Insights Gained from Customer Discovery of an AI-based Clinical Decision Support Tool for Critical Care Workflow

M. Samie Tootooni, PhD[1], Nafiseh Mollaei, PhD[1]
[1]Loyola University Chicago, Maywood, USA

Introduction

Customer discovery is crucial during the translation phase of a Clinical Decision Support (CDS) system, as it involves engaging with end-users to understand their needs and preferences and ensure that the system is well-suited to their needs. Our product is an Artificial Intelligence (AI) based dosing decision support tool for Intensive Care Unit (ICU) practitioners, which monitors the patient in real-time and provides on-demand recommendations to ensure appropriate and timely drug dosing. We initiated this effort with vancomycin, which is a commonly prescribed antibiotic in ICU. High levels of vancomycin Harm the kidneys or ears and increase hospital length of stays, cost of care, and mortality rate. Also Low levels cause Therapeutic failure and Antimicrobial Resistance which doubles the chances of developing a serious health issue and triple the chances of death. Despite efforts to optimize dosing, dosing vancomycin remains challenging, especially for complex patients in the ICU.

To ensure that our AI tool for vancomycin dosing is effective in improving outcomes and integrates well with clinical workflows, it is crucial to gain a comprehensive understanding of the ICU workflow from the perspective of stakeholders. This study presents a comprehensive account of our customer discovery process for an AI-based Clinical Decision Support (CDS) tool. We believe that the findings of this study could serve as a valuable reference point for researchers who are working in this field. Our research was conducted as part of the I-Corps@NCATS (National Center for Advancing Translational Science) training program, which forms a key component of the author's recent award [1]. Our overarching goal was to provide insights into effective strategies for conducting customer discovery in translational science, thereby helping to drive innovation in the field.

Methods

We adopted the guidelines and recommendations outlined in the Value Proposition Design framework [2]. Our approach was structured and involved defining our business thesis at the outset and continually updating it throughout the customer discovery phase. To ensure that our efforts were focused and effective, we segmented the ICU stakeholders based on their roles (e.g., physicians, pharmacists). This approach provided us with a clear framework for conducting customer discovery and developing value propositions that would resonate with our target audience.

The primary focus of this study was conducting in-depth interviews with ICU stakeholders to gain a thorough understanding of their needs and challenges. To ensure the effectiveness of our customer interviews, we followed the guidelines outlined in [3, 4]. Our interviews were structured around four main questions:

* What is their role?
* What is your day-to-day job?
* What are the challenge in their jobs?
* If they have a magic power, what would they do in their tasks/workflow?

To mitigate any potential biases, we refrained from informing the interviewees about the product prior to conducting the interviews. This allowed us to obtain unbiased and candid responses from the stakeholders. Drawing on the insights garnered from the interviews, we mapped out the ICU workflow and ecosystem to identify key touchpoints. We then tested and iterated our value proposition based on the feedback provided by the stakeholders, thus ensuring that our approach was aligned with their needs and preferences.

Result

We outlined our business thesis as follow:

"*Administrators of a teaching hospital with ~500 licensed beds and 100 adult ICU beds, will buy our tool to help their ICU pharmacists in dosing vancomycin mainly to decrease the ICU length of stay. Generally, sub and supra therapeutic vancomycin cases annually costs the hospital an estimate of 942 added days to ICU length of stay,* which costs more than $2.7M."

We derived our numerical estimates based on a range of factors, including the occupancy rate of staffed and ICU beds, which are consistent with national averages of 64% and 68%, respectively. We also took into account the average length of stay in the hospital and ICU, which we determined to be 4.35 days and 3.3 days, respectively. In addition,

we considered the estimated percentage of ICU patients treated with vancomycin and the associated dosing success rate. Our estimates also factored in an average of 3 days of additional hospital stay for every instance of sub- or supratherapeutic trough levels, as well as the average daily cost of a hospital stay in the U.S. We acknowledge that these estimates may not be entirely reliable and are subject to changes depending on several other factors.

We conducted interviews with individuals from five segments of our market, including Physician Consultants and intensivists, ICU Physicians (residents and fellows), ICU Nurses, ICU Pharmacists, and hospital administrations. Our goal was to understand the unique needs and challenges of each segment, and we conducted at least four interviews with each segment to gain insights. Through these interviews, we learned that ICU pharmacists are the primary end-users of our AI-based Clinical Decision Support (CDS) system, regardless of the hospital or ICU format. They are responsible for verifying all submitted drugs, except for rare life-saving emergencies, and make recommendations on dosing decisions. Based on this, we focused on developing ICU workflows and ecosystems that cater to the needs of ICU pharmacists.During our interviews with ICU pharmacists, we identified several main challenges they face. One of the most common issues is the difficulty in obtaining all necessary patient data easily, as the process often requires many clicks. As a result, they often rely on only a few pieces of patient data to make dosing decisions.

We also gained a deeper understanding of the decision-making dynamics in ICU and the roles and responsibilities of different stakeholders, including the department of pharmacy, chief informatics officer, and intensivists. We found that the decision-maker, a key stakeholder, may differ depending on the type of hospital and internal budget allocation policies. Hospital administrations, including chief informatics officer, director of pharmacy, chief finance officer, and director of ICU, are among the decision-makers. However, pharmacists are also involved in the process as they often need to "elevate" the case. ICU Consultants and Intensivists are partial decision-makers as they are typically the head of the ICU care team and expert clinicians. They have influence on the final decision-makers, and one of their main concerns is to minimize errors in their team. All intensivists and consultants that we interviewed were open to digital and AI-based solutions.

However, residents, fellows, and nurses are only considered influencers as they do not have a direct contribution to the decision-making process for buying AI-based CDS tools. They often face challenges such as long working shifts, having to prioritize among patients due to lack of staffing, and burn-out.

We conducted interviews with stakeholders from different segments of the healthcare industry and discovered several challenges related to dosing vancomycin. Our AI-based CDS was designed to address these challenges by providing real-time monitoring of patient data, personalized dosing recommendations, and an easy-to-use interface that displays only the relevant information. Our deep learning models are equitable and scalable, and the system provides explanations for its recommendations. It is also integrable into the existing medical workflow and takes into consideration clinical limitations. By reducing medical errors and complications, our AI-based CDS can lighten the burden on nurses and physicians and improve patient outcomes. Additionally, our system is equipped with a scenario-based mathematical model that takes into account the unique needs and limitations of each patient.

Conclusion

We conducted a customer discovery process to develop an AI-based Clinical Decision Support (CDS) tool for dosing vancomycin in the ICU. Our approach involved conducting in-depth interviews with various ICU stakeholders and using the Value Proposition Design framework to refine our business thesis. Through our interviews, we identified ICU pharmacists as the primary end-users of our tool and gained insights into their unique needs and challenges. We learned that obtaining necessary patient data is a common challenge and that dosing decisions are often made based on limited information. This study can highlights effective strategies for conducting customer discovery in translational science and provides valuable insights into the ICU workflow from the perspective of stakeholders.

References

1. Tootooni, M.S.A.A.F.a.E.A.I.-b.D.E., *KL2 [2UL1TR002389-06, PD/PI: Solway, J.] from the National Institutes of Healthryor TA, Gardner RM, Clayton RD, Warner HR. The HELP system. J Med Sys. 1983;7:87-101*.
2. Osterwalder, A., et al., *Value proposition design: How to create products and services customers want*. 2015: John Wiley & Sons.
3. Constable, G., *Talking to humans.* Giff Constable, 2014. **1**: p. 71.
4. Beckman, S.L. and M. Barry, *Innovation as a learning process: Embedding design thinking.* California management review, 2007. **50**(1): p. 25-56.