answers (green, yellow, red and black), the authors predicted that the answers would not be distributed evenly among the choices. Additionally, the population did not follow a normal distribution. Therefore, the Wilcoxon signed rank test was used to analyze the data.

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2) Analysis of free text

Content analysis was used as a method to analyze the free-text data written by the participants about challenges they faced in learning triage, or any other comments. As cutting every word out of each sentence would alter the implications of the free-texts, complete sentences were processed as entire units so that all the meaning of a sentence could be extracted. The data were then classified into medium and large categories, and indices were created for the large category. Data analysis was done by three co-authors (two doctoral course students and an associate professor) who have experience in content analysis. The lead author, a graduate school student (a different individual from the co-authors) and a faculty member of a nursing college who holds a Master's degree in nursing calculated the kappa coefficient to measure the inter-rater agreement. The inter-rater agreement about "challenges faced in learning triage and any other comments" was 88.5% in the pre-intervention test, and 87.2% in the post-intervention test.

III. Results

1. Analysis results before education and after education

The absence of significant difference in age as a basic attribute between the classes of 2012 and 2013 implies that they can be regarded as the same population. The average test score out of 30 and standard deviation were 21.98 (±5.76) in the pre-intervention test and 28.47 (±1.79) in the post-intervention test. These results showed a higher rate of correct answers ($p=0.0001$) as well as a significant development of knowledge about triage after the triage classes even though there was a one-week interval between the tests. (Table 1) Analysis of questions the students answered incorrectly in those tests revealed some tendencies. Many of those were about mis-categorizing "green" casualties as "yellow" and vice versa, which implied that students had difficulty in making triage decisions between the "walking wounded/minor" and "delayed" categories. Further analysis found that out of 30 questions, six questions led to certain patterns of incorrect answers. Five out of those six questions led the students to assign a casualty who should have been assigned to the "yellow" category to "green". Four out of those five questions related to "a casualty who walked in supported by someone", and the other was about "a child casualty arriving in his/her parent's arms". These patterns of incorrect answers indicate that the students wavered between the "minor (green)" and "delayed (yellow)" categories. Analysis of the remaining question, which also had a high rate of incorrect answers showed that the students also had difficulty in deciding between "immediate (red)" and "delayed (yellow)" categories. (Table 2)

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2.Analysis result of free description

Some common free-text comments found in the pre-intervention test answer sheets were about, in order of frequency, "difficulty in sorting casualties", "specific questions about triage", and "importance of triage", while in the post-intervention test answer sheets, most of them were about "importance of START triage", followed by "difficulty in deciding between 'green' and 'yellow' categories", and "the psychological burden of having to assign a casualty to the 'black' category". What caught the authors' interest was that many of the students who mis-assigned casualties in the "yellow" and "green" categories wrote that "it was difficult to decide between 'green' and 'yellow' categories." These results indicate that the casualties who "walked with someone's assistance" and those who "appeared to be severely injured" confused the students when making triage decisions. (Table 3, 4)

<Table 1>
Rate of correct answers in pre- and post-intervention tests Wilcoxon signed rank test

	mean	Standard deviation	p-value
pre-intervention	21.98	5.76	0.0001
post-intervention	28.47	1.79	

Table 2: Questions with high rate of wrong answers and number of respondents who made each answer choice
*underlined bold figure: number of respondents who made a wrong choice in the post-intervention test

Question number	Correct answer	number of respondents		
		green	yellow	red
4	red	0	**10**	105
18	yellow	**26**	84	5
21	yellow	**26**	87	2
23	yellow	**29**	84	2
24	yellow	**34**	79	2
27	yellow	**36**	77	2

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Table 3: Content analysis of free-text data from pre-intervention test "Challenges faced in triage exercise and any other comments"

"Difficulty in sorting casualties" (data count: 15)
● I found it difficult because I thought the casualty's category may differ depending on the body part affected by fractures or burns.
● A casualty with head contusion might be at risk of developing intracranial hemorrhage. I wondered whether his/her triage category would change at the time of examination and treatment and whether it was right to assign him/her to the "green" category.
● I had difficulty in deciding a category for a casualty with stable vital signs wondering if it might be better to assign him/her to the "red" category.
● Perception of pain may differ due to age or among individuals even for minor injury. It was hard to make triage decisions taking into account such difference and potential impact of shock from injury.
● I wondered whether I should upgrade a casualty in the "green" category with relatively severe injury to the "yellow" category.
● If I tried to base my triage decisions on both the casualty's actual state of injury and complaints, I would be misled into believing that everyone is severely injured.
"Specific questions about triage" (data count: 13)
● When triaging a pregnant woman, to what extent do I need to take the state of the fetus into consideration?
● Is it necessary to consider age as a factor? Is adult triage different from pediatrics?
● I was told to assign casualties who can walk to the "green" category. Does it really mean that their condition would never worsen?
"Importance of triage" (data count: 9)
● It is hard to imagine the feeling of the families of casualties who were assigned to the "black" category thinking that they might have survived otherwise.
● As my decision may mean someone dies, I need to acquire correct knowledge.
● I need to have the ability to anticipate what will happen next and make appropriate decisions.

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Table 4: Content analysis of free-text data from post-intervention test "Challenges faced in triage exercise and any other comments"

"Importance of START triage" (data count: 59)
● Triage is an important system meant to save the greatest number of casualties by prioritizing them for treatment. ● The classes were helpful in learning specific criteria such as "ability to walk". ● I could learn specific procedures of triage after exercising triage based on some case examples. ● Accuracy of triage decisions may be highly variable depending on our knowledge of START triage. ● I could understand that START triage will help us perform triage smoothly and fulfill the significance and purpose of disaster nursing.
"Difficulty in deciding between 'green' and 'yellow' categories" (data count: 7)
● Although by START criterion, a walking-wounded casualty should be assigned to the "green" category, I may become afraid of doing so in a real-world situation. ● It is difficult to determine whether a casualty can or cannot walk with assistance in the START triage system. ● It is difficult to make a triage decision on a casualty who cannot walk unassisted but walked over to the aid station with someone's assistance. ● It makes me feel uneasy because even casualties who seemed to be severely injured are assigned to the "green" category in the START triage system. ● If I tried to base my triage decisions on both the casualty's actual state of injury and complaints, I would be misled into believing that everyone is severely injured.
"Psychological burden of having to assign a casualty to the 'black' category" (data count: 2)
● I imagine performing triage in a real-world situation would be rather hard. Some casualties may ask me to provide care, or there may be situations where treatment from child casualties must be withdrawn. ● When there are a large number of casualties, it may be psychologically challenging to sort some casualties into the "green" and "black" categories in order to save many lives.

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Figure 1: Case-based triage questions and correct categories. (○: yes, ×: no)

	Age	Sex	Diagnosis	Triage category	Walk	Breathing	Ventilatory frequency	capillary refilling time	Verbal contact	Heart rate
1	Infant	female	Dead Baby	Black	×	×	0	×	×	0
2	82	male	Cut of the ear	Green	○	○	23	○	○	75
3	43	female	Epidermal burn	Green	○	○	22	○	○	56
4	25	male	Intestinal tract hernia	Red	×	○	23	×	○	92
5	19	female	Head blow	Green	○	○	28	○	○	96
6	54	female	Previous head abrasion	Green	○	○	20	○	○	82
7	45	female	Right cheek abrasion	Green	○	○	24	○	○	97
8	36	male	Left leg abrasion	Green	○	○	21	×	○	82
9	67	male	Myocardial infarction	Red	×	○	40	○	○	116
10	64	male	Radius artery damage	Green	○	○	29	○	○	104
11	8	male	Fall	Green	○	○	28	○	○	116
12	40	male	facial burn	Green	○	○	24	×	○	106
13	32	male	Crash syndrome	Red	×	○	32	○	△	84
14	32	female	Bone fracture of the nose	Green	○	○	20	○	○	80
15	52	male	Head cut wound	Green	○	○	20	×	○	80
16	23	male	Pelvis bones fracture	Red	×	○	36	○	○	120
17	67	male	Finger joint cutting	Green	○	○	28	○	○	72
18	72	male	Upper part of the body burns	Yellow	×	○	28	○	○	112
19	36	female	Cervical spine sprain	Green	○	○	24	○	○	78
20	71	male	Eye puncture wound	Green	○	○	24	○	○	78
21	43	male	Left leg open fracture	Yellow	×	○	28	○	○	116
22	60	female	Right second finger extensor tendon tear	Green	○	○	23	○	○	92
23	25	male	Left leg second-degree burn	Yellow	×	○	28	○	○	96
24	28	female	Breaking water of the pregnant woman	Yellow	×	○	24	○	○	64
25	21	female	Left wrist bone fracture	Green	○	○	25	○	○	82
26	35	female	Sticks wound by the glass	Green	○	○	29	○	○	104
27	2	male	Right forearm second-degree burn	Yellow	×	○	28	○	○	92
28	51	female	Back of the head blow	Green	○	○	22	○	○	86
29	10	male	Wrist burns	Green	○	○	27	○	○	94
30	78	male	Intraoral injury	Green	○	○	24	○	○	74

black tag : Apnea group (death)　　red tag : Top priority treatment group

yellow tag : Standby treatment group　　green tag : Retention group (mild group)

DOI: http://dx.doi.org/10.14391/ajhs.13.10
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IV. Discussion

The average score of the post-intervention test (held a week later) provided a confirmation that the students' knowledge of triage had increased. As the participants were fourth-year university nursing students, the authors had predicted that their prior education in nursing would help them develop their knowledge of triage quickly. However, despite completing the triage classes, many students gave the same wrong answers to the questions they had answered incorrectly in the pre-intervention test, and many of those wrong choices related to the "yellow" category. The results of free-text analysis indicated the influence of visual information on the students' triage decisions. The triage simulation video used in the exercise contained some quite realistic depictions of injuries such as facial burns and open fractures which gave the impression that the casualties had suffered severe injuries. The key point of observation needed to assign a casualty to the "green" category is the ability to walk. However, the visual information from the video may have made the students wonder if it was right to assign the casualty to "green" category, worrying that his/her condition might take a sudden turn afterwards. It is also possible that their imagination held them back from making appropriate decisions. Moreover, "walking" means both walking unassisted and walking with assistance, but according to START triage criterion, unless the casualty is walking unassisted, he/she should be assigned to the "yellow" category. Some of the questions may have misled the students. One such question was about a casualty whose condition was stated in the question sheet as being "able to walk with assistance", but about whom the video clip gave the impression that he/she was walking unassisted but accompanied by someone. As the video image seemed more realistic, the students possibly relied mainly on the visual information in categorizing this casualty. It is conceivable that the students' perception of such video images is the cause of their hesitation in making triage decisions even when the casualty's condition is clearly stated, as for instance, "able to walk with assistance". Teaching triage by showing video content which depicts close to real-world scenarios can be difficult. However, allowing the students to make errors and send feedback will provide an opportunity to identify the cause of such errors (Brannigan, 2006; Foronda, 2016) . Therefore, it is reasonable to assume that video-based simulation exercises can improve student learning.

In mass casualty incidents, over-triage is often accepted on the basis that it is better to err on the side of medical safety. But when under-triage occurs, a casualty who can wait but needs medical attention is assigned a lower treatment priority and this creates the risk of overlooking a casualty whose condition could deteriorate at any moment. If the assessment of "ability to walk", a criterion for determining between the "yellow" and "green" categories is confusing to students, it is important to take a focused approach in preparing them so that they will always adhere to the criterion under all circumstances. The results of the study showed that most students were likely to answer the triage

DOI:http://dx.doi.org/10.14391/ajhs.13.10
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questions largely based on their perception of visual information (such as video images) rather than on triage criteria. The authors believe that it is necessary to make the students aware of the need to adhere to the criteria in order to triage casualties appropriately, bearing in mind that their decisions are likely to waver in the face of visual information (Leibovici, 1997).

A casualty's complaints may also be a factor which makes triage decision difficult. Casualties' complaints of pain or suffering seemed to have caused the students to believe that those casualties were severely injured. There were several free-text comments that support this observation such as "by the appearance and complaints of the casualties, I was misled into believing that everyone was severely injured." It is said that in real-world mass casualty incidents, casualties who complain frequently are less likely to have severe injuries, while quiet casualties who cannot verbalize their pain are more likely to be suffering from severe injuries. Therefore, it is also important to remind students of the need to pay attention to this phenomenon when they perform triage.

There were fewer incorrect answers to questions regarding triage decisions around the "yellow" and "red" categories. A probable reason is that although both categories are for casualties with severe injuries, the criteria for "red" such as loss of consciousness and two-second or more of capillary fill time are clear and easily understood both visually and numerically. Although START is an important triage system, it is nothing more than a primary triage that only determines the severity of an illness or injury. Primary triage is followed by secondary triage, in which casualties are categorized for the levels of severity, and priorities of immediate medical treatment and transport to medical institutions. If the students are told about this process in detail beforehand and understand that casualties can be re-triaged in this recurrent process, they will be able to make more accurate triage decisions based on the casualty's current condition without worrying about potential deterioration afterwards, and it may help improve their skills in START triage.

This study found that when learning about triage criteria and using simulation video, students can place undue weight on the visual information even if the casualty's condition is clearly stated. This can lead to incorrect triage decisions. This finding has some important implications for START triage education in the future. The authors believe that it is necessary to make practical use of triage criteria and visual teaching resources while explaining in detail that relying solely on visual information would lead to incorrect triage decisions.

V. Conclusion

Despite having learned about triage criteria, students were still greatly confused in making triage decisions even on cases of minor injury when visual information was realistic and gave an impression

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of severe injury. It also became clear that the triage criteria "walking" and "walking with assistance", was an area of common mis-categorization and that casualties' complaints about their pain and suffering were misleading to the students.

Limitations of this study

As the number of participants of this study is limited to 115, interpretation of its results requires circumspection. At this stage, the university can offer only video-based simulation exercises despite being aware that a more physically engaging learning experience is better in terms of students' memory retention. It is also a limitation of this study.

Future Challenges

As this study suggested the possibility of errors or confusion in triage decisions caused by visual information, future triage training should include and adhere to the basics of performing triage according to triage criteria before relying on visual information. The course content will continue to be revised, and the educational outcome thereof will be evaluated in order to help improve the quality of triage education. Currently, triage classes are offered only to fourth-year university nursing students. The authors plan in future to study and discuss whether decision-making and assessment abilities in triage are different between fourth-year students and first-year students with no knowledge of triage.

Acknowledgment

We wish to express our sincere thanks to the students of the Nursing Department who participated in this study. Our very special gratitude goes out to Professor Masahiro Nakano of the Faculty of Health Sciences, Junshin Gakuen University, who provided valuable advice on statistical matters.

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Asian Journal of HUMAN SERVICES

Asian Society of HUMAN SERVICES

Asian Journal of Human Services
VOL.13 October 2017

Editor-in-Chief Masahiro KOHZUKI

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Publisher Asian Society of Human Services
Faculty of Education, University of the Ryukyus, 1 Senbaru, Nishihara, Nakagami, Okinawa, Japan
FAX: +81-098-895-8420 E-mail: ashs201091@gmail.com

Production Asian Society of Human Services Press
Faculty of Education, University of the Ryukyus, 1 Senbaru, Nishihara, Nakagami, Okinawa, Japan
FAX: +81-098-895-8420 E-mail: ashs201091@gmail.com

Asian Journal of Human Services
VOL.13 October 2017

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Published by
Asian Society of Human Services
Okinawa, Japan