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ORIGINAL ARTICLE

The role of messaging services in day-to-day practice in pediatric neurosurgery, advantages of a *bubble network*, and an international survey

Danil A. Kozyrev[1] · Harishchandra Lalgudi Srinivasan[1] · Jehuda Soleman[1,3] · Yurii Perekopayko[1] · Shlomi Constantini[1,2] · Jonathan Roth[1,2]

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Abstract

Introduction Messaging services (MS) are used widely worldwide. The implications of MS usage in daily hospital patient care have not been investigated. In this study, we discuss the extensive usage of MS in our Pediatric Neurosurgical Department, introduce our bubble algorithm, and provide additional input from an international survey.

Methods WhatsApp activity in the department of pediatric neurosurgery at Dana Children's Hospital, Tel Aviv, Israel, was analyzed. We designed a graphic representation of the content of the different conversation bubbles and how they interact. We also described a survey evaluating MS use in daily neurosurgical practice was sent to 25 neurosurgeons around the world. Collected data included details on the usage of MS, the type of information being transferred, and the participants' opinion of the potential risks and benefits of these systems. We began collecting messaging data November 2018, *before* the COVID pandemic era. We continued to collect data over the course of almost 3 years.

Results We identified a *bubble network* structure that reflects a logical method of communication between different segments of pediatric neurosurgical care in our institution. Additionally, we analyzed 22 survey responses, received from 14 different countries. The vast majority of centers with "department groups" use messaging services to transfer multimedia files of patient-related data. Nineteen responders believe that MS significantly improve overall patient care.

Conclusion MS has revolutionized and improved the patterns of communication in our department. The great benefits of quick, simple access to information strongly outweigh formality and the potential for medicolegal disadvantages (e.g., HIPAA).

Keywords Messaging · WhatsApp · Neurosurgery · Data transfer · Patient care · Patient privacy

Introduction

Smartphone-based applications have become an inseparable part of our life. One of the most widely used types of applications (apps) are messaging services (MS), including WhatsApp (Facebook, Inc., Menlo Park, California, USA), Telegram (Telegram Messenger Inc.), Viber (Rakuten Inc., Cyprus), and WeChat (Tencent, Shenzhen, China). Another type of application whose use was significantly boosted by the COVID-19 pandemic is video conferencing. These include Zoom (Zoom Video Communications, San Jose, California, USA), Teams (Microsoft Corporation, Redmond, Washington, USA), and Google Meet (Google, California, USA). While these two types of apps were designed for different purposes, they actually share a lot of common features, such as video conferencing modules, which are common to almost all communication apps. Communication apps have achieved enormous popularity during pandemic lockdown periods and stay-at-home orders, further demonstrating the value of virtual communication.

Communication apps have expanded to all aspects of human endeavor, including medicine. Development of

✉ Jonathan Roth
jonaroth@gmail.com

[1] Departments of Pediatric Neurosurgery, Dana Children's Hospital, Tel Aviv Medical Center, Tel Aviv 64239, Israel

[2] Tel Aviv University, Tel Aviv 64239, Israel

[3] Departments of Neurosurgery and Pediatric Neurosurgery, University Hospital and Children's University Hospital of Basel, Basel, Switzerland

instant communication apps greatly impacted such spheres as telemedicine, gaining enormous attention during the recent COVID-19 pandemic. These apps provide rapid and ubiquitous network access, enabling almost-immediate exchange of different kinds of medical information, including text, images, and videos (for example, a recording of patient symptoms such as seizures).

A growing number of healthcare professionals use MS in their medical practice for providing patient care and education [1–6]. Yet few articles discuss the advantages and disadvantages of mobile-based MS in neurosurgical practice [7, 8]. Medicolegal concerns related to patient privacy have limited its use in certain countries. Instead, other "secured" systems are provided by some institutions. These systems are usually less intuitive to use, more time consuming, and limited in their ability to widely spread information to large groups. MS are also far quicker and more intuitive and effective than emails. Another challenge in using MS systems in medical organizations is to limit and focus the discussion groups, so as to reduce smartphone-related fatigue [9].

The role of MS applications has become extremely important during the COVID-19 pandemic, highlighting once again the advantages of these systems. In the current study, we aim to describe, discuss, and analyze the extensive usage and the role of MS in our neurosurgical practice and to evaluate the current usage of MS in other neurosurgical centers around the world.

Methods

Tel Aviv Medical Center Institutional Review Board waived a consent for this study as no private patients' related information was analyzed. The WhatsApp (WA) activity in the Department of Pediatric Neurosurgery at Dana Children's Hospital, Tel Aviv was analyzed. We also analyzed the communication structure between neurosurgical and other services, methods of interaction, communication patterns, and the related risks and benefits of this means of communication. We began collecting WA usage data November 2018 (pre-COVID) and continued to collect monthly data through June, 2021.

An international survey with 15 questions was sent to 25 neurosurgeons around the world in January 2019 (also pre-COVID—see supplemental material). We received 22 replies from 14 countries. We distributed our survey through the international messaging-based group of our institution, a group that includes past and present fellows of our department. We also sent this survey to colleagues around the world, based on personal connections. Data collected included details about the nature of service at the participants' department, types of messaging services used, types of information transferred, the existence of a specific *department group* (DG), and the opinion of participants about risks and benefits of such an approach. A DG was defined as a group that includes physicians and (optionally) other related medical specialists from the same department. We compared MS traffic at three points in time: November 2018, June 2020, and June 2021. This allowed us to identify our natural MS traffic patterns pre-COVID and also to identify the impact of the COVID-19 pandemic, if any, on the traffic of our DG.

Data were analyzed using Microsoft Excel (Microsoft Office 2013, Microsoft, USA) and included mean and standard deviation for numerical values, as well as a descriptive analysis.

Results

The Tel Aviv PNS Experience

We designed a plan of interaction (bubble network) amongst the pediatric neurosurgery-related WhatsApp groups in our institution (Fig. 1). Each bubble represents a group dedicated to a specific aspect of patient care (e.g., radiology, ICU, and office/administration) and includes a range of specialists. The main hub is the PNS (*Pediatric NeuroSurgery)* group, including attending physicians, fellows, and residents. Information about neurosurgical patients is usually transferred between the bubbles through the main hub. Our bubble network includes 9 groups. To demonstrate how information circulates within the bubble network, we created a flow chart illustrating how messages spread within the network.

The following example demonstrates how the bubble network serves our neurosurgical service. Assume we have a hypothetical patient, diagnosed with a posterior fossa tumor and hydrocephalus. Often, such patients are initially diagnosed in another institution and then transferred to our center for further management. In addition, the patient's family themselves may be communicating directly with one of the senior members of the PNS group, such as an attending.

In this example, initial information is sent from the bubble *Referring centers* to our *PNS* bubble, which serves as the main bubble hub. From the PNS bubble, information is shared simultaneously with other potentially related bubble groups. In our example, these are *imaging*, *intensive care*, *anesthesiology*, and *administration.* Our emergency attendings are also members of the referring hospital bubble. This means that all services are efficiently notified and able to prepare in advance for their part in the patient's arrival and care, including planning and arranging the necessary neuroimaging in a very busy radiological service, preparing a place in the intensive care unit, scheduling an operating room, etc. All the groups involved receive information with continuous updates on-line, almost in real-time, through the bubble network, streamlining the

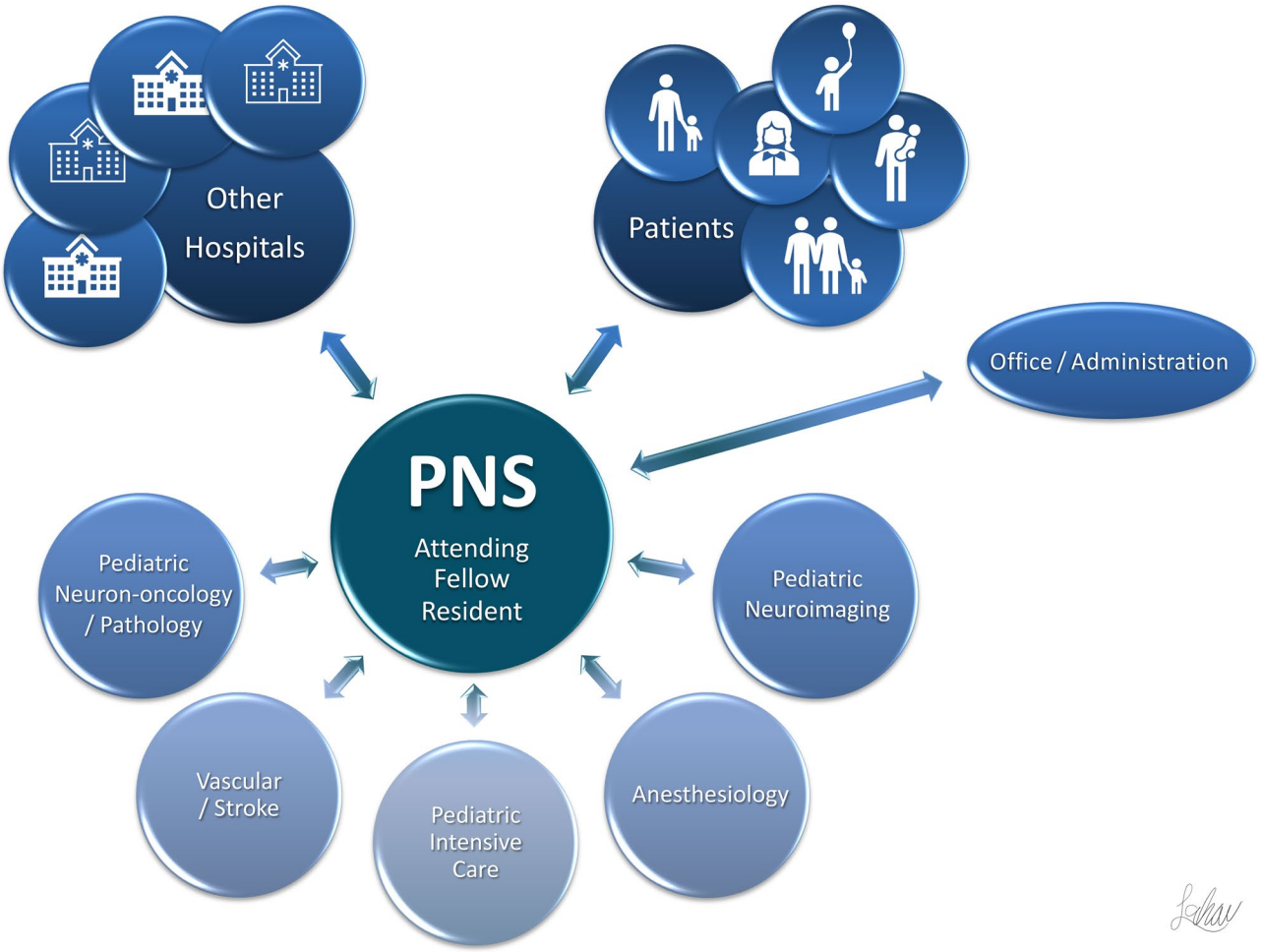

Fig. 1 The bubble scheme: interaction within WhatsApp application used in Tel Aviv. PNS: pediatric neurosurgery

continuous care of that patient. After the surgical treatment stage, other bubbles are activated, like *pathology/oncology* and *radiology*. Most of the information that circulates within the bubble network includes both text and images. Sometimes other types of information are shared, like videos of imaging or clinical symptoms.

Note that we do not activate our entire bubble network for all admissions. The network is typically active only within the main hub. Multiple bubbles are activated selectively, for specific cases where the simultaneous activity of several services is crucial and effective.

When we evaluated 3 different month-long periods of WA activity (November 2018, June 2020, and June 2021), we found that our departmental MS monthly traffic has remained constant, ranging between 1000 and 1250 messages. It is interesting to note that in this context, pre-COVID or post-COVID timing did not make a difference; the activity and messaging necessary to support optimal patient care remained essentially the same.

International survey results

We received 22 replies from 14 countries, covering 3 continents. The ratio between public and private centers was 18: 4. Approximately half of the participants (10) work in pediatric neurosurgical services; the remaining included mixed (9) and purely adult (3) services. Of the medical centers that responded, the average department included 6 attendings, 1 fellow, and 4 residents (Table 1).

The vast majority of responders (18) have a DG defined for their department (Table 2). Even the medical staff who do not have an 'official' DG defined still use private communication (through MS) to share information related to patient care.

The most popular MS used for DG was WhatsApp (8 centers). Viber and Siilo were used in 3 centers each. Other MS used were WeChat (1), LINE (1), iMessage (1), and email lists (1).

Table 1 Characteristics of participating departments

Characteristic/number	Range	Average
Attendings	1–14	6
Fellows	0–4	1
Residents	0–19	4
Number of surgeries (annual)	130–2000	640
Number of participants in department group	3–29	12
Number of messages in department group during November 2018	20 to over 2000	251

All 18 centers with DG convey text information through the group. Patient-related images (e.g., clinical images, state of wounds, and X-ray) were transmitted via MS by 12 centers. 11 centers use MS to transmit specific patient-related videos (e.g., radiological series and video clips of patient symptoms like ataxia).

Most responders (17 centers) used MS for general workflow/administrative information such as times of meetings, changes in operative plans, and dates of conferences. 14 centers transmit patient-related medical data such as results of various tests, imaging, and updates on patient condition. 10 centers also use DG for sharing educational information like video lectures, articles, and electronic books.

Even with the variety of data actually being transmitted, 11 responders report that patient safety regulations limited transmitted data. Nevertheless, 18 responders believe that MS utilization improves patient care, mostly due to instant communication and assistance in decision-making.

Department group

On average, a department group consisted of 12 members, including attendings, fellows, residents, and nurse practitioners. Attendings and residents form the backbone of most groups. Nurse practitioners were included in less than half of the groups. This could be a statistical anomaly due to the structure of certain centers (that do not include nurse practitioners) or due to the more active participation of clinicians than nurses in the messaging services [10].

Table 2 Characteristics of messages' department groups ($N=18$)

Type of exchange info	Yes	No
Text	18	0
Radiological images	12	6
General workflow info	17	1
Patient-related med info	14	4
Education info	18	0
Patients' regulation affects transferred info?	11	7

Discussion

This is the first paper focusing on the usage of messaging services in Pediatric Neurosurgery. In this manuscript, we would like to show and convince the reader that the advantages in daily usage of common, free of charge, MS, strongly outweigh formality, and the potential for medicolegal disadvantages (e.g., HIPAA).

For the last few years, we have been heavily using the WhatsApp application to *routinely* run our department, communicating with trainees, anesthesiologists, intensivists, pathologists, oncologists, radiologists, and colleagues from external referring medical centers (Fig. 1). WhatsApp has become the main conduit to transfer information and to discuss treatments and alternatives. In some ways, our *bubble network* resembles a human neural network, where a signal travels along the network and all connected sections talk to each other. Our signal may be, for example, a multimedia file, such as video, image, or voice message, that can be distributed or broadcast between different sections of the network simultaneously. The main hub of our network is the Pediatric NeuroSurgery group (PNS). Through this main hub, information is selectively transmitted to the relevant sub-networks. This enables us to keep the relevant groups updated simultaneously. Another feature of our management approach is direct patient–neurosurgeon communication. This practice guarantees efficient, fast communication and eliminates additional bureaucratic restrictions. This efficient communication is especially important in shunted children, for whom some symptoms may necessitate urgent referral. At the same time, this open, instant method of communication adds an additional burden of obligations and distractions on the shoulders of the specialist, requiring constant availability even outside of working hours.

At this point, we are convinced that this method of using WhatsApp and other MS for almost-instant communication has produced a massive revolution in our daily practice, leading to a quantum change and improvement in patient care. This is why we decided to describe and consolidate our thoughts on this subject, analyzing the full spectrum of advantages and disadvantages in this approach, including a discussion of the corresponding privacy issues. In addition, the recent COVID pandemic has forced us to shift even more communication to different MS systems, due to social distancing requirements. This study, which was designed over 3 years ago, is now more relevant than ever.

Our survey studies usage of MS in neurosurgery. Most of the survey responders use MS for technical work and administrative communication (95%). Besides routine work data,

MS are commonly used for distributing educational information. However, the most important aspect of MS usage is the ability to transmit clinical information regarding patients, including radiological images and videos. Even physicians from different institutions who do not share a common PACS (Picture Archiving and Communication System) can easily consult each other, exchanging multimedia files and providing better care for patients.

Attending perspective

The majority (> 90%) of department groups include medical staff at all levels of experience, providing direct interaction between the residents and attendings, with fast, efficient distribution of information, and enabling improved senior decision making [11]. The more experienced clinicians can be updated continuously about the patient status while on call, even if not physically present at the institution [11, 12]. They can closely oversee patient management by their team, with regular updates. The senior clinicians can seek the help of other attendings if there is a dilemma concerning patient management [7]. Another positive feature of MS usage is simplifying the handover of information concerning the patient to the subsequent on-call team. Ninety percent of the survey responders also participated in an international messaging forum. They found that this helped them quickly obtain opinions from other international experts in complex neurosurgical issues.

Resident/fellow perspective

In our survey, only two groups (< 10%) have no attendings as members. In these two groups, MS was used for technical, work-related discussions between residents. These groups help the junior clinicians with day-to-day running of the department and updates about pending work (e.g., removing drains/sutures and lumbar punctures). Current scheduling requirements have increased the number of shift changes that require information transfers, some of which may be beyond the scope of patient care charts (e.g., minor patient-related issues). Each shift change, and the necessary information transfers, bring with them the risk of losing information. Incorporating regular use of MS enhances information transfers, enabling, for example, creation of a log book available to all participants, including those who are not physically present in the hospital, and improves the general work flow.

Multiple departmental groups

Even among the departments with DGs that include medical staff at all levels of experience, there are often additional departmental messaging groups, such as resident groups (without attendings), used for sharing only resident-related information. This multiple-departmental-groups aspect is not reflected in this survey, since we asked about DG in general.

Patient perspective

Availability of specialists at "arm's length" using MS is extremely useful for patients and families. Patients or their relatives can ask urgent questions and easily send any multimedia file (images and/or videos) to the physician. They can get an immediate opinion about whether or not it would be necessary to come in for an unscheduled appointment, or go to the emergency department. Images and videos can also be used for postoperative care and enable earlier diagnosis of such formidable complications as a surgical site infection [13]. Another example can be a child with a cerebrospinal fluid shunt who develops new symptoms. Parents or relatives can contact the treating physician and describe the clinical condition of the child. This enables earlier identification of life-threatening conditions such as a shunt malfunction. Nevertheless, over-use of this instrument may add an additional burden to treating physicians and have a significant impact on their private life.

Understanding the potential downsides

Medicolegal concerns

Several organizations/countries have restriction on sharing patient data over messaging services [14]. As an example, in the US, the Health Insurance Portability and Accountability Act (HIPAA) regulates usage of electronic protected health information [15]. In European Union, General Data Protection Regulation (GDPR) aiming protection of private information was put on effect in 2018 [16]. Furthermore, some centers have their own rules limiting usage of medical information. This adds another layer of difficulties, making fast and synchronous information exchange almost impossible. On the other hand, such strict regulations help to protect patients' privacy and sensitive information from intruders.

Current regulations prohibit sharing sensitive patient-related information, using instruments unauthorized for these aims. This creates a pressure on medical systems, as current ways of information exchange between health providers are cumbersome and do not match with essential course of modern care.

More than 60% of the survey responders agree that these restrictions affect using such applications for clinical purposes despite the obvious benefits. Newer applications claiming to maintain the confidentiality of shared data were used by a few centers in our survey. This indicates a positive approach towards an attempt to find the balance

between patient privacy on one hand, and medical benefits from MS (potentially improving patient care) on the other.

When using MS, avoiding the use of patient identifying data may add to patient confidentiality, although conveying information is significantly simplified when using the patient's name. It also avoids erroneous patient attribution.

Another concern relates to the lack of formal documentation of the MS discussion about a specific patient within that patient's medical records. Discussions through DG in MS do not have the same legal implications compared to discussions during department meetings. Thus, we recommend documentation of DG discussions in the medical record in appropriate cases.

We are also aware of the fact that some centers refuse to *formally* state that they work with DG, despite actual using MS, because of legal regulations. A possible solution for exchanging medical information might be using MS designed and created specifically for medical specialists (e.g., Siilo).

One of the main points of vulnerability for DG is the lack of "end-to-end encryption" that is widely implemented for personal communication between two parties in many messaging services (WhatsApp, Messenger, etc.). This gives an intruder an opportunity to hack information that is transmitted within such groups. Even specially designed hospital-based protected communication systems might not be able to protect their data from cyberattacks [17]. The reality is that no universal protection exists, and in professional hands, any advanced system connected to the internet might be hacked. Data from DG includes personal, sensitive information. Unauthorized usage of such data can cause direct and indirect harm to patients, as well as medical specialists.

Finding the right balance between supervision and autonomy

MS serves as a medium for interaction between the clinicians irrespective of the hierarchy [10]. While most physicians believe that DG eases the communication with attendings, some feel there is a strong risk of loss of autonomy for a junior clinician [10]. Junior colleagues, and even senior counterparts, may feel under constant supervision of more senior clinicians, depriving them of the experience of decision-making. Constant supervision by senior colleagues makes junior colleagues feel uncomfortable making their own decisions and provokes uncertainty. Awareness of this point is important, since it reminds the attendings to step back and encourage younger colleagues in autonomic thinking. Finding the *golden mean* between supervision and autonomy would improve training and would help young physicians develop independence.

Finding the right balance between work and private life

A major disadvantage of MS usage is the loss of clear borders between working hours and private life. Once you start working with instant messaging, the assumption is that all participants are tied to their smartphones, and must be available on-line at all times, especially while on-call. Trainees need to make sure they have a good internet connection and adequate battery. Instant messaging adds extra interruptions during busy on-call periods and possibly distracts from direct patient care [7, 11].

DG, similar to other workgroups on MS, lead to an ill-defined border between work and private life, potentially negatively affecting the physicians' work-life balance, and, some would say, facilitating burnout. Both attendings and residents need the option to disconnect from the DG, to respect their private time off work. A simple solution may be to "mute" the DG as necessary. Certain institutions have a separate messaging group for weekends to address such concerns [11]. We did not directly address this issue in our survey and hence could not state what were the routines in the responders' groups.

Adding an additional layer of communication and record keeping

It is essential that the clinical discussions about a patient on MS be transferred to the main medical records, leading to unnecessary duplication of work. (Although it is to be hoped that at some point this data transfer stage would happen automatically.) At the same time, a clinical discussion on the DG might benefit group members who are not on-call, enhancing the learning perspective. Finally, posting a message on the DG should not and does not decrease the responsibility of the resident to actively call and discuss patients with the attending.

Types of transmitted data

Most survey responders use MS for general workflow. This includes plans of admissions, discharges, operating room status, and daily routine in the ward. All members state that the DG enables them to remain continuously updated about department activity. This may lead to an overflow of DG communication, swamping the participants with trivial information, if not regulated among members. When a lot of unnecessary information is transmitted, there is a risk of missing out on essential data [18].

Transferring of patient-related information was reported by 80% of participated centers. Among them, 60% upload media files. This percentage, far from 100%, may be related to the departments' attempt to avoid transferring sensitive patient data on a messaging service [12]. Lack of good internet connections may also hinder the uploading of large media files [7, 11, 18].

Most responders (90%) agree that DG helps in improving patient care by providing immediate access to several opinions simultaneously and enabling rapid decision making. However, there is a potential risk of misinterpretation of text descriptions, leading to a disparity in understanding the urgency [8, 10]. The (poor) quality of image/video files may also limit decision making [7]. There is a risk for right–left disorientation, as well as missing certain subtle findings on the smartphone screen (e.g., subacute subdural hematoma or linear fracture) [7].

Around 50% of DG utilize MS for sharing educational information (articles, videos, and presentations). Difficulty in reading/accessing documents from smartphones may contribute to limited academic usage [18]. Messaging services still form a large part of social media; however, we found that less than 1/3 of the centers use the DG for sharing jokes/social events. This reinforces the ideology behind such a group as being *purely* work related.

Messaging services

Of the seven different applications used in various centers (Table 3), WhatsApp (WhatsApp Inc., 2013) was used in more than 50% of the centers. This is probably a function of what most people found convenient to use (or have been using), its availability in their country/region [12]. Another major advantage of most of the applications is that they are free of charge, or are extremely cheap [12]. Most MS claim to have end-to-end encryption for all messages [11]. This technology, which is intended to maintain confidentiality, becomes irrelevant if the smartphone is lost. The media files transferred may get saved automatically on the user's cloud, which could be a soft target to extract patient information [11].

Table 3 Message services used for DG groups ($N = 18$)

Name of messaging service	Number of centers
WhatsApp	8
Viber	3
WhatsApp/Siilo*	3
WeChat	1
Line	1
iMessage	1
Email list	1

*Three centers recently started using Siilo messenger (free secure messaging service created for medical specialists). These centers still have department group in both message services. Siilo is used to transfer patient-related information while WhatsApp for other issues

Role of messaging services during outbreaks

The COVID-19 pandemic highlighted the usefulness of messaging services in patient care. The measures taken to prevent spreading infection between people, including medical workers, significantly affected communication methods. The widespread enforcement of lockdown measures across many countries pushed many areas of human activity into an on-line setting. Established restrictions and self-quarantine policies gave digital technologies a leading role, including expanding remote patient care [19]. Remote consultations with high-quality audio and video enabled provision of care to patients staying in isolation and also helped medical specialists to communicate better without increasing risk of spreading infection. Exchanging anonymized multimedia patient-related information provides a unique tool and decision-making support instrument when discussion in-person is unavailable.

Limitations

Describing a mode-of-action in one center does not necessarily apply to other centers, countries, or cultures. The current survey is limited by several factors. First, we had a relatively small number of responders. This small group may not represent the general population of neurosurgeons, as our responders were all personally connected. Second, a bias in our data towards public systems and towards pediatric neurosurgery is apparent, and therefore cannot be extrapolated to other systems and disciplines. Third, data analysis was mainly qualitative and not quantitative; the responses were subjective. Several MS were described, each differing in features and degree of privacy. As described, patient safety regulations prevented certain centers (despite using MS) from participating in the survey. Despite these limitations, the survey describes the widespread use of MS across the globe and highlights the role of MS in patient care.

Our international survey form was distributed and completed prior to the COVID pandemic. We have no way of identifying how many changes have occurred during and following the COVID-19 pandemic with this type of communication. As stated previously, our department's experience didn't reveal any changes in MS traffic. Nevertheless, we do not know what happened in other centers that participated in the survey.

Conclusion

Messaging services seem to have an increasing role in neurosurgical clinical care. Beyond administrative communication, MS provides a practical platform for sharing

educational data, as well as patient-related clinical data. Our survey shows that even with patient confidentiality concerns, many departments use MS for conveying patient-related clinical data and believe it significantly improves patient care.

Abbreviations MS: Messaging services; DG: Department group; PNS group: Pediatric NeuroSurgery group; PACS: Picture Archiving and Communication System; WA: WhatsApp application; HIPPA: Health Insurance Portability and Accountability Act

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Author contribution Danil A. Kozyrev prepared concept, design, and international study and wrote the main manuscript text. Harishchandra Lalgudi Srinivasan wrote part of the text. Jehuda Soleman wrote part of the text. Yurii Perekopaiko wrote part of the text. Shlomi Constantini prepared concept, design, and study supervision. Jonathan Roth prepared concept, design, international study, and study supervision. All authors reviewed the manuscript.

Availability of data and material Replies to questionnaire from the participated centers are available for review.

Declarations

Ethics approval and consent to participate This is not applicable.

Consent for publication Tel Aviv Medical Center Institutional Review Board waived a consent for this study as no private patients' related information was analyzed.

Conflict of interest This is not applicable.

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