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Original article

Title

Current Management for Foreign Body and Toxic Agent Ingestion in a Paediatric Primary
Emergency Centre

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Abstract

Objectives: Accidental foreign body ingestion (FBI) and toxic agent ingestion (TAI) are commonly encountered among children in primary emergency settings. Early detection and appropriate medical intervention are crucial to improve outcomes. Although many reports from tertiary institutions have shown improvements in therapy, data are still lacking from primary emergency facilities.

Methods: We performed a retrospective analysis based on medical records of FBI/TAI over 4 years at the Kobe Children's Primary Emergency Medical Center. We collected patient information, including age, sex, time between FBI/TAI occurrence and centre visit, provision of first aid, symptoms, type of FBI/TAI, examinations, treatments, and outcomes.

Results: A total of 580 children were enrolled. The median age was 1.3 years, and patients under 2 years old accounted for 70% of total cases. Cigarettes (17.5%) were the most common ingested foreign body, followed by medicines (15.3%), detergents (8.1%), in TAI, plastics (14.1%), metal (13.4%), batteries (9.0%) in FBI, and others (22.6%). A total of 42 patients were transferred to advanced hospitals; among these, 22 patients were hospitalised but the foreign body was removed in only 3 (0.9%) patients. Transferred patients were

significantly older ($P<0.05$) in FBI and had a higher rate of any of symptoms ($P<0.05$) in FBI/TAI.

Conclusions: This large-scale retrospective study of accidental FBI/TAI conducted at a primary emergency facility clarified current management, including treatment at a primary facility. Very few cases of FBI/TAI were treated, even when they were transferred to an advanced treatment hospital. Unified protocols should be established, to improve the management of FBI/TAI.

Key words

Foreign body ingestion, toxic agent ingestion primary emergency centre, transfer

Number of figures and tables

-Figures: 3

-Tables: 3

Introduction

Accidental foreign body ingestion (FBI) and toxic agent ingestion (TAI) are commonly encountered among children in primary emergency settings. In most cases, natural and spontaneous resolution can be expected, without any complications. However, in a few cases, serious life-threatening complications can develop, including with ingestion of batteries and drugs such as analgesics and anaesthetics. According to a 2019 report from the United States, 1,236,227 children experience accidental FBI/TAI annually, with a mortality rate of 0.008%¹. Therefore, early detection and appropriate medical intervention are crucial to improve outcomes^{2,3}.

In recent years, many reports from tertiary institutions have shown improvements in therapy, such as prompt diagnosis or early appropriate intervention, and FBI/TAI has resulted in fewer poor outcomes^{2,4-7}. However, most patients with FBI/TAI show very mild or no symptoms and are observed at primary childcare institutions, without transfer to a tertiary institution. Therefore, the overall incidence, characteristics, and severity of FBI/TAI are not fully understood.

The population of Kobe City under the age of 15 years is 200,000. Kobe has only one paediatric primary emergency centre with the capability to attend to paediatric patients at night and on weekends: Kobe Children's Primary Emergency Medical Center (KCPEMC).

Therefore, KCPEMC cares for nearly all children with FBI/TAI that occur at night or on weekends. In this report, we retrospectively analysed cases with FBI/TAI at KCPEMC, a primary emergency facility in Kobe City, Japan.

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Materials and Methods

Setting

We conducted a retrospective study at KCPEMC, located in a city in central Japan with 1.5 million residents, including 200,000 children aged less than 15 years. This centre provides medical services without hospitalization for paediatric patients during holidays and outside of regular working hours. Approximately 30,000 paediatric patients per year visit the centre to receive medical treatment. More than 140 paediatricians work there on a part-time basis, most of whom are non-emergency specialists.

Research design

This was a retrospective observational study. Patients' background characteristics, including age, sex, time between FBI/TAI occurrence and centre visit, provision of first aid, symptoms, type of FBI/TAI, examination, treatment, and outcome were collected from the medical records and analysed. The study was approved by the ethical committee of KCPEMC (#2020-14, 25 September 2020). The need for written informed consent was not

required owing to the retrospective study. The study procedures were in accordance with the ethical standards of the responsible committee on human studies and the Declaration of Helsinki of 1975, as revised in 2008.

Definitions and classification

Patient data were collected from the medical records and categorized in accordance with the International Classification of Diseases, Tenth Revision (ICD-10), for FBI/TAI (code numbers T-17.2-3, T18.1-9, T36-65). FBIs were divided into 6 groups as follows: metal (including rings, pins, and metallic toys), batteries, plastics, papers, magnets, and others. TAIs were divided into 5 groups as follows: cigarettes (including electronic cigarettes and water-filled cigarettes), medicines, detergents, alcohol, and others. Triage colour codes green, yellow, and red were defined as FBI/TAI that was not life-threatening, required observation, and required immediate treatment, respectively.

Statistical analysis

Data are expressed as median (range) or number (%). Statistical analysis was performed using JMP version 10.0 (SAS Institute, Cary, NC, USA). In univariate analyses, a Fisher's exact test was used for categorical variables and a Mann-Whitney U test for noncategorical variables. For multivariate analysis, logistic regression was used to identify risk factors. In all analyses, P values less than 0.05 were considered statistically significant.

Results

Patient characteristics

Between April 2016 and March 2020, 111,232 children (age 0 to 15 years old) visited KCPEMC. Of these patients, 628 were classified as FBI/TAI (T-17.2-3, T18.1-9, T36-65), in accordance with the ICD-10. After exclusion of 48 cases owing to insufficient information regarding FBI/TAI, a total of 580 [FBI 324, TAI 256] patients were enrolled (Figure 1). The median patient age was 1.3 [FBI 1.3, TAI 1.4] years, and 326 (56.2%) patients were male. Patients visited KCPEMC a median of 1.5 hours after FBI/TAI occurred. Patients were triaged as green (n=416 [FBI 264, TAI 152], 71.7%), yellow (n=88 [FBI 18, TAI 70], 15.2%), and red (n=76 [FBI 42, TAI 34], 13.1%). Ninety-six ([FBI 26, TAI 50], 16.6%) patients had overt symptoms, more than half of which involved nausea/vomiting (n=54 [FBI 25, TAI 29], 56.3%) (Table 1). The most frequent patient age was 1 year (n=219 [FBI 112, TAI 107], 37.8%), followed by patients younger than 1 year old (n=187 [FBI 120, TAI 67], 32.2%). Children less than 2 years old accounted for 70% of cases (Figure 2).

Foreign or toxic objects

The suspected FBI/TAI are shown in Figure 3. Plastics (n=82, 14.1%) were most common, followed by metals (n=78, 13.4%) including coins (n=23), batteries (n=52, 9.0%) including button batteries (n=41), papers (n=28, 4.8%), magnets (n=18, 3.1%) in FBI. Cigarettes were

the most common (n=101, 17.5%), followed by medicines (n=89, 15.3%), detergents (n=47, 8.1%), alcohol (n=10, 1.7%) in TAI. And other objects were such as foods, rubber, or garbage (n=75, 12.9%). It has been reported that only a small rate of FBI events are actually witnessed^{8,9}. Among 138 patients suspected to have ingested radioopaque objects (metals, batteries, and magnets), only 31 (22.5%) were actually found to have ingested foreign bodies. Eight (25.8%) were over 20mm diameter (Table 2).

Treatment and prognosis

Treatment was performed in KCPEMC or in an advanced treatment hospital after transfer. In KCPEMC, 24 [FBI 10 TAI 24] patients (4.1%) were treated with gastric lavage, infusion, inhalation therapy, observation, or enema. Nine [FBI 5 TAI 4] of these patients consulted an advanced facility or a poison centre and the cases were resolved without being transferred. Forty-two ([FBI 16 TAI 26] 7.2%) patients were transferred to an advanced hospital. Endoscopic or catheter removal was performed in only 3 patients (0.9% of total FBI cases) and 19 [FBI 4 TAI 15] patients (45.2%) were admitted for observation. Nineteen [FBI 9 TAI 10] patients (45.2%) returned home without hospitalization (Figure 1). Details of the transferred patients are described in Supplemental Table 1. The three patients who underwent FBI removal by endoscopy or catheter had ingested a metal plate, ring, and button battery. The former two patients had the FBI lodged in oesophagus, which was the reason

for removal. There was no rule for whether or not to be removed by size or shape.

We then compared transferred patients with those that were not transferred. The results in FBI showed that transferred patients were significantly older ($P=0.0272$) and a high proportion presented with symptoms ($P=0.0343$) and X-ray findings ($P=0.146$). There were no differences in the sex ratio ($P=0.7370$), triage ($P=0.5937$), or any type of FBI between groups (Table 3-1). Multivariate analysis showed that older age (odds ratio: 0.73 95%CI 0.59-0.90, $P<0.01$), symptom presentation (odds ratio: 5.19, 95%CI 1.21-21.6, $P<0.05$), were independent predictive factors of transfer. In TAI, the results that transferred patients were a high proportion presented with symptoms ($P=0.0407$), and medicine ($P=0.311$). There were no differences in the age ($P=0.1048$) sex ratio ($P=0.2103$), triage ($P=0.1669$), or any type of other TAI between groups (Table 3-2). Multivariate analysis showed that only symptom presentation (odds ratio: 3.19, 95%CI 1.22-8.11, $P<0.05$), were independent predictive factors of transfer.

Discussion

This retrospective study revealed the background, treatment, and outcomes of FBI/TAI in a Japanese primary paediatric emergency centre. Despite many reports from tertiary facilities regarding active interventions^{2,4-6}, there have been few reports to date from primary

emergency facilities.

Regarding foreign or toxic objects, more patients ingested cigarettes than coins or button batteries, which are the main objects involved in FBI/TAI in Western and other Asian countries^{1,4,10,11}. Other reports from Japan show similar distributions of foreign substances⁹.

In terms of symptoms, fewer patients (16.6% in total, [14.2% in FBI, 19.5% in TAI]) showed symptoms in this study than in other previous reports^{8,9,12,13}. The reason for this finding is that children in Japan have easier access to a hospital. Children were sometimes brought to our centre by a parent complaining that an object was missing and may have been ingested by the child but was not witnessed.

When we focused only on cases of accidental ingestion of radio-opaque objects, only 22.5% of these were proven to be FBI by X-ray (Figure 2), suggesting that parental complaints are often unreliable. The accuracy of parental testimony has not been properly analysed, but it has been estimated to be around 40%^{2,8}. Our data were lower than previous reports, but this may reflect the fact that parents can more easily access primary emergency facilities in Japan.

With regards to treatments and transfers, few treatments were given in our centre. In KCPEMC, we cannot conduct endoscopic or catheter interventions^{14–16}. Therefore, medical staff tend to immediately refer patients when those interventions are needed. Transfer was most often associated with clinical symptoms. This may reflect that the presence or absence

of symptoms are considered to be an important factor for physicians to determine transfer.

After transfer, active treatment was administered in only three patients (0.9%), among which two had a foreign object lodged in the oesophagus. In general, a foreign body in the oesophagus should be removed as soon as possible^{4,5,11}. Surprisingly, only one patient who ingested a button battery received the treatment of removal. There was no rule for whether or not to be removed by size or shape, as shown in Supplemental Figure1. In the United States, it has been known that batteries containing lithium or large batteries (>12 mm) increase the frequency of serious complications, therefore should be removed urgently¹⁷.

Although we do not decide treatment at KCPEMC, it is not secure because even such cases return home without treatment. In summary, it is suggested that every patient with an ingested button battery of lithium, a button battery of 12 mm or larger, or a button battery in the airway or the oesophagus needs transfer for further treatment, and should not be returned home.

Medicine ingestion is also a major cause of transfer (Table 3-2), although it is not significant in multivariate analysis. The reaction of medicine is widely diverse and extremely complicated, such as the lethal dose and action time depending on age and physique¹⁸. This is the reason why only few guidelines are available until now^{19,20}. In our facility, patients were triaged red for abnormal vital signs or accidental ingestion of drugs that can cause them. Some cases were referred to a poison center where anyone can use in Japan. However, every patient

who ingests medication should receive consultation with the poison center unless the staff member at the primary center knows enough to determine that the exposure is nontoxic. An online application which was verified in the United States is a promising tool²¹, which allow more appropriate and individual approach to medicine ingestion.

Finally, most patients recovered with observation only, and half of transferred patients returned home after transfer to an advanced facility. This result indicated that a unified protocol or close communication between KCPMEC and advanced hospitals is needed, to avoid unnecessary transfers, and guidelines for treatment of FBI/TAI should be prepared, as in other countries^{22–25}.

There are some limitations to this study. First, although this was a relatively large-scale retrospective study, some clinical information or details regarding the FBI/TAI episodes was lacking in the medical records. Second, more detailed analysis regarding patients' socioeconomic background is needed. Third, many doctors work in KCPMEC, therefore, treatment or transfer policies differ among physicians.

In summary, this relatively large-scale retrospective study clarified the current status and obstacles involved in providing medical care for FBI/TAI at a primary facility. This study will provide valuable information for the treatment of FBI/TAI in primary care facilities.

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Note

Conflicts of interest/Competing interests

The authors have nothing to disclose.

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Author's contributions

Ninchoji T and Nozu K: conception or design of the work. Ninchoji T, Ishiko S, and Kondo A: data collection and analysis. Ninchoji T drafted manuscript and Nozu K, Kondo A, Ishiko S,

Unzaki A, Nagano C, Yamaguchi H, Takeda H, Hayashi T, Tanaka R, Nagase H, Iijima K, Ishida A: critical revision of the article. All authors: Final approval of the version to be published.

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Figure legends

Figure 1: Flow chart of enrolled patients and outcomes.

Figure 2 Numbers of patients who ingested foreign bodies or toxic agents

Figure 3: Types of foreign body or toxic agent ingestion

Table 1: Patient characteristics

Table 2: X-ray findings and location in FBI

Table 3-1 Comparison of patients transferred to advanced hospital with those not in FBI

Table 3-2 Comparison of patients transferred to advanced hospital with those not in TAI

Supplemental table 1: The detail of transferred patient

Table1. Patient characteristics

	FBI (N=324)	TAI (N=256)
Age(year)	1.3 (0.2-11.9)	1.4 (0.3-10.3)
Male	169(52.2%)	157(31.6%)
Re-visit within 24H	1(0.3%)	0
Time to visit (hours)	1.5 (0.1-72.0)	1.5(0.5-24.0)
Triage (Green/Yellow/Red)	264/18/42	152/70/34
Symptoms	46(14.2%)	50(19.5%)
Nausea/Vomit	25	29
Cough/Dyspnea	12	1
Rash/Eczema	0	10
Disturbance of conciousness	0	6
Abdominal pain/diarrhea	1	3
Pale	1	1
Others	7	0

Table2. X-ray findings and location in FBI

	FBI N=324
X-ray in total	147(45.4%)
X-ray for radio-opaque subjects (metals/batteries/magnet)	138
X-ray out of metals/batteries/magnet ingestion	31(22.5%)
Esophagus	3
Gastric	15
Small intestine	4
colon	9
Size <5.0 mm	1
5.0-10.0 mm	4
10.0-15.0 mm	11
15.1-20 mm	7
>20 mm	8

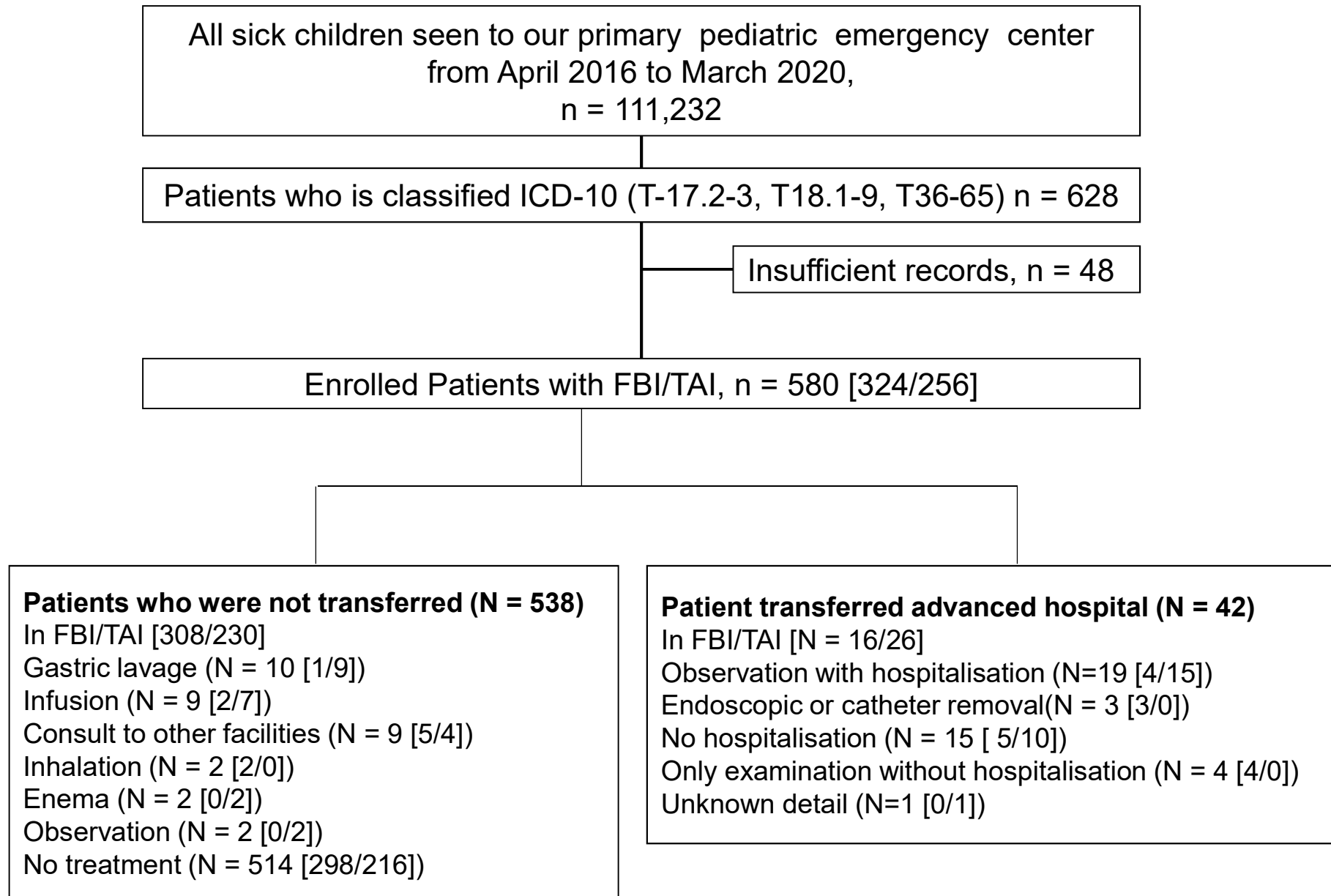
Table 3-1 Comparison of patients transferred to advanced hospital with those not in FBI

	No transfer N=308	Transfer N=16	P value
Age	1.3	2.6	0.0272
Male	160	9	0.7370
Triage	R38 Y17	R4 Y1	0.5937
Symptoms	40	5	0.0343
X-ray findings	135	12	0.0146
Type of FBI			
Metals	73	5	0.4911
Plastics	80	2	0.2268
Batteries	47	5	0.0893
Paper	26	1	0.7571
Magnets	17	1	0.9010

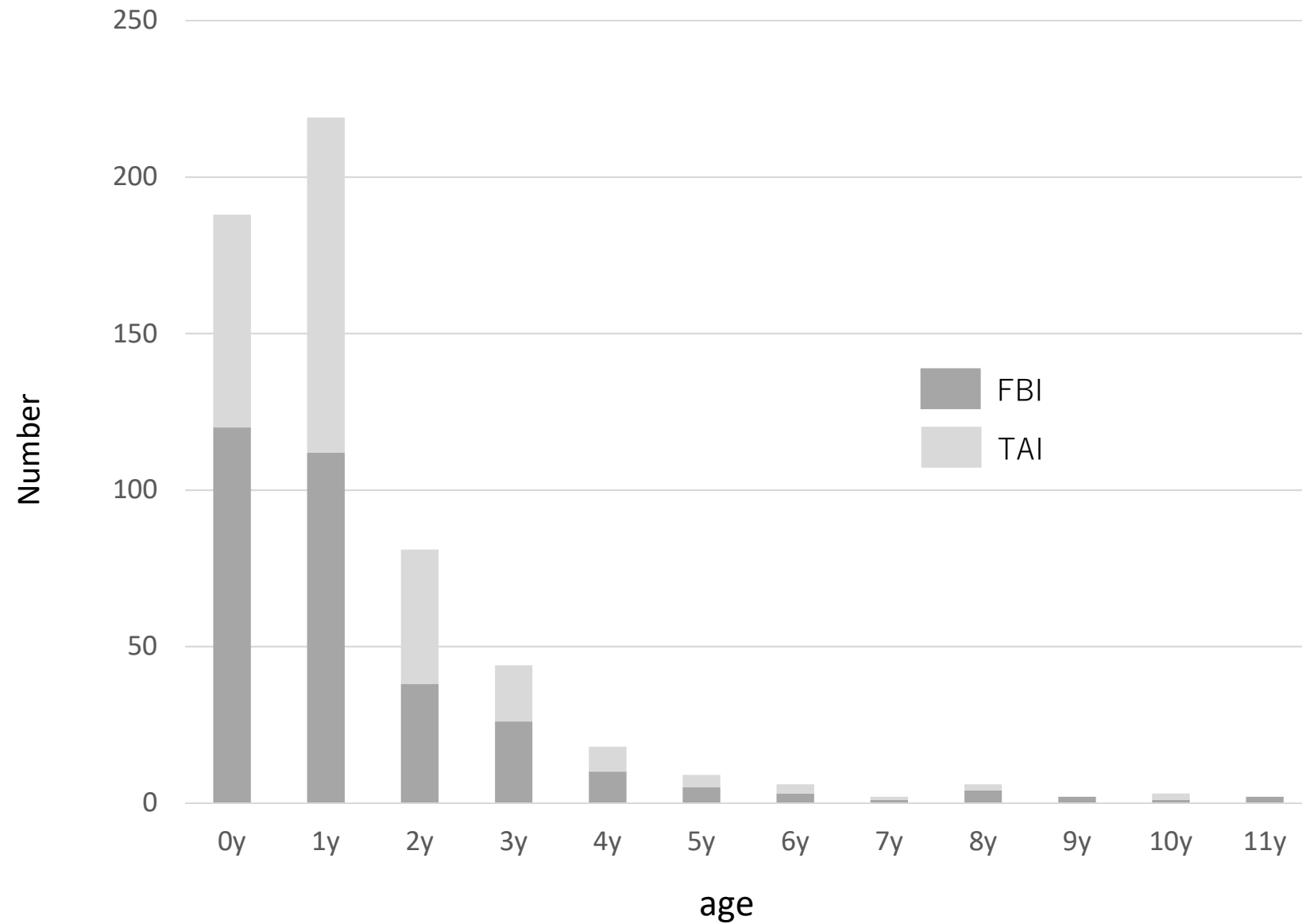
Table 3-2 Comparison of patients transferred to advanced hospital with those not in TAI

	No transfer N=230	Transfer N=26	P value
Age	1.4	2.5	0.1048
Male	133	19	0.2103
Triage	R24 Y60	R8 Y10	0.1669
Symptoms	41	9	0.0407
Type of TAI			
Cigarette	94	7	0.1679
Medicine	75	14	0.0311
Detergent	42	5	0.9036
Alcohol	10	0	0.2781

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Ninchoji et al. Figure2



Ninchoji et al. Figure3

