

Impact of a Multilingual Ambient AI Scribe: A Real-World Time-Motion Study

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Impact of a Multilingual Ambient AI Scribe: A Real-World Time-Motion Study

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Abstract

Background: Ambient AI scribes are increasingly used to reduce clinician burnout and cognitive load, though their impact on documentation time remains inconsistent across studies. Most existing real-world impact studies have been conducted in the United States and rely on electronic health record timestamps, which may not accurately reflect actual documentation time. No published studies assessed their effectiveness in multilingual clinical environments, where language diversity may influence outcomes.

Objective: To quantify the impact of an ambient scribe technology on clinician efficiency and patient engagement in a multilingual outpatient setting using direct observational methods and patient surveys.

Methods: We conducted a prospective, within-clinician quality improvement study at a large academic medical centre in Singapore from December 2024 to May 2025. Nine clinicians participated in matched observation sessions with and without an in-house ambient scribe tool. The ambient scribe tool supported multiple languages, enabling evaluation in a naturally multilingual clinical environment. Five trained observers used standardised time-motion methodology to capture documentation time, proportion of eye contact, and consultation duration across 169 consultations. Patient surveys were administered following consultations using the ambient scribe. Linear mixed-effects models were used to account for clustering within clinicians.

Results: Ambient scribe use was associated with a 15.0% reduction in documentation time per consultation (5.3 to 4.5 minutes; $P=.036$), 10.6% increase in proportion of eye contact time (69.6% to 77.1%, $P=.009$), and no significant change in consultation duration (11.5 vs 10.9 minutes, $P=.415$). Effects were consistent across new and follow-up patients. Among consultations with the ambient scribe, 81% were conducted in English, 18% in Mandarin, and 1% in Malay. Patient acceptance was favourable: among 39 surveyed patients, 69% agreed their doctor focused on them more during the consultation, and none expressed discomfort with the technology.

Conclusions: This first real-world evaluation of ambient scribe use in a multilingual Asian healthcare setting demonstrates that

experienced users achieved reduced documentation time and improved patient engagement without affecting consultation duration. The technology was effective across multiple languages and well accepted by patients. These findings suggest ambient scribes should be viewed as quality-of-care interventions that shift clinician attention from clerical tasks to patient engagement, supporting broader implementation in diverse healthcare settings.

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Original Manuscript

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ABSTRACT

Background: Ambient AI scribes are increasingly used to reduce clinician burnout and cognitive load, though their impact on documentation time remains inconsistent across studies. Most existing real-world impact studies have been conducted in the United States and rely on electronic health record timestamps, which may not accurately reflect actual documentation time. No published studies assessed their effectiveness in multilingual clinical environments, where language diversity may influence outcomes.

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Keywords: Ambient Intelligence; Generative Artificial Intelligence; Clinical Documentation; Physician-Patient Interaction; Time-Motion Study; Eye Contact; Multilingual Clinical Setting; Ambient Scribe

INTRODUCTION

Clinical ambient scribes use artificial intelligence (AI) to convert verbal clinician-patient interactions into structured clinical documentation. This is one of the fastest-adopted uses of generative AI in health systems globally [1].

Recent real-world studies across health systems in the United States (US) demonstrate consistent improvements in clinician wellbeing and patient interactions, with studies reporting significant reductions in cognitive load, task burden, and burnout scores, alongside enhanced patient experience during consultations [2-7]. However, reported time savings vary considerably between organisations. While some implementations report substantial reductions in documentation time and after-hours charting, others show minimal productivity gains [8,9].

To our knowledge, no comprehensive real-world impact studies have been conducted outside of the US, leaving questions about the technology's effectiveness in other healthcare contexts unanswered. Documentation burdens and clinical workflows may differ between countries, potentially affecting the magnitude of time savings and productivity gains achievable through clinical ambient scribes. Additionally, no published studies have evaluated clinical ambient scribe outcomes in multilingual clinical environments, despite the prevalence of such settings in many healthcare systems worldwide. Shah et al have previously highlighted limited functionality with non-English speaking patients as a specific barrier to ambient scribe adoption [7]. As digital health tools increasingly permeate global healthcare systems, evaluating their performance in linguistically diverse environments is essential to ensure equitable and effective implementation.

From a methodological perspective, existing studies have relied primarily on electronic health record timestamp analysis to measure documentation time and productivity outcomes [4-6,10]. While convenient for large-scale analysis, EHR-based metrics provide only proxy measures that may not accurately reflect the actual time spent on documentation tasks. These metrics often rely on timestamps that capture when a note window is open, which may overestimate documentation time if clinicians multitask or leave notes open [11]. Direct time-motion observation, though more resource-intensive, offers superior accuracy in distinguishing active documentation from passive or multitasking periods [12].

To address these evidence gaps, we aimed to determine the effectiveness and acceptability of an ambient scribe technology when compared to standard-of-care in a multilingual healthcare setting using direct observational methods.

METHODS

Study Design

We conducted a prospective within-clinician observational study to evaluate the real-world clinical impact of an in-house clinical ambient AI scribe in outpatient clinics of Singapore General Hospital (SGH), a quaternary referral centre with >1,700 beds that is the largest academic medical centre in Singapore [13]. This study was conducted over 5 months between 27 December 2024 and 30 May 2025.

Ambient Scribe Technology

Note Buddy, the ambient scribe tool used in this study, was developed in-house using speech recognition and large language model technology. This tool transcribes multilingual conversations, supporting English, Mandarin, Malay, Tamil, and Cantonese – languages commonly used in Singapore. Note Buddy identifies different speakers and different languages at the word level throughout conversations, transcribing in the native language spoken then translating to English. Personally Identifiable Information (PII) entities are automatically masked before processing.

Note Buddy then uses GPT-4o (OpenAI, 2024) to reformat and summarize the transcripts into clinical consultation notes. Users can customize note style and tone by using their own custom prompt templates or selecting from the prompt library. As the tool was not integrated into the electronic health record during the study period, clinicians reviewed the AI-generated notes and manually transferred it into the system.

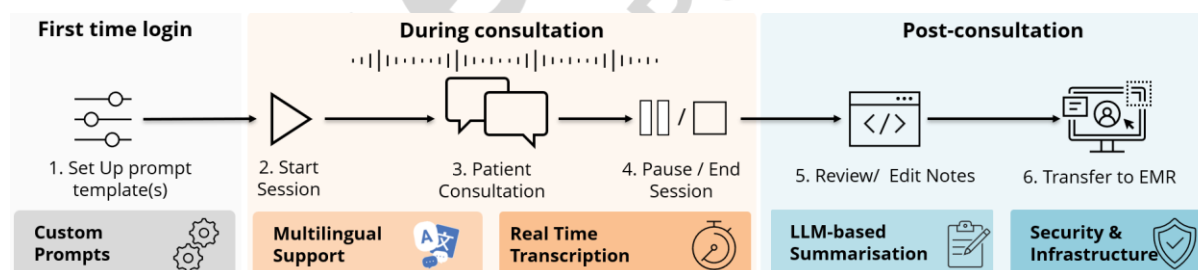


Figure 1: Workflow of Note Buddy usage in clinical practice

Participants and Settings

This study was conducted in an outpatient clinic setting where consultations naturally occur in multiple languages according to patient preferences. We recruited clinicians who had generated at least 30 notes using the ambient scribe tool in the three months prior to study commencement. Clinicians unable to participate in two consecutive clinic sessions were excluded. Due to the time-intensive nature of direct observation, we intentionally focused on experienced clinician users who had achieved proficiency with the system and were most likely to demonstrate its optimal impact. From 27 eligible clinicians, 9 were selected through convenience sampling based on scheduling feasibility and observer availability.

Each clinician selected two clinic sessions within the same clinical specialty for observation: one session using the ambient scribe tool and one using standard documentation methods. Each clinician decided whether to use the ambient scribe tool in the first or second observed session. The duration between the two clinic sessions was kept within three weeks to minimise changes in practice patterns over time. Scheduled appointments remained unchanged to reflect the natural distribution of new and follow-up patients in the real-world setting. The total number of patients per clinic session ranged from 8 to 15.

Data Collection – Observation Methodology

Five observers conducted the observations. The same observer was assigned to the same clinician for both clinic sessions to maintain consistency.

All five observers participated in a joint training session to minimize inter-observer variability. This included instruction on using a macro-enabled Excel worksheet for time-motion data collection. The session concluded with group practice on mock consultations until consensus was reached on measurement definitions and recording techniques.

Using the standardised macro-enabled Excel worksheet, observers recorded real-time data on three key metrics. Consultation duration was calculated as the time between patient entry and exit from the consultation room. Proportion of eye contact was defined as the percentage of the consultation duration for which the clinician was looking directly at the patient. Documentation time was measured as the total time that the clinician interacted with the computer, both during and immediately after the consultation.

Data Collection - Sample Size Explanation

Due to the resource-intensive nature of direct observation and the pragmatic evaluation design, we determined the sample size based on clinician availability and feasibility constraints rather than formal power calculations. Although we did not conduct an a priori power analysis, we performed a post-hoc approximation using paired t-test assumptions as a conservative proxy, given the complexity of power calculations for mixed-effects models. Assuming a medium effect size of 0.5, significance level (α) of 0.05, and power of 0.95, this calculation indicated a minimum required sample of 54 observations. Our final sample of 169 consultations exceeded this threshold, supporting the robustness of the evaluation despite its pragmatic design.

Patient Surveys

Standardized surveys were administered verbally by surveyors to evaluate patient perspectives on the use of ambient scribe technology immediately following consultations where the ambient scribe tool was used. The survey assessed four domains, namely: perceived quality of the clinical encounter, clinician's attentiveness and engagement, comfort level with AI-assisted documentation, and likelihood of recommending the technology for other clinical encounters.

Statistical Analysis

We used descriptive statistics to summarise the characteristics of participating clinicians and consultation sessions. We applied Pearson's chi-square test to assess whether the distribution of new versus follow-up patients differed between consultations conducted with and without the ambient scribe tool. Linear mixed-effects models were used to account for clustering of consultations within individual clinicians and unequal numbers of observations per clinician. These models included random intercepts for individual doctors to control for baseline differences in practice patterns, and fixed effects for ambient scribe use and patient type (new versus follow-up consultation). Statistical significance was set at $P < 0.05$ and all analyses were conducted using IBM SPSS Statistics Version 26.0.

This manuscript was prepared using the Standards for Quality Improvement Reporting Excellence (SQUIRE) reporting guideline.

Ethics Approval Statement

The study evaluated process metrics of an existing ambient scribe tool without collecting identifiable patient data or implementing clinical interventions. As such, it was determined to be a quality improvement study and did not require formal institutional review board approval. Verbal consent was obtained from patients for participation in anonymous satisfaction surveys.

RESULTS

Sample Characteristics

Nine clinicians participated in the study, representing 7 different specialties (*Table 1*). They had a mean of 20.8 (SD 7.8) years in practice. All nine clinicians completed matched observation sessions, with and without ambient scribe use.

As shown in *Table 2*, a total of 169 consultations were observed across the study period: 78 (46%) conducted with the ambient scribe and 91 (54%) without. The unequal distribution reflected natural variation in scheduled appointments and patient attendance across the matched clinic sessions. Of all the consultations, 54 (32%) involved new patients and 115 (68%) were follow-up appointments. Among the 78 consultations conducted with ambient scribe, 63 were conducted in English, 14 in Mandarin and 1 in Malay.

Table 1: Characteristics of Clinicians

Characteristic	
Years in practice, mean (SD)	20.8 (7.8)
Observed consultations per clinician, mean (SD)	18.8 (6.5)
Number of clinicians per specialty	

Respiratory Medicine	2
Endocrinology	2
Gastroenterology	1
Neurology	1
Rehabilitation Medicine	1
Neonatology	1
General Surgery	1
Total	9

Table 2: Consultation Characteristics

Characteristic	Overall (N=169)	Without AI Scribe (n=91)	With AI Scribe (n=78)	p-value
Patient Type[†]				
New patients	54 (32%)	28 (31%)	26 (33%)	0.72
Follow-up patients	115 (68%)	63 (69%)	52 (67%)	

[†]Chi-square test comparing distribution between groups

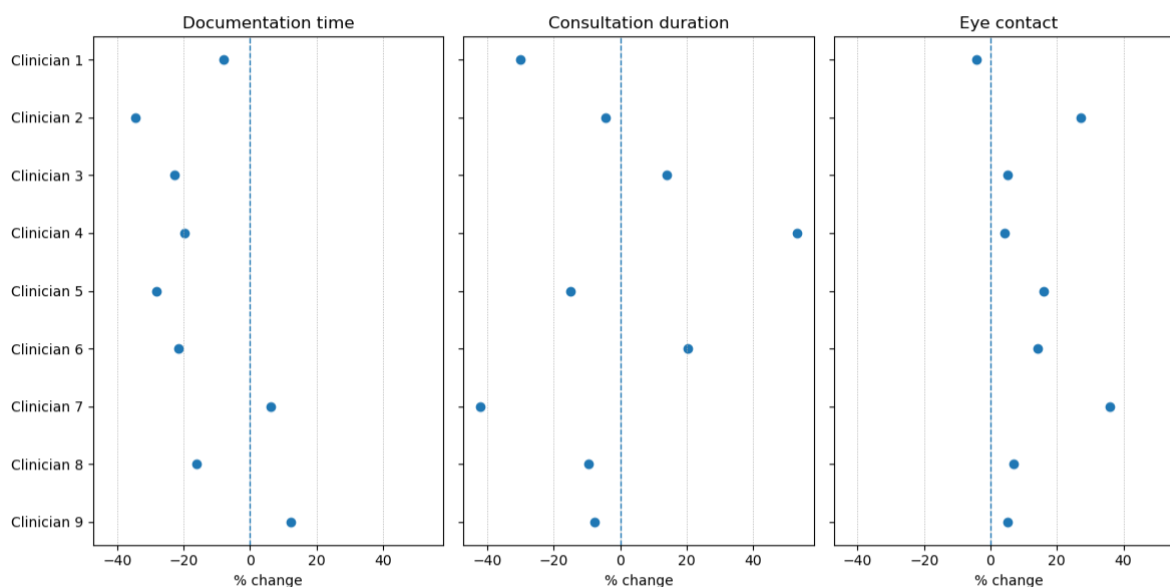
Table 3 summarizes the outcomes associated with the use of ambient scribes. The use of the tool was associated with 15.0% less time spent on documentation compared to without (from 5.3 to 4.5 minutes per consultation, $P=.036$). The proportion of eye contact was 10.6% greater with ambient scribe use compared to without (from 69.6% to 77.1% proportion of consultation duration, $P=.009$). Overall consultation duration remained unchanged with ambient scribe use (11.5 vs 10.9 minutes, $P=0.415$). The effects of the ambient scribe effects were consistent across new and follow-up patients for both documentation time and eye contact (interaction P -values of 0.79 and 0.35 respectively), indicating uniform benefits across different consultation types.

Table 3: Results of Linear Mixed-Effects Model for Outcomes Without and With AI Scribe

Outcome	Without AI Scribe (unadjusted mean, SD)	With AI Scribe (unadjusted mean, SD)	Adjusted difference (95% CI)	Change, %	P-value
Documentation Time per consultation, min	5.3 (2.7)	4.5 (2.4)	-0.8 (-1.5 to -0.05)	-15.0	0.036
Proportion of Eye Contact time, %	69.6 (18.6)	77.1 (17.7)	+7.4 (13.0 to 1.9)	10.6	0.009
Consultation Duration, min	11.5 (6.9)	10.9 (5.6)	-0.7 (-2.6 to 1.1)	-6.1	0.415

Crude independent samples t-tests treating all consultations as independent observations yielded similar effect sizes for eye contact (+7.5%, $P=.008$) and consultation duration (-0.67 min, $P=.495$). However, the reduction in documentation time reached statistical significance only in the adjusted mixed-effects analysis (crude: -0.74 min, $P=.065$ vs adjusted: -0.8 min, $P=.036$). This highlights the importance of accounting for clinician-level clustering.

Figure 2: Unadjusted clinician-level outcome changes with AI scribe use. Each dot represents the percentage change for one clinician comparing sessions with and without AI scribe. The dashed line indicates no change (0%). These unadjusted



analyses demonstrate individual variation and potential confounding; adjusted overall effects are presented in Table 3.

Secondary Outcomes – Patient Experience

Thirty-nine patients completed surveys following consultations with ambient scribe use. Age demographics are shown in Table 4, with 16 (41%) aged 65 years and above. Survey language preferences were: English 31 (79%), Mandarin and dialects 7 (18%), and Malay 1 (3%). Survey responses were collapsed into broader categories to facilitate interpretation of results. For questions with a 5-point Likert scale, responses were grouped as 1–2 = No, 3 = Neutral, and 4–5 = Yes. For questions with fewer response options, similar grouping was applied as appropriate.

Table 4: Age bands of survey participants

Count of Age of Surveyed Participants	
0 – 19 Years Old	1
20 – 29 Years Old	3
30 – 39 Years Old	7
40 – 49 Years Old	5
50 – 64 Years Old	7
65 Years Old and above	16
Total	39

Overall, patient acceptance of the AI tool was favourable (Figure 3), with 69% agreeing that their doctor focused on them more during the consultation and 62% expressing willingness to recommend the technology to other physicians. While a few patients were neutral in their

responses and one reported that the ambient scribe did not enhance their visit, none expressed discomfort with its use.

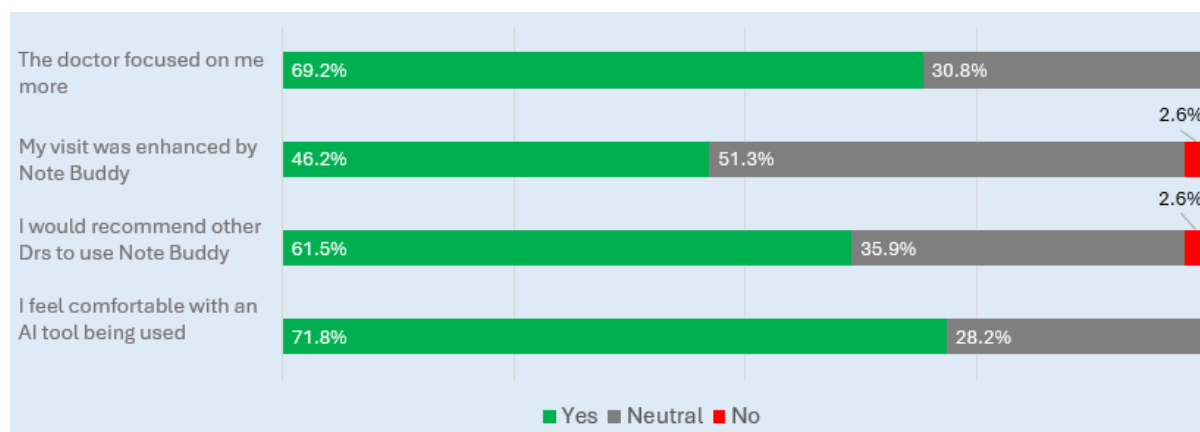


Figure 3: Patient perceptions of ambient scribe technology (Note Buddy)

DISCUSSION

To our knowledge, this is the first study of the real-world impact of an ambient scribe conducted in a multilingual healthcare environment in Asia. Use of an in-house ambient scribe tool was associated with reduced documentation time and increased eye contact, while consultation duration remained unchanged. This suggests that the ambient scribe enabled clinicians to redirect time from clerical tasks toward patient engagement rather than simply shortening consultations.

Our findings align with recent studies in the US which indicate that time savings tend to be modest rather than spectacular. Our observed reduction of 0.8 minutes is comparable to findings from Sutter Health (drop from 6.2 to 5.3 minutes) [6], The Permanente Medical Group (0.4 minutes reduction) [14] and Stanford Health (0.57 minutes reduction) [10]. However, our study uniquely demonstrates improved patient engagement through increased eye contact, which we were able to quantify because we used direct observation rather than EHR-based metrics.

Our within-clinician comparison design offers certain advantages by controlling for individual clinician variability and practice patterns that could confound results. This allowed us to isolate the specific effects of ambient scribe implementation while accounting for the natural variation in consultation styles and documentation practices across different specialists.

We demonstrate that the benefits observed in Western healthcare systems translate effectively across different cultural and linguistic contexts. Among the 78 consultations observed with the ambient scribe, consultations were conducted in English (81%), Mandarin (18%) and Malay (1%), demonstrating the technology's utility in multilingual clinical environments. The favourable patient responses observed, particularly among older adults who comprised 41% of survey respondents, provide reassuring evidence of ambient scribe acceptance across age groups.

Our finding that consultation duration remained unchanged despite reduced documentation time suggests that ambient scribes should be viewed primarily as a quality-of-care intervention rather than a productivity enhancement tool [14]. The technology appears to shift clinician attention from clerical tasks to patient engagement, potentially improving care quality without necessarily increasing clinic throughput.

Limitations

This study has several limitations. First, our sample was limited to nine clinicians in specialist outpatient clinics due to the resource-intensive nature of direct observation, which restricts generalisability to other specialties and to primary care settings. Second, we focused on experienced users, meaning our findings reflect optimal rather than average implementation outcomes and are most applicable to clinicians likely to become high users. This approach was intentional. Prior research has shown highly skewed adoption patterns; for example, one large implementation study involving 10,000 physicians found that only one-third became regular users, accounting for 89% of all system activations [15]. Third, participating clinicians were relatively senior in years of practice and may have already developed greater efficiency in patient communication compared to more junior colleagues. Fourth, the presence of observers during consultations may have influenced clinician behaviour due to the Hawthorne effect [16]. Similarly, clinician blinding was not feasible, as participants were necessarily aware of whether they were using the ambient scribe tool in each session. However, these potential biases were partially mitigated by our within-clinician design, which ensured that both conditions were subject to the same influences.

Future Directions

Future studies should evaluate the impact of ambient scribe technology across a broader range of clinicians and practice environments to identify which user profiles benefit most, and which may require additional support to optimise outcomes. In particular, qualitative research into factors affecting adoption and sustained use will be required to ensure long-term effectiveness and scalability. Further work should also examine language-specific performance in multilingual healthcare settings, as consultation language may affect transcription accuracy and note quality. While our study demonstrated effectiveness across a naturally multilingual patient population, future work could systematically analyse outcomes by consultation language to optimise ambient scribe performance for diverse linguistic communities.

CONCLUSION

This quality improvement study found that ambient scribe usage among experienced users was associated with reduced documentation time and improved patient engagement, with high patient acceptance across diverse demographic and linguistic groups. These findings demonstrate the real-world effectiveness of ambient scribes under routine clinical conditions

in a multilingual healthcare setting. The results provide encouraging evidence for broader implementation and support the need for longitudinal trials across diverse subspecialties to comprehensively evaluate ambient scribing effectiveness at the health system level. Importantly, our findings demonstrate that meaningful benefits can be achieved through solutions developed in-house. This offers healthcare systems a viable alternative to commercial products, especially where data privacy, cost, or localisation are key concerns.

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DATA AVAILABILITY

The datasets generated or analyzed during this study are available from the corresponding author on reasonable request.

AUTHORS' CONTRIBUTIONS

Conceptualization: JYET, IBMR, KWC

Data Curation: JYET, IBMR

Methodology: JYET, IBMR, GH

Investigation: JYET, IBMR, ELYL

Formal Analysis: GH

Writing – original draft: JYET, IBMR

Writing – review & editing: JYET, IBMR, GGRS, JYMT, DYZL, LGH, JOCL, EYLL

Supervision: KWC, MKKH

CONFLICT OF INTERESTS

The authors declare no conflicts of interest in relation to this work.

DISCLOSURES

The authors used Anthropic's Claude 4.0 Sonnet for proofreading and language editing during manuscript preparation. All content was subsequently reviewed and edited by the authors, who take full responsibility for the publication.

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ABBREVIATIONS

AI: Artificial Intelligence

GPT: Generative Pre-trained Transformer

EHR: Electronic Health Record

PII: Personally Identifiable Information

SGH: Singapore General Hospital

