Integrating Telemedicine in Assisting Poison Center Service: Line Application

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Objective: To characterize Line, a mobile chat application, usage in Ramathibodi Poison Center (RPC) for further improvement of toxicological consultation services.

Materials and Methods: Retrospective data were retrieved from Line messages together with concurrently recorded cases in the RPC database for six months, between November 16, 2018 and May 15, 2019. Time of consultation, time to response, types of toxins, reasons for consultation, and delivered content were recorded.

Results: Over six months, 12,686 consultations were made via the hotline with 1,181 cases that used Line as an adjunct with 1,301 conversations. Median response time was three minutes. The most common poisonings were pesticides with 525 contacts (40.4%), followed by pharmaceutical agents and animal toxins. Most requests were for treatment suggestions with 731 contacts (56.2%), followed by notifying case progression and substance or animal identification. Among 1,030 files sent by consultees, the most common were photos of substances and animals for identification. Among 997 responses, most RPC staff used Line as an adjunct for treatment suggestions at 659 times (66.1%), followed by substance or animal identification and providing diagnoses. Overall, 602 protocols were delivered.

Conclusion: Ten percent of all consultations were accompanied by Line usage. Most contacts were about pesticides and for appropriate treatment. RPC also used Line to effectively deliver diagnoses and treatment and increase coverage nationally.

Keywords: Telemedicine, Line, Application, Poison center

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Telemedicine signifies the use of information and communications technology (ICT) to improve patient outcomes by increasing access to care and medical information as defined by the World Health Organization (WHO)[1]. For many countries, adopting telemedicine as an electronic consultation has proven efficacious in increasing the timeliness of consultation, reducing the cost of treatment, and improving overall satisfaction[2,3].

Line is a mobile chat application with a user-friendly interface delivering all domains of connection in telemedicine technology, store-and-forward, real-time, and virtual[4]. The application has not only gained popularity among social media users, but also become a tool to bridge geographic gaps in health care systems. Ramathibodi Poison Center (RPC) has provided a nationwide hotline for toxicological consultation since 1996 and incorporated Line application as an adjunct service since 2014. The objective of using the application is to assist the hotline service. The Line account is managed by specialists in poison information (SPIs) and toxicologists. It has been used for several aspects of poison center consultation including 1) identification of animals or substances, 2) assisting diagnoses such as sending electrocardiogram, chest X-rays, or video of clinical signs from consultees, 3) sending summary of the suggestions and treatment protocol from RPC, 4) follow up cases' progression. For identification, the authors have affiliated with many specialists such as herpetologist, botanist, mycologist, etymologist, and scientists. The consultation services aim to empower

primary teams caring for patients so they can retain their autonomy and responsibility in making decisions and in management.

The present research was primarily conducted to describe RPC consultations using the application as an adjunct service including 1) characteristics such as number, time, and type of poisoning, 2) aspects of Line usage for consultation by consultees including diagnosis, progress, and treatment, 3) types of content received from consultees, 4) aspects of Line usage in response to a consultation by RPC, 5) types of content delivered by RPC, and 6) period from contact via Line to response or the "response time". The data from the present research will benefit further improvement in toxicological consultation services.

Materials and Methods
Study setting

RPC provides information and evidence-based advice for health care providers on the management of poisoning and envenomation through a 24-hour telephone service nationwide. The data were stored in RPC's electronic database. Data security was the main concern since transferring patient's information was inevitable for telemedicine. Therefore, information in the application was confidentially stored in the Line management desktop accessible only at the RPC station. The computer was only used for communicating through Line and did not connect to other social media platform. Staff and SPIs also needed to log in to verify themselves before using the application. The authors encouraged sharing only de-identified data for communicating with the health care provider who took care of the case as stated in the authors' disclaimer for every application user. If the primary physician had initially requested case consultation via Line, they were informed that Line was only an adjunct to the hotline service and were advised to contact RPC through the hotline service.

Data source and study design

Retrospective data were retrieved from Line messages together with concurrently recorded cases in the RPC database for six months, between November 16, 2018 and May 15, 2019. The time of consultation, time to response, types of toxins, reasons for consultation, and delivered contents were recorded. The number of consultations were compared among morning, evening, and night shifts. The present study was approved by the Institutional Ethics Committee Board of Ramathibodi Hospital Faculty of Medicine, Mahidol University (MURA2019/871).
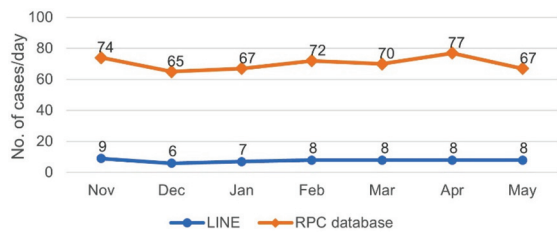

Figure 1. Average numbers of contacts (Line and RPC database) per day in a month.

RPC=Ramathibodi Poison Center

Population and selection criteria

All cases with Line contacts were recorded. Line chats without specific inquiries were excluded.

Definition

The types of toxins/substances were categorized using the World Health Organization/International Programme on Chemical Safety (WHO/IPCS) classification as a reference[5].

The morning shift was from 8.00 a.m. to 4.00 p.m., the evening shift was from 4.00 p.m. to midnight, and the night shift was from midnight to 8.00 a.m.

Statistical analysis

Categorical data were presented as frequency and percentage. Continuous data were presented as median, interquartile range (IQR), and range.

Results
Characteristics of consultations

During the six months, the number of consultations through the hotline was 12,686. In total, 1,181 cases (10.3%) used the Line application as an adjunct, including 1,301 conversations for an average of 217 conversations per month and seven conversations per day. In 81 cases, there were multiple Line contacts.

Of the 1,301 conversations in the application, two-way communication accounted for 1,135 instances. One-way communications involved 155 contacts from consultees and 11 contacts from RPC to attach a treatment protocol or additional messages, both of which were mostly sent after telephone consultation.

The median response time via either Line or telephone was three minutes (IQR 1 to 14 minutes, range 0 to 944 minutes). Distributions of total case consultations and case consultations using Line as an adjunct are shown in Figure 1. The Line contacts were distributed equally over months and days. It should
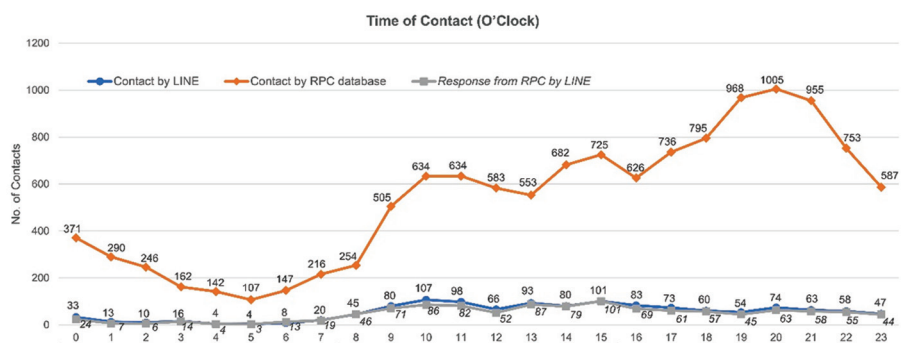
Time of Contact (O'Clock)

Legend: Contact by LINE — Contact by RPC database — Response from RPC by LINE

Y-axis: No. of Contacts (0, 200, 400, 600, 800, 1000, 1200)
X-axis: 0 to 23

Contact by RPC database: 371, 290, 246, 162, 142, 107, 147, 216, 254, 505, 634, 634, 583, 553, 682, 725, 626, 736, 795, 968, 1005, 955, 753, 587

Contact by LINE / Response from RPC by LINE: 33, 13, 10, 16, 4, 4, 20, 45, 80, 107, 98, 66, 93, 80, 101, 83, 73, 60, 54, 74, 63, 58, 47; 24, 7, 7, 14, 3, 13, 19, 46, 71, 86, 82, 52, 87, 79, 101, 69, 61, 57, 45, 63, 58, 55, 44

Figure 2. Distribution of numbers of Line and RPC database contacts and Line responses according to time.

RPC=Ramathibodi Poison Center

Table 1. Distribution of numbers of Line and RPC database contacts and Line responses according to shifts

Shifts	Night shift (0 to 8 a.m.)	Morning shift (8 a.m. to 16 p.m.)	Evening shift (16 to 24 p.m.)
Number of contacts			
From RPC database	1,681	4,570	6,425
From Line	108	670	512
Number of responses			
From RPC by Line	90	604	452

RPC=Ramathibodi Poison Center

be noted that data collection was conducted for only half of the month in May and November.

The time of consultation was distributed unequally among shifts in a day, as shown in Figure 2 and Table 1. The number of Line contacts from consultees and RPC response messages was highest during the morning shift, followed by the evening and night shifts, respectively. The number of consultations through the hotline was highest during the evening shift, followed by the morning and night shifts.

The most common categories of poisoning consulted via Line were pesticides, pharmaceutical agents, and animal toxins. Details are shown in Table 2.

Aspects of Line usage in consultations requested by consultees

Among 1,301 contacts, consultees used Line as an adjunct in requesting treatment suggestions with 731 contacts (56.2%), notifying case progression with 584 contacts (44.9%), substance or animal identification with 173 contacts (13.3%), confirming diagnosis with 73 contacts (5.6%), information inquiries regarding substances, how and where to send to a lab, and referenced research with 69 contacts (5.3%), and requesting a urine paraquat test kit with 26 contacts (2.0%).

Types of contacts with content sent by consultees

During the study period, there were 1,030 files attached from consultees. The most common attachment was photos of substances and animals for identification and confirmation. Details are shown in Table 3.

Aspects of Line usage for responses to consultation by RPC

Among 997 responses, RPC staff used Line as an adjunct for treatment suggestions 659 times (66.1%), as well as for substance or animal identification with 173 contacts (17.4%), laboratory results interpretation and providing diagnoses with 73 contacts (7.3%), information delivery 39 times (3.9%), inquiries from physicians in charge 38 times (3.8%), collaboration in antidote delivery 10 times (1.0%), and following-up cases five times (0.5%). All snake and spider identifications were confirmed by specialists.

Types of content delivered by RPC

Some treatments were complex and detailed. Therefore, the present study poison center distributes updated treatment guidelines in PDF form. There were 602 protocols delivered during the study period, details are shown in Table 4. More than one protocol was delivered in 33 cases.

Discussion

About 10% of poisoning cases reported to RPC used Line as an adjunct for facilitating consultations. Line usage was more frequent in the morning, despite that more telephone consultations took place during the evening shift. This might be because more

Table 2. Number and percentage of toxin category consulted via Line

WHO category	No. of contacts (n=1,301); n (%)
Pesticides	525 (40.4)
Paraquat	364 (69.4)
Organophosphate/carbamate	44 (8.4)
Phosphide	30 (5.7)
Chlorophenoxy compounds	11 (2.1)
Pyrethroid	10 (1.9)
Chloroacetanilide	9 (1.7)
Glyphosate	7 (1.3)
Abamectin	7 (1.3)
Other pesticides	43 (8.2)
Pharmaceutical agents	233 (17.9)
Psychotropics	32 (13.7)
Tricyclic antidepressant	31 (13.3)
Calcium channel blocker	27 (11.6)
Iron	26 (11.2)
Beta blocker	21 (9.0)
Valproic acid	14 (6.0)
Acetaminophen	13 (5.6)
Salicylic acid	11 (4.7)
Benzodiazepines	11 (4.7)
Theophylline	10 (4.3)
Ergotamine	8 (3.4)
Other pharmaceuticals	29 (12.5)
Animals	202 (15.5)
Snakes	163 (80.7)
Spiders	13 (6.4)
Insects	10 (5.0)
Jellyfish	10 (5.0)
Other animals	6 (2.9)
Household products	104 (8.0)
Cleaner/polish	33 (31.7)
Methanol	16 (15.4)
Skin cosmetics	10 (9.6)
Hydrofluoric acid	9 (8.7)
Bleach/disinfectant/sterilant	6 (5.8)
Other household products	30 (28.8)
Substances of abuse	28 (2.2)
Amphetamine/derivatives	7 (25.0)
Ethanol	6 (21.4)
Other substances of abuse	15 (53.6)
Plants and herbal products	22 (1.7)
Industrial/commercial products for non-domestic use	16 (1.2)
Environmental contaminants	13 (1.0)
Mushrooms	10 (0.8)
Agricultural products other than pesticides	9 (0.7)
Foods/beverages	6 (0.5)
Pharmaceuticals for veterinary use	1 (<0.1)
Bacteria (botulism)	1 (<0.1)
Unknown	131 (10.1)

WHO=World Health Organization

Table 3. Number and percentage of toxin category according to attached files

Attached files	No. of files attached (n=1,030); n (%)
Clinical	311 (30.2)
Wound photos	141 (45.3)
Electrocardiogram	84 (27.0)
Videos of clinical signs	33 (10.6)
Gastric contents	25 (8.1)
Other clinical files	28 (9.0)
Laboratory investigations	293 (28.4)
Results of urine dithionite test	134 (45.7)
Results of whole blood clotting test	11 (3.8)
Other laboratory reports	148 (50.5)
Photos of substances/animals	280 (27.2)
Substance	164 (58.6)
Snakes	94 (33.6)
Spiders	11 (3.9)
Other substances/animals	11 (3.9)
Imaging/intervention	117 (11.4)
Chest X-rays	85 (72.6)
Abdominal X-rays	15 (12.8)
Other investigations	17 (14.6)
Other attached documents	29 (2.8)

SPIs and staff attended the application during the morning shift. The present study can help to guide administrative aspects in terms of staff allocation over shifts, emphasizing Line responses during the evening shift.

The time to response was nearly immediate in the RPC service, unlike the asynchronous eConsult, which can have a response time of one to three days[3]. This is because physicians mainly used LINE as an adjunct to real-time telephone consultation for audiovisual. Although real-time video consultation might be more effective[6], it requires more human resources, which are currently limited, as well as a more secure and stable online platform.

The most common class of toxins according to WHO classification are pesticides and pharmaceutical agents. In terms of specific toxins, the six most common were paraquat, snake, organophosphate/carbamate, phosphide, calcium channel blocker (CCB), and iron, in descending order. Undoubtedly, the reasons for consultation were mainly for treatment, which are similar to a previous systematic review[7] and can be explained by the use of this platform to deliver treatment protocols. The most commonly delivered

Table 4. Number and percentage of toxin category according to delivered protocols

Delivered protocols	No. of delivered protocols (n=602); n (%)
Pesticides	353 (58.6)
Paraquat	202 (57.2)
Urine dithionite test	100 (28.3)
Phosphide	25 (7.1)
Organophosphate/carbamate	14 (4.0)
Other pesticides	12 (3.4)
Antidotes	88 (14.6)
Whole bowel irrigation	53 (60.3)
Methylene blue	9 (10.2)
Intralipid emulsion/high-dose insulin	9 (10.2)
Deferoxamine	8 (9.1)
Other antidotes	9 (10.2)
Pharmaceuticals	80 (13.3)
Calcium channel blocker	26 (32.5)
Beta blocker	25 (31.2)
Tricyclic antidepressant	11 (13.8)
Other pharmaceuticals	18 (22.5)
Animal toxins	40 (6.7)
Whole blood clotting time	19 (47.5)
Antivenom administration	15 (37.5)
Jellyfish	6 (15.0)
Household/industrial products	23 (3.8)
Methanol	16 (69.6)
Hydrofluoric acid	7 (30.4)
Plants and mushrooms	6 (1.0)
Other toxins/conditions	12 (2.0)

protocols were for treatment of paraquat poisoning and the urine dithionite test procedure, whole bowel irrigation method, and CCB and phosphide treatment, which corresponded to the toxins involved. However, evaluation of the primary physicians' adherence to the protocols and the influencing factors would be valuable to further improve the service and promote a favorable outcome[8,9]. Despite not being evaluated in the present study, the obvious benefit of Line in RPC practices is that the application helps in providing more accurate diagnosis and management in that substance or animal pictures and written treatment protocols could be sent directly instead of verbal description. Another benefit is that the application can serve as a back-up when the hotline is out of service. The application facilitates communication, especially when the provider in-charge cannot conveniently provide information by telephone.

There were some limitations to the study. First, because the service involved the combination of a telephone call with the Line application, the interaction time could be confounded. Some responses might seem slow because management guidance had already been delivered by phone. The study period was only six months. A longer study period might better reflect the inquiries over an entire year. Confidentiality, an "unforeseen medico-legal implication of telemedicine"[10], has been a concern in physician's practice because the patients' information is sent to others who are involved. Many countries have considered legal regulation over many aspects of telemedicine that may require attention[11]. Although there are no robust regulations regarding these matters, the authors emphasize to the SPIs and primary physicians that they should avoid sending photos that might enable patient recognition, such as photos of the face or otherwise identifying photographs. There are many potential innovations and research that could arise from the present study findings, such as development of an enhanced encrypted platform to ensure patient confidentiality.

Users' satisfaction such as SPIs and patients, is another important aspect. Satisfaction with the care team experience in improving the work life of health care providers, enhancing the patients' experience, improving population health, and reducing costs, have been proposed as core effectiveness metrics for electronic consultation programs in the quadruple aim framework[12].

Medical toxicologists were among the earliest pioneers in the field of telemedicine, using electronic toxicology databases and telemedicine to deliver diagnoses and treatment[13]. The authors look forward to incorporating a more holistic and comprehensive approach to telemedicine in practice, such as its application as a decision support system, video consultation with experts, or as a robust platform for toxicovigilance.

Conclusion

Apart from conventional hotline services, RPC incorporates the Line application as an adjunct platform to facilitate consultation. Using the application synchronously or asynchronously, diagnoses and treatment can be delivered more effectively and can increase coverage nationally.

What is already known on this topic?

Telemedicine has spread both geographically

and in terms of specialty services offered, toxicology included. For many countries, adopting telemedicine as an electronic consultation to obtain a specialist's opinion has proven efficacious in increasing the timeliness of consultation, reducing the cost of treatment, and improving overall satisfaction.

What this study adds?

Line application delivers all domains of connection in telemedicine technology such as store-and-forward, real-time, and virtual, which helps RPC to communicate toxicological information more precisely and effectively.

Ethical approval

The present study was approved by the Institutional Ethics Committee Board of Ramathibodi Hospital Faculty of Medicine, Mahidol University. Because this was a retrospective study that used a pre-existing confidential database from the poison center, patient consent was not required. The results of the present study are reported anonymously and are in compliance with the Declaration of Helsinki.

Data availability statement

The data are not available for public access because of patient privacy concerns but are available from the corresponding author upon reasonable request.

Authors' contributions

Thumtecho S, Tanpudsa Y, Rittilert P, Pradoo A, Tongpoo A, and Sriapa C collected data. Thumtecho S drafted the manuscript, Thumtecho S and Srisuma S revised, edited, read, and approved the final manuscript.

Conflicts of interest

The authors report no conflicts of interest.

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