

Developing an automated, AI-powered paediatric orthopaedic clinical registry

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Abstract

Despite the fact that paediatric trauma is the leading cause of morbidity and mortality in children, the long-term impact of paediatric musculoskeletal injuries remains poorly understood. Furthermore, orthopaedic clinical outcome registries are expensive, labor-intensive, and have largely ignored children. We collaborated with Bot MD to create a first-of-its-kind automated, AI-powered clinical outcome registry for paediatric orthopaedics. Starting with orthopaedic trauma and subsequently expanding to sports medicine, foot & ankle surgery, and reconstructive microsurgery, we developed a WhatsApp chatbot to collect validated patient-reported outcome measures (PROMs) from patients on a pre-programmed, automated schedule. To date, over 313 patients have been successfully enrolled with an enrolment rate > 95%. Compared to conventional clinical registries costing over SGD\$100,000 annually, our registry costs just \$18814.2 annually inclusive of manpower, translating to over 80% cost-savings and over 1700 manpower-hours saved. Compared to our previous PROM software's compliance rate of < 25%, our compliance rates range from 63-78%.

Background

For a multitude of reasons, clinical research focused on musculoskeletal injuries in children have lagged behind the adult populations. These include the scarcity of certain injuries, adapting clinical outcome scores to patients who are non-verbal or unable to fully articulate themselves, or even the fact that traditional endpoints like X-rays may not fully capture the effect that trauma can have on quality of life. This is despite the reality that paediatric trauma is the most common cause of childhood morbidity and mortality and has a mortality rate of 2.4% for children admitted secondary to paediatric trauma. Consequently, the approach to orthopaedic management of children is often extrapolated from work done in adults.

Early studies done in the 2000s showed that automation of surveys and use of emails significantly improved completion of surveys by parents, suggesting that digitalizing clinical outcome registries, particularly in the context of paediatric musculoskeletal injuries, was a potential way forward. Furthermore, there is growing interest in shifting to the use of patient-reported outcome measures (PROMs) in paediatric orthopaedics, specifically in assessing functional health status and health-related quality of life, particularly in the development of clinical outcome databases and registries.

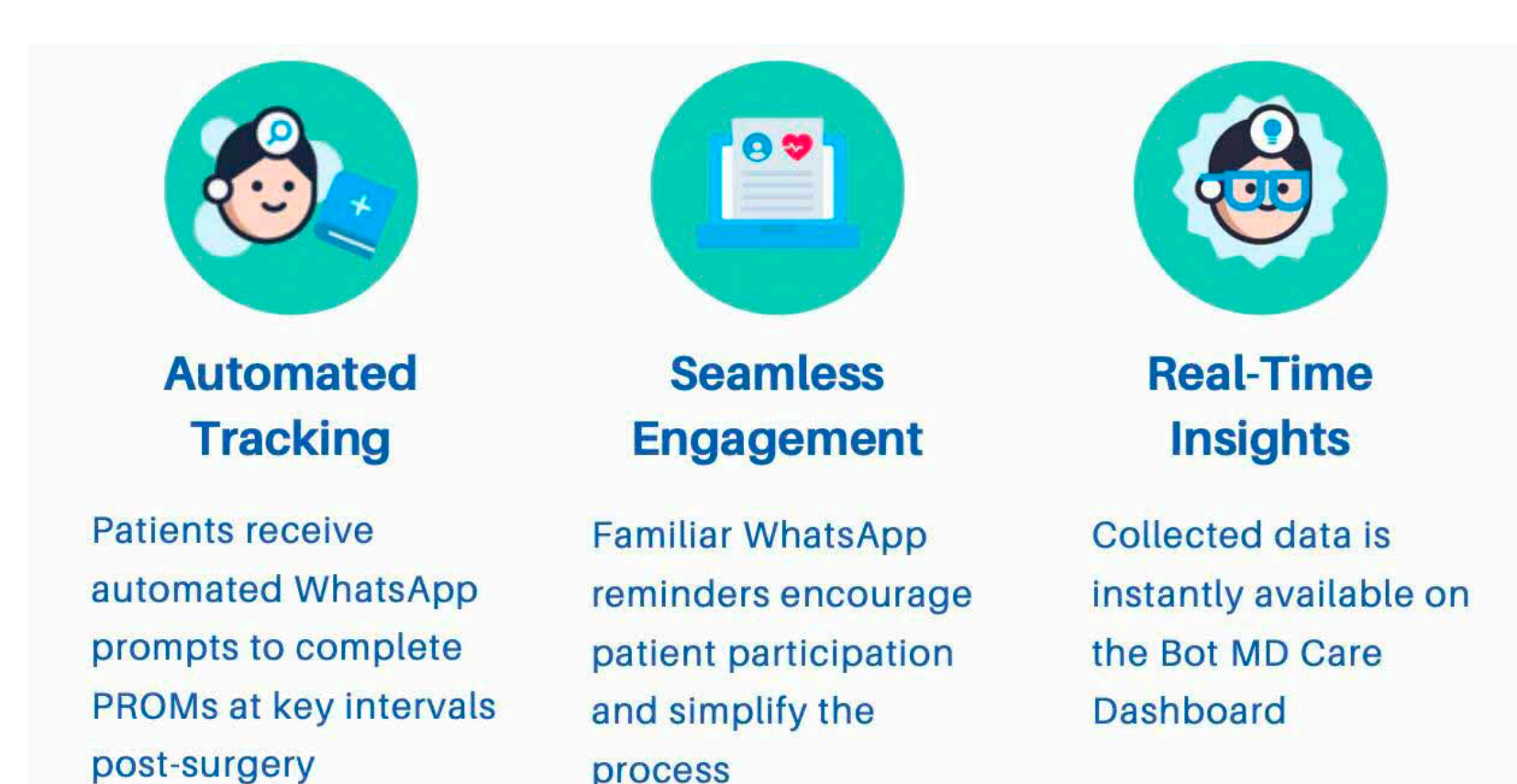
Solution Planning & Design

Problem Statement

1. Lack of manpower, high cost, difficulty in data extraction, and poor compliance rates were identified early on as significant issues towards establishing a paediatric orthopaedic clinical outcomes registry, which led the team towards digital solutions.
2. Initial feedback from doctors was that they wanted enrolment to be quick and easy, while the registry can should be easy to access, monitor patients, and download data.
3. Initial feedback from patients showed that patients wanted something familiar, easy to use, and did not warrant downloading or installing new software on their mobile devices

Human Centered Design

1. Based on this feedback, Bot MD chose **WhatsApp** for its chatbot, which over 74% of Singaporeans have installed already.
2. Data collection was done via **FormSG**, a Singapore government approved platform already used by healthcare institutions to collect data.
3. Patient enrolment was designed to take **less than 1 minute** and can be done **remotely**, while the registry dashboard can be accessed via mobile devices and data is easy to download.
4. The PROM questionnaires were deliberately designed to be **concise, take < 5 mins to fill, and the same each time**, with the chatbot auto-prompting patients to fill them at pre-determined intervals and reminding them if they forgot.



How It Works

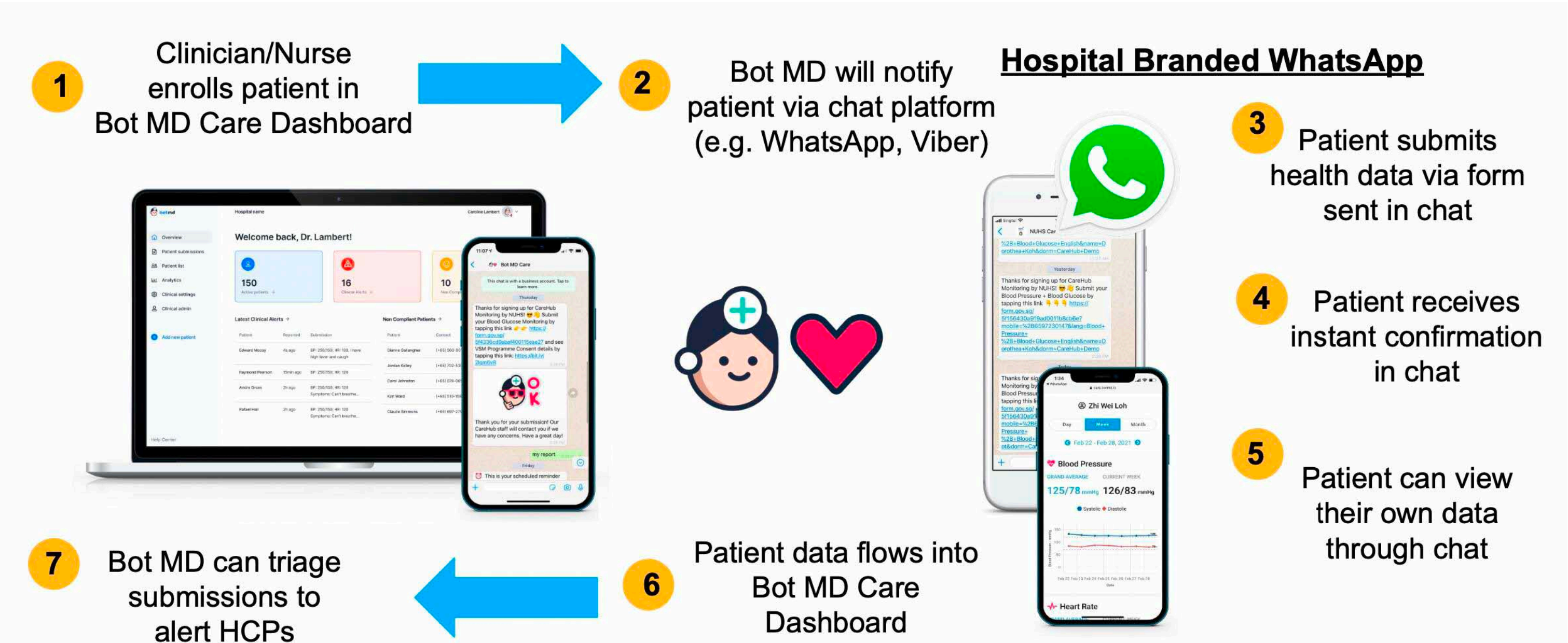


Figure 1. (Above) Workflow depicting patient enrolment and data collection.

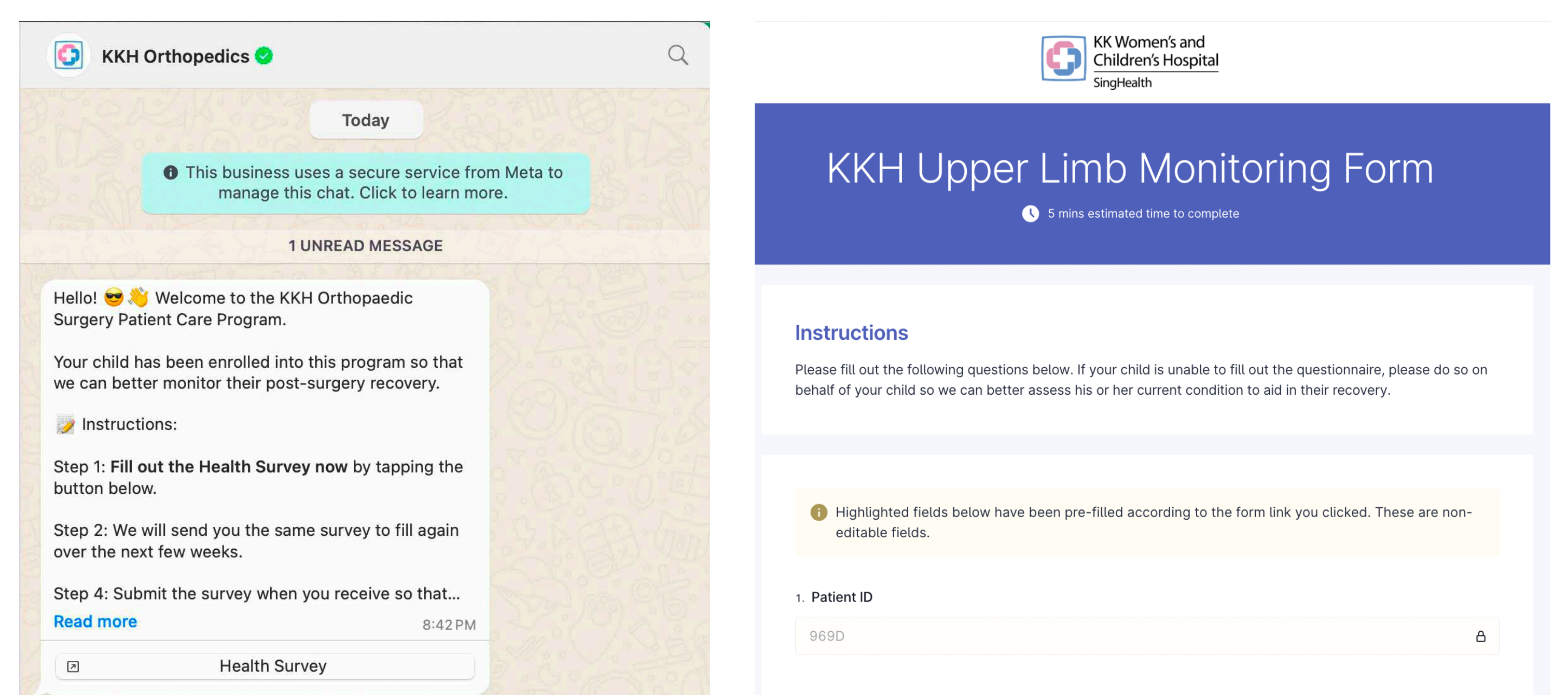


Figure 2. (Left) Upon enrolment, patients receive a WhatsApp message from the KKH Orthopaedics chatbot. (Right) PROM collection is via FormSG.

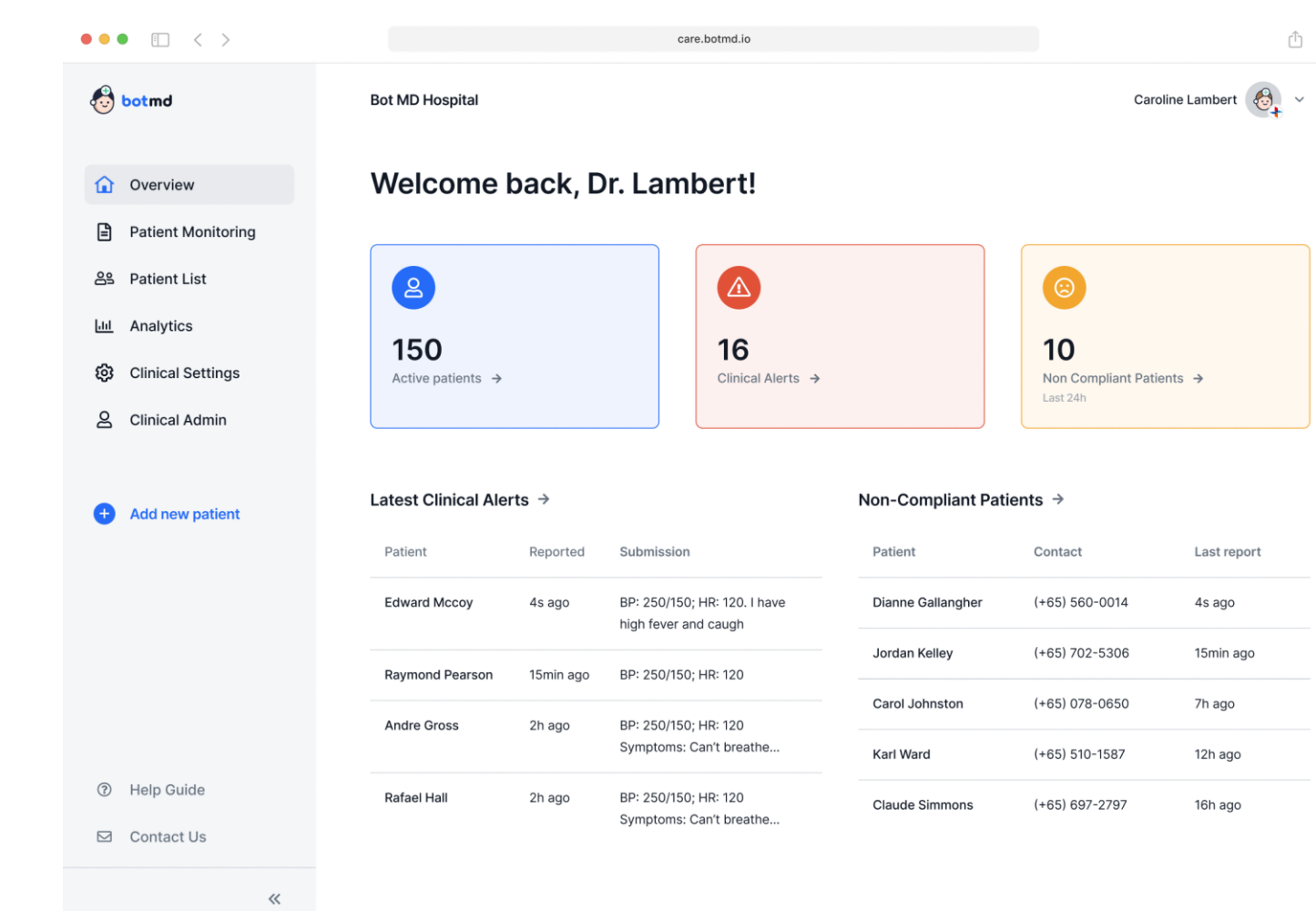


Figure 3. (Left) Clinical outcomes registry enables tracking of patients and flags up patients who are non-compliant or have not made submissions.

Impact

Current clinical outcomes registry usually run on software such as REDCap and require a full-time clinical research coordinator to manage, which can be time-consuming, expensive, and cumbersome to access data with poor compliance rates. The literature shows an orthopaedic clinical outcomes registry can easily cost at least SGD\$100,000 annually.

The automated AI-powered chatbot clinical registry specifically addresses numerous pain points faced by conventional orthopaedic clinical registries:

1. **Cost:** Total annual registry costs inclusive of manpower, set-up of forms, WhatsApp fees, and software license are SGD\$18814.2, < 80% the average clinical registry cost.
2. **Manpower:** By automating data collection, we are able to reduce labour required to manage the registry significantly. In fact, only a part-time (0.1 FTE) clinical research coordinator is required to maintain the registry, saving over 1700 manpower hours annually.
3. **Data:** Accessing and downloading data from conventional registry software is cumbersome, slow, and expensive. The Bot MD clinical registry dashboard is easy to use, pain-free, and retrieves data in seconds.
4. **Compliance:** By utilizing a safe, familiar data collection medium (FormSG) on a platform already installed by the majority of users (WhatsApp), the clinical data registry has significantly higher compliance rates of 63-78% compared to pre-existing PROM collection software, which had < 25% compliance rates.

Conclusion

Developing an automated, AI-powered chatbot clinical registry enables us to run a conventional clinical outcomes registry at a fraction of the cost and manpower.